STEMI OLYMPIADS AND COMPETITIONS CONFERENCE PROCEEDINGS 2018

S.T.E.M.I

Olympiads and Competitions

Community of Practice

Conference

THE CONFERENCE STEMI COMMUNITY OF PRACTICE CONFERENCE

science & technology
Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation | SAASTA South African Agency for Science and Technology Advancement

BACKGROUND

Education and training, research and development are some of the key elements of the National System of Innovation (NSI). One of the major challenges facing our science system is inadequate renewal of the science, engineering, and technology (SET) human capital and making it repre-sentative of the country's demographics. It is against this background that the Department of Science and Technology (DST) initiated the Youth into Science Strategy (YISS). This strategy aims to broaden the pool of matriculants with passes in Mathematics and Science, appropriate to enter for science-based degree studies at higher education institutions and ultimately increase the SET capital in South Africa. Central to the implementation of the YISS is the use of science, technology, engineering, mathematics and innovation (STEMI) Olympiads and Competitions as instruments to identify learners with potential to follow SET careers. Through this programme the DST intends to provide funding to existing Olympiad and Competition Organisers to increase the number of learners participating in Olympiads and Competitions, as well as coaching mentors and/or educators to support these learners.

The STEMI Olympiads and competitions programme targets the following:

Learners from grade one to twelve in remote disadvantaged areas, including urban areas (townships) with the objective of increasing the footprint (covering municipal districts with limited prior coverage) of participation, mentoring, and coaching.

To provide educator training workshops on STEMI Olympiads and Competitions, as well as training and support for mentors.

Conceptualisation of a strategy towards the establishment of a community of practice for STEMI Olympiads and Competitions.

CONFERENCE SCOPE

The STEMI Olympiads and Competitions Community of Practice Conference is an annual conference that is dedicated to the advancement of the Science, Technology, Engineering, Mathematics, and Innovation (STEMI) Olympiads and Competitions in South Africa by creating a community of practice where best practices are identified and benchmarked. This is achieved by bringing Olympiad and Competition organisers and other in-dustry stakeholders together to present academic and non-academic research and talks and to facilitate a platform for engagement between parties.

OBJECTIVES OF THE CONFERENCE:

- To positively contribute towards a STEMI-driven culture.
- To create a platform for collaborative problem solving.
- To act as a catalyst between people and organisations.
- To facilitate the development of tools to improve the inflow of science in society.
- To assist in transforming innovative ideas and actions into benchmarked practices.

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Programme

2018 STEMI Olympiads and competitions community of Practice conference

19 – 22 February 2018

			Day 1: Monday 19 February
Programme Director	**Mr Steve Sherman**		
Slot	**Activity**	**Delegate**	**Venue**
09:00 – 10:45	Registration	All	Registration Table
11:00 – 11:20	Opening and welcome and Address from SAASTA	Dr Nukeri Managing Director: NRF|SAASTA	
11:20 – 11:40	Objectives of the 2018 Conference	Mr Isaac Ramovha Director: DST Science Promotion	Main Venue: Mandela Conference Centre
11:40 – 12:10	Update on the STEMI Olympiads and Competitions	Mr Moloko Matlala Science Education Manager: SAASTA Mr Daniel Maubane: Chairperson: ASTEMI	Main Venue: Mandela Conference Centre
12:10– 12:30	Introduction of the Guest Speaker	Programme Director	Main Venue: Mandela Conference Centre
12:30 – 13:00	Keynote Address	Mr Jim Adams Former Deputy Chief Technologist of NASA	Main Venue: Mandela Conference Centre
13:00 – 14:00	Lunch	All	Dining Area
Programme Director	Ms Krishnie Naidoo		
14:00 – 14:15	Ice breaker	[speaker to be identified]	Main Venue: Mandela Conference Centre
14:15 – 14:30	Science communication through the media	Mr Michael Ellis Science Communications Manager: SAASTA	Main Venue: Mandela Conference Centre
14:30 – 15:00	Human Sciences Research Council Report on STEMI Olympiads and Competitions	Ms Ncami Zulu Human Sciences Research Council	Main Venue: Mandela Conference Centre

Slot	Activity	Delegate	Venue
15:00 – 15:30	Presentation: An integrated Career Development System for South Africa	Nozuko Mfenyana Department of Higher Education and Training	Main Venue: Mandela Conference Centre
15:30 – 15:40	Tea Break	All	Tea Area
15:40 – 16:00	Presentation: An International perspective on the involvement of STEMI professionals in Olympiads and Competitions.	Dr Vino Paideya University of KwaZulu Natal	Main Venue: Mandela Conference Centre
16:00 – 16:20	Presentation: 10 Years of Astronomy Quiz: Reflections on the impact of the astro quiz in Western and Northern Cape	Mr Sivuyile Manxoyi SAAO	Main Venue: Mandela Conference Centre
16:20 – 16:40	Presentation: Opportunities for STEMI involvement in volunteerism, service and community engagement!	Ms Patricia Gouws UNISA: I-SET	Main Venue: Mandela Conference Centre
16:40 – 17:00	Discussion: Questions, Comments & Responses	All	Main Venue: Mandela Conference Centre
17:00 – 17:10	Announcements	Programme Director	Main Venue: Mandela Conference Centre
18:00 – 20:00	Dinner served	Hotel guests only	Dinning Area
			DAY 2 – TUESDAY 20 FEBRUARY
Programme Director	Mr Johannes de Vries		
06:30 – 07:30	Breakfast served	Hotel Guests only	Dining Hall
07:00 – 08:15	Morning Tea	Non-Guests	Tea Area
08:30 – 08:40	Opening and Welcome	Programme Director	Main Venue: Mandela Conference Centre
08:40 – 09:00	Presentation: The rewards that scientists experience when engaging with public audiences	Ms Marina Joubert University of Stellenbosch	Main Venue: Mandela Conference Centre
09:00 – 09:20	Presentation: The Impact of Conducting Science Experiments the Intensive Care Unit Way	Mr Mlungisi Nyamane Osizweni Science centre	Main Venue: Mandela Conference Centre
09:20 – 09:40	Presentation: Interrogating learner performance in a District Science Olympiad: Implications for teaching and learning	Dr Vasuthavan Govender	Main Venue: Mandela Conference Centre

09:40 – 10:00	Discussion: Questions, Comments & Responses	All	Main Venue: Mandela Conference Centre
10:00 – 10:20	Presentation: Teachers going the extra mile: Science teachers perceptions on science fairs in Limpopo, South Africa.	Mr Sure Mupezeni Eskom Expo for Young Scientists	Main Venue: Mandela Conference Centre
10:20 – 10:40	Presentation: Effective ways in creating Marine Litter Awareness	Ms Sizwekazi Yapi Sea World	Main Venue: Mandela Conference Centre
10:40 – 11:00	Discussion: Questions, Comments & Responses	All	Main Venue: Mandela Conference Centre
11:00 – 11:20	Tea Break	All	Tea Area
11:20 – 11:40	Demonstration: STEMI Community of Practice Online Platform	Mr Sipho Dhlamini Mr Simon Rametse NRF/SAASTA	Main Venue: Mandela Conference Centre
11:40 – 12:00	Presentation: Moving Forward the Online Olympiads	Mr Case Rijsdijk: The South African Institute for Physics	Main Venue: Mandela Conference Centre
12:00 – 12:20	Presentation: Six tips of teaching mathematics Olympiad classes	Dr Harry Wiggins: University of Pretoria	Main Venue: Mandela Conference Centre
12:20 – 12:40	Presentation: Umkhanyakude District physical Sciences olympiad	Mr David Malati Phathisiwe Sithole Department of Education and Malati Foundation	Main Venue: Mandela Conference Centre
12:40 – 13:00	Discussion: Questions, Comments & Responses	All	Main Venue: Mandela Conference Centre
13:00 – 14:00	Lunch	All	Dining Hall
Programme Director	**Mr Michael Cameron**		
14:00 – 14:15	Ice Breaker	[speaker to be identified]	Main Venue: Mandela Conference Centre
14:15 – 14:35	Presentation: Using a culture of volunteerism and community service to reduce poor use of computers in teaching and learning of mathematics: A case study of three selected schools in Mthatha Education District, South Africa.	Dr Simon Tachie	Main Venue: Mandela Conference Centre

14:35 – 14:55	Presentation: The Siyanqoba Olympiad Training Programme	Mr Poobhalan Pillay: University of Kwa-Zulu Natal	Main Venue: Mandela Conference Centre
14:35 – 14:55	Presentation: The Siyanqoba Olympiad Training Programme	Mr Poobhalan Pillay: University of Kwa-Zulu Natal	Main Venue: Mandela Conference Centre
14:55 – 15:15	Presentation: The role and involvement of teachers, academics and institutions in preparing students for National and International Biology Olympiads	Mr Sooklachar Robin Naidoo: National Science Olympiad (South African Science Olympiad)	Main Venue: Mandela Conference Centre
15:15 – 15:35	Discussion: Questions, Comments & Responses	All	Main Venue: Mandela Conference Centre
15:35 – 15:55	Tea	All	Tea Area
15:55 – 16:15	Presentation: Retaining Volunteers within science organisation	Ms Makubuntu Nkgadima Ms Mokgomotsi Rabothata Ms Alone Thabela: SAASTA	Main Venue: Mandela Conference Centre
16:15 – 16:35	Discussion: Questions, Comments & Responses		
16:35 – 16:45	Announcements	Programme Director	Main Venue: Mandela Conference Centre
18:00 – 20:00	Dinner	Hotel Guests	Dining Hall
			DAY 3 – WEDNESDAY 21 FEBRUARY
Programme Director	**Mr Danie Heymans**		
06:30 – 07:30	Breakfast served	Hotel Guests only	Dining Hall
07:00 – 08:15	Morning Tea	Non-Guests	Tea Area
08:30 – 08:40	Opening and Welcome	Programme Director	Main Venue: Mandela Conference Centre
08:40 – 09:10	Presentation: S.T.E.M.I. Under a Different Guise The How, Why & What of Volunteering	Ms Lorraine Collins	Main Venue: Mandela Conference Centre
09:10 – 10:10	Parallel Session: How a mathematics competition within a schools project has ignited the flame of volunteerism in teachers	Ms Anthea Roberts: University of Cape Town	Break-away Room 1: Serengeti Break-away Room 2: Tshwane 2-3

09:10 – 10:10	Parallel Session: South African Mathematics Olympiad Junior Paper 3: Lessons learnt from 2004 to current	Mr Hendrik de Kock: SAMF	Break-away Room 1: Serengeti Break-away Room 2: Tshwane 2-3
10:10 – 11:10	Demonstration: Are you ready to share your knowledge at a conference? Some ideas on how to write the proposal and the conference paper.	Dr H Oosthuizen NECSA	Break-way Room: Serengeti
11:10 – 11:30	Tea	All	Tea Area
11:30 – 12:30	Demonstration: Effective science communication for increased impact	Michael Ellis / Zamuxolo Matiwana NRF|SAASTA	Main Venue: Mandela Conference Centre
12:30 – 13:30	Lunch	All	Dining Hall
Programme Director	**Prof Thapelo Mamiala**		
13:30 – 13:45	Ice breaker	[speaker to be identified]	Main Venue: Mandela Conference Centre
13:45 – 14:45	Break-away sessions:		Tshwane 1 Serengeti Tshwane 2-3 Tshwane 5
14:45 – 15:05	Tea Break	All	Tea Area
Feedback from Break-away Sessions			
15:05 – 15:20	Report: Group A: VOLUNTEERISM AND PROFESSIONALS What, where and when could professionals volunteer in the STEMI environment? Where do we source them? How to approach them?	Nominated speaker	Serengeti Conference Room
15:20 – 15:35	Report: Group B: VOLUNTEERISM AND ALUMNI What, where and when could Alumni of Olympiads and competitions volunteer in the STEMI environment? Where do we source them? How do we approach them?	Nominated speaker	Serengeti Conference Room

15:35 – 15:50	Report: Group C: VIRTUAL MENTORING AND COACHING What will be needed by mentor /coach and mentee? Is this a viable solution? What are the challenges? Any creative ideas to kick-start such a programme? Where do we source mentors and coaches? How to approach them?	Nominated speaker	Serengeti Conference Room
15:50 – 16:05	Report: Group D: VIRTUAL AND ONLINE COMPETITIONS / OLYMPIADS What are the needs to set up such activities? Are traditional organisers ready to transition? Should these be alternatives to the traditional way of hosting event or should these be completely different events (content-wise)? Any challenges to be overcome.	Nominated speaker	Serengeti Conference Room
16:05 – 16:25	Discussion: Questions, Comments & Responses	All	Serengeti Conference Room
16:25 – 16:35	Announcements	Programme Director	Serengeti Conference Room
16:35 – 17:30	Recess		
17:30 – 18:00	Cocktail dinner registration	All	Pool Area
18:00 – 18:15	Opening and Welcome: Purpose of the evening:	Dr Gillian Arendse Programme Director	Main Venue: Mandela Conference Centre
18:15 – 18:30	Remarks from the DST	Mr Isaac Ramovha Director: DST Science Promotion	Main Venue: Mandela Conference Centre
18:20 -20:00	Networking session and Cocktail dinner	All	Main Venue: Mandela Conference Centre
20:00 – 20:15	Vote of Thanks	NRF|SAASTA	Main Venue: Mandela Conference Centre
20:15 – 20:30	Closure		
DAY 4 – THURSDAY 22 FEBRUARY			
Programme Director	**Dr Vasuthavan Govender**		
06:30 – 07:30	Breakfast served	Hotel Guests	Dining Hall
07:30 – 08:20	Check-out	Hotel Guests	Reception

07:30 – 09:00	Morning Tea	Non-Guests	Tea Area
09:00 – 09:10	Opening and Welcome	Programme Director	Main Venue: Mandela Conference Centre
09:10 – 09:25	Mentoring and Coaching Framework Adoption	Mr Bersan Lesch DST	Main Venue: Mandela Conference Centre
09:25 – 09:45	Summary of the Conference Proceedings: • Plenary Recommendations • Panel Discussions Recommendations	Mr Moloko Matlala NRF/SAASTA	Main Venue: Mandela Conference Centre
09:45 – 10:05	Key Deliverables: Short to Long Term	Mr Bersan Lesch DST	Main Venue: Mandela Conference Centre
10:05 – 10:25	Morning Tea Break	All	Tea Area
10:25 – 10:45	Evaluation of the 2018 Conference Objectives	Mr Isaac Ramovha DST	Main Venue: Mandela Conference Centre
10:45 – 11:05	Post Conference Evaluation	Ms Joyce Khunou NRF/SAASTA	Main Venue: Mandela Conference Centre
11:05 – 11:30	Vote of Thanks	NRF/SAASTA	Main Venue: Mandela Conference Centre
11:30 – 13:30	Lunch	All	Dining Hall

INTERROGATING LEARNER PERFORMANCE IN DISTRICT SCIENCE OLYMPIADS: IMPLICATIONS FOR TEACHING AND LEARNING

Dr VG Govender
Eastern Cape Department of Education &
Nelson Mandela Metropolitan University

There are numerous STEMI Olympiads/competitions in South Africa. These Olympiads/competitions target learners in both primary and high schools and are regarded as enrichment programmes. Teachers who are given the responsibility for Science Olympiads and competition at their schools usually have the experience and a track record of such involvement and may be regarded as "volunteers". In education district offices in South Africa, STEMI Olympiads/competitions fall under the category of "support programmes" and the districts work with the provincial departments of education to encourage schools to take part in regional and national STEMI Olympiads/competitions.

Unfortunately, the vast majority of learners do not take part in STEMI Olympiads/competitions and are not likely to do so unless there is a concerted effort to change this scenario. In 2016, the PE Office of the Nelson Mandela Bay District in the Eastern Cape introduced its own competitions for learners in the District. The competitions targeted schools which were involved in a number of Science projects within the district. The competitions included a Natural Sciences Olympiad for grade 8 & 9 learners and a Sciences Olympiad for grade 10 & 11 learners. These competitions continued in 2017 with new ones such as a Statistics Olympiad and a Science & Engineering competition being added. The writer of this paper, together with subject advisors, coordinated the various competitions and did so in a voluntary capacity.

This paper interrogates learner performance in the 2017 District Natural Sciences and Sciences Olympiads and the findings of this paper may point to ways in which schools may strengthen teaching and learning practices in Science subjects.

INTRODUCTION

There are a number of National Olympiads or competitions in the Sciences for high school and primary school learners in South Africa. The ASTEMI brochure lists 25 of these competitions. These competitions cover Mathematics, Science. Physics, Computers and other science related areas. Each Olympiad or competition has its own entry requirements and in some cases there are entry fees (ASTEMI, 2017).
There writers' personal experiences are that participation in these Olympiads or competitions are actively encouraged by the MSTE sections in provinces and districts. However, not schools take part in these competitions. It is mostly learners from schools in more affluent areas who participate in these competitions. In this regard, there are a number of obstacles which prevent learners from schools in less affluent areas from participating.

These obstacles include a lack of teacher and parental support, lack of resources and, perhaps, a lack of a competitive environment or an Olympiad culture at the schools. This means that learners at these schools are not given the opportunity to develop or showcase their talents outside their school environment (Govender, 2017).

In 2016 and 2017, the Port Elizabeth office of the Nelson Mandela Bay Education District in the Eastern Cape introduced its own Mathematics & Science competitions for schools involved in Science related projects initiated by the Department of Education or outside partners. Details of the 2016 competition are outlined in Govender (2017).

LITERATURE SURVEY

This literature survey provides an insight into the aims of Science competitions in both South Africa and other countries. It examines the cognitive demands of the science subjects and calls for improved classroom practices in these subjects. Improved classroom practices are likely to improve learner performance in the subjects and give them the necessary confidence to participate in Science competitions. It also examines how these competitions may prepare learners for STEMI careers once they have finished school

The South African Agency for Science and Technology Advancement (SAASTA) website provides details about the Natural Sciences and National Sciences Olympiad in South Africa. The aims of the Natural Sciences Olympiad are to:

- Identify and nature talent in Natural Sciences, Life Sciences and Physical Sciences
- Increase the number of learners who opt for Physical Sciences, Life Sciences, Accounting and Mathematics at high schools (FET level)
- Act as a feeder for SAASTA's National Science Olympiad for grades 10 – 12
- Help learners prepare for the year's Natural Sciences syllabus
- Showcase some of South Africa's brightest young scientists in the making

(SAASTA, 2017a)

Preparation for the Natural Science Olympiad starts at the beginning of the year, when schools register for the competition and learners start preparing for the examination.

The National Science Olympiad is one of SAASTA's flagship projects. The project which is now in its 54th year offers learners in grades 10 – 12 an exciting opportunity to compete in science with fellow learners from SADC countries such as Lesotho, Zimbabwe and Namibia. The competition comprises an annual examination in science (Physical and Life Sciences). The top national performers win all-expenses-paid trips to the London International Youth Science Forum and the Australian National Youth Science Forum.

THE AIMS OF THE NATIONAL SCIENCE OLYMPIAD ARE TO:

- Identify and nature talent in Life Sciences and Physical Sciences
- Encourage excellence in Science Education
- Stimulate interest in the Sciences
- Inspire young people to consider careers in Science and Technology

(SAASTA, 2017b)

IN THE USA, SCIENCE OLYMPIAD IS A NATIONAL NON-PROFIT ORGANISATION. ITS MISSION IS GUIDED BY THE FOLLOWING GOALS:

- Improve the quality science education from kindergarten to grade 12 of K-12 science education,
- Increase male, female and minority interest in science,
- Create a technologically-literate workforce and providing recognition for outstanding achievement by both students and teachers.

These goals are achieved by participating in Science Olympiad tournaments and non-competitive events, incorporating Science Olympiad into classroom curriculum and attending teacher training institutes (Science Olympiad, 2017)

Barr (2013) did a self-study on Science Olympiad. The purpose of the self-study was two-fold: To further explore and understand the challenges, frustrations, and dilemmas of coaching Science Olympiad at the middle school level and to investigate elements of the Science Olympiad model that could prove useful in his own classroom. He used two sources of evidence as his data set: his actions and reactions, and his personal analyses in the form of a weekly journal comprised of observations, critical questions, and reflection.

The self-study had both challenges and successes. The biggest challenge faced by coaches was getting students to use the scientific method and think critically about the possible solutions for the Science Olympiad problems and events. The unique structure of Science Olympiad makes events fun, but very challenging for students. The events engage students in problem solving activities where they have to work collaboratively to form creative solutions. Students must use scientific inquiry to generate hypotheses and test experimental strategies while collecting data and making inferences. They would tend to look for coaches to enable them, seeking instant gratification for the answers to their questions instead of using resources in the classroom or searching the depths of the internet for guidance.

One of the key successes of the Science Olympiad programme the observance of middle school students (grades 4 – 6) being engaged in academic activities on a voluntary basis after regular school hours. As the programme went on, student interest and motivation to do well in science seemed to increase, along with students' scientific literacy, process, and critical thinking skills. Not only were students learning and engrossed in the scientific process, but they were doing so and having fun at the same time (Barr, 2013)

BARR CONCLUDES HIS SELF-STUDY WITH THE FOLLOWING STATEMENTS:

- Implementing real-world experiences into the classroom is essential practice for teachers preparing students for the rigours of the 21st century.
- Classroom environments where students take control of their own learning experiences serve as a fundamental piece for developing students' higher order thinking skills

Science Olympiad is an authentic student-centred programme as a result of its emphasis on problem solving, hands-on, minds-on constructivist learning practices, scientific inquiry and critical thinking.

As indicated earlier from the SAASTA website, Science Olympiads and competitions are designed to stimulate interest in the Sciences and motivate and inspire school learners to take up careers in the sciences. This has been confirmed by various papers and studies on Science Olympiads and competitions.

One of these studies, which involved 1488 college students in the USA, is by Forrester (2010). Her study, on competitive science events, show how these events may influence academic major choice, create general interest in science, and interest in out-of-school science experiences. Her study indicated that relationships with teachers, parents, and peers influenced student motivation to participate in a competitive science event and in academic major choice. In this regard, it is important for parents and teachers to work together in sparking and sustaining student interests in science. Competitive science events can serve as a platform for that initial spark. The informal and cooperative teamwork found in many of the science competitions can be motivating to students, including underrepresented students (females, minorities, and students with learning disabilities) that may not be reached in the formal science classroom.

This study found evidence that participation in competitive science events can influence students' choice of a STEM major in college, especially if the event is held at university campus. University personnel may be able to identify future scientists, engineers, and science educators from the events. While participation in a competitive science event did not motivate all students to choose a STEM major, the positive experiences with science that non-STEM majors had during these events may inspire them to apply their non-STEM interests to science contexts as science writers, photographers, or science policy makers (Forrester, 2010).

Govender's (2017) study on a district initiative to promote Mathematics and Science competitions has also shown that competitions may stimulate learner interest in the sciences and promote science subjects and careers. Most learners were participating in competitions for the first time and were honoured to represent their schools. They indicated that they did not want to let their families and schools down and strived to do well in the competitions. Most responded that they did some revision for the competitions. This was done mostly on their own and, probably, had the effect of improving and deepening their knowledge in the Sciences appropriate to their school level. Further, by participating in competitions, learners become more aware of the importance of the Mathematics and Science and the need to do well in these subjects in order to access careers in Science and Engineering.

Education departments and schools are always making efforts to improve Science teaching and learning. At the heart of these efforts should be those who teach Science subjects at schools. In this regard, teachers are guided by the cognitive levels of understanding which are explicit in the CAPS documents for Natural Sciences, Physical Sciences and Life Sciences.

THERE ARE FOUR COGNITIVE LEVELS FOR NATURAL SCIENCES IN THE SENIOR PHASE (DBE, 2011A, 67). THESE ARE SHOWN IN TABLE 1.

Cognitive level	Description	Question type	Percentage
1	Knowing science	Low order question	40%
2	Understanding science	Middle order questions	45%
3	Applying scientific knowledge	Middle order questions	45%
4	Evaluating, analysing, synthesising scientific knowledge	High order question	15%

Table 1: Cognitive levels for Natural Sciences (Senior Phase)

We note that for a Natural Sciences test or examination, 60% of the questions should be middle order or higher order questions. Teachers should take these cognitive levels into account in their lesson planning and preparation.

There are also four cognitive levels for Physical Sciences in the FET (DBE, 2011b, 143).These are shown in table 2.

Table 2: Cognitive levels for Physical Sciences (FET)

Cognitive level	Description	Paper 1 (Physics)	Paper 2 (Chemistry)
1	Recall	15%	15%
2	Comprehension	35%	40%
3	Analysis, Application	40%	35%
4	Evaluation, Synthesis	10%	10%

We note the differences for Physics and Chemistry at levels 2 and 3. However, the total percentage for both these levels (for Physics and Chemistry) is the same at 75%.

Similarly, there are for cognitive levels for Life Sciences (DBE, 2011c, 67). These are shown in table 3.

Table 3: Cognitive levels for Life Sciences (FET)

Cognitive level	Description	Paper 1 & 2
1	Knowing science	40%
2	Understanding science	25%
3	Applying scientific knowledge	20%
4	Evaluating, analysing, synthesising scientific knowledge	15%

We note that the descriptions of the cognitive levels for Life Sciences are exactly the same as that for Natural Sciences.

The writer believes that should teachers follow the prescripts of the cognitive levels of understanding for Natural Sciences, Physical Sciences and Life Sciences when teaching then it is more than likely that the knowledge and understanding of learners in these subjects should improve. Further, well-planned classroom activities pitched at cognitive level 3 and 4 may also provide learners with an adequate foundation for Science Olympiads/competitions.

However, the implementation of successful classroom strategies to boost Science teaching and learning at various levels will depend on the qualifications, experiences and commitment of Science teachers. Teachers who are not able to bring their learners to the requisite performance in the Science subjects may be recommended for further development.

A study by Mogari, Kriek, Atagana & Ochonogor (2016) highlights key issues to consider when designing and shaping a teacher development programme (for Mathematics and Science teachers). These are:

- It is important to determine the teachers' needs and use the findings to design and shape an in-service programme for them. By so doing the programme tends to address what the teachers want to be helped with, thus rendering the programme effective.
- The duration of the programme should be informed by the goal and purpose of the programme.
- It is advisable use experienced facilitators who are considerably knowledgeable about the actual teaching and learning settings and curriculum offered.
- A teacher development programme should have interlinked, dynamic and iterative steps, as this enhances relevance and effectiveness.

The impact of science teacher development programmes should be carefully monitored as the intention of such programmes is for improved teaching and learning of the Sciences. Improved teaching and learning in the Sciences are likely to impact positively on learners' understanding and performance in Sciences. A positive outcome of this may be improved learner performance in Science competitions.

THE LITERATURE SURVEY FOR THIS PAPER CAN BE SUMMARISED AS FOLLOWS:

- Science Olympiads and competitions are used to stimulate interest in the sciences at both primary and high schools as well as identify and nurture talent among the learners. This may motivate and encourage junior learners to take up science subjects when they start with the FET (grade 10) and encourage senior learners to take up science related careers after completing high school (grade 12) .
- The CAPS documents for Natural Sciences, Physical Sciences and Life Sciences are very explicit when it comes to the assessment of content in these subjects. Teachers must be mindful of the cognitive levels for these subjects and should ensure that their class activities cover all these levels. This will probably improve their performance in tests and examinations.
- Further, learners' exposure to higher order questions (levels 3 and 4) may give them the necessary confidence and adequately prepare them for Science Olympiads/competitions.
- Teachers may be supported to improve their classroom practices in the Science subjects by being enrolled in teacher development programmes.

PROBLEM STATEMENT

A further obstacle to learner participation in Science competitions is the performance of learners. In some of the competitions, there are second and even third rounds and only a small percentage of learners make it to further rounds of the competitions. This lack of success in going further in competitions may deter schools from participating in such competitions or let schools enter only the top learners.

In this regard, a study by Taylor (2011) on the participation of township learners in the Science expo has relevance. At the beginning, learners were very enthusiastic and conceptualised the Science Expo as an opportunity for success, only for them to experience the opposite of success and seeing themselves as "losing". They saw no relation between their classroom science and their Expo projects and the time spent on the Expo projects could have been better spent on their classroom science and focussing on the grade 12 examinations. It is unfortunate that these learners did not realise that by participating in the Science Expo, they were also learning at the same time.

While going on to further rounds of competitions and winning prizes may be an indicator of success in competitions, one should not underestimate the importance of participating in such competitions.. While the Department of Basic Education and Provincial Education Departments in South Africa are constantly working on improving exam results in the various subjects, organisations and institutions involved in the running of Olympiads and competitions should also interrogate learner performance in such competitions with a view to improving learner performance and deepening learner understanding.

In 2017, the Port Elizabeth office of the Nelson Mandela Bay district organised a Natural Science Olympiad for grade 8 and 9 learners and a Sciences Olympiad for grade 10 and 11 learners. Learner performance in these two competitions are analysed in this paper.

RESEARCH QUESTION

In the light of the aforementioned discussions in this paper, the following research question was developed for this paper:

How do learners view their performance in a District Science Olympiad and how do these views compare with their actual performance?

THE FOLLOWING SUBSIDIARY QUESTIONS WERE FORMULATED WITHIN THE CONTEXT OF THE RESEARCH QUESTION:

- What are the views of learners about participation in a Science Olympiad?
- What are learners' thoughts about their performance in a Science Olympiad?
- What is the actual performance of learners in a Science Olympiad?
- Are there teaching practices which may impact positively on Science learning and possibly improve learner performance in the Science competitions?

THEORETICAL FRAMEWORK

In South Africa, Science Olympiads are an "add-on" for learners and teachers. Learners tend to work through Olympiad- type questions in their own time and their teachers may or may not give them support. However, these Olympiads have the capacity to enrich the learners' science knowledge. Schools may use Science Olympiads and competitions to promote excellence in science learning, develop and enhance self confidence in learners and also nurture creativity among them.

In this regard, the Enrichment Triad Model (ETM) may be an appropriate framework in which to locate this paper. (Renzulli, 1977). This model consists of three different kinds of interrelated forms of enrichment activities that are integrated as a complement to the regular curriculum. Type I enrichment consists of general exploratory experiences that are designed to expose students to topics and areas of study not ordinarily covered in the regular curriculum. Type II enrichment consists of group training in thinking and feeling processes, learning-how-to-learn skills, research and reference skills, and written, oral, and visual communication skills. Type III enrichment consists of first-hand projects or investigations intended to solve real problems (Renzulli, 1999).

The Natural Sciences and Sciences Olympiad organised by the Port Elizabeth office of the Nelson Mandela Bay District, each consisted of twenty multiple choice questions. There were both "syllabus type" and "enrichment type" questions in the Olympiad. Learners had read and interpret questions, identify which of the content was familiar to them, and do a bit of reasoning and problem solving. For purposes of this research, these questions would fall mostly in the category of type I enrichment and some type III enrichment.

To examine how the Olympiads are linked to the school curriculum, one has to look at the CAPS document for the various subjects. The CAPS document distinguishes between informal assessment (Assessment for Learning) and formal assessment (Assessment of Learning). Since this study interrogates learner performance in Science Olympiads, it may fall in line with assessment of learning, albeit in an enrichment context.

It is the writer's experience that most learners prepare for Science Olympiads with little or no support from their teachers. They may go over past year papers to get a sense of the types of questions which appear in such Olympiads. However, as stated earlier, improved classroom teaching and learning of the Sciences may impact positively on learner performance in Science competitions. It is noted that the type III enrichment as described by the ETM consists of "first-hand projects or investigations intended to solve real problems". Teachers may consider using problem-based learning (PBL) approaches in some of their lessons. Etherington (2011) describes problem-based learning as a learner-centred method of teaching that involves learning through solving unclear but genuine problems. It is a constructivist, learner-focused approach that promotes reflection, skills in communication and collaboration, and it requires reflection from multiple perspectives. Learners are confronted with real-life scenarios or a problem that requires a solution. The problem is often ill defined and messy, so there is no clear path or procedure to follow. They analyse the problem and the context and apply deductive and inductive processes to understand the problem and find a possible solution or solutions. Learners are, thus, using the scientific method and inquiry in the process. The teacher plays a facilitative role during PBL while learners deepen and strengthen their knowledge of the subject matter.

This paper interrogates learner performance in District Science Olympiads and tries to come up with possible classroom practices which may impact positively on learner performance in these and other Science Olympiads/competitions. In summary, "the assessment of Science learning within an ETM context" would be an appropriate theoretical framework for this paper.

RESEARCH METHODOLOGY

Research Sample

The research sample consisted of 46 learner participants. Of these 26 participated in the Natural Sciences Olympiad and 20 in the Sciences Olympiad.

Data Collection

Both qualitative and quantitative were collected for this study. Qualitative data emerged from the survey, via questionnaires which was administered to learners after they completed the Olympiad. The questionnaires elicited responses to the following:

- Learners' thoughts on participation in the District Olympiads
- Learners' views on the questions in the Olympiads
- Learners' reasons for their views on the questions
- Quantitative data emerged from the analyses of the questions and learner performance in both Olympiads.

Results

Questionnaires

Learners' thoughts on being selected to participate in the District Olympiads

26 learners completed the questionnaires for Natural Sciences Olympiad and 20 learners completed the questionnaires for the Sciences Olympiad. The actual words of learners, with some minor editing, are captured here:

Natural Sciences Olympiads

"That I was number one in my level on term one"; "I thought that this will be a good opportunity and it will help me to improve and be better than how I was doing then"; "I thought I should go and tell my parents"; "I thought that this would be a valuable life opportunity for me to increase my knowledge for science and approach my skills"; "I thought that I was good Natural Science that is why I was chosen"; "I was surprised because this is the second time I have been selected. It motivates me to work even harder in order to archive my dreams and it teaches me that anything is possible in life"; "I felt great because it is a big opportunity for me to been know that I once represented my school even if I did not win"; "I thought about the schools that we were competing with and the knowledge we would gain. I was happy and excited that I can improve and at the same time I was nervous"; "I have not put much thought into this; I felt about happy knowing that I'm representing my school"; "I was excited and nervous because this is actually my first year being selected in a Natural Science Olympiad. I felt like, I had to do this just to make my school proud and I felt very excited because I always score top marks in Natural Sciences"; "I thought it would be very easy to win since I am passionate about it, I also felt very lucky"; "My thoughts were that this is the opportunity for me or other learners to prove how good you are in natural science"; "Well it was just exciting"; "I was nervous felt unprepared but also felt good because this meant that my school believes in me"; "I thought that being selected for Natural science Olympiad was a chance for me to prove to myself and others that I really love natural science". I told myself to do as best as I can especially on my favourite subject"; My thoughts were that is the paper is hard to understand but I found it easy to read"; "When I found out I was chosen to take part in the Natural Sciences Olympiad I was shocked at first, but I felt really honoured to take part in it"; "I will try my best to keep my school name high, I was very nervous at first but I told myself that I can do it"; "I was very happy"; "I was proud of myself and parents were happy for me and they said they believe in me"; "I was honoured and excited"; "I was happy or excited to be appointed that I will represent my school".

Sciences Olympiads

"I felt honoured"; "I am blessed to be here"; "I pondered why this was so important. It was very sudden"; "I did not want to participate because I felt like I was being forced, but I appreciate this opportunity"; "I am going to do so horribly"; "I feel honoured to represent my school"; "It was great representing my school doing something I love"; "Good to represent my school because I got good marks"; "I was scared and happy at the same time"; "I was scared and excited at the same time as it is my first time competing against other schools"; "I couldn't believe that I was chosen to represent my school"; "It is a privilege and an honour"; " I am forever grateful for this opportunity"; It was a little intimidating but I wrote what I could:; "It was a big opportunity for me , as I would participate with different schools and lets me prove myself"; "It was a marvellous opportunity so I grabbed it with both hands because it is an opportunity to make my school proud"; "I saw it as an opportunity to learn more about science"; "I was ecstatic, I felt they saw some potential in me"; "To be chosen is very important because I have been intrusted to represent my school thus, I will do everything to excel in this as people are relying on me: "At first I was not confident but my teacher told me he had faith in me, so I listened and now I do believe in myself";" Why not go through with it"; "I was scared of Physics as it is not so easy so I thought it would be hard to handle. It was a good experience".

INSIGHTS FROM LEARNERS' THOUGHTS

Learners gave a variety of responses. These responses were analysed by looking at key trends and patterns of coherence. Their responses for both Olympiads may be summarised as follows:

- Although there were certain misgivings on the part of some learners, nearly all were honoured to represent their schools and wanted to make their schools and families proud
- Some of them indicated they were the top learners and welcomed the opportunity of competing with learners from other schools. At the same time there were learners who were not sure about how they will perform in the Olympiads.
- Most saw their participation in the Olympiad as an opportunity to work hard, learn more and improve in Natural Sciences, Physical Sciences and Life Sciences

LEARNERS' VIEWS ON THE QUESTIONS IN THE DISTRICT OLYMPIADS

Learners were asked to comment on the questions given in the Olympiad. They had to state whether the questions, overall, in the Olympiads were easy (low order questions), intermediate (middle order questions) or difficult (higher order questions).
Their responses are captured in tables 4 and 5

Table 4: Learners' classification of questions in the Natural Sciences Olympiad

Classification of questions	Number of learners
Easy	-
Intermediate	20
Difficult	6

Natural Sciences learners' responses on their choices
Learners were asked to explain their classification of the questions in the Natural Sciences Olympiad. There was some synergy with their choices in table 4 and their reasons for their choices. Learners indicated that on the whole, questions ranged from intermediate to difficult, with some questions being a bit "tricky". A few reported that they were not familiar with some questions, possibly as a result of not having yet covered the related topics at school. One learner reported having difficulty with Physics and Chemistry and another learner complained about having the questions in English, rather than Afrikaans which was the language of teaching and learning at his school.

Table 5: Learners' classification of questions in the Sciences Olympiad

Classification of questions	Number of learners
Easy	4
Intermediate	16
Difficult	-

Sciences learners' responses on their choices
Learners were also asked to explain their classification of the questions in the Sciences Olympiad. Although none of them classified questions as difficult some reported that there were questions which involved "deep thinking". These "deep thinking" questions could be classified as "difficult", thus contradicted table 5. In the main, most of the content assessed in the Olympiad was familiar to learners, having been covered in class or being general knowledge.

ACTUAL LEARNER PERFORMANCE

The actual performance of learners in the Natural Sciences Olympiad is shown in tables 6 and 7.

Table 6: Question by question performance in the Natural Sciences Olympiad

Question	Number correct
1	2
2	5
3	6
4	12
5	20
6	16
7	16
8	2
9	16
10	8
11	10
12	12
13	0
14	2
15	17
16	9
17	16
18	17
19	3
20	1

Table 7: Overall performance in the Natural Sciences Olympiad

Marks	Number of learners
16 - 20	-
14 - 15	-
12 - 13	1
10 - 11	2
8 - 9	11
Below 8	12
Total	**26**

Trends emerging from actual learner performance in the Natural Sciences Olympiad

When examining table 6, one notices that performance in questions 1, 2, 3, 8, 10, 13, 14, 16, 19 and 20 leaves much to be desired. In fact, less than five learners got questions 1, 8, 13, 14, 19 and 20 correct. Question 13 was linked directly to question 12, These questions are shown in annexure A.

Interestingly, questions 8, 13 and 14 required learners to have a mathematics background. Question 8 required the use of formulas and momentum (only 2 got the correct answer). Question 13, which was linked to question 12, required learners to work out a percentage (no one got this answer correct). Question 14 was about the interpretation of a bar graph (only 2 got this answer correct).

In terms of overall performance, only 3 learners managed to achieve 50% and above. If there was a round 2 of the Olympiad, and using 50% as a cut-off, only these 3 learners would have qualified.

The actual performance of learners in the Sciences Olympiad is shown in tables 8 and 9.

Table 8: Question by question performance in the Sciences Olympiad

Question	Number correct
1	17
2	11
3	17
4	18
5	8
6	16
7	9
8	8
9	9
10	12
11	3
12	13
13	3
14	2
15	9
16	9
17	19
18	13
19	13
20	10

Table 9: Overall performance in the Sciences Olympiad Marks Number of learners

Marks	Number of learners
16 - 20	2
14 - 15	4

12 - 13	4
10 - 11	4
8 - 9	5
Below 8	1
Total	**20**

Learner performance in the Sciences Olympiad appears to be far better than the performance in the Natural Sciences Olympiad. We find that for questions 5, 7, 8, 9, 11, 13, 14, 15 and 16 only nine learners or less obtained the correct answer. Four of these were questions from the Physical Sciences section of the Olympiad and five from the Life Sciences section. With further scrutiny, it is noted that questions 11, 13 and 14 were challenging to the learners, with at most three obtaining the correct answer. These were all Life Sciences questions. Overall, learners did reasonably well. If there was a second round, 14 of the 20 learners would have made it to the second round (using 50% as a guide).

Findings and implications for teaching and learning
Although this study involved only 46 participants (26 grade 8 & 9 learners and 20 grade 10 & 11 learners), it provided rich data which are now incorporated into the findings of the study. These findings are written within the context of the research and subsidiary questions.

- Views of learners about participation in the District Science Olympiad
- Learners who were selected to participate in the District Olympiads were usually the top learners of the schools.
- They were honoured to be chosen to represent their schools and this was the first time that the majority of them had participated in an Olympiad and looked forward to the experience.
- Although they did not know what to expect, it would appear that they did revise for the Olympiads as they were familiar with most of the content assessed as these had been "covered in class".
- Further, the fact that they wanted to make their schools and parents "proud" would mean that they would not go into Olympiads without having done any revision. Any revision for the District Olympiads was likely to deepen or strengthen their knowledge.
- Learners' thoughts about their performance compared to their actual performance
- The junior learners, who wrote the Natural Sciences Olympiad, were on the mark in their assessment of the questions in their Olympiad, stating that the questions ranged from "intermediate to difficult". This is backed up by the data in tables 6 & 7. Some learners were very specific when giving reasons for their choices such as difficulty with Physics and Chemistry and writing the Olympiad in English rather than Afrikaans. A further scrutiny of table 7 indicates that the three worst performing questions were those with a Mathematics context.
- The senior learners were also on the mark when stating how they would perform in the Sciences Olympiad. These learners responded that the questions were "easy to intermediate" and this is backed up by their actual performances as shown in tables 8 & 9. However, there is a slight contradiction as some learners indicated that the questions required "deep thinking" and may not have actually been "easy to intermediate". The three poor performing questions were on Life Sciences.

Possible reasons for differences in performance

Natural Sciences is a compulsory subject in grades 8 and 9. It is designed to give learners a proper foundation for FET subjects such as Physical Sciences, Life Sciences, Agricultural Sciences and Geography (DBE, 2011a). The poor performance in the Natural Sciences Olympiad could be attributed to a possible lack of maturity on the learners' part as they are still developing and may have not had the necessary exposure to higher order questions. The situation is different in grade 10 and 11. Learners have already chosen their subjects, usually based on their performance at the end of grade 9. They have matured and probably have a better grasp of the Physical Sciences and Life Sciences content.

Implications for teaching and learning

One of the issues in South African education is the focus on grade 12. Lots of resources are given to schools in order to improve the grade 12 percentage pass of the learners. Schools have extra classes for their learners and districts give a wide range of support to schools. Some of this support is in the form of winter or spring schools where learners from selected schools are taken to central venues and are tutored in various subjects. This occurs because the grade 12 final examination is considered to be a high stake examination (Howie, 2012). The academic year in South Africa usually starts with the release of the grade 12 results of the previous year by the Minister of Basic Education. Rankings of provinces and districts are based on the overall percentage pass. There is very little mention of how learners performed in other grades, except by those who comment on the drop-out rate of learners, especially from grade 10 onwards. In grades R – 11, learners in South Africa are able to move to the next grade provided they meet the pass requirements of the grade. There is also a provision for learners to "progress" to the next grade under certain circumstances.

When the focus is on overall pass percentage, quality of passes, both overall and in specific subjects, tends to recede into the background and may have a negative influence on the Science subjects. For example, learners who pass Mathematics and Natural Sciences in grade 9 at a low level may be excluded from the Science stream in grade 10. Similarly, poor quality Grade 12 passes in Mathematics, Physical Sciences and Life Sciences are likely to impact negatively on learners pursuing studies in Science and Engineering. In this regard, arising out of the findings and the literature survey of this study, the writer would like to highlight the following implications for teaching and learning of Science subjects:

- There is a need for improved teaching and learning practices in Science subjects as these may impact positively on the quality of passes in these subjects. The role of the teacher is critical in this process. Teachers must be very meticulous in their lesson planning and preparation and their class activities should be interesting, meaningful and cover all cognitive levels.
- Teachers may incorporate PBL (Problem Based Learning) approaches for some of their class activities. In PBL, Science is seen as both bodies of knowledge and ways of thinking and doing. Thus, learners' thinking, problem solving skills and habits such as curiosity, questioning, openness to ideas, learning from errors and persistence are likely to promote exploration and discovery.
- Wiggins and McTighe (1998) report much more takes place, when the learner is the one who looks deeper to create meaning and develop understanding. Perkins and Blythe (1994) explain that understanding is deep learning that goes well beyond simply "knowing", such as being able to do thought-demanding things with a topic like finding evidence and interpreting information in new ways.
- An approach combining different teaching strategies (including PBL) may result in learners strengthening and deepening their knowledge in the Sciences and may result in more learners passing and more learners obtaining 80% and above.
- When more learners do well in their Science subjects at schools, schools have a bigger pool of quality learners to select for participation in Science competitions. This makes learners more competitive. Learners who do well in the Science subjects at school and then participate in Science competitions are likely to enter Science and Engineering programmes after completing high school. This is confirmed in the study by Forester (2010).
- The Department of Education, through their subject advisors and curriculum specialists, should monitor the classroom teaching of the Sciences at all levels. There should be certain minimum standards set for Science teachers. Those who are not able to reach the acceptable standard should be recommended for further development in the subject.

Conclusion

As stated at the beginning of this paper, there are numerous STEMI competitions in South Africa. However, the vast majority of South African learners do not take part in these competitions for various reasons. For these learners, the sum total of the science experiences is limited to their classrooms. This may change if schools arrange inter-class or inter-grade Science competitions and successful learners from these school competitions are entered in District and Regional competitions.

In the District competitions described in this paper, the performance in the Sciences Olympiad was exceptional and exceeded by a great margin, the performance in the Natural Sciences Olympiad. This is probably due to the maturity and knowledge of the learners who wrote the Sciences Olympiad. These learners appear to be fairly settled in Physical Sciences and Life Sciences, having probably made the right subject choices for the FET.

However, performance in the Natural Sciences Olympiad may point to some serious issues with regard to the teaching and learning in grades 8 & 9, especially in Natural Science and Mathematics. There were 6 questions where only a maximum of 6 of the 26 learners gave the correct response. These very poor performing questions which were spread across Mathematics (3); Physical Sciences (1); Life Sciences (2). If more learners are to take up Science subjects in grade 10 and Science and Engineering careers later, then more should be done to improve teaching and learning practices in the Sciences, in the earlier grades.

It would be appropriate to end this paper with a quote by Azwinndini Muronga (Executive Dean of Science at Nelson Mandela University) on what Science faculties should be doing to attract learners to Mathematics and Science programmes at universities:

"Our pupils and students are every bit up to outstanding achievements when given the right kind of guidance. It is not acceptable to tell students that our courses are very difficult and only a few of them will pass. Instead, we need to achieve an overriding success rate by investigating our policies, methods and approaches, and changing or improving those that do not serve 21st century dynamic, relevant, African science faculties". (Muronga, 2018, 8).

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Annexure A: Questions with poor performance: Natural Sciences Olympiad

Which theory helps to explain the property and behaviour of materials?
A. Chaos theory
B. Gas theory
C. Force theory
D. Potential theory
E. Kinetic theory

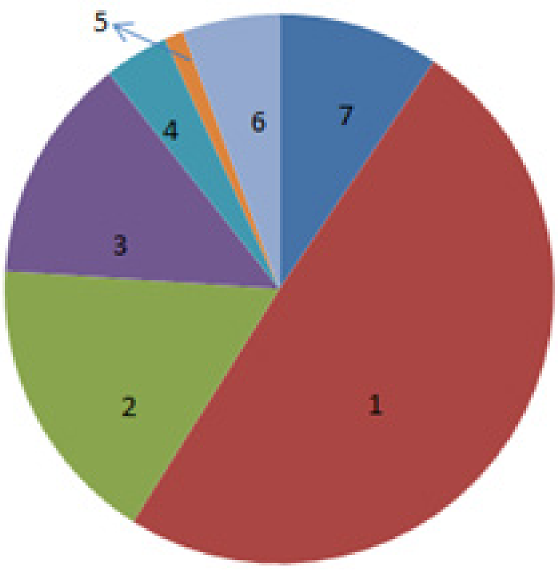
A particle of mass “m” with a velocity “v” strikes a stationary particle of mass “2m” and sticks to it. What will be the speed of the system?

A. v/2
B. v/3
C. 2v
D. 3v
E. 4v

The table below shows a balanced daily diet for an average woman:

Food group	Daily intake (in grams)
Protein	50
Carbohydrates	260
Sugar	90
Fats	70
Saturates	20
Salt	6
Fibre	30

The information is also shown in the pie graph alongside:



Which food group does number 7 on the pie graph represent?

A. Fibre
B. Fats
C. Protein
D. Sugar
E. Saturates

Refer to the table and pie chart in question 12. What percentage of woman's daily diet should consist of carbohydrates? (link to 12)

A. 50%
B. 51,4%
C. 49,4%
D. 49,2%
E. 48%

In a survey of 40 learners, 10 stated that they had cereal for breakfast. Which bar on the graph above represents the number of learners having cereal for breakfast?

A
B
C
D.
None of the bars

In which of the following groups do animals have a backbone and spinal cord?

A. Molluscs
B. Chordates
C. Invertebrates
D. Echinoderms
E. Coelenterate

Plants synthesise protein from

A. starch
B. sugar
C. amino acids
D. fatty acids
E. nutrients

Annexure B: Questions with poor performance: Science Olympiad

11. Pollination is best defined as

A. transfer of pollen from anther to stigma
B. germination of pollen grains
C. growth of pollen tube in ovule
D. visiting flowers by insects
E. transfer of pollen from one plant to another

13. In which parts of a plant does photosynthesis generally take place?

A. Flowers
B. stem and leaf
C. Roots and chloroplast bearing parts
D. Bark and leaf
E. Leaf and other chloroplast bearing parts

.

Most fish do not sink in water because of the presence of

Swim bladder
Air bladder
Air sacs
Air in spongy bones

(i) and (ii) are correct
(ii) and (iii) are correct
(iii) and (iv) are correct
(i), (ii) and (iii) are correct
(i), (ii) and (iv) are correct

BRIDGING THE GAP BETWEEN LOCAL AND INTERNATIONAL OLYMPIAD STANDARDS – WHY UNIVERSITY ACADEMICS MUST BE INVOLVED?

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Our national physical science Olympiads lacks the scope and rigor, with respect to content, as compared to analogous national Olympiads in other countries. The main reason for this is that our high school syllabi do not cover sufficient material and content as compared to other countries, be they established or developing countries. In this paper we will compare and discuss the high school Physics curricula from other countries around the world and expose the shortcomings in South Africa's current CAPS syllabi. The syllabus of the International Physics Olympiad (IPhO) will also be examined and we will motivate that its content is beyond the reach of our current physical science teachers, unless they possess a BSc degree in Physics. For this reason we propose that STEMI professionals, especially those at academic institutions, might be the only candidates that are able to bridge the gap between our local Olympiads and national Olympiads from abroad, let alone international Olympiads.

1. INTRODUCTION

Our current physics CAPS syllabus (Department of basic education 2011) and mostly the fact that physics is not treated as an independent subject on the same footing as mathematics or any other high school subject in South Africa, is proving to be a major stumbling block in achieving par standards with other Olympiads around the world.

South Africa is one of few countries in the world where physics and chemistry are combined into a single subject, somewhat aptly called 'physical sciences'. The Umalusi research report (Umalusi Research Report 2008) seems to support this combination and states, "It is better for their (the learners) broad education to be exposed to a greater number of subjects, rather than in-depth subjects which take the place of other possibilities." In such a combination, the content of each of these separate disciplines taught in the senior phase, is basically halved which also leaves less room for in-depth study of certain topics. Only allocated half the time as dedicated to a full subject limits the amount of topics that can be covered. It is evident from a quick glance at the physics CAPS syllabus that important topics such as thermal physics, physical optics and even circular motion are absent. These are topics that form part of most of the world's secondary school education and more importantly appear in almost all national Olympiads around the world. Also, in-depth study is what is required so that learners can be exposed to more higher level and challenging concepts, not to mention developing special mathematical skills to solve Olympiad type questions. Once again, a quick look at the CAPS syllabus treats certain topics at a very basic level. An obvious example is the superficial treatment of vectors in CAPS, where the concept of the unit vector is not even introduced, let alone the dot or cross products which gives deeper meaning to other concepts encountered in mechanics and, electricity and magnetism.

The gap between what is taught in South African secondary school and at University is enormous, both in content and degree of difficulty. Even students who obtained distinctions for mathematics and physical science in grade 12 find it difficult to succeed during their first year at University (Govender & Moodley 2012). We do not even have to look at first world or Asian countries to see the limitations in our physics curriculum. Just looking at countries within our continent can highlight the fundamental deficiencies in our schooling models. It is widely documented that students from many other African countries reading first year physics at South African Universities perform much better than our local students. In fact, at the University of KwaZulu-Natal (UKZN), it is often that the top ten highest marks in any of these first year physics modules are dominated by foreign African students. The reason for this is simple – these foreign African students study most of the first year physics syllabus at their secondary school level and have teachers that are qualified to teach that content and at that level.

The goal of this paper is not to criticize the physics CAPS syllabus but to point out the facts; if we are to compete in the world arena our current syllabus has to be brought up to world standard and the only qualified individuals to do this, in the short term, are physics academics since our high school teachers are not trained at that level. Until the day comes when our higher government authorities see this as a problem and implement a new curriculum with an appropriate enhancement of the standards at Initial Teacher Education (ITE) programmes, the universities have to step up. Physics academics have to adopt a culture of volunteerism in transferring their knowledge to the wider Olympiad community by coaching and mentoring young talented minds.

The structure of this paper is laid out as follows. In Section 2., we summarize and list the content of the CAPS physics syllabus and compare it with the physics syllabi of a few selected African countries. In section 3., we list some of the advanced topics contained in the syllabus of the International physics Olympiad (IPHO) and motivate that it is beyond the level of our current high school physical science teachers. In section 3. we discuss how physics academics need to get involved and volunteer to help bring our learners to gain a knowledge of physics on par with their peers from around the world.

2. COMPARISON OF PHYSICS CAPS SYLLABUS WITH OTHER AFRICAN COUNTRIES

Table 1. lists the topics covered in the physics CAPS syllabus (Department of basic education 2011), obtained from the department of basic education (DBE) website (https://www.education.gov.za/Curriculum/CurriculumAssessmentPolicyStatements(CAPS)/CAPSFET.aspx). A more detailed list, verbatim form the CAPS document , can be found in Appendix 1. Further details including lesson plans and contact hours can be found in the aforementioned document. The level of difficulty of the content can easily be ascertained by browsing the plethora of so-called CAPS Physical Science textbooks on the book market. The true level is obviously gauged from looking at the senior grades' exemplar exams that can be found on the DBE website or the grade 12 physical science paper 1 exams over the many years that CAPS has been in place.

A first glance at Table 1. will immediately alarm a physicist, yet alone a student who has taken a first year physics course at University, at how limited this syllabus actually is. It's limitations becomes even more apparent when we compare it to the syllabi of some African countries. It was relatively easy to source from the Internet, official documents (Physics syllabi 2018), released by the appropriate education governing bodies, the physics syllabus or in some cases the physical science syllabus of various African countries. We have scrutinized the syllabus of six African countries. Four of them are our neighboring countries; Botswana, Lesotho, Swaziland and Zimbabwe. The other two are Nigeria and Ghana which are of special interest since these are two African countries (apart from Egypt and South Africa) that take part in the IPHO. It should be noted that out of the six countries, only Lesotho and Swaziland offer 'physical sciences' (like South Africa) as a single subject combining physics and chemistry.

It was found that the African countries covered all the topics that are listed in Table 1. and in most cases, in more detail. The surprise is in Table 2., which shows whole topics or sub-topics covered by most of these counties but not South Africa. Even Lesotho and Swaziland, have place in their syllabus to include important topics like physical optics and radioactivity, not to mention moments and torque which are fundamental to any discussion of mechanics. The syllabi of Ghana and Nigeria cover much more topics and a closer look at their curriculum statements shows syllabi more closely aligned with modern syllabi from most countries around the world. It should be noted that the Zimbabwean syllabus.

Table 1: List of topics covered in the CAPS syllabus as per year of study.

TOPIC		CONTENT
Mechanics	Grade 10	Introduction to vectors & scalars; Motion in one dimension; Energy
	Grade 11	Vectors in two dimensions; Newton's Laws and Application of Newton's Laws
	Grade 12	Momentum and Impulse; Vertical projectile motion in one dimension (1D); Work, Energy & Power
Waves, Sound & Light	Grade 10	Transverse pulses on a string or spring; Longitudinal waves; Sound; Electro-magnetic radiation
	Grade 11	Geometrical Optics; 2D & Wave fronts
	Grade 12	Doppler Effect (either moving source or moving observer)
Electricity & Magnetism	Grade 10	Magnetism; Electrostatics; Electric circuits
	Grade 11	More Electrostatics; Electromagnetism; Electric circuits
	Grade 12	More Electric circuits; Electrodynamics
Matter & Materials	Grade 10	Revise matter and classification; States of matter and the kinetic molecular theory; Atomic structure
	Grade 11	Ideal gases (taught for some reason as chemistry)
	Grade 12	Optical phenomena and properties of materials

Table 2: List of topics covered in other African countries but not in our CAPS syllabus.

EXTRA TOPICS	BOTSWANA	GHANA	LESOTHO	NIGERIA	SWAZILAND	ZIMBABWE
Moments/torque	x	x	x	x	x	x
Circular motion	x	x		x		x
Physical optics/ lenses	x	x	x	x	x	x
Oscillations	x		x			
Thermal physics/ calorimetry	x	x	x	x		x
Electricty - capacitors		x		x		x
Magnetism – magnetic force		x		x		x
Nuclear physics - radioactivity	x	x	x	x	x	x

Referred to in Table 2. is their O-level syllabus and not their A-level syllabus, an advanced syllabus which is closely related to a first year university physics course.

Even at this stage without describing the IPHO syllabus, it is impossible for our current cohort of secondary school physical science teachers to deliver the curricula of either Ghana or Nigeria to our learners. It is not because the teachers lack the suitable qualification (Hofmeyr and Draper 2015) but the fact that the Initial Teacher Education (ITE) programmes they come from, lack the necessary advanced level content that is required and so to, they lack 'academic depth' as discussed in (Rusznyak, Balfour, Van Vollenhoven and Sosibo 2016).

3. THE INTERNATIONAL PHYSICS OLYMPIAD SYLLABUS

Besides the many topics listed in Table 1. and Table 2., we list some of the other topics required for the IPHO, as can be found on the official IPHO website: http://ipho.org. The caveat that goes with the theoretical IPHO syllabus is that it is not only calculus based but also requires a fair bit of advanced mathematical concepts that is covered in a first year University mathematics course, which we will not discuss here.

Table 3: Selected advanced topics covered in the IPHO syllabus.

TOPIC	SUB-TOPICS
Mechanics	Ridgid body dynamics and moments of inertia via integration. Hooke's law, stress, strain, and Young modulus. Stable and unstable equilibria. Potential energy as a line integral of the force field. Non-inertial reference frames. Kepler's laws and energy of elliptic orbits. Fluid dynamics, bouancy and Bernoulli equation.
Electricity and magnetism	Lorentz force; Ampère's force; Biot-Savart law. Integral forms of Maxwell's equations - Gauss' law (for E- and B-fields); Ampère's law; Faraday's law. Method of image charges. Electric and magnetic dipoles. Kirchhoff's laws. Capacitors and capacitance; self-induction and inductance; energy of capacitors and inductors; mutual inductance; time constants for RL and RC circuits. AC circuits: complex amplitude; impedance of resistors, inductors, capacitors, and combination circuits; phasor diagrams; current and voltage resonance.
Oscillations and waves	Harmonic oscillations and the Physical pendulum. Damped oscillator and forced oscillations. Free oscillations of LC and LC-resonators. Waves in inhomogeneous media. Sound waves: speed as a function of pressure (Young's or bulkmodulus) and density, Mach cone. Linear polarisation; Brewster angle; polarisers; Malus' law.
Relativity	Principle of relativity and Lorentz transformations. Mass-energy equivalence; invariance of the spacetime interval and of the rest mass. Addition of parallel velocities; time dilation; length contraction; relativity of simultaneity; energy and momentum of photons and relativistic Doppler effect; relativistic equation of motion; conservation of energy and momentum for elastic and non-elastic interaction of particles.
Quantum physics	Particles as waves: relationship between the frequency and energy, and between the wave vector and momentum. Energy levels of hydrogen-like atoms and of parabolic potentials; quantization of angular momentum. Uncertainty principle. Structure of matter: Emission and absorption spectra for hydrogen-like atoms. Pauli exclusion principle for Fermi particles. Particles (knowledge of charge and spin): electrons,electron neutrinos, protons, neutrons, photons; Compton scattering. Protons and neutrons as compound particles. Atomic nuclei, energy levels of nuclei (qualitatively); alpha-, beta- and gamma-decays; fission, fusion and neutron capture.
Thermodynamics and statistical physics	Concepts of thermal equilibrium and reversible processes; first and second laws of thermodynamics. Kinetic theory of ideal gases: Boltzmann factor and gas constant; translational motion of molecules and pressure; translational, rotational and oscillatory degrees of freedom; equipartition theorem; internal energy of ideal gases; root-mean-square speed of molecules. Isothermal, isobaric, isochoric, and adiabatic processes; specific heat for isobaric and isochoric processes; the Carnot cycle; efficiency of non-ideal heat engines. Planck's law, Wien's displacement law; the Stefan Boltzmann law.

As can be seen from Table 3. (together with Table 1. and Table 2.), the theoretical IPHO syllabus is quite advanced and extensive, encompassing the entire first year university physics syllabus and some components of second and third year level. It is sufficient to make any physics lecturer educated in South Africa gasp with intimidation. It should be noted at this stage that there is also an experimental examination component to the IPHO, but this is something we will not discuss in this paper.

3. PHYSICS ACADEMICS AND VOLUNTEERISM

As can be seen from the previous two sections, it is impossible for our physical science teachers to coach or train learners at this high a level in physics, unless they at least possess a BSc degree in physics. To this extent, it is left to university physics academics to take secondary school physics and our Olympiads to this higher level. But how can we do this?

Ever since South Africa's involvement in the IPHO beginning in 2012 (Moodley & Bissessur 2017), physics academics at the University of KwaZulu-Natal have played a pivotal role in coaching and training our team. All academics involved, volunteered their time without any renumeration and some even provided printed notes and older physics textbooks for the team. Individual academics lectured, to the team, the same sections or topics that they regularly taught at university, so there was not much extra work they had to do other than to confine their lectures to the IPHO syllabus. It was apparent that all academics involved welcomed the challenge and enjoyed their interaction with the learners in the team. One can conclude that getting academics from all across the country involved and to volunteer their time is something they would do whole-heartedly.

The best way to get secondary school learners to study advanced physics material is for universities to run their own Olympiads and dictate a syllabus, obviously more advanced than CAPS, and conforming to international standards. This could be done in the similar guise as the University of Cape Town's mathematics competition (http://www.math.uct.ac.za/overview-34) which has produced well prepared learners to compete successfully in the International Mathematics Olympiad (IMO). The physics equivalent could be done at provisional or regional level depending on which university is hosting the competition. If university physics departments are committed to such an endeavour it will be natural for academics to get involved, be it out of passion for their discipline or improving their key performance area (KPA) for outreach and community engagement. The respective universities could set up web pages where notes and resources could be uploaded for interested schools to download. The on-line open source teaching utility, Moodle, could also be used to set up lessons on certain topics, where the learner can teach himself/herself without the assistance of a teacher. Dedicated academics could also run Saturday morning lectures as the UKZN academics do for our IPHO team.

These competitions or local Olympiads would certainly get more learners interested in physics and hopefully increase physics-degree enrollments at universities which are currently extremely low. For reference, UKZN, one of the largest universities in South Africa, has only eight students at third year level registered in 2018. Would it not be exceptional if we could increase our enrollments using Olympiads.

4. CONCLUSION

If our secondary school physics syllabus is brought up to world standard, then our national Olympiad can encompass a greater variety of topics which can be comparable to other national physics Olympiads around the world, not to mention the IPHO. Hampered by a secondary school physics syllabus that is nothing more than below average when compared to even other African countries, we need a vehicle to introduce our senior learners to higher level physics. It is only university physics academics that can coach and mentor our learners to this higher level since our current secondary school physical science teachers' knowledge is limited to only what they are taught in their respective teaching diplomas at ITE programmes. Since these programmes are not even at the level of a first year university level physics course they also become insignificant in coaching our national IPHO team.

It is evident that Ghana and Nigeria already have an advantage in their preparation for their participation in the IPHO since their physics curriculum already overlaps significantly with the IPHO syllabus. It is sadly unfortunate that our high school teachers cannot play a role in leading our learners to achieve at least a satisfactory knowledge of physics as compared to international standards. This is however contrary to what happens in most other countries. From a survey carried out at the 2015 IPHO (Petersen and Wulff 2017), it was reported that only about 10% of countries participating in the IPHO used universities for the coaching of learners.

University physics academics are always open to volunteering their time and knowledge, and setting up university controlled provincial or regional physics Olympiads based on an advanced syllabus might be the only avenue for our learners to advance beyond our CAPS syllabus and be prepared to participate confidently in the IPHO.

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Lesotho - http://www.examscouncil.org.ls/LGCSE%20Syllabus/Physical%20Science/Physical%20Science%20Syllabus.pdf
Nigeria - https://www.myschoolgist.com/wp-content/uploads/2016/05/PHYSICS-1.pdf
Swaziland - http://www.examscouncil.org.sz/index.php/downloads/all-downloads/file/208-sgcse-syllabuses-2017-2018
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APPENDIX 1.

Table 4: Complete summary of Physics syllabus from CAPS (DBE 2011)

TOPIC		CONTENT
Mechanics	Grade 10	Introduction to vectors & scalars; Motion in one dimension (reference frame, position,displacement and distance , average speed, average velocity, acceleration, instantaneous velocity, instantaneous speed, description of motion in words, diagrams, graphs and equations.) Energy (gravitational potential energy, kinetic energy, mechanical energy, conservation of mechanical energy (in the absence of dissipative forces))
	Grade 11	Vectors in two dimensions (resultant of perpendicular vectors, resolution of a vector into its parallel and perpendicular components), Newton's Laws and Application of Newton's Laws (Newton's first, second and third laws and Newton's law of universal gravitation, different kinds of forces: weight, normal force, frictional force, applied (push, pull), tension (strings or cables), force diagrams, free body diagrams and application of Newton's laws(equilibrium and non-equilibrium))
	Grade 12	Momentum and Impulse (momentum, Newton's second law expressed in terms of momentum, conservation of momentum and elastic and inelastic collisions, Impulse), Vertical projectile motion in one dimension (1D) (vertical projectile motion represented in words, diagrams, equations and graphs), Work, Energy & Power (work , work-energy theorem, conservation of energy with non-conservative forces present, power)
Waves, Sound & Light	Grade 10	Transverse pulses on a string or spring (pulse, amplitude superposition of pulses), Transverse waves (wavelength, frequency, amplitude, period, wave speed, Longitudinal waves (on a spring, wavelength, frequency, amplitude, period, wave speed, sound waves), Sound (pitch, loudness, quality (tone), ultrasound), Electromagnetic radiation (dual (particle/wave) nature of electromagnetic (EM) radiation, nature of EM radiation, EM spectrum, nature of EM as particle - energy of a photon related to frequency and wavelength)
	Grade 11	Geometrical Optics (Refraction, Snell's Law, Critical angles and total internal reflection), 2D & Wave fronts (Diffraction)
	Grade 12	Doppler Effect (either moving source or moving observer) (with sound and ultrasound, with light - red shifts in the universe.)
Electricity & Magnetism	Grade 10	Magnetism (magnetic field of permanent magnets, poles of permanent magnets, attraction and repulsion, magnetic field lines, earth's magnetic field, compass), Electrostatics (two kinds of charge, force exerted by charges on each other (descriptive), attraction between charged and uncharged objects (polarisation), charge conservation, charge quantization),Electric circuits (emf, potential difference (pd), current, measurement of voltage (pd) and current, resistance, resistors in parallel)
	Grade 11	Electrostatics (Coulomb's Law, Electric field), Electromagnetism (Magnetic field associated current-carrying wires, Faraday's Law), Electric circuits (Energy, Power)
	Grade 12	Electric circuits (internal resistance and series-parallel networks), Electrodynamics (electrical machines(generators, motors), alternating current)

Matter & Materials	Grade 10	Revise matter and classification (materials; heterogeneous and homogeneous mixtures; pure substances; names and formulas; metals and non-metals; electrical and thermal conductors and insulators; magnetic and nonmagnetic materials). States of matter and the kinetic molecular theory. Atomic structure (models of the atom; atomic mass and diameter; protons, neutrons and electrons; isotopes; energy quantization and electron configuration).
	Grade 11	Ideal gases (motion and kinetic theory of gases; gas laws; relationship between T and P)
	Grade 12	Optical phenomena and properties of materials (photo-electric effect, emission and absorption spectra)

AN INTERNATIONAL PERSPECTIVE ON THE INVOLVEMENT OF STEMI PROFESSIONALS IN OLYMPIADS AND COMPETITIONS

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Abstract

The introduction of Olympiads in Science (and many other learning areas) in South Africa (and internationally) provides the above average and talented learners with greater cognitive experiences in Science. While the Olympiad questions are based on the knowledge gained, they test other abilities such as understanding, analysis, problem-solving, critical thinking and develop learners metacognitive skills. According to the national priorities for South Africa 2030, in the new global economy there is a need for a workforce with knowledge and skills to compete internationally. A new workforce of problem- solvers, innovators, and inventors who are self-reliant and are able to think logically and critically. With this in mind educators, academics and government officials would need to develop a culture of collaborative engagement which favours learners' participation in national and international Olympiad competition in South Africa. This paper aims to understand the relationship between the key role players in Science Olympiads and learner success at both National and International Olympiads. The results of this study indicate that this endevour if replicated here in South Africa would be based to a certain degree on volunteerism, financial support from major stakeholders and dedication as well as commitment from the community of STEMI personal to enhance the quality of science, mathematics and technology education in South Africa.

Keywords: STEMI professionals and Olympiads,

Introduction

This paper investigates the involvement of STEMI professionals in Olympiads and Competitions from an international perspective. Not much is known about the effects of STEMI professionals support and participation in competitions on participants' further development. Thus, the current study aims to investigate which factors determine success or failure in science competitions as well as the influence of successful practices on students' further cognitive development. In this study questionnaires were handed to jury members at the International Biology Olympiad in Birmingham, United Kingdom 2017. Twenty six questionnaires were collected from participating countries and analysed.

The main focus of this research was to understand the dynamics of involvement of STEMI professionals in learner success in International Science Olympiads. Research in this area is limited and deemed essential in understanding the road to success in these competitions.

Five key areas were investigated with respect to STEMI professionals' involvement in Olympiads and Competitions. Namely, their coordination roles, the key role players in terms of teaching / coaching students for the competitions, funding for Olympiads and Competitions, main procedural functions (selection of students for competitions and the International Olympiad, type of exam written and frequency of competitions) and lastly the role of government in international participation.

Data was analysed using thematic analysis. Key themes were established and frequency tables were assessed to establish STEMI professionals' participation in

Olympiads and Competitions in the 26 countries. The most significant finding in this data set reveals that there is a community of practice involved in the success of students' participation in the Science Olympiads.

Literature Review

It has been suggested that a school-based curriculum is geared towards providing learners and the teachers with guidance on what has to be taught at each age. Hence teachers are trained professionally and are therefore equipped to cover fixed syllabi at each grade/age of a learner. This limits the scope of the subject material taught at each age.

Though teachers and learners are encouraged to also demonstrate understanding, skills and values linked to the knowledge gained, the school calendar, time available and student ability restricted the growth in these areas. The school population and class numbers are usually too large for teachers to give special attention to the above average and especially the gifted and talented learners. Therefore classroom teaching and learning is often governed by and restricted to the syllabus and to a large extent is knowledge-based.

The introduction of Olympiads in Science (and also in many other learning areas) in South Africa (and in other parts of the world) provides the above average and talented learners with greater challenges in Science. Whilst the questions are based on the knowledge gained, they test other abilities such as understanding, analysis, problem-solving and values. These Olympiad questions are regarded as being more difficult and of a higher level in nature and usually challenge students to think.

According to Park, Ryu, and Choi (2016), The International Science Olympiad is an international intellectual Olympic in which students, aged under 20 and who have not entered university, compete using their creative problem solving skills in the field of science. Many nations participate in the Olympiad with great interest, for this competition is a global youth science contest which is also used to measure national basic science levels.

Learners' participation and success in STEM related courses and the extension of learners' cognitive ability through Olympiad training and participation has been of grave importance as depicted by many research studies. Williams (2011), attributes five key ingredients to learner success which can be deliberated when taking into consideration grooming learners for Olympiad competition:

a) Teacher motivation
- It is believed that students who are supported and motivated along the way excel in their field of study. Hence, the role of the tutor / coach in preparation of participants for Olympiad competition is a vital component leading to success.

b) Content knowledge
Students require coaching and support from a team of experts that enables them to develop critical thinking skills and extent their content knowledge.

c) Methods / processes involved
According to Wenger (1998) learners develop skills of different methods / processes involved through collaborative learning techniques in communities of practice.

d) Environment (school atmosphere, administrative support, supervisor's role, family support)

The learning environment is crucial in developing learner success through a combination of supportive stakeholders for example, a supportive teacher, an encouraging coach and family support.

Other studies in this area of Science Olympiads are "the relationships between participation in competitive science events, gender, race, science self-efficacy, interest in science, and choosing a STEM discipline as a college major" (Forrester, 2010); "the Role of Competition in Collaborative Science Inquiry" (Brown and Stombler, 2004); "Science Olympiads as vehicles for identifying talent in the Sciences: Singapore experience" (Lim, Cheah and Hor, 2014) and "An Exploratory Case Study of Olympiad Students' Attitudes towards and Passion for Science" (Oliver and Venville, 2011).

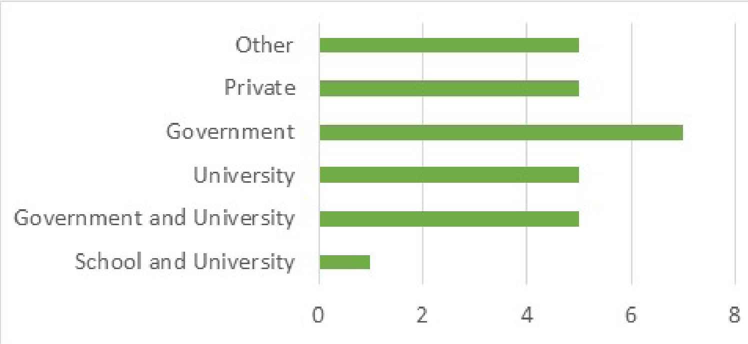
Although there is a knowledge on various aspects of Science Olympiads (increase in student achievement, interest and gain in scientific inquiry skills; relationships between participation in competitive science events, gender, race, science self-efficacy, interest in science; Science Olympiads as vehicles for identifying talent in the Sciences; Students' Attitudes towards and Passion for Science and historical growth and success of the European Union of Science Olympiads from its establishment in 2003 to the present day. It has been established that most research in this field of Science Olympiads is internationally located. Furthermore, what is lacking in this research is an understanding of the relationship between the key role players in Science Olympiads and learner success at both National and International Olympiads.

This research study will attempt to shed some light on which factors determine success or failure in science competitions as well as the influence of successful practices on learners' further cognitive development

Results

The following graphs represent data derived from questionnaires completed by Jury members of 26 countries participating in the International Biology Olympiad 2017. It should be noted that all 61 participating countries did not complete the questionnaire as it was administered on a voluntary basis. Hence there was a 43% response rate which can be regarded as a representative sample.

The data revealed three key themes viz. coordination roles, funding opportunities and key procedural functions. The data will be presented under these themes as follows:
1. Co-ordination of National and International Olympiad (who co-ordinates these events?)



Number of responses

Figure: 1
Figure one reveals the different levels of coordination involved in the national and international Biology Olympiads of participating countries. From the data it is evident that government involvement in seven of the twenty six of the countries researched is the main coordinator of the national and international Olympiads. In addition, it can be seen that the Private Sector, Universities and a combination of university and government involvement feature strongly in terms of preparing and supporting learners towards Olympiad participation.

2. Role of STEMI Professionals in Olympiad

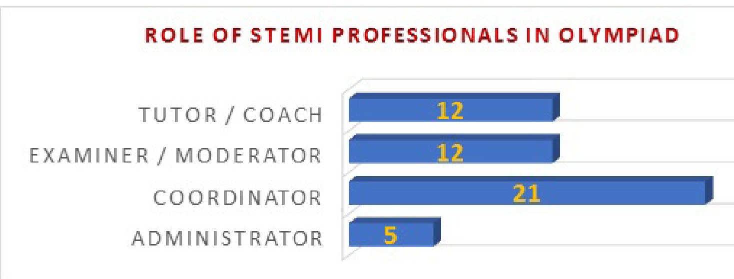


Figure 2:
Figure two discloses that the majority (81%) of IBO 2017 Jury members researched served a coordination role. This was followed by 46 % of the members who were either Tutors / coaches or Examiners who were directly involved with IBO 2017 examination. It is interesting to note the different roles assumed by IBO Jury members which range from coordinators, examiners / moderators, tutors / coaches and administrators. It is evident that stakeholder involvement on all levels is essential to ensure learners are supported and prepared for all aspects of the Olympiad competition.

3. Financial Support for National and International Olympiad

Table 1: Funding of the National and International Olympiad

Financial Support provider	Number of responses
Parents	2
School	0
Sponsor	5
Government	19
No payment	6

Table one displays the responses received with respect to financial support received for participation in national and international Science Olympiads. It is evident that in 19 countries the government sponsors participation in national and international Olympiads. Two countries indicated that the learners' parents sponsors the financial costs of participation whereas 5 countries indicated being sponsored by the Private sector with respect to participation. Six countries revealed no payment and noted that they were sponsored either by government or sponsor.

These results divulge that Government plays a major role in the majority of countries with respect to financial support of participating learners. It is evident that the government support in these countries can be foreseen as an investment in STEM learners as a means of improving the future economy of the country.

4. Role of Government in International Olympiad

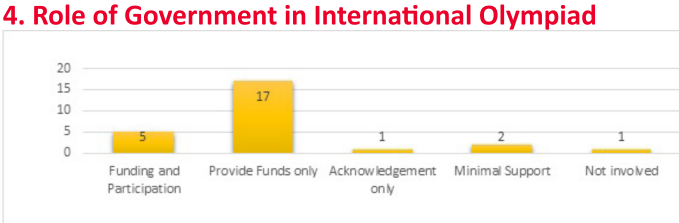


Figure 3:
From Figure 3 it becomes evident that in most instances Government of the country merely provides funds for participation. However, five countries have indicated that Government personnel provide funding and are also feature as participants involved in supporting candidates in preparation of competitions.

5. Key procedural functions

In an attempt to better understand the Olympiad preparation and support system. Jury members from the 26 different countries were asked to reveal how coaching / training for Olympiads is managed, how students are selected for national and international competition, who were the coaches/ trainers of the Olympiad teams and lastly who was involved in preparation and moderation of the national Olympiad examinations.

Table 2:

Category	University	School	Other Institutions
Category	23	0	3
Category	15	10	5
Category	17	15	2
Category	20	9	9

Key:

- Where is coaching/training done? (Category 1)
- Where are selection competitions held? (Category 2)
- Status of coaches (Category 3)
- Who are the examiners and moderators of national exam? (Category 4)

Table two highlights that in most countries (88%) university lecturers and professors are involved with coaching/training of Olympiad participants. Further, it was noted that universities (58%) and Schools (38%) served as venues for selection competitions. This practice emphasizes the collaborative community of practice that is involved in preparation and support of Olympiad participants.

Discussion

Data on the involvement of STEMI professionals in Science Olympiads and Competitions revealed the following key findings:

- Universities and Government were found to be major stakeholders involved with coordination and or support of the Science Olympiad participants.
- Of the 26 countries surveyed majority (81%) of the jury members indicated that STEMI professionals performed a coordinator function. (2 countries receiving top 10 awards indicated that they served as coordinators, examiner/ moderator and coaching roles)
- It is evident that IBO participating countries are supported and /or funded mostly by Government and by a few sponsors
- Jury members who were surveyed (99%) revealed that they are full-time employees. Their roles involved selection, coaching and training of the Olympiad teams for their Country.
- Further, it was revealed that STEMI professionals coaching students were highly qualified with Master's and doctoral degrees. These professionals were linked directly or indirectly to Universities and the Government of the country.

Conclusion

The key finding in data set allude to Universities and the Government in each of these countries playing major role in International Science Olympiads. Further it is indicative that learner success at International Science Olympiads is multifaceted with many stakeholder involvement.

In addition involvement of STEMI professionals is based on team effort between government, schools, universities and /or sponsors.

The most significant finding in this data set reveals that there is a community of practice involved in the success Universities and the Government in each of these countries play a major role in coordination, funding and preparation of students for the Science Olympiads.

This research reveals that a community of practice which involves volunteerism, dedication and commitment to Olympiad teams is what is required to enhance the quality of South African student participation in Olympiads at an international level since 99% of IBO Jury members (2017) indicated being full-time employees of Olympiad teams.

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TEACHERS GOING THE EXTRA MILE: SCIENCE TEACHER'S PERCEPTIONS ON SCIENCE FAIRS IN LIMPOPO SOUTH AFRICA

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ABSTRACT

Only a quarter of the schools are participating in science fairs in Limpopo province. It will be interesting to find out why this is the case by analyzing the perceptions of the teachers. This paper aims to explore science teachers' perceptions on science fairs in Limpopo province. The aim is to compare the perceptions of participating teachers in science fairs and the perceptions of non-participating teachers. In order to gain an in-depth understanding of the teachers` perceptions, a qualitative study approach was adopted. Symbolic Interactionism was the guiding theoretical framework used to conduct this study. Symbolic interactionism provides a framework that concludes that the meanings and actions of teachers and learners involved in science fairs result from the interactions with each other as well as the interpretations of the roles, norms, and goals that help set up the conditions and consequences for their actions (Blumer, 1969).

A grounded theory research design was used to study the perspectives of 10 teachers participating in the interviews. Using symbolic interactionism as a framework, data was collected and analyzed using grounded theory method of constant comparative analysis. As categories emerged, meanings and actions of teachers were revealed. The interview transcripts were subjected to thematic analysis and issues raised by physical science teachers were clustered into categories and related to themes and sub themes.

The findings suggest that most teachers consider science fairs as beneficial and contributing to the scientific skills, communication skills and content knowledge of the learners. Also the teachers indicate that they too benefit in knowledge acquisition and scientific research skills as they mentor the learners. However, a few teachers are of the opinion that science projects are not part of the school curriculum and that it's a worst of time for the learners and teachers.

Keywords: science fairs, symbolic interactionism, volunteerism.

TEACHERS AS VOLUNTEERS

Volunteerism

The principle of donating time and energy for the benefit of other people in the community as a social responsibility rather than for any financial reward.
Title: "Teachers going extra mile" refers to going beyond their normal duties and time.

- Give their time
- Their resources
- heir knowledge and experiences

STATEMENT OF THE PROBLEM

A significant number of teachers is not participating in Eskom Expo for Young Scientists organised science fairs. According to a study conducted recently by Mupezeni and Kriek (2017), the learners cite the lack of teacher support as one of the reasons for their poor performance at science fairs.

RESEARCH QUESTION

What are the teachers' perceptions of Eskom Expo for the Young Scientists organised Science fairs?

PURPOSE OF THE STUDY

The purpose of this study was to understand teachers' experiences and perceptions on science fairs with reference to Eskom Expo for Young Scientists. The data and information gathered from this study was used to examine teachers' perceptions on the Eskom Expo science fairs.

LITERATURE REVIEW

More studies on science teacher beliefs and perceptions are needed (Yung, 2011).
Students also shape the teachers` practice (Busher, 2012).
Students benefit from teacher support but many

schools are not providing the support and mentoring for science fair projects (Akınoğlu, 2008).
The poor performance of learners at science fairs has been attributed to lack of resources and teacher assistance (Alant, 2010; Ndlovu, 2013; Ramnarain and de Beer, 2013; Flanagan, 2013). There is evidence that learning science in the out-of-school setting is beneficial as seen in prior literature (Stott, 2015).

Teachers, parents and science mentors should provide a platform for learners to explore their interests in a less formal environment to enable innovation and creativity in STEM (Wagner, 2012). Science expos give learners a chance of success in their present and future aims and goals (Taylor, 2011). One of the main aims of science fairs is to motivate and encourage learners to be involved in science and become involved in STEM careers (Anderson, 2015; Dionne et al., 2012; Gray, 2014; O'Neille, 2016; Taylor, 2011; Taylor, 2016; Wirt, 2011). In addition, learners have an opportunity to consult and collaborate with the real scientist before and during science fairs (Kahenge, 2013; CWSF, 2016; Molefe, 2011).

THEORETICAL FRAMEWORK

Symbolic Interactionism was the guiding theoretical framework used to conduct this study. Symbolic interactionism provides a framework that concludes that the meanings and actions of teachers and learners involved in science fairs result from the interactions with each other as well as the interpretations of the roles, norms, and goals that help set up the conditions and consequences for their actions (Blumer, 1969).

A grounded theory research design was used to study the perspectives of 10 teachers participating in the interviews. Using symbolic interactionism as a framework, data was collected and analyzed using grounded theory method of constant comparative analysis. As categories emerged, meanings and actions of teachers were revealed.

RESEARCH METHOD

Research Design: A qualitative research. To gain an in-sider view of the perceptions of teachers on science fairs, an interpretivist paradigm was taken as point of departure. An exploratory case study research design was followed. An inductive analysis, which is the identification of patterns and themes in the data, was applied (Bertram & Christiansen, 2015; Creswell, 2014; Leedy & Ormrod, 2010).

Sampling: The population size was 36 teachers from science fair participating schools and purposeful random sample was used to select 10 teachers; 5 from rural schools and 5 from urban schools in Vhembe district of Limpopo province of South Africa.

Data collection: Primary data sources for this study were telephone interviews which were conducted using an interview guide consisting of 4 questions.
Data analysis: The semi structured interviews were digitally recorded and transcribed and the participating teachers were asked to comment on the accuracy of the transcription to strengthen the trustworthiness of the study.

Generalizations were made about the concerns and perceptions of teachers on science fairs.

DATA COLLECTION PROCEDURES

Interviews were conducted over the phone. The interviews averaged 20 minutes each. All interviews were recorded and then transcribed. The researcher took notes during the interviews. The notes and transcriptions of the interviews served as the primary data sources.

A "general interview guide" (Patton, 1990, p. 280) was developed to address the research question.

The interview guide consisted of the following four questions:

1. What are your reasons for participating or non-participating in science fairs?
2. Describe your school`s participation or non-participation in science fairs
3. What advice would you give to a) Eskom Expo coordinators b) learners, c) school, d) teachers, for successful learner participation in science fairs.
4. What would you consider as contributing factors to successful quality science projects?

TRIANGULATION

Validity of a qualitative study is obtained by triangulation (Patton, 1990). The primary form of triangulation for this study was "triangulation of sources" (Patton, 1990, p. 464). The data triangulation was achieved by use of multiple interviews. By comparing data from multiple interviews (teacher conversations and curriculum advisors) consistency of statements was checked. To a limited extent, triangulation was done by use of information collected from literature searches.

DATA ANALYSIS

The data open coding techniques were employed to construct categories and subcategories and finally emerging themes were identified (see table 1).

Table 1: Participating teachers

Interview question	Category	Sub-category	Codes
What are your reasons for participating or non-participating in science fairs?	Participating teachers	Exciting, fun for learners	Excitement, interesting fairs, practical activities, motivated
		Develop interest in STEMI	Investigations, research, peer learning, positive attitude towards STEMI, learner centeredness
		Understanding scientists more	Desire to be scientists, science career, demystifying science and mathematics, aware of scientific developments, science as part of life.
		Research projects, presenting findings at fairs	Peer learning, access to mentors/ scientists, scientific skills, communication skills, collaboration, team working
		Teacher professional growth	Gain scientific knowledge, content, skills development

Table 2: Non participating teachers

Interview question	Category	Sub-category	Codes
What are your reasons for participating or non-participating in science fairs?	Participating teachers	Not included in school curriculum	Job description, Expectations from school/parents/HOD, Do not see link with science fairs
		Personalization of interventions	Responsible teacher do not share, when they leave school/quit all is gone
		Lack of confidence to mentor learners	Lack of knowledge and research skills, need training
		Need to finish syllabus	Desire for high pass rates, all time for drilling learners
		School not assisting	Principal hide information, school does not create enabling platform

RESEARCH FINDINGS
The research findings were summarized in table 3 below.

Table 3: Reasons given by teachers.

Reasons for teachers participation or non-participation	
Reasons for participation	Reasons for non-participation
• Desire to assist learners. • Understand the link between science fairs and the learning of science. • Learners gains skills, communication • The learners share ideas with others	• There is not enough time for the science fairs in school program. • It's not part of my job description • Not well informed about scientific method of doing research • Don't have enough information to help learners.

Teachers advice to learners, school and fellow teachers:
1. Learners: should work hard and not wait for support from teachers, they should use libraries and internet. They should not be shy to ask teachers or other professionals for assistance.
2. School: schools should create platforms for learners to do research projects, support them with computers, printing and laboratory equipment.
3. Teachers: It's a 2 way learning process, as you support learners you will also be learning. Science projects are linked to school curriculum

Contributing factors to successful science fairs:
- Judges need to be fair and motivating to learners.
- Coordination of the science fairs must be smooth with effective communication.
- Learners to be linked to professional mentors.
- Schools to be very supportive with their teachers and materials.

CONCLUSIONS
Teachers are willing to support the learners with their science projects but they would want the education department to include science fairs in extra curricula activities of the school.

Teachers need workshops on scientific research skills and the support of the schools by creating enabling platform for learners to do science research projects.

LIMITATIONS OF THE STUDY
This study is exploratory in nature and the assertions, categorizations, and generalizations need to be considered within the context and the limited information upon which these statements are based.
- Future studies to be conducted at a larger scale, since this study only comprises 10 participants.
- The study was voluntary and it's possible that the teachers who did not participate could have provided different perspectives to those who were interviewed.

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STEMI Olympiads and Competitions and Community of Practice Conference

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Theme of the conference - Building a culture of volunteerism and community service in Science, Technology, Engineering, Mathematics, and Innovation (STEMI) 2018

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The South Africa Agency for Science and Technology Advancement (SAASTA) is a business unit of the National Research Foundation (NRF) with the mandate to advance public awareness, appreciation and engagement of science, engineering, innovation and technology in South Africa.
Science, through research, has a crucial role to play in the growth of South Africa's economy. Active dialogue and engagement between science and society ensures that scientific research findings are easily translated into relevant, appropriate and beneficial innovation and entrepreneurial opportunities. Research findings should also have an impact on policy and social conditions in a country. This can only be achieved when science becomes a daily dialogue and discourse.
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Mission
To advance public awareness, appreciation of and engagement with science, technology, engineering, mathematics and innovation in South Africa.

Vision
SAASTA aims to be the leading science advancement agency communicating the value and impact of science and technology in a dynamic knowledge economy, and simultaneously building the science engineering technology human resource based in South Africa.

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