Education and Skills Development

Science Engagement Framework and Youth into Science Strategy: Science Centre Capacity Building Project Evaluation 2016

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Abbreviations

CEO	-	Chief Executive Officer
DST	-	Department of Science and Technology
FET	-	Further Education and Training
HartRAO	-	Hartebeesthoek Radio Astronomy Observatory
HSRC	-	Human Sciences Research Council
IAU	-	International Astronomical Union
ICT	-	Information and Communication Technology
I-SET	-	Inspired towards Science, Engineering and Technology
JICA	-	Japan International Cooperation Agency
JOCV	-	Japanese Overseas Cooperation Volunteers
KZN	-	KwaZulu-Natal
NECSA	-	South African Nuclear Energy Corporation
NGO	-	Non-governmental organisation
NMBSTC	-	Nelson Mandela Bay Science and Technology Centre
NRF	-	National Research Foundation
SAAO	-	South African Astronomical Observatory
SAASTA	-	South African Agency for Science and Technology Advancement
SAASTEC	-	Southern African Association of Science and Technology Centres
SANSA	-	South African National Space Agency
SCCB	-	Science Centre Capacity Building
SES	-	Science Engagement Strategy
STEM	-	Science, Technology, Engineering and Mathematics
UNISA	-	University of South Africa

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Executive Summary

In response to the capacity challenge experienced among the growing number of South African science centres, the Department of Science and Technology (DST) introduced the Science Centre Capacity Building (SCCB) project in 2005/06. The responsibility for the delivery of this project rests with the South African Agency for Science and Technology Advancement (SAASTA) which was mandated to address capacity building within science centres through the provision of training opportunities which support science centre officials in enhancing the management of their centres, and encourage networking among the network of science centres.

The training which was conducted through the SCCB in 2016 is evaluated in this study in relation to the objectives and expected outcomes of the SCCB project. The 2016 training included four workshops, the job shadowing programme held at six centres during the year, and the annual Southern African Association of Science and Technology Centres (SAASTEC) Conference which was held in KwaZulu-Natal in November.

The data for the study was collected in three phases: 1) information related to the workshops and job shadowing, including attendance registers was obtained; 2) questionnaires were administered to attendees of the 2016 SAASTEC Conference; and 3) online surveys were used to collect data from participants of the SCCB workshops and the job shadowing programme.

The training opportunities were found to have an important impact on the individual capacity of participants, with many of the respondents from all three training interventions indicating that they had gained valuable knowledge and skills from participating. In the majority of cases, enabling environments were found to exist at the science centres, where the transfer of knowledge gained through training is encouraged. The practical application of this knowledge is also encouraged, with respondents being given new responsibilities or asked to implement new programmes or strategies, activities or exhibits. These enabling environments allow for the enhancement of institutional capacity. The training interventions have also provided the opportunity for networking and collaboration, both among South African science centres, and with international organisations. The findings of the study reveal that the SCCB project is addressing its stated objectives and expected outcomes, through enhancing the capacity of individuals and the capacity of science centres at the institutional level, as well as promoting networking.

A number of recommendations to further address the objectives and expected outcomes of the SCCB project were developed from the findings of the study. The different forms of training should be extended to incorporate as many participants as possible, while a number of core modules which focus on areas which are central to the responsibilities of science centres should be presented regularly. The provision of training material through a variety of avenues will extend the reach of the training, and the transfer of knowledge and skills gained from training, as well as their practical application, should be encouraged within science centres. Strategies to retain human capacity are crucial, and supporting younger and less experienced staff members and science centres, is key to the success of these institutions. Collaboration and sharing of best practices should be encouraged, not only among science centres, but also between science centres and the wider STEM community.

Part One: South Africa's Science Centre Network

1.1. Introduction

The Science Centre Capacity Building (SCCB) Programme was imitated in 2005/06 by the Department of Science and Technology (DST) as a response to the capacity challenge evident within South African science centres. This challenge occurred as a result of the rapid pace in the growth of these centres. This programme addresses capacity building through the provision of training to support science centre officials in improving the effective management of their centres, as well as providing networking and information sharing opportunities. The task of implementing this project was given to the South African Agency for Science and Technology Advancement (SAASTA)[1]. The target audience of the SCCB project is science centre staff, science outreach programmes from National Facilities, and science outreach staff from Institutions of Higher Learning (SAASTA, 2009b; SAASTA, 2012; SAASTA, 2013).

At the beginning of 2015, the DST adopted the Science Engagement Strategy (SES), which recognises science centres (including natural science museums, zoos, aquaria and botanical gardens) as providing the basic platform or infrastructure for pursuing the strategic goals[2] of the SES (DST, 2015). Building capacity among the human resources in these spaces is therefore even more important, and the SCCB project will play an important role in ensuring that science centres are able to effectively pursue Science, Technology, Engineering and Mathematics (STEM) engagement, awareness and education.

The DST's Science Engagement Strategy Implementation Plan highlights the important role which science centres play within the country as the only permanent DST-supported institutions that are responsible solely for science engagement. They are therefore recognised as the "key infrastructure for science engagement" (DST, 2017: 10), and the plan indicates the need to strengthen the existing science centres and establish new science centres where possible (DST, 2017). In addition, the document puts forward that the annual Southern African Association of Science and Technology Centres (SAASTEC) Conference should continue as it provides a platform for engagement within the science community, including science advancement practitioners, scientists and relevant theoreticians (DST, 2017).

This study, which was conducted by the Human Sciences Research Council (HSRC), evaluated the SCCB training which was provided during 2016, in an attempt to understand the impact of the training on the capacity within the country's science centres. This report presents the findings from secondary data, as well as from primary data, in the form of a questionnaire and an online survey, which were completed by participants of the SCCB training.

[1] SAASTA is a business unit of the National Research Foundation (NRF) and the key South African institution for promoting science (SAASTA, 2009b).

[2] The strategic goals of the strategy are: 1) To popularise science, engineering, technology and innovation, 2) To develop a critical public that actively engages and participates in the national discourse of science and technology, 3) To promote science communication that will enhance science engagement, and 4) To profile South African science and science achievements domestically and internationally.

The first part of the report provides an outline of the importance of science centres, and presents an overview of the science centres in South Africa. In the second part of the report, information is provided about the SCCB project and the intervention areas which it seeks to address. The research questions and the methodology which was used to evaluate the training are described in part three. Thereafter, the findings of the study are presented in parts four, five, six and seven. A number of recommendations which emerged from the findings of the study are presented in the final part of the report.

1.2. Science centres and capacity building

The DST defined a science centre as "a permanently established education facility that provides an interactive educational experience through the use of interactive science, technology, engineering and mathematics exhibits, displays and programmes" (DST, 2005: 9). Science centres are designed to include exhibits that incorporate a mix of scientific knowledge and science-based technology (Tlili, 2008). Through their activities and exhibits, science centres aim to highlight the relevance of science to everyday life (Rix and McSorley, 1999), with the goal of inspiring individuals to engage with science and technology (Meisner *et al*, 2007), ultimately supporting science learning (Falk and Needham, 2011). Consequently, these centres possess the potential to promote science and technology, and as such it is important to ensure that they have the capacity to adequately accomplish these goals.

The promotion of ongoing capacity building or development is therefore key to the success of these centres. Capacity building can be defined as "the process by which individuals, groups, organizations, institutions and societies increase their abilities to: (a) perform core functions, solve problems, define and achieve objectives; and (b) understand and deal with their development needs in a broad context and a sustainable manner" (UNESCO and IIEP, 2010: 82). The SCCB project therefore has a central role to play in building the capacity within South African science centres to assist them in achieving their objectives.

1.3. Why are science centres important?

It has for a long time been recognised that children learn science from a variety of sources outside of the classroom, and that these sources have the potential to supplement and interact with science learning which occurs within the classroom. Informal learning relates to activities that occur outside of the school environment (Beiers and McRobbie 1992; Sasson, 2014). Science centres are considered to have a key role to play in the informal learning of science (Rennie and Williams, 2002).Visits to science centres can motivate students to learn science and can affect students' learning (Rennie and McClafferty, 1995). Such environments may also address aspects of science education that might be lacking in formal, class-based science learning environments (Sasson, 2014).

Engagement with science centres has been found to positively influence the learning of scientific knowledge, as well as scientific skills and processes (Beiers and McRobbie 1992; Rix and McSorley, 1999; Sasson, 2014). The largest gains however are made in the influence which science centres have on the development of positive attitudes towards science, which may also result in an increase in interest and enthusiasm for learners' everyday science lessons (Rix and

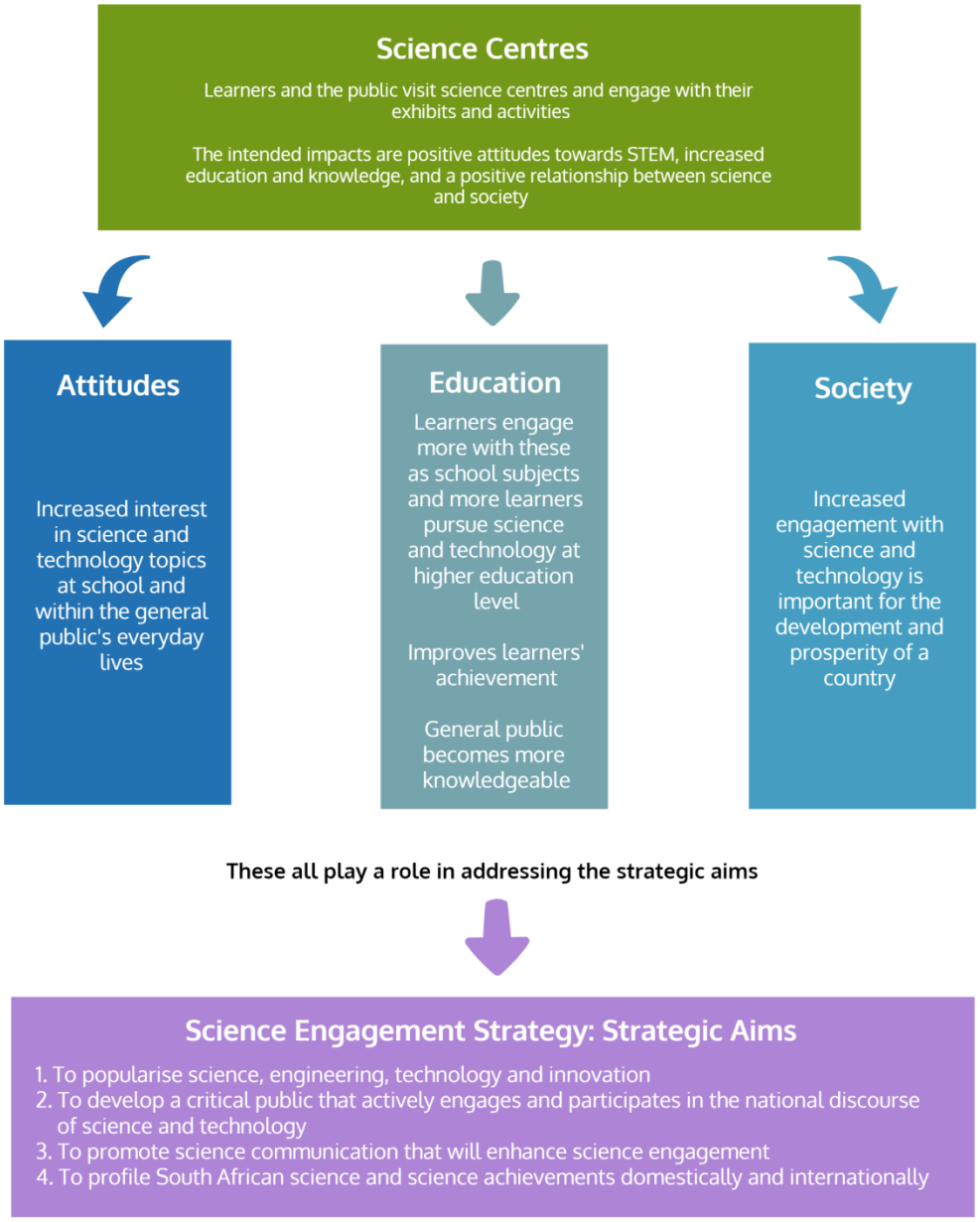
McSorley, 1999). Learners' achievement may therefore be positively influenced by more positive attitudes towards science (Juan et al, 2014).

Science centres also play an important role in encouraging youth to pursue science and technology at the higher education level (Fors, 2006; Aguirre, 2014). This has important implications for society as there has been a lack of learners choosing to continue science in the final years of their secondary education and at the higher education level (Fors, 2006; George, 2006; Mji and Makgato, 2006; Sarjou *et al*, 2012). South Africa is no exception to this trend. Many students perform poorly in science, and therefore do not choose to continue with it, or may not qualify to study science at university (Mji and Makgato, 2006; Martin *et al*, 2012).

Science centres also engage with the general public, encouraging the participation of people of all ages. Through this engagement, the public may gain scientific knowledge, an understanding of important contemporary debates about science and technology, as well as an interest in science and technology (Aguirre, 2014; Heath and vom Lehn, 2008). Science centres are therefore involved in the education and transformation processes taking place in the society with which they are engaged (Aguirre, 2014).

Promoting an understanding of, and interest in, science are key aspects for the development and future prosperity of a country (Fors, 2006). Figure 1 illustrates the significant impact which science centres may have on learners and the general public, highlighting the importance of these spaces in achieving the aims of the Science Engagement Strategy.

Figure 1: The potential impact of science centres



1.4. South African Science Centres

In 2011, it was announced that the country planned to increase the number of science centres (www.southafrica.info). Between 2011 and 2017, the number of science centres has increased from 26 centres in eight provinces in 2011 (Hweshe, 2011) to 35 science centres in nine provinces in 2017 (DST, 2017).

Gauteng is home to 10 science centres, 6 are located in KwaZulu-Natal, 5 in Western Cape, 4 in Mpumalanga, 4 in Limpopo, 2 in Eastern Cape, 2 in North West Province[3], and 1 each in Northern Cape and Free State. Figure 2 shows the location of the country's 35 science centres, and Table 1 provides the key for the map.

[3] The North West University Mafikeng Science Centre was burnt down in 2016 by protesting students who were unhappy about the change in their Student Representative Council.

Figure 2: The location of science centres in South Africa

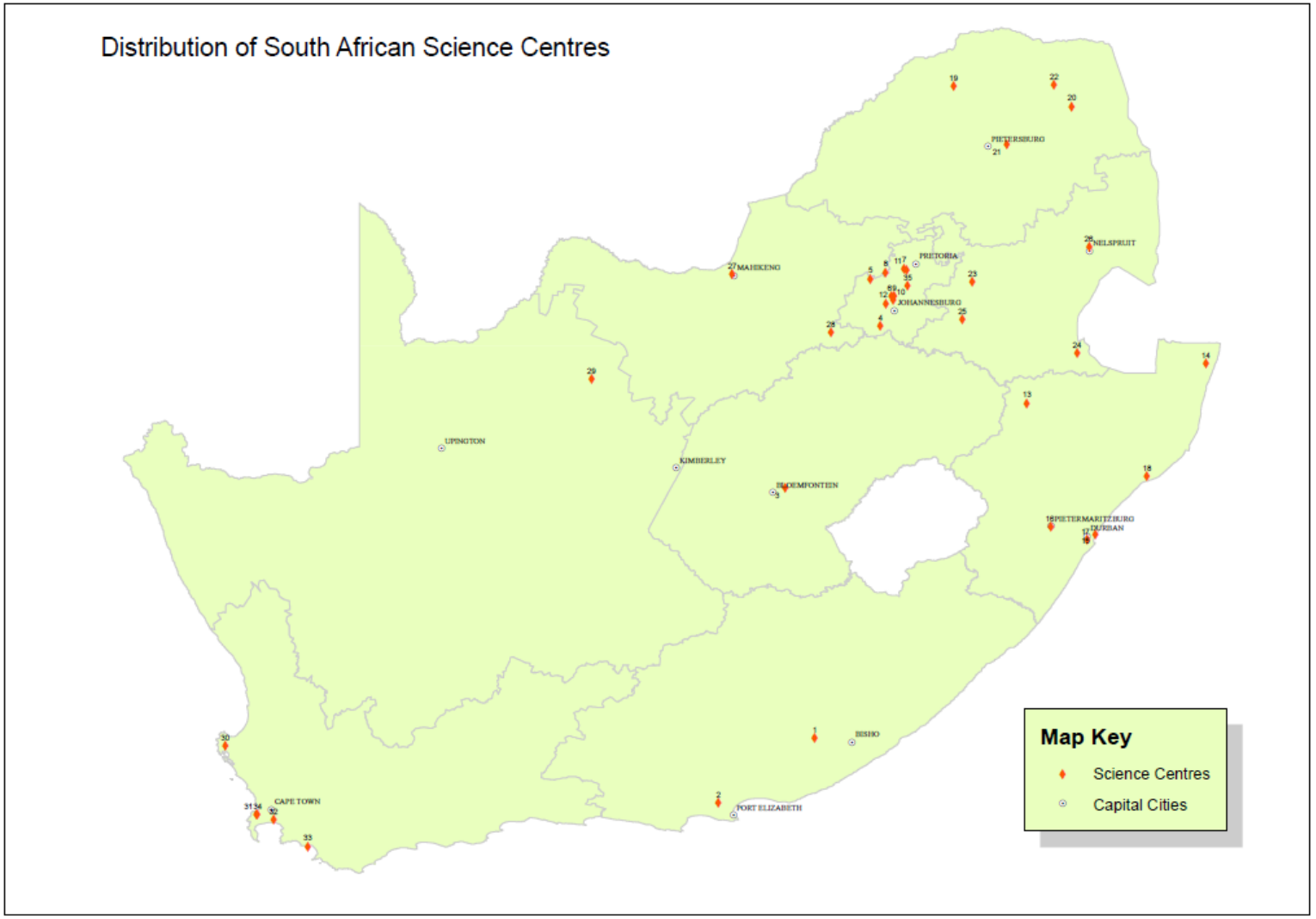


Table 1: Key for Figure 2

Science centre distribution			
1	FOSST Discovery Centre	**19**	Bostec Science Centre
2	Nelson Mandela Bay Science and Technology Centre	**20**	Giyani Science Centre
3	Boyden Observatory Science Centre	**21**	University of Limpopo Science Centre
4	Arcelor Mittal Science Centre Sebokeng	**22**	Vuwani Science Resource Centre
5	HartRao	**23**	Anglo-American Science, Career Guidance and ICT resource centre
6	Johannesburg Botanical Gardens Science Centre (Johannesburg City Parks)	**24**	Mondi Science, Career Guidance and FET Skills Centre
7	National Zoological Gardens	**25**	Osizweni Education and Development Centre
8	NECSA Visitor Centre	**26**	Penreach Science and Education Centre
9	Sasol Inzalo Foundation	**27**	North-West University Mafikeng Science Centre
10	Sci-Bono Discovery Centre	**28**	North-West University Science Centre Potchefstroom
11	Sci-Enza	**29**	Mothibistad Science Centre
12	Soweto Science Centre	**30**	Arcelor Mittal Science Centre Saldanha
13	Arcelor Mittal Science Centre Newcastle	**31**	Cape Town Science Centre
14	Isibusiso Esihle Science Discovery Centre	**32**	iThemba Labs
15	KZN Science Centre	**33**	SANSA Science Centre
16	Olwazini Discovery Centre	**34**	South African Astronomical Observatory
17	University of KZN Science and Technology Centre	**35**	Moipone Academy Science Centre
18	Unizulu Science Centre		

Part two of the report outlines the SCCB project and the intervention areas which are targeted through the project.

Part Two: Science Centre Capacity Building Project

SAASTA introduced the Science Centre Capacity Building (SCCB) project in 2005/2006. The training has incorporated a range of training workshops each year, international study visits and a job shadowing programme. These interventions aim to improve the management of the centres through capacity building, as well as to provide opportunities for networking.

2.1. Intended intervention areas of the SCCB project

The main aims of the SCCB project are ***to provide skills and knowledge development within the science centre network,*** and ***to address South Africa's immediate need to attain scientific and technological self-resilience.***

Within this aim, the specific objectives are:

1. To support capacity building of science centre staff at a national level
2. To support the development of capacity building for exhibit development
3. Liaison with stakeholders from DST and the Science Centre Council

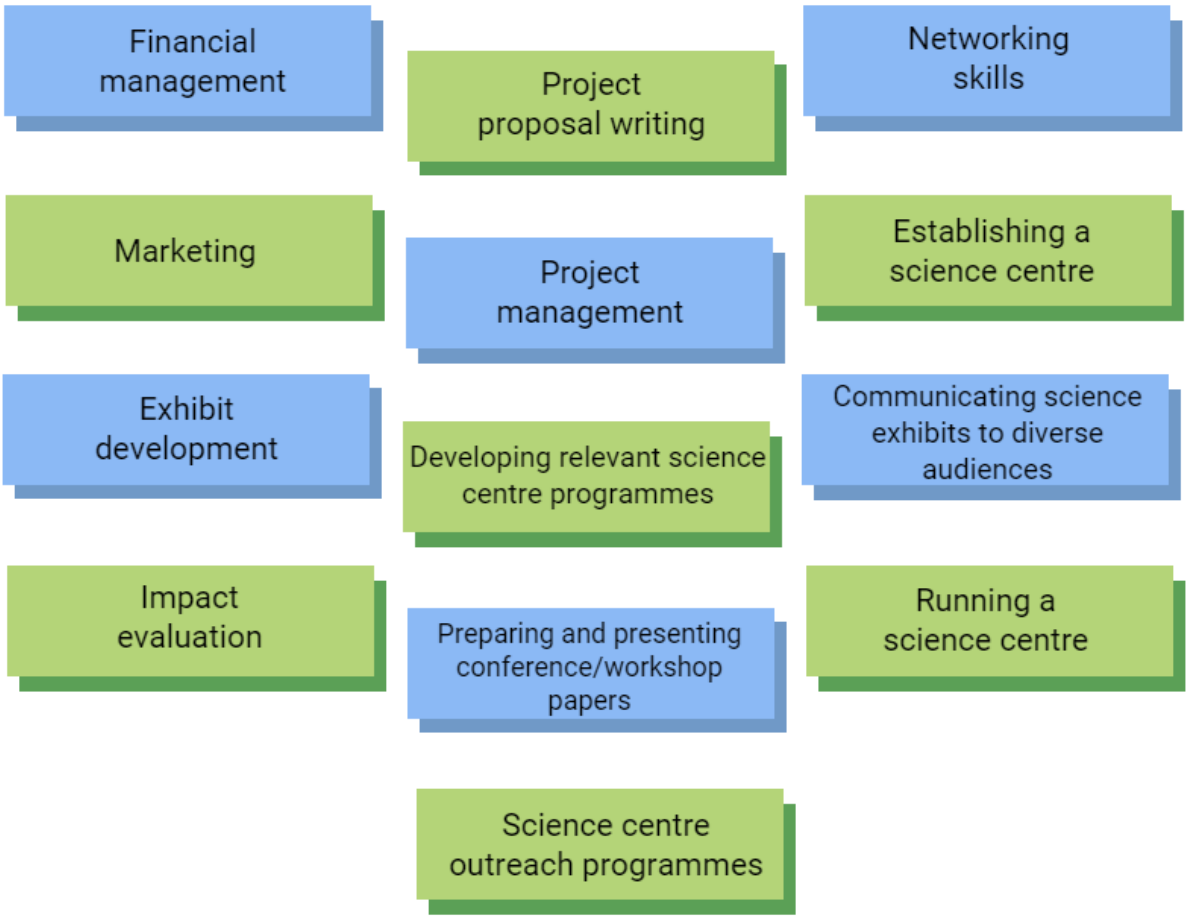
The expected outcomes of the SCCB project are:

1. Developed and enhanced core skills of participants
2. Developed exhibit prototypes
3. Improved programmes at science centres
4. Increased networking amongst science centres
5. Increased local and international networking opportunities for participants from science centres

(SAASTA, 2009a).

The SCCB project identified thirteen intervention areas which required focus in order to achieve the defined outcomes. A 2004 feasibility study initially provided input to the determination of these areas, following which informal discussions took place with the science centre community and the leadership of the Southern African Association of Science and Technology Centres (SAASTEC). Shortcomings which were identified by the DST through its interaction with the centres were also incorporated. Finally, these areas for skills enhancement were reconfirmed and expanded through a 2007 internal implementation evaluation of the SCCB Programme by the DST (DST, n.d.). The intended intervention areas are presented in Figure 3.

Figure 3: The intended intervention areas of the SCCB project



(DST, n.d.).

2.2. SCCB training

In order to determine the specific training that the SCCB provides, the requirements of science centre staff members, in terms of their personal development plans, are taken into account. Skills gaps at the science centres are identified, following which staff members who require training in these particular skills are identified. A panel is then responsible for selecting some of these staff members to be involved in the training. The process of identifying skills gaps is a collaborative one between the science centres and SAASTA.

2.3. Funding for the SCCB project

Funding for the SCCB project is provided by the DST, and has increased from R450 000 for the 2009/2010 financial year to R1 250 000 for the 2016/2017 financial year. Table 2 shows the amount which has been allocated to the SCCB project annually over this period.

Table 2: Funding for the SCCB project: 2009-2017

Financial Year	Amount
2009/2010	R450 000
2010/2011	R450 000
2011/2012	R500 000
2012/2013	R500 000
2013/2014	R600 000
2014/2015	R800 000
2015/2016	R1 075 000
2016/2017	R1 250 000

2.4. Evaluating the SCCB project

This evaluation of the SCCB project focused on the capacity building opportunities provided by the SCCB during 2016 in order to determine whether the objectives and intended outcomes of the project are being met. Additionally, the study informed a set of recommendations which may enhance the effectiveness of the project in supporting science centres at an institutional level, and science centre staff members at an individual level, as well as promoting networking among science centre in the country.

The third part of the report presents the research questions which informed the study, and the methodology which was used to answer these questions.

Part Three: Research Questions and Methodology

3.1. Key research questions

The broad research objective was to evaluate the impact of the capacity building training on South African Science Centres. The key research questions were:

1. What training has occurred?
2. What are the views of the participants of the training?
3. Has the training had an impact on the individual capacity of science centre staff?
4. Has the training had an impact on the institutional capacity of science centres?
5. How can the SCCB training be improved?

3.2. Methodology

This study assessed the quality and success of the SCCB project in reaching its stated goals, through an evaluation of the training which was conducted as part of the project in 2016. The study focused on the impact of the training on staff members, as well as the impact on science centres at the institutional level, and the enhancement of networking among science centres. Both qualitative and quantitative data were used in the study. Three phases of data collection occurred:

Phase 1

Data related to the training workshops and job shadowing which took place were initially collected from SAASTA, including information regarding each of the workshops which were conducted in 2016. The attendance registers for each workshop and for the job shadowing opportunities were also provided by SAASTA.

Phase 2

A researcher attended the 2016 South African Association of Science and Technology Centres (SAASTEC) Conference which was held in Rickards Bay in KwaZulu-Natal in November 2016. On the final day of the conference, attendees were asked to complete a questionnaire regarding their experience at the conference. Responses were received from 63 participants.

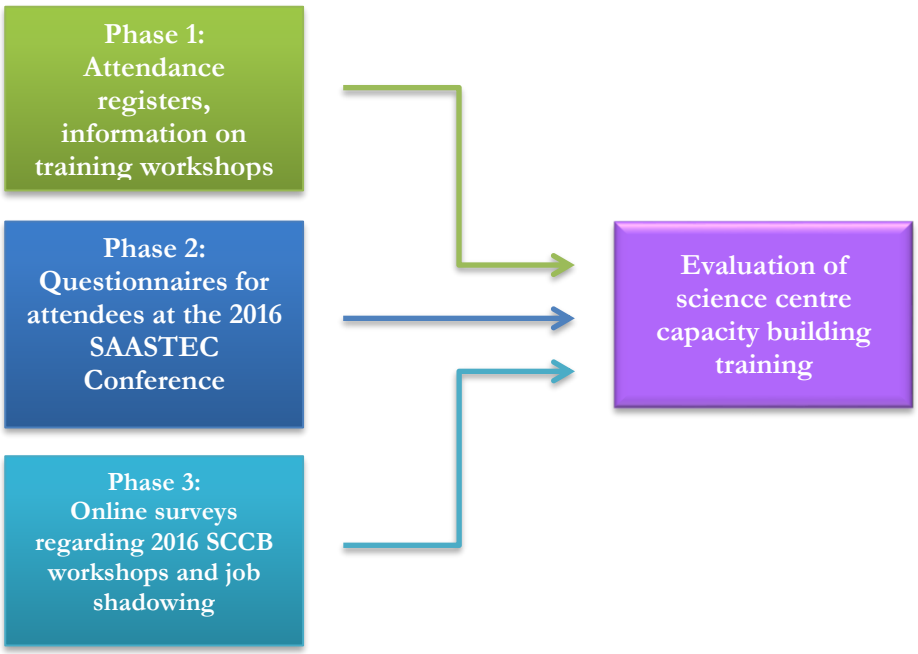
Phase 3

Two online surveys were developed which asked questions about the 2016 training workshops and the job shadowing programme. One survey was sent to those who had attended at least one of the workshops, or at least one workshop and job shadowing. A different survey was sent to those who had only attended job shadowing in 2016. Contact details for the participants were available in the attendance registers which were provided by SAASTA.

For the workshops, 87 science centre participants were identified. Some of these participants had incorrect e-mail addresses or did not provide e-mail addresses. Attempts were made to contact these respondents telephonically to obtain this information, if their contact numbers were provided. The final sample for the workshop participants was 68. Forty one responses were received, providing a 60% response rate.

For the job shadowing, 42 participants were identified from the registers. There were no contact details for four of the participants, leaving a sample of 38. Of these, 24 responses were received, providing a response rate of 63%. Figure 4 provides an outline of the phases of data collection.

Figure 4: Phases of the data collection



Parts four to seven of the report present the findings of the study. Part four provides an overview of the 2016 training, part five presents the findings from the SAASTEC Conference, and part six discusses the findings from the online survey related to the 2016 workshops. The final findings section, part seven, explores the findings from the questions asked to participants of the 2016 job shadowing.

Part Four: 2016 SCCB training

This section provides information about the various types of SCCB training which took place in 2016, including the SCCB workshops which were held, the annual SAASTEC Conference and the annual job shadowing programme.

4.1. What capacity building has occurred?

In 2016, four workshops were held as part of the SCCB training. In addition the annual SAASTEC Conference held at Unizulu Science Centre in Richard's Bay, KwaZulu-Natal (KZN) provided the opportunity for participants to gain valuable knowledge and skills, as well as opportunities for networking and charring experiences. Job shadowing, which allows participants to spend time at host science centres, took place at six science centres during 2016[4]. The training interventions which took place in 2016 are shown in Table 3.

Table 3: 2016 capacity building

Training	Date	Participants
Japanese Overseas Cooperation Volunteers (JOCV) Workshop	16-18 August	34
Robotics Workshop	6-7 September	37
Mobile Lab Workshop	21-23 September	43
HySA Workshop	13-14 October	40
2016 SAASTEC Conference	7-9 November	Not available
Job shadowing	Throughout the year	42

4.1.1. JOCV Workshop

The Japanese Overseas Cooperation Volunteers (JOCV) Workshop followed on from the success of the collaboration between the Japan International Cooperation Agency (JICA), DST and SAASTA. A JOCV Workshop was also held in 2015. The workshop provided an opportunity for Saitama volunteers from Japan to engage and share ideas and experiments with science centre staff from various South African science centres. A range of topics were covered in the workshop including sound waves; piezoelectric element; atmospheric pressure and flame reaction. Initially, two science centres in KZN and one in Mpumalanga hosted the workshop for learners and the public during National Science Week. Following this, a three day workshop was held for science centres in Gauteng.

Saitama prefecture (province) education board in Japan committed to sending science volunteers to South Africa over the next few years. Workshops such as this which provide engagement between these volunteers and science centre staff members allow for sharing and the spread of science interest within the country, as well as allowing the volunteers to learn and experience new ways of engaging in science, which they are then able to share with others in Japan.

[4] Sci-Bono Science Centre hosted job shadowing twice in 2016

4.1.2. Robotics Workshop

The Robotics Workshop was hosted by SAASTA on the 6th and 7th September 2016. The workshop was facilitated by two UNISA I-SET (Inspired towards Science, Engineering and Technology) delegates and an I-SET Fulbright scholar from Texas Tech University. The purpose of the workshop was to equip and train robotics coaches and mentors to inspire science, engineering and technology for a team of learners at each science centre. A secondary goal of the workshop was to ensure that each science centre is represented by at least one robotics team at the FIRST Lego League competition, for which teams consist of 6 -10 learners, aged from 10 to 16 years.

4.1.3. Mobile Lab Workshop

The Sasol Inzalo Foundation was asked by the DST/SAASTA to extend its annual training programme to implementers of Mobile Labs at science centres nationally. Both theoretical and practical aspects of the Mobile Lab activities were covered in the programme, drawing from the expertise and experience of both government and non-governmental organisation (NGO) players. The training was intended to lead to the development of a Mobile Lab Handbook, facilitated by the Sasol Inzalo Foundation with input provided by participants of the workshop.

4.1.4. HySA Workshop

The HySA Workshop was held on the 13th and 14th October 2016, focusing on Hydrogen Fuel Cell Technology. The workshop was sponsored by SAASTA and Anglo American Platinum. Hydrogen and fuel cell technologies was identified by the DST as a "frontier science and technology" platform that would allow proactive innovation and knowledge generation to benefit from South Africa's natural resources. The HySA Public Awareness Demonstration and Education Platform was created; to market the technology locally and internationally. Science centres are poised to play an important role in familiarising society with this technology.

4.1.5. Job shadowing

Job shadowing opportunities were provided during 2016 at six science centres. Job shadowing allows science centre staff members to visit an experienced science centre for a week, learning about different aspects of science centres. Staff members are able to share their experience during these visits. During the week, three days are allocated for the host centres to focus on their strengths; while the remaining two days allow visitors to explore other avenues that they may have encountered. The host science centres for 2016 were:

- Vuwani Science Centre
- Sci-Bono Discovery Centre
- Cape Town Science Centre
- FOSST Discovery Centre
- Giyani Science Centre
- ArcelorMittal Science Centre Sebokeng

The next three parts of the report (five, six and seven) present the findings from the evaluation of the various training interventions held in 2016. Part five focuses on the 2016 SAASTEC Conference.

Part Five: Evaluation of the 2016 SAASTEC Conference

Part five discusses the findings from the questionnaires which were administered at the 2016 SAASTEC Conference. Section 5.1 provides the profile of the respondents. This is followed by an evaluation of the conference, in terms of the participants' rating of their experience, the knowledge and skills which they gained, what they learned, their preparation and feelings about presenting, as well as areas they highlighted which require improvement.

5.1. Who were the respondents?

The questionnaire was administered to all attendees who were present on the final day of the conference in order to be able to evaluate as much of the conference experience as possible. The questionnaires were completed by 63 attendees, including those from various South African science centres, as well as participants from the Botswana International University of Science and Technology; Christoph Meyer Maths and Science Centre; Durban Natural Science Museum; Eding! International Science Festival; Formula D Interactive; IAU- Office of Astronomy for Development at SAAO; ICT Club Mpumalanga; Informal Learning Experience Inc; Japan International Cooperation Agency (JICA); Lasec SA; the National Science and Technology Forum; the South African Institute for Aquatic Biodiversity; Sustainable Enterprise for Enabling Development Trust and the Zimbabwe Science Fair. Table 4 provides a summary of the demographic characteristics of the respondents.

Table 4: Profile of respondents at the SAASTEC Conference

Race	**Percentage of respondents**
Black	**74%**
Coloured	2%
Indian	7%
White	16%
Other	2%
Sex	
Male	**55%**
Female	45%
Age	
Under 25	8%
25-35	**47%**
35-45	17%
45-55	18%
55-65	7%
65 and over	3%
Number of years at the science centre/organisation	
Less than 1 year	14%
1-3 years	**36%**
4-6 years	22%
7-9 years	9%
10-15 years	10%
16-20 years	2%
More than 20 years	7%

Full Time/Part Time/Volunteer	
Full Time	**63%**
Part Time	8%
Volunteer	24%
Contract	2%
PhD student	2%
Fellowship	2%

The majority of respondents from the conference were therefore Black (74%), with just over half being male. Just under half of the respondents were between the ages of 25 and 35, and approximately a third had been at their science centre or organisation for a time period of between one and three years. The majority were also full time employees at their respective institutions.

Twenty percent of the respondents were project or programme co-ordinators, 16% were science communicators and 13% were managers. The rest of the respondents held a variety of positions: CEO managing member, founder, owner, director, education liaison officer, youth outreach and media liaison officer, outreach officer, STEM learning officer, field advisor, education officer, administrator, operations manager, volunteer/intern, career guidance curriculum advisor, curriculum of education programmes officer, PhD student in science communication, Fulbright scholar, lab technician, edutainer, branch librarian, freelance researcher, and new business development: education CSR.

5.2. Conference attendance

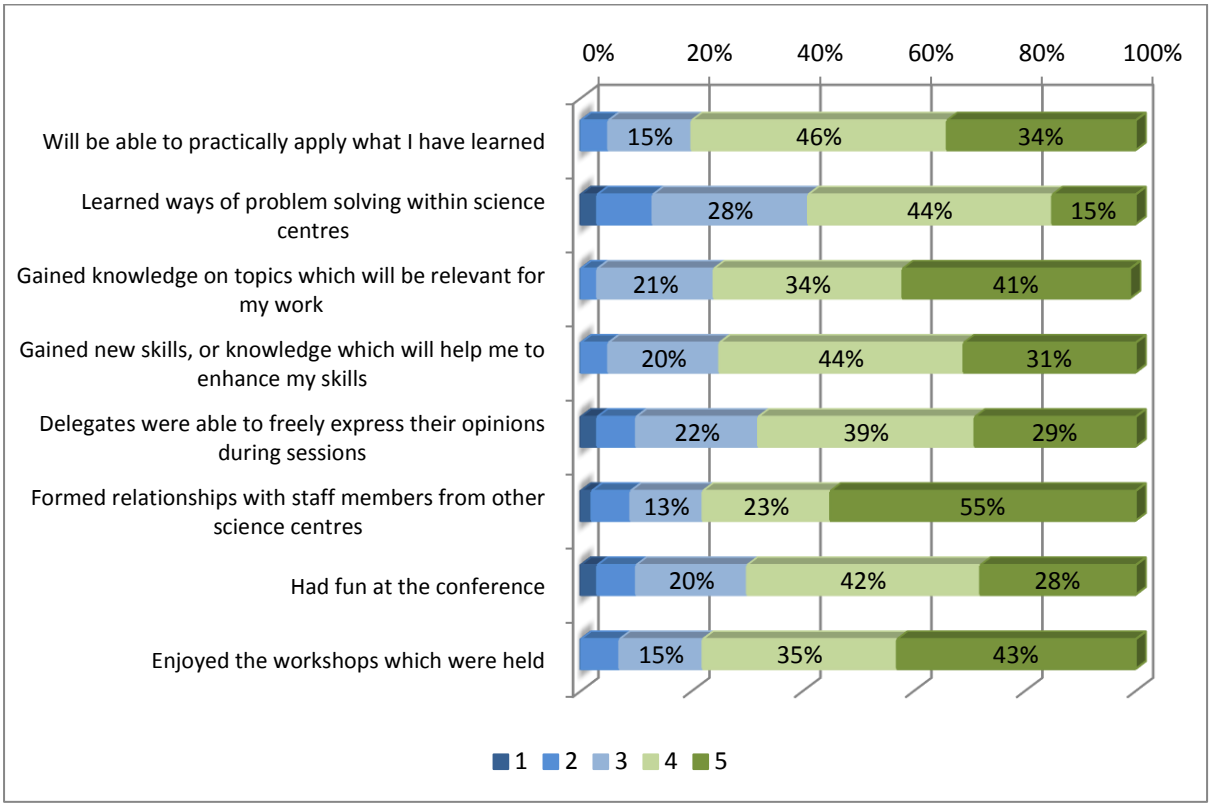
The SAASTEC Conference provides an important opportunity for capacity building and promoting STEM engagement within the science centre community. It is therefore important for the opportunity to attend the conference to be extended to as many people as possible. Respondents were therefore asked whether they had attended a SAASTEC Conference before. Fifty three percent had not attended a SAASTEC Conference before, indicating that opportunities are being provided for different people to attend the conference thereby allowing for further capacity building to take place.

The 10th November, the day after the conference ended, was International Science Centre and Science Museum Day. The conference was planned to coincide with this, and an event was held at Unizulu Science Centre where the centre linked to international proceedings on the day. Seventy eight percent of the respondents indicated that they would be attending this event.

5.3. Participants' experience of the conference

The questionnaire aimed to assess the experience of the attendees at the SAASTEC Conference. Questions related to what they learned, whether they gained knowledge and skills, and whether they were able to network with staff from other science centres and organisations. In Figure 5, the rating of the respondents' experience is indicated, on a scale from 1 (lowest) to 5 (highest).

Figure 5: Participants rating of their experience at the conference



Ratings of 4 or 5 are considered as the highest ratings, and the analysis will therefore focus on these categories. Eighty percent of the respondents felt strongly (rated as 4 or 5) that they would be able to practically apply what they had learned at the conference. Three quarters felt strongly that they had gained new knowledge, or gained new skills or the ability to enhance their skills from the conference. Nearly eighty percent (78%) of the respondents indicated that they had formed relationships with staff members from other science centres during the conference. During the conference it is important that participants feel that they can engage with others, and sixty eight percent stated that felt they could express their opinions freely. Fifty nine percent of the respondents rated as 4 or 5 the statement "learned ways of problem solving within science centres". Problem solving is an area which requires attention as science centres can learn from one another based on experiences which have involved overcoming challenges. This is however not an area which would be extensively focused on during presentations at the conference.

The majority of participants enjoyed the conference, and many indicated that they had fun. In addition, eighty six percent highlighted that attending the conference was worthwhile and eighty seven percent indicated that they would like to participate in future conferences: (rated as 4 or 5).

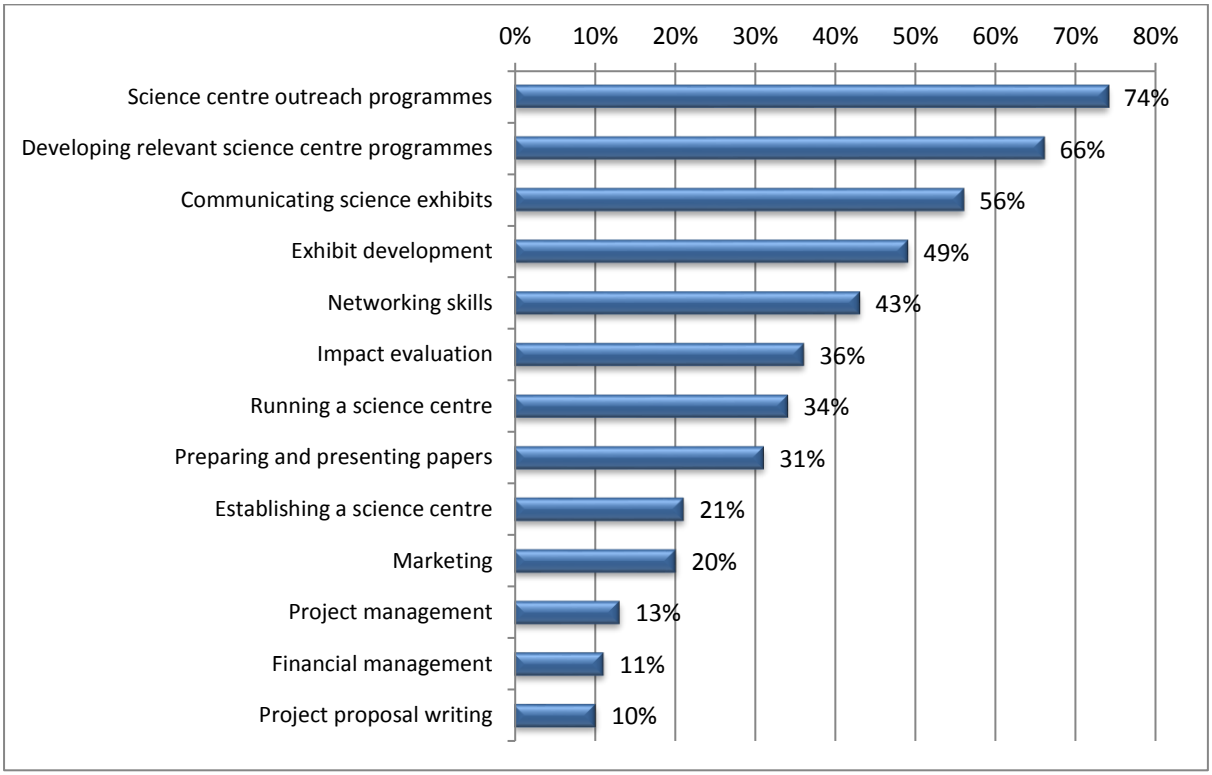
5.4. Knowledge and skills gained from the conference

In order for science centres to operate effectively, staff members must possess a range of relevant knowledge and skills. Respondents were therefore asked whether they had gained knowledge or skills related to the thirteen intervention areas identified by the DST (Figure 3), as well as knowledge and skills to enable them to improve a number of specific areas of their jobs.

5.4.1. Intervention areas which participants gained knowledge in from the conference

The questionnaire asked respondents which of the thirteen intended intervention areas identified within the SCCB project they felt they had gained knowledge in from attending the conference. The results are shown in Figure 6.

Figure 6: Intervention areas in which the participants gained knowledge from the conference

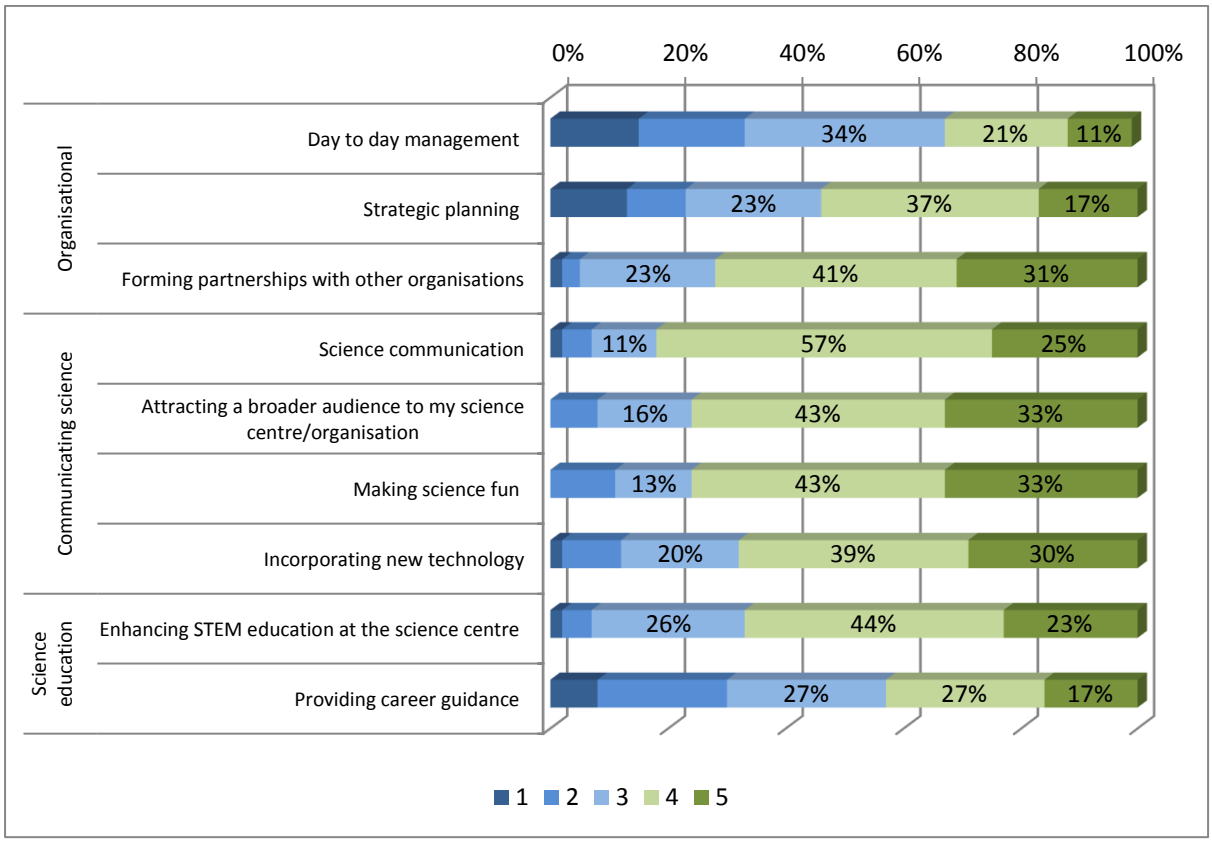


Almost three quarters of respondents highlighted that they had gained knowledge related to science centre outreach programmes and two thirds noted a knowledge gain in developing relevant science centre programmes. Around half gained knowledge in communicating science exhibits to diverse audiences, and exhibit development. These are all core functions of science centres and are important in terms of STEM engagement, awareness and education. Twenty percent or less felt they had gained knowledge in marketing, project management, financial management, and project proposal writing. These are however areas which would not be specifically focused on during the conference, and would be better suited to coverage during a workshop or job shadowing. These topics would also only be relevant to particular staff members who are responsible for these areas at their science centres or organisations.

5.4.2. Extent to which the conference provided capacity in areas of participants' jobs

Respondents were then asked the extent to which they felt the conference had provided them with the knowledge and skills to improve a number of areas of their jobs related to organisation, communicating science and science education. The results are provided in Figure 7.

Figure 7: Extent to which the conference provided participants with knowledge and skills to improve areas of their job



Respondents felt the most strongly (rated 4 or 5) that they had gained knowledge and skills to enhance the following areas of their jobs: science communication (82%), attracting a broader audience (76%), making science fun (76%); and forming partnerships with other organisations (72%). The two lowest rated areas were day to day management and providing career guidance. Although these areas are not topics which would require significant emphasis at a conference, they are both important areas to focus on through the SCCB training, with day to day management being targeted specifically at staff in management positions.

Of the three dimensions identified, 'communicating science' showed the most positive responses, with more than 70% of respondents rating the four areas within this dimension as either 4 or 5. The responses to the areas within the dimensions of 'organisational', and 'science education' showed more variation, and a lower percentage of respondents rating the areas as 4 or 5.

5.4.3. What else did they learn?

To expand on the understanding of the knowledge and skills which were gained during the conference, respondents were asked what new things they had learned.

Respondents highlighted elements of some of the intervention areas, such as science communication (importance of extending science communication to communities and the public); exhibit development (different types of exhibits, how to design interactive exhibits and

exhibits that meet specific objectives); outreach activities, networking and forming partnerships with other centres, as well as reaching diverse audiences. In addition, they noted various other topics which they had learned about: These are shown in Table 5 and some quotes from participants are provided in Figure 8.

Table 5: Further topics participants gained knowledge about

1. Using drama/performance and comedy to communicate science concepts	2. The need to bring theory and practical science closer to each other
3. Coding	4. The value of good hands on workshops
5. Different concepts such as sustainability, sustainable projects , indigenous knowledge systems (IKS)	6. Best practices from other science centres
7. The extent of science- covers a lot of disciplines	8. Engaging youth into science, engaging learners
9. The important role of science museums, and how science centres and museums can work together to achieve the same goals	10. Technology: virtual reality, robotics, new technology tools for teaching, using social media as an efficient and cheaper way of communication
11. Different STEM programmes/ activities	12. The consideration of ethical/ controversial issues
13. Implementing new programmes	14. Confidence in presenting

Figure 8: Quotes from participants related to what they learned

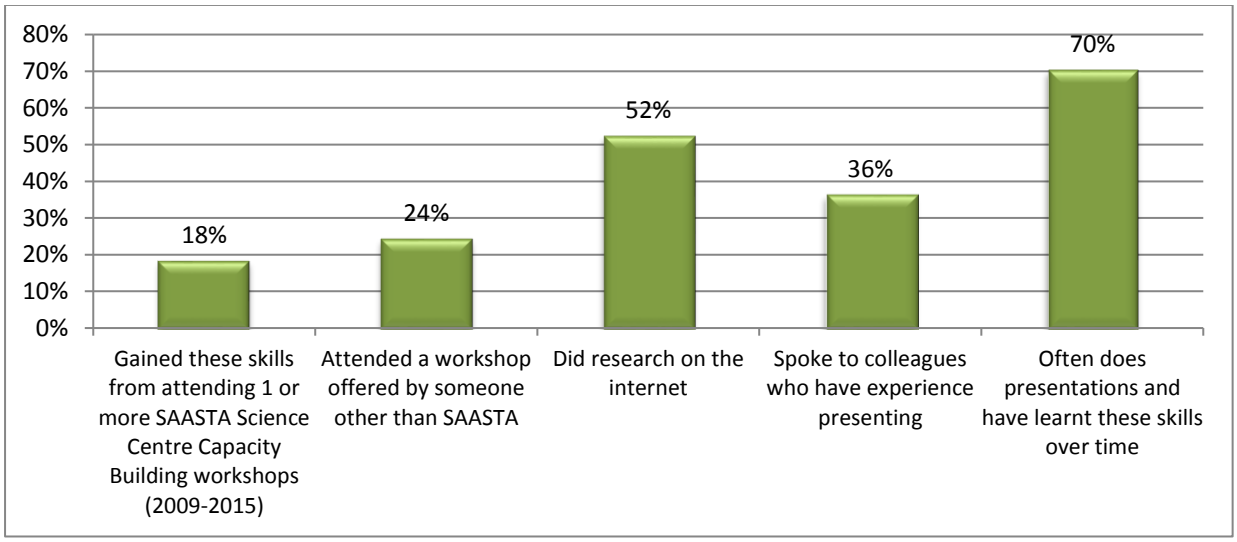
5.5. Presenting at the conference

One of the key aspects of science communication and engagement at the conference is the presentations that take place. Respondents were asked whether they had presented, how they had prepared for presenting and how they felt about presenting. These results show responses from those who had already presented when the questionnaires were administered.

5.5.1. Presentation preparation

In order to prepare for giving a presentation, it is necessary to incorporate a set of activities and skills, including doing research, becoming familiar with the content, writing a conference paper, and public speaking. Respondents were asked which of the methods shown in Figure 9 they had used to prepare for their presentations.

Figure 9: Preparation by presenters

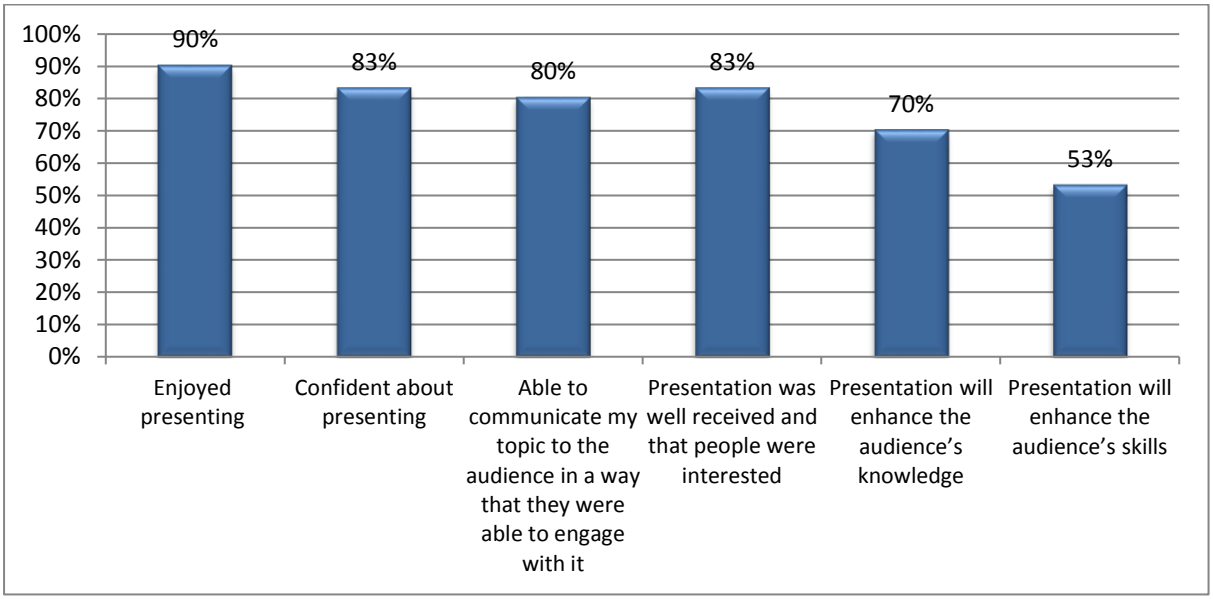


Seventy percent of the respondents noted that they often do presentations and have learned the necessary skills over time, while just over half noted that they did research on the internet. Just over a third indicated that they had spoken to colleagues who had more experience presenting, highlighting the sharing of knowledge within science centres. A number of other respondents had attended a previous SCCB workshop or a workshop offered by someone else.

5.5.2. Attitudes towards presenting

It was also important to understand how presenters felt about their presentations afterwards. The percentages of respondents who agreed to particular statements regarding their presentations are shown in Figure 10.

Figure 10: How participants felt about presenting

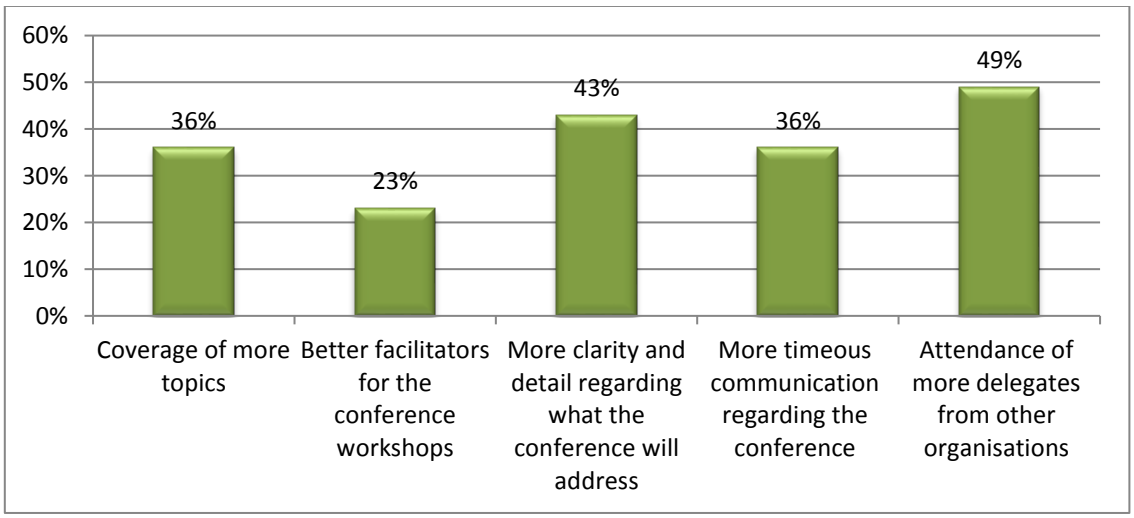


The majority of presenters felt confident and enjoyed presenting. They also felt that they were able to communicate their topic to the audience in a way that allowed them to engage with it, and that their presentations were well received. The respondents felt to a lesser extent that their presentations would enhance the audience's knowledge (70%) and skills (53%). Eighty three percent also indicated that they would submit presentations for future conferences

5.6. Areas for improvement: communication, organisation and content

In order for the conference to have a positive impact, there needs to be an evaluation of where there is room for improvement. Respondents were therefore asked about a number of ways in which the conference can be improved in relation to communication, organisation and content.

Figure 11: Areas for improvement



The most commonly highlighted area for improvement was the attendance of more delegates from other organisations (49%), while forty one percent indicated the need for more clarity and detail regarding what the conference will address. Around a third noted the need for more

timeous communication and the coverage of more topics, while just less than a quarter highlighted the need for better workshop facilitators.

5.7. Summary

The attendees of the SAASTEC Conference expressed positive opinions about their experience, and the results suggest that participants are gaining valuable knowledge and skills through taking part in the conference. Respondents indicated that they had gained knowledge in a number of the SCCB's intended intervention areas, particularly those related to outreach programmes, developing relevant programmes, exhibit development and communicating exhibits, as well as networking,. These are all crucial areas for science centres to build capacity; and exhibit development and networking are specifically identified as expected outcomes of the SCCB project. Respondents also gained knowledge and skills which would assist them in areas of their jobs related to three dimensions: organisational, communicating science, and science education. Respondents exhibited positive attitudes overall in the areas identified within each dimension; particularly those related to communicating science.

Many of the respondents that presented at the conference were positive about their presentations, feeling that their presentations were communicated effectively, were well received, and had an impact on enhancing the knowledge, and to a certain extent, the skills of the audience. This part of the report concluded with an examination of areas for improvement in relation to the communication, organisation and content of the conference.

The conference provides an important opportunity for science centre staff members, as well as staff from other organisations, to share their knowledge and skills, as well as to learn from the experiences of others in their field. Additionally, it provides the opportunity for the science centre community to share examples of best practice, and to identify opportunities for learning and collaboration, facilitating networking among STEM institutions. It therefore provides a critical platform for STEM engagement with both the local, and to a limited extent, the international STEM community.

The next part of the report discusses the findings from the 2016 SCCB workshops.

Part Six: Evaluation of the 2016 training workshops

This section presents the findings from the online survey related to the 2016 workshops. The profile of the participants is initially presented. Following this, the participants' rating of their experience at the workshops is discussed, and the extent to which the training has impacted on various aspects of their knowledge and skills is highlighted. The existence of enabling environments for the transfer of knowledge at the science centres is then examined, followed by an examination of the practical application of the knowledge and skills gained from the workshops. Details of the career paths of those who have left the science centres are then provided. Part six concludes with recommendations concerning the ways in which the communication, organisation and content of the training can be improved.

6.1. Who were the respondents?

The online survey was sent to all of the participants who attended at least one of the SCCB workshops.in 2016 Table 6 provides a summary of the demographic characteristics of the 65 respondents.

Table 6: Profile of the workshop respondents

Race	**Percentage of respondents**
Black	**94%**
Coloured	0%
Indian	3%
White	3%
Other	0%
Sex	
Male	**58%**
Female	42%
Age	
Under 25	7%
25-35	**52%**
35-45	23%
45-55	16%
55-65	3%
65 and over	0%
Number of years at the science centre/organisation	
Less than 1 year	16%
1-3 years	**40%**
4-6 years	12%
7-9 years	12%
10-15 years	16%
16-20 years	0%
More than 20 years	4%
Full Time/Part Time/Volunteer	
Full Time	**53%**
Part Time	5%
Volunteer	43%

Ninety four percent of the respondents to the online survey which related to the workshops were Black, and just less than 60% were male. Around half of the respondents were between the ages of 25 and 35, and the majority had been at their science centres of organisations for between one and three years. Just over half were full time employees, with 43% being volunteers.

Almost one quarter of the respondents were facilitators (including for science, environmental education and ICT), 15% were science communicators and 13% were managers or CEOs. The rest of the respondents held various positions in their science centre including volunteer/intern, administrator, operations manager, co-ordinators (including career guidance, robotics, and educational programmes), education officer, educator, supervisor, lab technician, operations manager, edutainer and mentor.

6.2. Participants' experience at the workshops

In order to evaluate the impact of the training on the capacity of science centres, it is necessary to understand participants' experience of the workshops. A low rating by participants indicates that the impact on their capacity of attending the workshops is limited.

6.2.1. Rating of overall experience of the SCCB workshops

Workshop participants were asked to rate various elements of their experience for each of the workshops which they had attended, on a rating scale ranging from 1 (very poor) to 5 (very good). Figures 12 - 15 present the rating of each of the four 2016 workshops.

Figure 12: Participants' rating of their experience of the JOCV Workshop

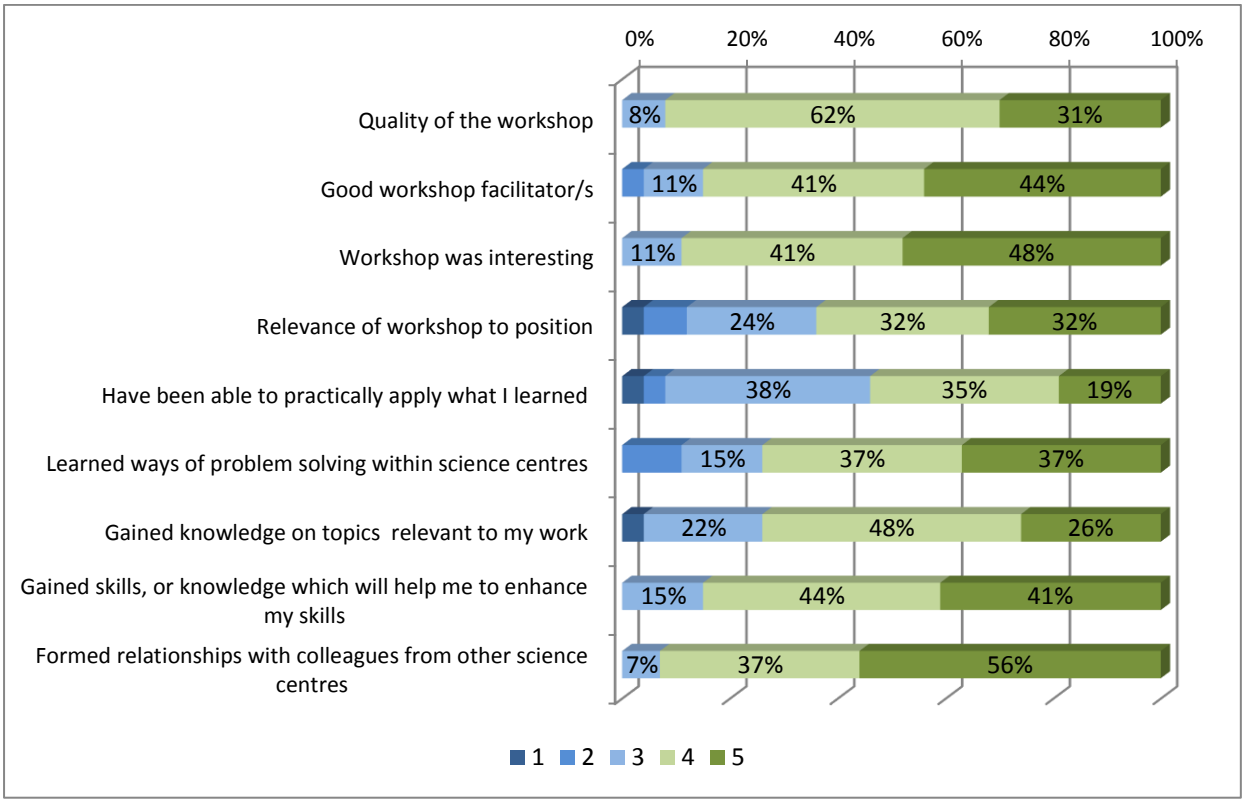


Figure 13: Participants' rating of their experience of the Robotics Workshop

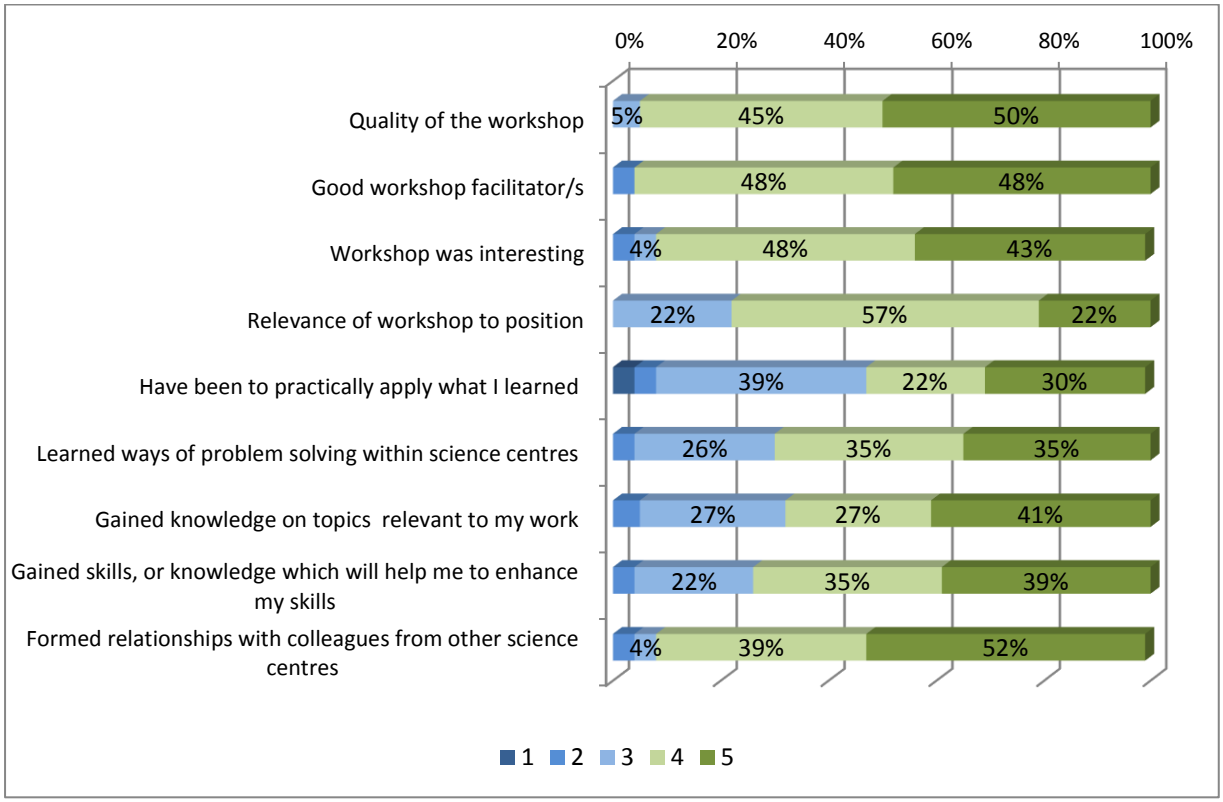


Figure 14: Participants' rating of their experience of the Mobile Lab Workshop

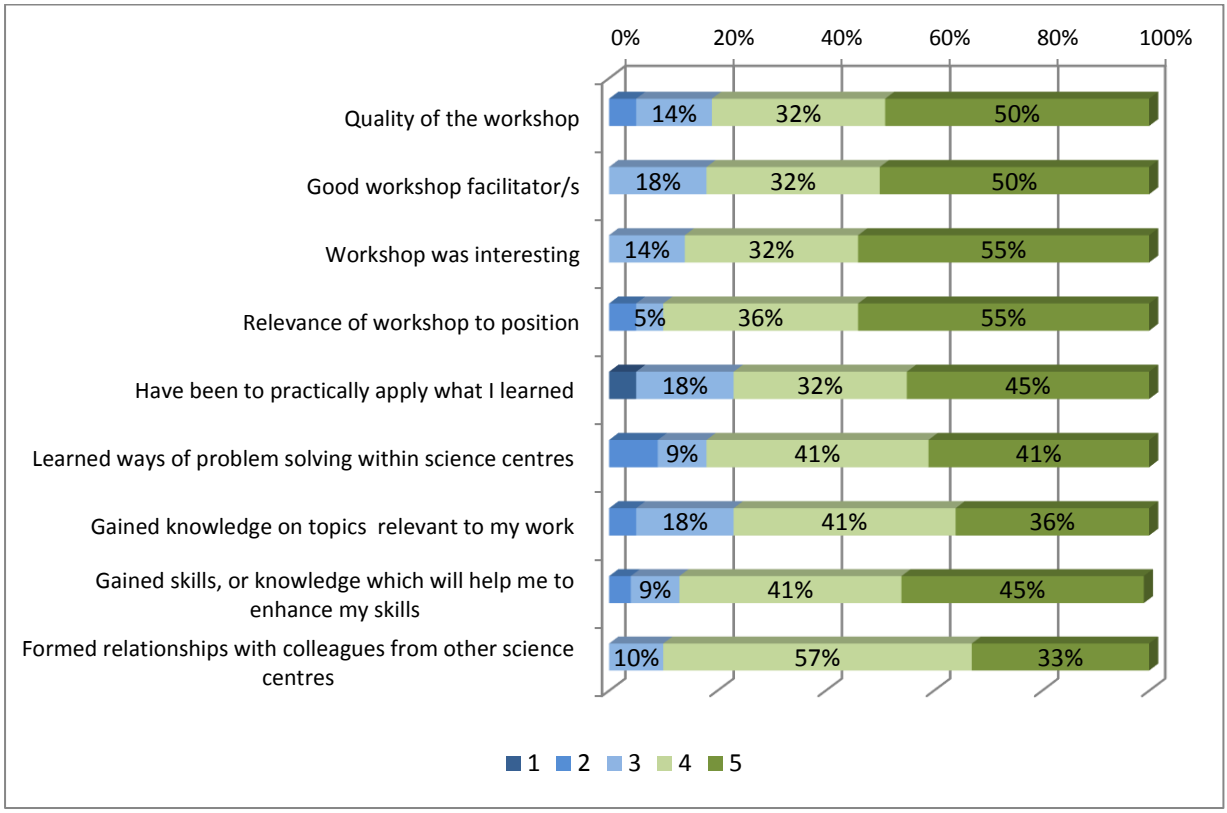
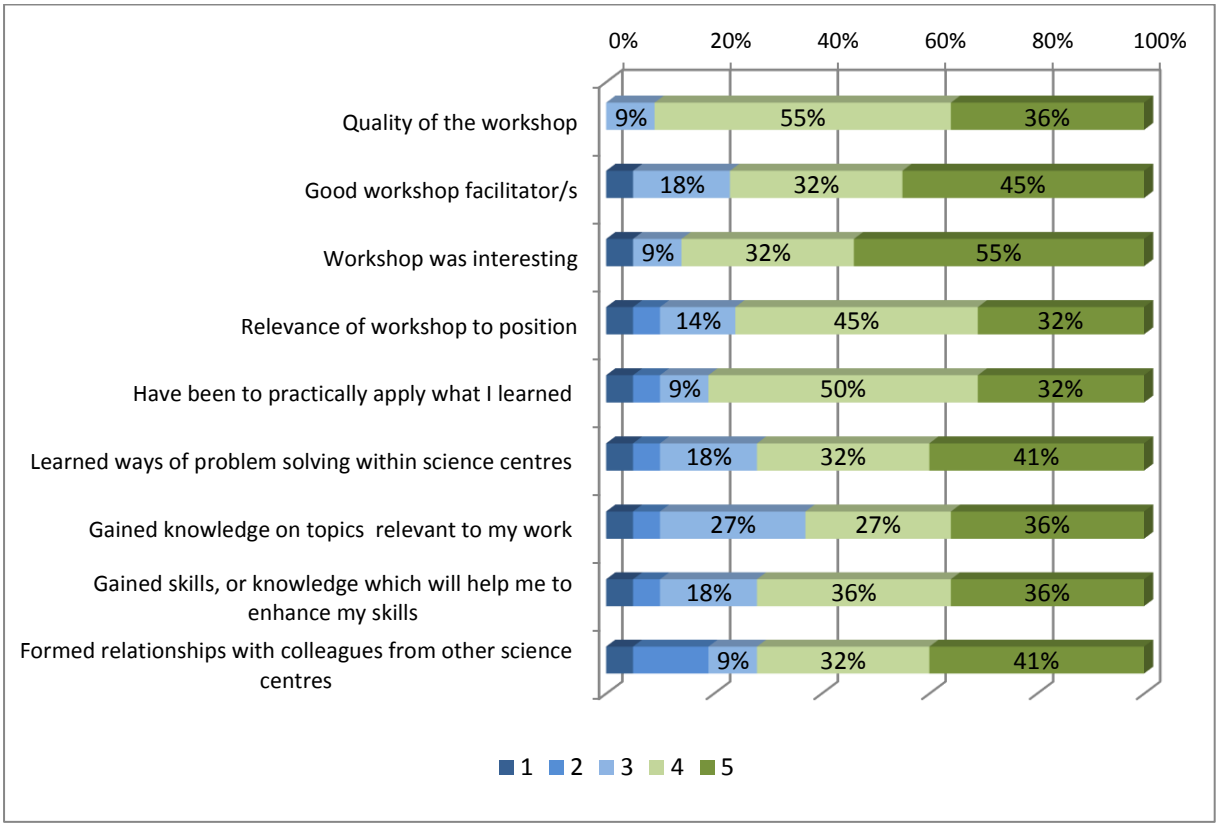


Figure 15: Participants' rating of their experience of the HySA Workshop



For three of the workshops, over 90% of respondents rated the quality of the workshop as 4 or 5. The exception was the Mobile Lab Worship, which was rated as 4 or 5 by 82% of the respondents. For all of the workshops, except the HySA Workshop (77%), more than 80% of the respondents felt strongly (rated 4 or 5) that the facilitators were good. Around 90% for all of the workshops felt strongly that the workshops were interesting. The Mobile Lab Workshop was the one which was rated the highest in terms of relevance to the respondent's position, while the JOCV Workshop was rated as the least relevant in this regard.

The practical application of what was learned was rated as 4 or 5 by around half of the respondents for the JOCV and Robotics Workshops, and over 75% for the remaining two workshops. This highlights the need to ensure that all workshops provide practical examples of how what is taught can be applied, as this is a critical element of capacity building. Problem solving is also an important area in science centres, and this was rated as 4 or 5 by over 70% of respondents for all of the workshops.

The most crucial goal of any workshop is to ensure that participants gain new knowledge or skills. Between 63% (HySA Workshop) and 77% (Mobile Lab Workshop) of respondents felt strongly that they had gained new knowledge about topics which were relevant to their work. A higher percentage (between 72% and 86%) of respondents indicated (rated 4 or 5) that they had gained skills, or knowledge that would help them to enhance their skills from the workshops attended.

A key element of enhancing the capacity of science centres within South Africa is the formation of relationships of support and collaboration between different science centres. Over 90% of respondents from three of the workshops rated as 4 or 5 the statement related to forming relationships with colleagues from other science centres. For the HySA Worksop, the percentage rating of 4 or 5 was just less than a quarter (73%).

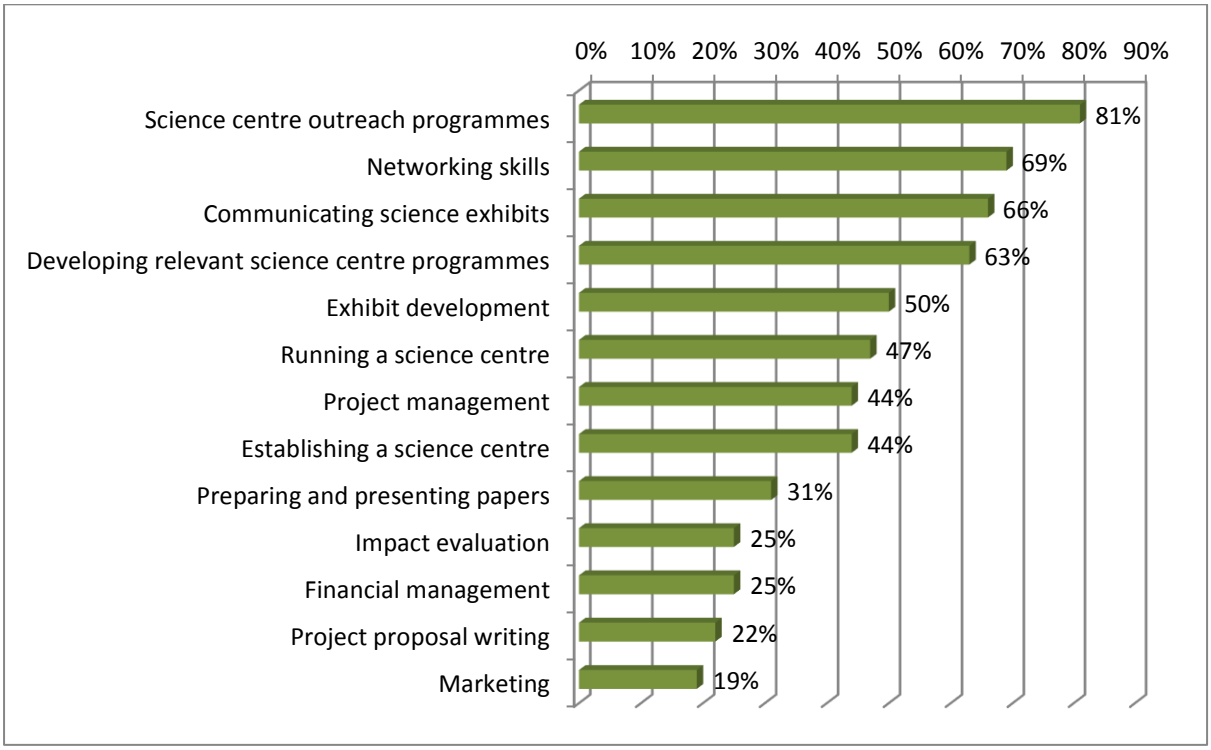
6.3. Knowledge and skills gained from the workshops

The next two questions focused on: 1) the intervention areas in which participants felt they had gained knowledge from the workshops, and 2) the extent to which they felt they had gained knowledge and skills which would enable them to improve a number of specific areas of their jobs.

6.3.1. Intervention areas which participants gained knowledge in from the workshops

Participants were asked to indicate which of the thirteen identified intervention areas they had gained knowledge in from the workshops they attended. The results are shown in Figure 16.

Figure 16: Intervention areas in which participants gained knowledge from the workshops



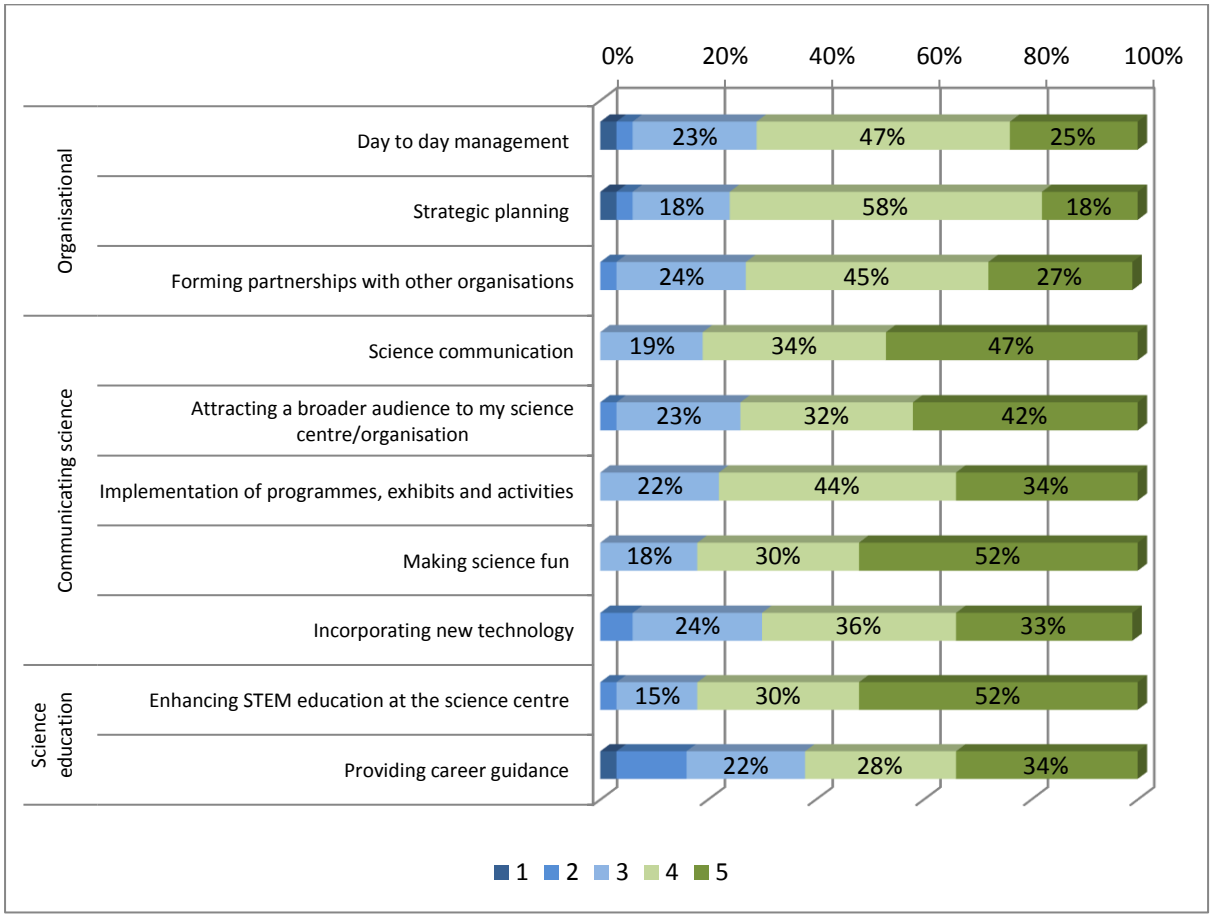
The intervention areas which the most participants indicated that they had gained knowledge in were science centre outreach programmes, networking skills, communicating science exhibits and developing relevant science centre programmes. These are all crucial areas of science centres' responsibilities and contribute to their ability to effectively promote science and engage with learners and the public. The areas which were the least cited were those which are more specialised, and would be the responsibility of only a few people in the science centres. Exhibit

development is perhaps one area which requires further incorporation into all of the workshops presented, as exhibits form the focal point of the activities undertaken in these centres.

6.3.2. Extent to which the workshops provided capacity in areas of participants' jobs

The next question asked respondents the extent to which they felt that attending the workshops had provided them with the knowledge and skills to improve a number of areas of their jobs. These areas were categorised into three dimensions: organisational, communicating science, and science education. Participants were again asked to rate the extent form 1 (very little) to 5 (very high). Figure 17 provides the results from this question.

Figure 17: Areas in which the workshops provided the participants with knowledge and skills to improve their performance



All but two of the areas were rated as 4 or 5 by over 70% of the respondents. These were incorporating new technology (69%) and providing career guidance (62%). This indicates that participants of the workshops are getting the opportunity to learn about various areas of their jobs while attending these workshops. Making science fun and enhancing STEM education were the areas rated as 4 or 5 by the most respondents (82%), followed closely by science communication (81%). Providing STEM education and communicating science are two of the key roles which these institutions are responsible for, and making science fun is one of the most effective ways to reach a broader audience and inspire an interest in STEM. These are all critical

areas which require attention in order to enhance the capacity of science centres. It is positive to note that around three quarters of the respondents rated day to day management and strategic planning as 4 or 5. These are both areas which are important for the long term sustainability of science centres.

The dimension of 'communicating science' again showed positive ratings, with over 70% of respondents rating each of the areas as 4 or 5, apart from incorporating new technology (69%) The 'organisational' dimension also received ratings of 4 or 5 for each of the areas from over 70% of respondents. In terms of 'science education', enhancing STEM education was rated highly, while providing career guidance was rated less positively by respondents (rated as 4 or 5 by 62%).

6.4. Building institutional capacity: the existence of enabling environments

In order for the training to have an impact on the capacity of science centres, it is necessary for an enabling environment to exist which promotes the sharing and application of the knowledge and skills gained from the training. This is an important indicator of the extent to which the transfer of knowledge and practical application can occur within the science centres. Respondents were therefore asked questions regarding the environment of their science centres, and the extent to which they were encouraged to share their knowledge or implement changes.

6.4.1. Encouragement from managers and co-workers

Respondents were asked to what extent they were encouraged by their managers and co-workers to share what they had learned from the workshops, as a means of gauging the extent to which the knowledge and skills gained from the workshops is transferred within the science centres. Figures 18 and 19 show the extent to which respondents felt they were encouraged to share what they had learned.

Figure 18: Encouragement by managers

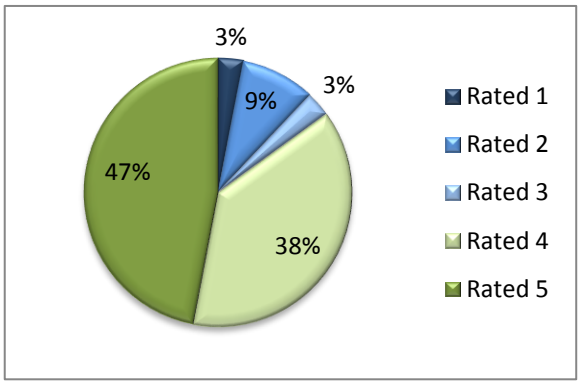
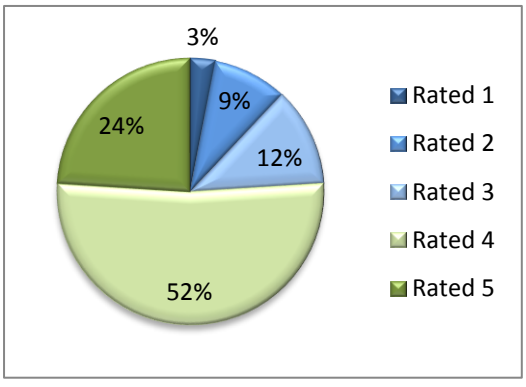


Figure 19: Encouragement by co-workers

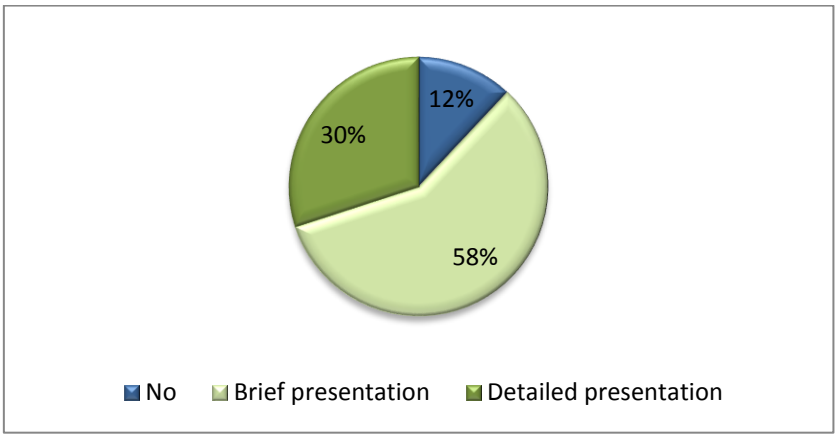


Eighty five percent of respondents rated the encouragement by their managers to share what they had learned as either 4 or 5. In addition, just over three quarters rated the encouragement from their co-workers at the top two levels. This is important as it is vital that staff members are interested in learning from the experiences of others, as this will provide them with knowledge and skills which will enhance their capacity.

6.4.2. Transfer of knowledge within the science centres

Respondents were then asked whether they were required to present what they had learned to others at their science centres. Figure 20 indicates the percentage of responders who were required to present a brief outline or give a detailed presentation of what they had learned.

Figure 20: Presentation of what participants had learned



Just over 10% of respondents indicated that they were not required to present what they had learned, while the majority were asked to provide a brief presentation to other staff members at their respective science centres, while almost a third gave detailed presentations. This is important as the sharing of new knowledge and skills with other staff in the science centres will enable the training to have an impact beyond only those staff members who attend the workshops. It also provides the opportunity for staff members in different positions and at different levels to share their perspectives and experiences, thereby enhancing the knowledge gain of all staff members.

6.4.3. The practical application of the knowledge gained from the workshops

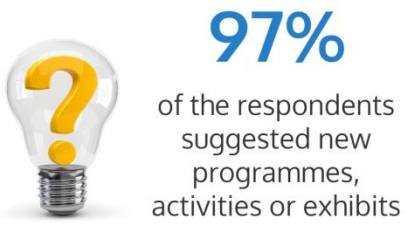
In order for the new knowledge and skills which participants gain to enhance the capacity of the broader science centre, it is necessary for practical application of what is learned to occur. Consequently it is important to encourage staff members to use what they have learned to implement new programmes or strategies. Fifty three percent of the respondents said they had been given new responsibilities and 85% indicated that they had been asked to implement new strategies or programmes. Furthermore, almost all of the respondents (97%) noted that they had suggested new programmes, activities or exhibits based on what they learned from the workshops. This highlights the impact of the workshops, not only in providing participants with new knowledge and skills, but also with the desire and confidence to make changes within their science centres.

53%

of the respondents were given new responsibilities

85%

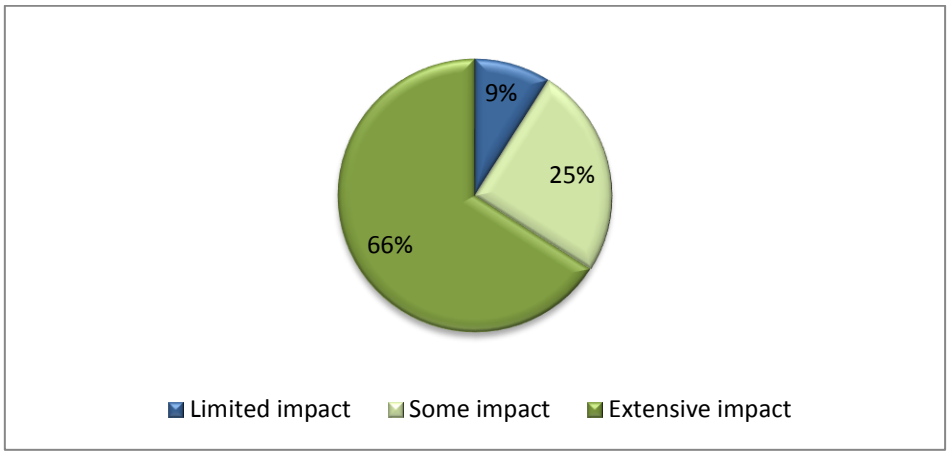
of the respondents were asked to implement new programmes or strategies



6.5. Impact of the workshops on science centres' capacity

The impact of the training on the capacity of science centres as a whole is extremely important. The impact of the training should extend beyond the individual level and be used to enhance the ability of science centres to promote science awareness, education and engagement. Respondents were therefore asked to what extent they felt the SCCB workshops have a positive impact on the capacity of science centres. Figure 21 highlights that two thirds of the respondents felt that the training has an extensive impact on the capacity of science centres, while 25% felt that it had some impact.

Figure 21: Extent to which the SCCB workshops have a positive impact on science centre capacity



In order to improve capacity, it is not only knowledge and skills which are required, but also confidence in staff members' ability to perform well in their job. Participants were therefore asked whether they felt more confident in their ability to do their job after attending the workshop/s, with all of the respondents noting an increase in their confidence as a result of the training.

6.6. Where are they now?

An important finding of the online survey was that 72% of respondents were still at the science centres where they were when they attended the training. This is important as it signifies the retention and enhancement of human capacity within these institutions. Of the nine respondents who indicated that they had since left the science centre, eight were volunteers. In addition, four indicated that they have been able to use the knowledge which they gained from the training in their new jobs. Table 7 shows where the respondents who have left the science centres have moved to, by organisation and the positions they have occupied.

It is important to bear in mind that those who have left the science centres would have been less likely to respond to the survey.

Table 7: The labour market trajectories of those participants who have left the centres

Number	Organisation	Position	Position when at science centre
1	-	Student	Volunteer
2	PFG Building Glass	Graduate Mechanical Engineer	Volunteer
3	Unemployed	-	Volunteer
4	University of Limpopo	Research assistant	Volunteer
5	Ampath Laboratory	Learner Medical Technician-	Volunteer
6	-	Masters student	Volunteer
7	Unemployed	-	Volunteer
8	De Beers	Operator	Administrator
9	Ponti Secondary School	Teacher-	Volunteer

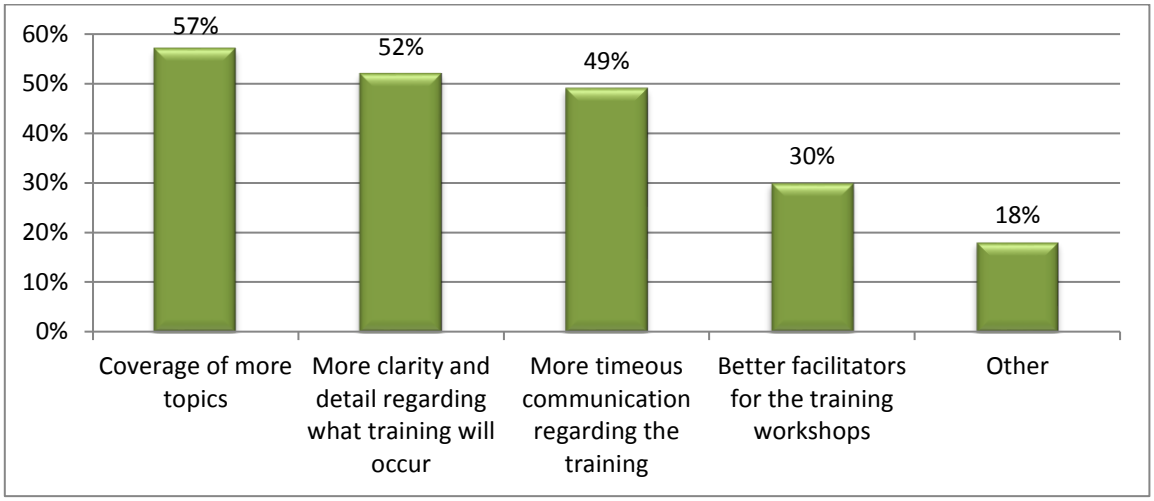
It is encouraging to note that of the nine staff members who had left the science centres, all but two had found employment or were studying further. It is important that these individuals are able to continue to contribute to STEM capacity in the country where possible.

6.7. Areas for improvement: communication, organisation and content

In order to ensure that the training is able to achieve the goal of enhancing the capacity of science centres, it is necessary to identify areas in which the communication, organisation and content of the training can be improved. Participants were therefore asked to indicate in which of the areas in Figure 22 improvements were required.

Almost sixty percent of respondents said that they would like the training to cover more topics, while just over half requested more clarity and detail regarding the specific workshops beforehand. Just under half of the respondents noted the need for more timeous communication regarding the training, while just under a third stated that they would like better facilitators for the workshops.

Figure 22: Improvements which can be made to the workshops



Further suggestions included:

- The workshops should be as practical as possible
- More time should be allocated to the workshops (number of days)
- Resources used at the workshops should be provided to participants
- More opportunities should be provided to attend workshops
- Workshops should allow space for staff members from all science centres, ensuring that at least 2 staff members from each science centre are able to attend each workshop

6.8. Summary

The preceding sections have highlighted the impact which the SCCB workshops have had in terms of enhancing the knowledge and skills of participants in a range of areas which have an impact on their capacity. Respondents noted knowledge gains in the thirteen intended intervention areas of the SCCB project, particularly science centre outreach programmes, networking skills, communicating science exhibits to diverse audiences, developing relevant science centre programmes, and to a lesser extent exhibit development. Respondents also highlighted gains in areas related to organisation, communicating science and science education, with those related to communicating science again being the most positively rated.

At the institutional level, the existence of enabling environment within science centres where knowledge and skills sharing, and the practical application of these, was explored. To a large extent, science centres have provided an environment where the transfer of knowledge is encouraged between staff members and the practical application of what is learned through the training has been supported, through giving staff members new responsibilities, and encouraging them to implement new programmes or strategies. Through inspiring these changes, the workshops therefore play an important role in improving the capacity of science centres for STEM engagement, awareness and education. Areas for improvement are also highlighted which may improve the SCCB workshops.

The next part of the report presents the findings from the online survey which related to the job shadowing programme conducted during 2016.

Part Seven: Evaluation of the 2016 job shadowing

This section presents the findings of the 2016 job shadowing which forms part of the SCCB training. The profile of the respondents is provided, followed by the experience of the job shadowing participants. The areas which the respondents gained knowledge and skills in are then explored, followed by a discussion of the existence of enabling environments within the centres. The section concludes with comments from respondents about the experience and the impact of the job shadowing on the capacity of science centres.

7.1. Who were the respondents?

The online survey was sent to the participants of the 2016 job shadowing programme. Table 8 provides a summary of the demographic characteristics of the 24 respondents.

Table 8: Profile of the job shadowing respondents

Race	**Percentage of respondents**
Black	**96%**
Coloured	0%
Indian	4%
White	0%
Other	0%
Sex	
Male	**57%**
Female	43%
Age	
Under 25	4%
25-35	**57%**
35-45	26%
45-55	13%
55-65	0%
65 and over	0%
Number of years at the science centre/organisation	
Less than 1 year	4%
1-3 years	**46%**
4-6 years	21%
7-9 years	21%
10-15 years	8%
16-20 years	4%
More than 20 years	0%
Full Time/Part Time/Volunteer	
Full Time	**63%**
Part Time	0%
Volunteer	38%

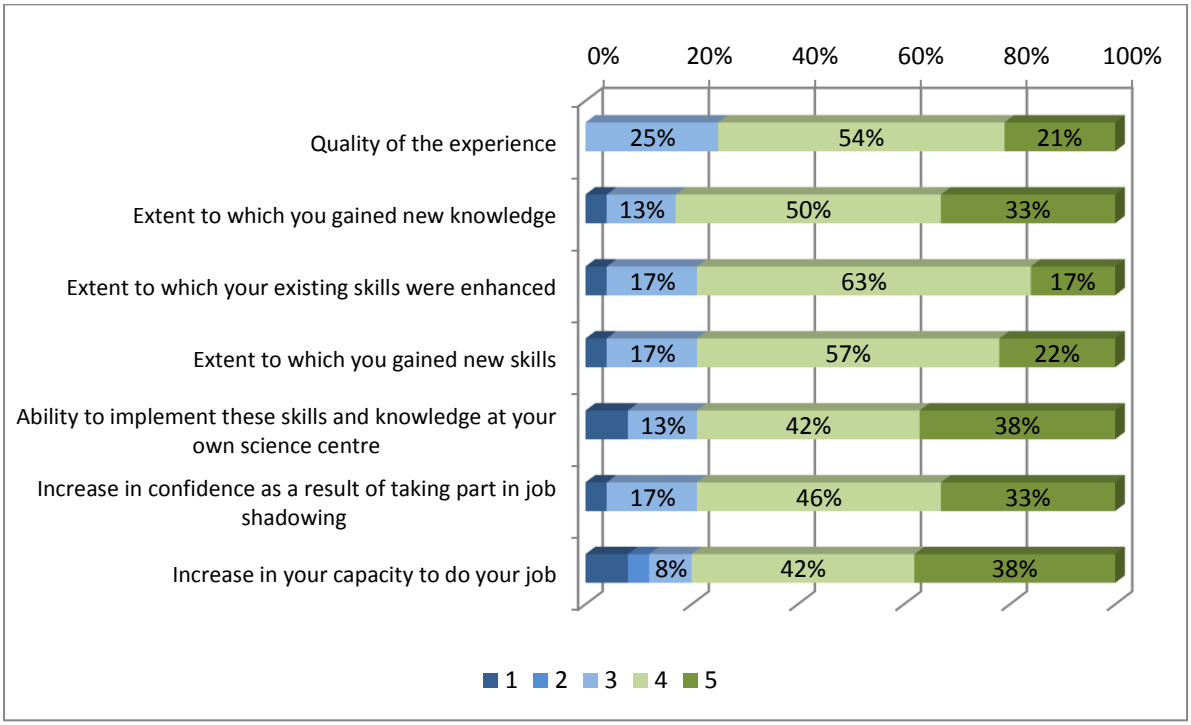
The majority of the respondents comprised Black science centre staff member, and just less than 60% were male. More than half were between the ages of 25 and 35, and just under half had been at their science centres or organisation for between one and three years. Nearly two thirds were full time staff members.

Equal proportions (17%) of the respondents were science communicators, managers and programme facilitators. The rest of the respondents held various positions: volunteer, subject facilitators (environmental education, physical sciences), administrator, science liaison officer, and career guidance co-ordinator.

7.2. Participants experience of job shadowing

The experience of participants of the job shadowing which they attended is important in terms of understanding the impact of the programme. As in the previous evaluations, respondents were asked to rate their experience from 1 to 5.

Figure 23: Participants' rating of their experience of the job shadowing



Participants reported overall positive experiences of the job shadowing. For all of the statements, at least three quarters of the respondents rated their experience as either 4 or 5. Seventy five percent rated the quality of the experience in the top two categories, while 80% or more felt strongly (rated as 4 or 5) that they had gained new knowledge or that their skills were enhanced through attending job shadowing. An important aspect of attending any of the training is the subsequent practical application of what is learned. Eighty percent of the respondents rated their ability to implement the skills and knowledge gained in their own centre as 4 or 5. Just less than 80& also rated as 4 or 5 the increase in their confidence as a result of the experience, and 80% felt strongly that their participation in the job shadowing had increased their capacity to do their job. These are crucial aspects which the job shadowing should contribute to in order to enhance the capacity of South Africa's science centres.

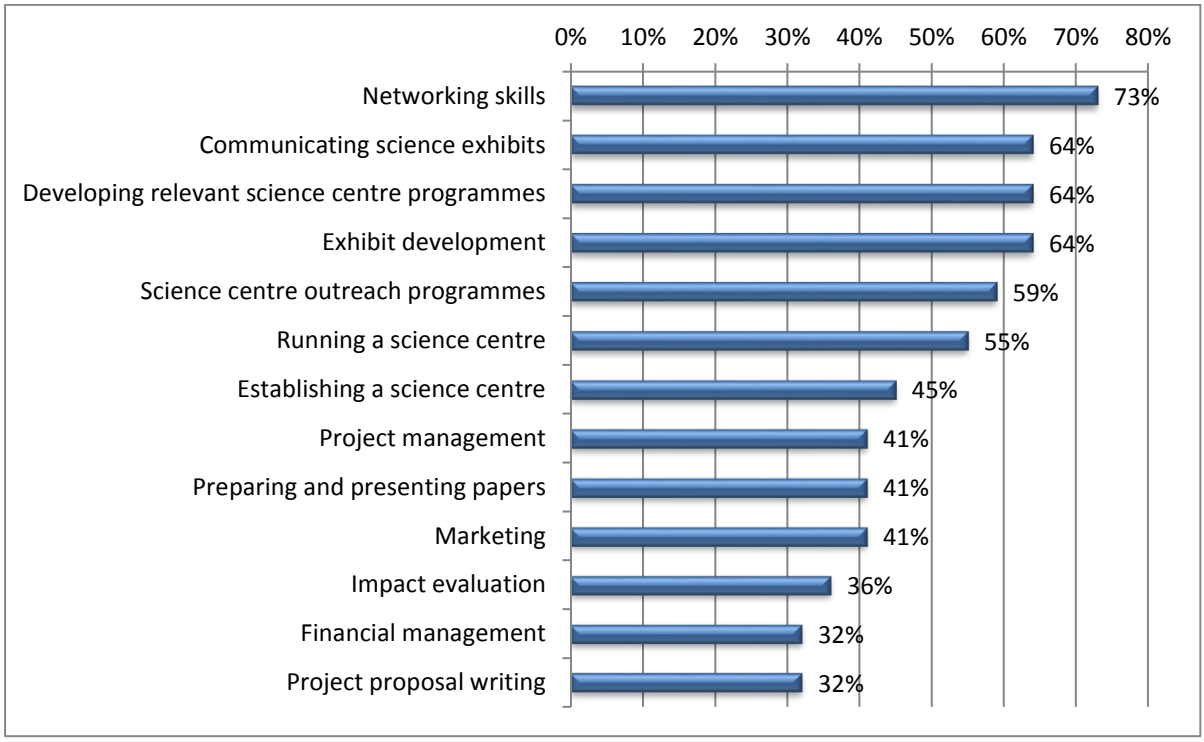
7.3. Knowledge and skills gained from the job shadowing

The following questions focused on the intervention areas in which participants felt they had gained knowledge, and the extent to which they felt they had gained knowledge and skills which would improve a number of specific areas of their jobs, from attending the job shadowing.

7.3.1. Intervention areas which participants gained knowledge in from the job shadowing

Similarly to the conference and workshop participants, respondents were asked to indicate which of the thirteen intervention areas they had gained knowledge in from the job shadowing. The results are shown in Figure 24.

Figure 24: Intervention areas in which participants gained knowledge from the job shadowing

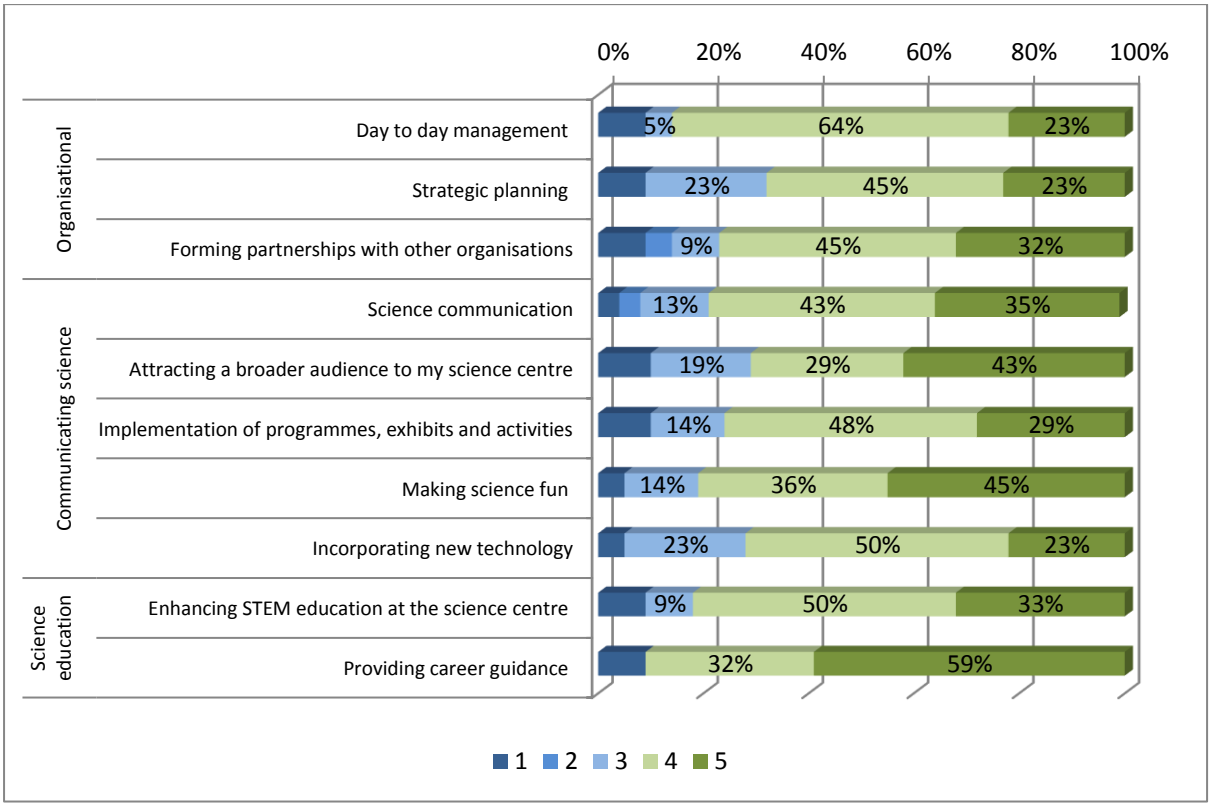


The intervention area which the most respondents gained knowledge in was networking skills, which is critical for enhancing the network of science centres in the country, and enabling science centres to work together and learn from each other, as well as other organisations. This was followed by communicating science exhibits to diverse audiences, developing relevant science centre programmes and exhibit development. This is important as there if a focus on exhibits within the expected outcomes of the SCCB project. This is positive as these are all areas which form the core activities for which science centres are responsible. The areas which the least respondents gained knowledge in were impact evaluation, financial management and project proposal writing. The latter two areas are specialised areas which would only be the responsibility of certain members of staff. However, impact evaluation is an important area which requires consideration in training in order for science centres to evaluate their own activities and thereby be able to identify ways in which they can improve what they are doing.

7.3.2. Extent to which the job shadowing provided capacity in areas of participants' jobs

Following this, respondents answered questions about the extent to which they felt that taking part in the job shadowing had provided them with the knowledge and skills to improve a number of areas of their job within three identified dimension: organisational, communicating science and science education. They were asked to rate the extent form 1 (very little) to 5 (very high). Figure 25 provides the results of this question.

Figure 25: Areas in which the job shadowing provided the participants with knowledge and skills to improve their performance



The area which the highest number of respondents rated as 4 or 5 in relation to the extent to which they had gained knowledge and skills from the job shadowing, was career guidance (91%). Following this, 87%) of respondents indicated gains in the area of day to day management (rated as 4 or 5) and 83% rated enhancing STEM education at the science centre as 4 or 5. STEM education is a priority within science centres; as they play a key role in informing learners about STEM, inspiring an interest in STEM, and encouraging learners to pursue STEM careers. Day to day management is also a critical area as the efficient daily functioning of these centres is key to their success. It is therefore positive to note that science centre staff members gained knowledge and skills in these areas to a great extent. The areas which the least respondents rated as 4 or 5 were strategic planning (68%), attracting a broader audience to science centres (72%) and incorporating new technology (73%). Strategic planning is a specialised area which would be the responsibility of certain staff members, however attracting a broader audience is an important area which requires discussion in order to ensure that the science centres in the country are able

to maximise their impact. The incorporation of new technology is also a more specialised area, and it is positive that almost two thirds of respondents indicated gaining knowledge and skills in this area (rated as 4 or 5).

The job shadowing has a significant impact on the capacity of staff members in relation to the various areas of their jobs which were identified. The two areas within the dimension of 'science education' were rated as 4 or 5 by over 80% of the respondents, while those in the 'communicating science' dimension were rated in these two categories by over 70% of respondents. The 'organisational' dimension received positive ratings, with the lowest percentage rating as 4 or 5 for an area of 68%.

7.4. Building institutional capacity: the existence of enabling environments

The SCCB training aims to build capacity within science centres. In order to allow knowledge and experience gained from the job shadowing to permeate through the science centres, it is important to establish enabling environments which provide the opportunity for the practical application and sharing of the knowledge and skills gained. Respondents were asked questions related to the environments within their science centres, and the extent to which they were encouraged to share their knowledge or put it into practice.

7.4.1. Transfer of knowledge within the science centres

Respondents were asked whether they were required to present what they had learned to others at their science centres after taking part in the job shadowing. Ninety six percent of respondents indicated that they have been required to share their experience with others. This is particularly important as the job shadowing programme teaches participants about various aspects of science centres' activities, and provides them with a wealth of knowledge and skills which they are then able to share with others, thereby enhancing the capacity of their science centres.

96%

of respondents taught/shared with others at their science centre what they had learned

7.4.2. The practical application of the knowledge gained from the job shadowing

Enhancing the capacity of science centres may also be achieved by encouraging the participants of the job shadowing programme to use what they have learned to implement new activities, programmes or exhibits. Seventy percent of the job shadowing respondents indicated that they had been asked to implement new activities, programmes or exhibits at their respective science centres.

70%

of the respondents implemented new activities, programmes or exhibits

7.4.3. Collaboration

Further to attending the job shadowing, it is important for staff members from different science centres to consult with and collaborate with each other, as this allows for the development of best practices and enhances the capacity of the science centre community in the country as a whole. Respondents were therefore asked whether after the job shadowing they had shared ideas or collaborated with staff members from the science centre where they had attended job shadowing. Almost 70% of respondents noted that they had. This has important implications for the South African science centre network, and beyond in terms of improving STEM engagement, education and awareness.

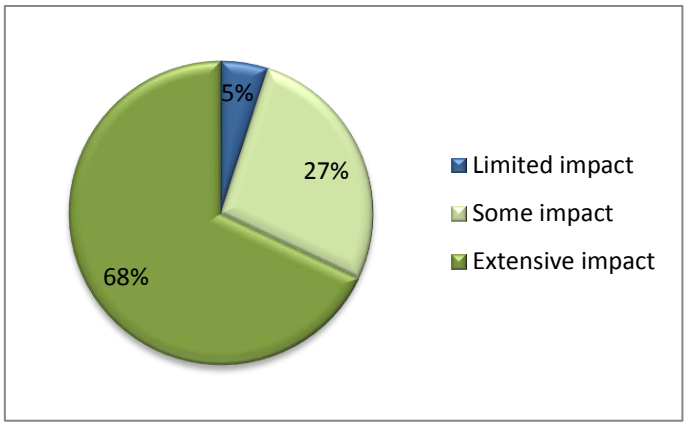
68%

of the respondents had shared ideas or collaborated with the staff members from the science centre where they attending job shadowing

7.5. Impact of the job shadowing on science centres' capacity

The impact of the training on the capacity of science centres beyond the individual level is an important consideration, as it should enhance the ability of science centres to promote STEM awareness and education. Respondents were therefore asked to what extent they felt the job shadowing has a positive impact on science centres' capacity. Nearly 70% of the respondents felt that the training has an extensive impact, with only 5% highlighting a limited impact (Figure 26).

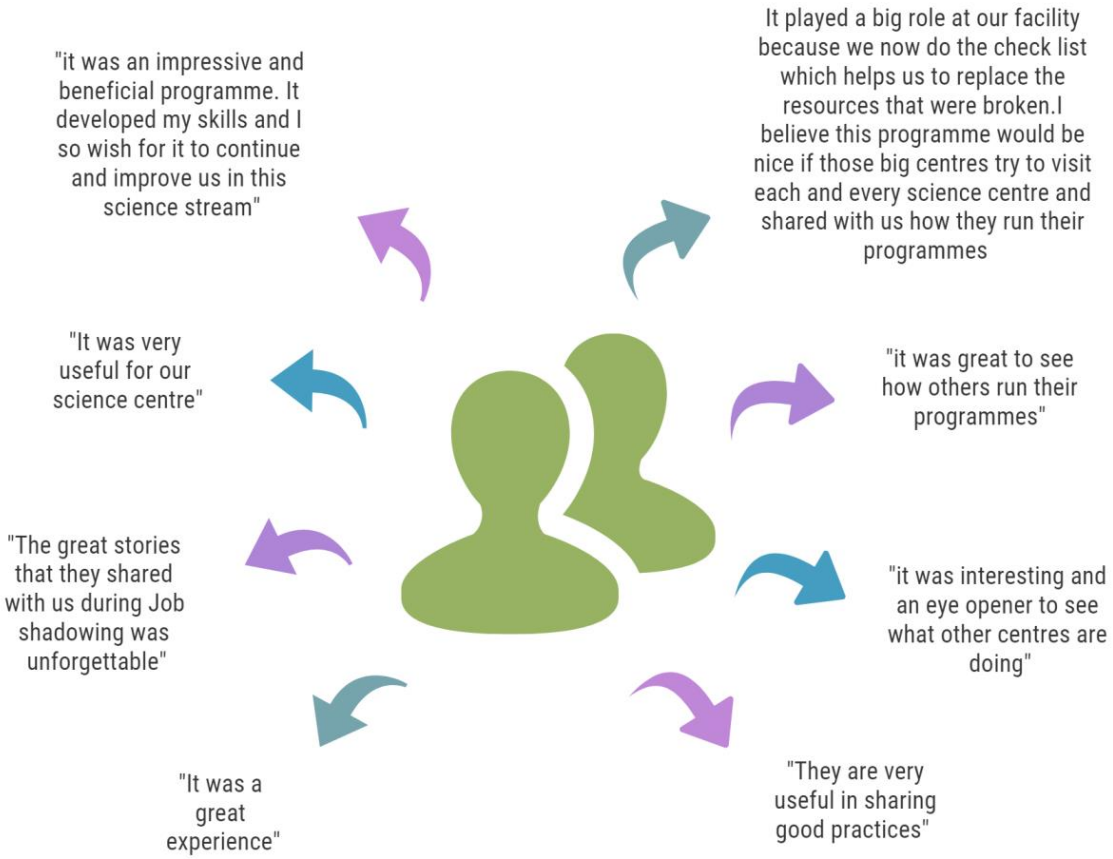
Figure 26: Extent to which the job shadowing has a positive impact on science centre capacity



7.6. Further comments

Respondents were asked if they had any further general comments regarding the job shadowing programme. These comments are shown in Figure 27.

Figure 27: Comments about the job shadowing programme



Some respondents noted that were unable to finish the programme due to student strikes on the campus related to the "Fees Must Fall" campaign. Respondents also highlighted the need for science centres hosting the job shadowing to be well prepared, with detailed programmes which could be submitted to SAASTA beforehand. In addition, one respondent highlighted that

perhaps SAASTA could provide a preparatory workshop for those science centres hosting the job shadowing.

7.7. Summary

The job shadowing programme forms a crucial part of the SCCB training as it provides participants with a unique opportunity to learn from other science centres over an extended period of time. Participants are exposed to the range of programmes, activities and exhibits which are run by the host science centres; and have the opportunity to interact with, and learn from, staff members in these centres.

At the individual level, respondents indicated that they had gained knowledge in the intended intervention areas, with networking skills, communicating science exhibits to diverse audiences, developing relevant science centre programmes, exhibit development, and science centre outreach programmes being highlighted by the highest number of respondents. The three dimensions of organisational, communicating science, and science education were positively rated overall, with more than two thirds of respondents rating each of the specific areas within the dimensions as 4 or 5. This highlights the important impact which the job shadowing programme has at an individual level.

The impact of the job shadowing is also extending beyond the individual level to the level of science centres as a whole, as the majority of the respondents indicated sharing what they had learned with others in their science centres, as well as a high percentage practically applying their new knowledge and skills, through the implementation of new activities, programmes or exhibits. In addition, the programme is encouraging collaboration and information sharing among science centres, as more than three quarters of respondents indicated that they had since shared ideas, or collaborated with, staff members from the science centre where they had attended the job shadowing. This will play a critical role in enhancing the science centre network in the country.

The final part of the report provides a number of recommendations based on the findings of the study.

Part Eight: Findings and recommendations

The Science Centre Capacity Building project has a positive impact on the science centres and institutions that participate in the various forms of training provided: workshops, the job shadowing programme and the annual SAASTEC Conference. In order to enhance the capacity building, it is important to identify ways in which the impact of the training can be improved. Based on the findings of the study, a number of recommendations can be made.

8.1. Findings

The following sections present a number of important findings of the study.

8.1.1. SCCB funding

The level of investment in the SCCB project has increased from R450 000 in 2009/2010 to R1 250 000 in the 2016/2017 financial year. Funding is therefore being made available for enhancing the capacity of science centres.

8.1.2. Individual capacity building

The 2016 SCCB training provided participants with valuable knowledge and skills in many of the thirteen intended intervention areas, particularly developing relevant science centre programmes, exhibit development, communicating science exhibits to diverse audiences, science centre outreach programmes, and networking skills. However, participants indicated limited learning in relation to some of the other intervention areas, including project proposal writing, project management, marketing, impact evaluation and financial management.

Participants are gaining knowledge and skills that have enhanced their capacity in a number of areas of their jobs related to three dimensions: organisational, communicating science, and science education. The dimension which was rated the most positively within each training intervention was communicating science (science communication, attracting a broader audience to science centres/organisations, making science fun, incorporating new technology).

Many respondents were young[5], less experienced[6], and volunteers[7]. It is positive to note that young and less experienced members of staff are provided with capacity building opportunities, as this will enhance the capacity of science centres in the longer term, as well as allowing these staff to translate their knowledge and skills gained into other STEM careers.

8.1.3. Institutional capacity building

In many cases, enabling environments exist within the science centres which encourage the transfer of the knowledge and skills gained through training. The majority of respondents indicated that they had been encouraged to share or present to others at their science centre what they had learned.

[5] Respondents 35 years of age or younger: Conference- 55%, workshops- 58%, job shadowing- 61%
[6] Respondents at their science centres for 3 years or less: Conference- 50%, workshops- 56%, job shadowing- 50%
[7] Respondents who were volunteers: Conference- 24%, workshops- 43%, job shadowing- 38%

The practical application of knowledge and skills gained was also evident, as many respondents had implemented new programmes, activities, exhibits or strategies at their science centres based on what they learned.

8.1.4. Networking and collaboration

The training encourages networking, and provides opportunities for science centre staff members to form relationships with colleagues from other centres or organisations. Furthermore, the SAASTEC Conference and the workshops which involve overseas collaboration provide further opportunities for international networking and collaboration.

8.1.5. Capacity building model

The model which is utilised in providing the training, which incorporates funding and support at a local level from the DST, and promotes support and collaboration at an international level, by incorporating people from outside the country, is providing unique opportunities for capacity building in South African science centres.

8.1.6. SCCB objectives and expected outcomes

The findings highlight that the objectives of the SCCB project are being addressed through the SCCB training. The SCCB project supports the capacity building of science centre staff at a national level (Objective 1); supports the development of capacity building for exhibit development (Objective 2); and promotes liaison with stakeholders from DST and the Science Centre Council (Objective 3).

In terms of the expected outcomes of the SCCB project, progress has been made through the various training opportunities which are being provided. The core skills of participants are being developed and enhanced (Outcome 1); improved programmes are being facilitated at science centres through the implementation of the skills and knowledge gained (Outcome 3); networking has been promoted among science centres, as well as collaboration (Outcome 4); and networking at both the local and international level has been enhanced, particularly through the SAASTEC Conference and the JOCV Workshop (Outcome 5). Outcome 2, which relates to the development of exhibit porotypes, requires further attention with more opportunities for the development and sharing of new and innovative exhibits.

8.2. Recommendations

A number of recommendations can be made based on the findings, which will potentially enhance the impact of the SCCB project.

Table 9: Recommendations

Recommendations
Individual level • Intervention areas which relate to the core areas of science centre functioning should continue to receive extensive focus in the training. A set of core modules which relate to the most important activities carried out in science centres and outreach programmes of the institutions should be

presented regularly.

- The training should also focus on areas which respondents indicated limited learning in such as project proposal writing, project management, marketing, impact evaluation and financial management. Training in these areas should target staff members in the relevant positions within the science centres.

- Each of the capacity building interventions should focus on reaching more staff members from more science centres and institutions. This may be achieved in a number of ways:
  - Conducting the same workshops on more than one occasion or in more than one location, or by developing workshops which can accommodate more participants at once. Job shadowing opportunities could also be provided more frequently.
  - Providing online databases of the material. Online material related to each of the 13 intervention areas would benefit all existing and new staff members.
  - Targeted workshops or online training courses which focus on the roles and responsibilities of science communicators, education officers, project co-ordinators and so on could also be developed. This would be particularly beneficial for mid-level and senior staff members who occupy permanent positions.

- Areas related to organisation, communicating science and science education are key to enhancing the capacity of science centres. Training therefore needs to incorporate these areas as much as possible.
  - Some areas such as the implementation of programmes, exhibits and activities; attracting a broader audience to science centres; and providing career guidance are particularly important in terms of science centre capacity. These areas are also relevant for all staff members.
  - At the management level, strategic planning, in terms of activities, reach and staff development should be emphasised, as this is a crucial aspect of the long term sustainability of science centres.

- Facilitators should be well trained and able to effectively communicate the subject material, providing additional support for participants where necessary. Science centre managers and senior staff members can provide important insights from their experience within the science centre environment, and their expertise should be harnessed for the training

Institutional level

- In order for the training to be successful in enhancing the capacity of science centres beyond the individual level, the transfer of knowledge needs to occur from those who attend the training to others at their science centres. Furthermore, the knowledge and skills which are learned need to be practically applied.
  - Science centre managers and staff should continue to encourage the sharing of knowledge and skills gained from the training. Staff members should be encouraged to implement new strategies, programmes or exhibits, or to find ways to enhance existing strategies, programmes or exhibits.
  - Practical application in turn requires that the training provided includes a practical component. This will equip participants with the knowledge, skills and confidence to implement new ideas within their centres.

- As some of the country's science centres are small and have limited capacity, and many rely on volunteers, it would be beneficial for them to be able to employ more permanent staff members in order to ensure that all centres have a core group of staff.
  - If it is not possible to employ volunteers once their contracts have ended, science centres should support and prepare these individuals to use their new knowledge and skills within the broader fields of STEM awareness and education.

Networking and collaboration

- Networking is a crucial piece of the puzzle in terms of enhancing the capacity of the South African sconce centre network. Opportunities for networking and information sharing should be extended, and collaboration and sharing of best practices should be encouraged amongst science centres.
  - An online platform for science centres which promotes networking and collaboration, both nationally and internationally, may provide support to science centres. These types of collaborations and learning opportunities will encourage innovation within science centres.
  - Collaboration, in the form of mentoring within each science centre, as well as among science centres, would also be beneficial, particularly for smaller science centres with less experienced staff members.

Organisation, communication and content

- In order to effectively enhance the capacity of science centres, they need to receive training which is timeous and relevant to their needs. It is therefore important to continue to regularly engage with science centres to determine which areas are the most crucial for training to focus on.

- It is necessary for science centres to be advised of the training and details related to what each will entail in advance. This will allow for scheduling which will ensure that staff members are able to attend the training, as well as ensuring that the most appropriate participants are sent to the training.

- In relation to the conference, the attendance of more delegates from other organisations would promote networking, information sharing and opportunities for collaboration within the broader STEM community.

- Science centres hosting the job shadowing need to be well prepared and have a detailed programme in place. Guidelines for hosting staff from other science centres could also be provided to science centres, outlining what they should cover and how best to engage the visitors, ensuring that both parties benefit from the experience.

This report has provided an in depth evaluation of the Science Centre Capacity Building project which is aimed at enhancing the capacity of South Africa's science centres. The final part provided a number of important findings, and related recommendations which may contribute to strengthening the impact of this project.

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Appendix: 2016 SAASTEC Conference

17th SAASTEC Conference 2016 Unizulu Science Centre, Richards Bay	
Science Centre	***Presenters***
ArcelorMittal Science Centre Newcastle	Njabulo Mpanza; Mzwandile Maphanga
ArcelorMittal Science Centre Sebokeng	Thami Mphokela; Daniel Motsapi
Cape Town Science Centre	Julie Cleverdon
FOSST	Aphiwe Baq; Sanelise Nongauza; Xolisa Williams; Sizo Golimpi
HartRao	Simphiwe Madlanga
Johannesburg City Parks	Sinah Magolo; Kogieluxmie Govender
Mothibistad SC	Chrisencia Moatshe
NMBSTC	Christopher McCartney
NWU Mafikeng SC	Lerato Molebatsi
NWU SC Potchefstroom	Jan Smit
NZG	Armstrong Mashakeni; Leavy Tau
SANSA	Violet Chabalala
SASOl Inzalo Foundation	Rufus Wesi
Sc-Bono	Tebogo Gule; Akash Dusrath; Stuart Hopwood; Carmen Adams Hoffman; Thami Mangena
Sci Enza	Puleng Tsie; Eva Seko; Meeloni Tanna
UKZN SC	Tanja Reinhardt
Unizulu Science Centre	Nxumalo Mdumiseni; Derek Fish; Alfred Tsipa; Silindile Mthembu; Diloshni Thambaran; MJ Schwartz