

Science Clubs: An Underutilised Tool for Promoting Science Communication Activities in School

M. Shaheed Hartley

Abstract The introduction of science at schools is an important vehicle for science communication. It is generally understood that the first experiences of science influence scientific interest. Sustaining this interest through the education pipeline from primary to secondary to post-school science careers is a challenge faced by the education system of all countries. It is therefore imperative that suitable vehicles are chosen to communicate science to learners at all levels to enable them to make informed decisions about opportunities presented by science, technology, engineering and mathematics (STEM). This chapter in general reviewed selected reports on the use of science clubs as a vehicle to promote science activities in various contexts. It also in particular reported on the outcomes of the implementation of science clubs in rural South African schools and highlighted the findings of the experiences of schools participating in a project using science clubs to develop a culture of science learning. The study revealed particular attributes identified by teachers involved in the development of science clubs which added to their own professional growth as science educators and science communicators. The chapter also identifies some guidelines for teachers to follow in setting up science clubs especially within developing countries.

Introduction

It is generally acknowledged that there is a need to improve the science and technology skills and knowledge of learners in order for them to navigate their way through the world they live in and to successfully access the opportunities

M.S. Hartley (✉)

Science Learning Centre for Africa, Faculty of Education, University of the Western Cape,
Cape Town, South Africa

e-mail: shartley@uwc.ac.za, <http://www.uwc.ac.za/Faculties/EDU/Pages/Faculty-Community-Outreach.aspx>

available to them (Afterschool Alliance, 2011). It is also generally understood that science and technology holds a myriad of employment and economic advancement pathways to future generations. It is therefore important for learners to be provided a solid foundation in science so that they can make informed decisions about their future based on scientific understanding and awareness of the potential that science holds in shaping that future. Hopefully this knowledge and awareness will encourage them to select science subjects and continue into science-based careers. As technology in the modern world develops and advances, greater demand is created for an appropriately skilled human resource base to best serve and interact with the available science and technology as well as to improve and create innovations of current and new technology.

There have been reports of a general downward trend of learner participation in science subjects, and a number of international reports have highlighted various governments' concern about the low uptake of science subjects (Pike & Dunne, 2011). In developing countries the challenge is even greater to ensure interest and enthusiasm for the learning of science at school level, with the numbers of learners taking up science and mathematics decreasing on an annual basis. International tests like TIMMS and PISA continually point to a trend of poor achievement in science and mathematics and highlight the challenges faced by developing countries. The PISA test (PISA in Focus, 2012) also identified successes of countries utilising science-related extracurricular activities to communicate and improve learners' participation, achievement and enjoyment of science. It is therefore imperative that the communication of science and all the potential it holds for future generations be done in a manner that would draw young learners to science and to sustain their interest and involvement in school science but also in activities beyond the school curriculum. The challenge to science practitioners, researchers and other stakeholders is to ensure that appropriate knowledge, skills and opportunities are conveyed to learners in a meaningful way that would allow them to comprehend, apply and interact within the science and technology field and to add to the science research pipeline towards higher degrees.

This chapter reports on science clubs as a vehicle for communicating science to learners. It will review the application and the effects of science clubs in various contexts and highlight the author's experience in South Africa.

Selected Reports of School Science Clubs

The following reports were selected by the author to present the findings of the use of school science clubs and to highlight similar and varying experiences in the different contexts. The reports also identified the various attributes and skills developed by learners as a result of their participation in science clubs.

In a report by Bennett (1956), evidence was provided of the establishment of school science clubs in a number (about 100) of British schools as early as the year 1949. These science clubs varied in size from 20 to 200 members, with an average

number of 60. The age of participants ranged between 14 and 18, and the majority were structured in terms of elected committees and participation. Their activities included visiting local museums, hospitals, industrial premises, field expeditions, film shows and lectures by visiting speakers. A great number of these clubs joined up to form societies and associations based on common interests pursued. The report indicated the educational value added to school learners who changed from delinquent behaviour before their membership of the science clubs and larger networks to a mature outlook and responsibility after participation in the organised activities. The report also identified the participation of learners in, for example, activities of the Museum of Natural History as well as conferences held by the different organisations of which membership was extended to school science clubs. The report also highlighted the country's rich heritage in science and attempts to make learners identify with this culture of science learning. Finally the report pointed out the formation of an organisation called Science Club, which provided information and support to schools that wanted to form new science clubs. In general, the report provided positive affective changes in learners towards science and improved attitudes towards science subjects.

In a recent study 52 years after the Bennett report, Mannion and Coldwell (2008) investigated 250 schools in England that were provided with funding to set up and run After School Science and Engineering Clubs (ASSECs) over 2 years. They used multiple methods to collect their data, including pupil, staff and club leader surveys; interviews; case studies; and survey of schools who decided against running clubs. As with the Bennett (1956) report, their findings showed that the majority of learners' views about their involvement in their club became more positive the longer they had been a member. Most learners thought they had developed their understanding of what engineers and scientists do, although most discussions with learners during case study visits revealed a number of misconceptions. A number of learners thought the club had helped their understanding more of science, design and technology than mathematics. The vast majority of club leaders and staff saw improvements in practical skills, self-confidence and thinking skills of learners as well as an improvement of attitudes to and understanding of science, mathematics and engineering although there were varying degrees of improvement in actual achievements in these subjects.

In a single case study reported by a secondary school teacher in Portugal (Viegas, 2004), she identified much like the reports of Bennett (1956) and Manion and Coldwell (2008) that having a science club was an important vehicle for developing scientific interest in schools. Her science club consisting of learners aged around 14 years proved useful where scientific topics might not be of the learners' direct interest. She suggested starting a science club with the initial ideas generated by learners and that the teacher's involvement comes in the planning and directing of the process. Her students indicated that it was important for them to be in the club, especially because they better understood some science topics which were taught in class. Similar findings were reported by Twillman (2006), who found that the greater effect of learner participation in the science club she established at her school came from a change in attitude. This improved attitude towards science

was also reported by Moore-Hart, Liggit and Daisy (2004). Twillman (2006) found that because most competitions require teamwork, club members' communication and leadership skills visibly improved. She also pointed out that missing school for an event could assist improve time management skills. She identified challenges similar to the South African context, namely, that learners experience social difficulty with achieving and that science enthusiasm, effort and interest were often frowned upon by their peers. The science club gave members the opportunity and space to express curiosity, and members often gained a sense of belonging to a community that they valued.

A study by Feldman and Pirog (2011) reported on teachers' and learners' participation in authentic science research in out-of-school science clubs at elementary schools in the United States. Four to five teachers worked alongside practising scientists as part of their research groups. Each teacher facilitated a science club with 10–15 learners who, by extension, were members of the scientists' research groups. In their findings, they presented case studies of teachers who were mentored by a research professor and how they in turn mentored the learners. They found that in less than one academic year, the teachers were able to gain the knowledge and skills to facilitate the children's participation in authentic scientific research. They also found that the learners gained methodological and intellectual proficiency needed to contribute useful data and findings to the scientist's research programme. The results of this study are also supported by the findings of Hartley (2010), who used a similar approach of training and mentoring teachers to cascade their knowledge and skills to learners in science clubs at their schools. The September issue of *Afterschool Alliance* (2011) summarised the evaluation reports from afterschool STEM programmes across the United States and identified common trends and strengths that afterschool learning brought to STEM education. Most of the programmes evaluated were specifically designed to provide services to underrepresented populations in STEM fields and many also focusing on providing girl learners with exposure to science and female role models. An analysis of the evaluations yielded STEM-specific benefits that can be categorised under three broad areas, namely, (1) improved attitudes towards STEM fields and careers, (2) improved STEM knowledge and skills, and (3) a greater likelihood of graduation and pursuing a STEM career. These three areas were also highlighted by Mkwandawire (2009) in his study on physical science activities and skills development in the Namibian curriculum. This view was also supported by Shadreck and Isaac (2012), who elicited learners' views on teachers' scientific knowledge in Zimbabwe. They reported that learners expressed a need for science teachers who made teaching science fun and interesting so that learners wanted to learn. Similar trends were found by Hartley & Treagust (2006) with teachers and learners participating in science clubs in South Africa. The following section highlights the findings of an outreach project to establish science clubs at rural schools in South Africa.

A South African Experience of Science Clubs

One of the national priorities in education in South Africa is the effective teaching and learning of science and mathematics at schools. The achievement of learners in examinations in these disciplines generally pointed to a systemic challenge that required novel and innovative solutions. In research conducted by Hartley (2011), it was found that developing the aptitude and interest of learners in science from an early age and sustaining that interest throughout their school career increases their achievement and performance in science. To this end, the Science Learning Centre for Africa of the University of the Western Cape (UWC-SLCA) in 2005 started a science development project which involved science clubs for rural schools and in 2009 received national recognition by winning the prestigious National Science and Technology Forum award as Science Communicator for Public Awareness for its contribution to science and technology education in this region. The project started with a total of 40 schools – 20 primary and 20 secondary schools – and currently has almost 100 science clubs in three provinces in South Africa.

The project was divided in three phases. The first phase involved training of science teachers, including specific content knowledge identified by various stakeholders, including science teachers, practical and experimental skills, pedagogical strategies and assessment. It was also during this initial phase that the notion of a science club was introduced to teachers as a vehicle to communicate science and to get learners hands-on with various science-related activities. The second phase required the teacher to establish a science club at their schools. Teachers were guided in this regard, including starting with a small group of learners that they were comfortable with or one class or one grade level. An internal exhibition/competition was held at each school for learners participating in the science clubs. The third phase was a science competition between the various science clubs, and learners or groups of learners that participated in the internal science competition were selected to participate in this phase. Competitions were held for both primary and secondary schools. The establishment of a series of science clubs at both primary and secondary schools has had a good effect on improving the culture of science learning amongst learners of participating schools as well as the successful development of a culture of science teaching with science teachers. Teachers also reported that discipline in their classes improved, and the popularity of the science club increased when they did some of their science activities during school assembly and gatherings (Hartley, 2012). The numbers of learners wanting to do science increased, and improvements in the achievement of learners participating in the science clubs varied between 5 and 20 %. The range of science activities also expanded, and the level of the activities in the science competition improved dramatically. Teachers readily shared their activities amongst each other but only after the science competition as they challenged each other before the competition. The overall outreach project also generated a number of smaller research projects for postgraduate students.

As part of the research projects of postgraduate students, learners that participated in the science clubs and science competitions were tracked to follow their progress from school to post-school study and careers. Current research data highlighted one story in particular of a group of learners that participated in the first interschool science competition. Nine learners in this group participated when they won the high school section of the competition in 2005. In the year 2011, three of the original nine learners were entrepreneurs owning their own businesses, four learners were in their final year of engineering, one learner was studying medicine, and one learner had just completed a science degree. Interviews with these students illuminated an interesting impression of their participation in the science clubs and how it influenced their chosen study fields and careers. These learners from humble rural schools indicated that when they started working in science clubs, they started to engage with more science literature and discovered the many opportunities that studies in science held for them. They described their interaction through the science clubs as “a whole new world opening up”. After winning the science club competition, they assumed a sense of responsibility as other learners were looking up to them. Over the years, many learners from the primary schools and secondary schools have shown great promise and direction in science and engineering.

The experiences of teachers that participated in the science club project from its inception and teachers who joined at a later stage were also recorded. A healthy relationship developed amongst teachers as they supported each other through innovative and creative science club activities for their learners. A work ethic and high standard of work developed in this community of practising science teachers, and new teachers had to join the prevailing work ethic to be part of the group. Research conducted by students highlighted a professional development journey of a number of teachers, and the science clubs could be identified as the golden thread in each one’s story. They identified their role in the science clubs as influencing their approach, content knowledge, pedagogical style and practical and experimental skills in terms of science teaching and their professionalism in their subject area. They also highlighted the important role that the science club activities play in maintaining discipline in the science classroom. There was also an improvement in the science achievement of learners that actively participated in the science club.

In a group interview with science teachers from 40 schools who participated in the science club project, teachers highlighted the following as important attributes that were developed during their interactions with the project:

1. Improved knowledge of science content
2. Improved practical and experimental skills
3. Improved pedagogical strategies
4. Greater confidence in conducting practical work
5. Better discipline in class
6. Greater interaction with learners
7. Development as a professional science educator
8. Improved management of science classes
9. Improved organisational skills

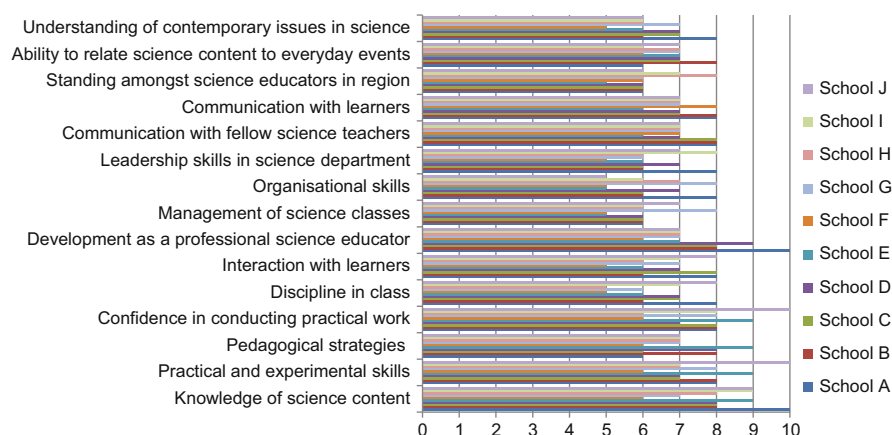


Fig. 1 Graph of attributes versus value addition on a scale of 1–10

10. Development of leadership skills in science department
11. Improved communication with fellow science teachers
12. Improved communication with learners
13. Improved standing amongst science educators in region
14. Ability to relate science content to everyday events
15. Better understanding of contemporary issues in science

In a pilot study of ten (10) schools to determine teachers' perceptions of these attributes, teachers were requested to rate the value addition of the attributes on a scale ranging from 1 to 10, with 1 being the lowest value and 10 representing the highest. The results of the pilot study are represented in Fig. 1.

The data collected for ten schools in the pilot study represented in Fig. 1 indicated an improvement in attributes identified by science teachers. An examination of the teacher perceptions indicated that most of the attributes were scored between 5 and 6, indicating that teachers viewed their involvement in the science club activities to be above average. The scores for the attributes professional development, confidence in doing practical work, pedagogical strategies, practical and experimental skills and content knowledge ranged between 8 and 10 in some schools, indicating greater value addition of these attributes to teachers in these schools.

Recommendations for Science Club Development

In many schools in developing countries, teachers were required to expand learners' involvement in science by participating in science weeks, science exhibitions, science competitions, science excursions or science expos. The extent of their involvement was either by direct participation in these activities or indirectly by

visiting science centres or a mobile science vehicle visiting their school. The teacher decided the type of science activity which was mostly determined by budget allowances. Where schools had no budget for this activity, parents were requested to contribute, or assistance was sought by the organisers of the activities. The outcome of their involvement wavered between “learners stimulated to explore more” and “learners considered it as a day away from school.” The degree to which teachers inculcated what was experienced in their teaching and classroom activities in many instances determined the extent of learners’ involvement in science. In some instances, further support was provided to teachers by the programme organisers or even higher education institutions. This allowed a support base for teachers who could then effectively organise and prepare a group of learners to participate in the various science-related events. It was during these participation opportunities that the notion of an organised science group or science club became entrenched at schools. Learners used their participation and competition with learners from science clubs of other schools as a measure of their own knowledge, skills and understanding in science. This experience in many instances prepared them for the following year’s event and the concomitant growth that accompanied their involvement.

Learners speak to other learners about their experiences, and soon the science teacher becomes inundated with requests from many learners to participate in the science club. It is advisable that teachers who are not confident with their own scientific knowledge, abilities and skills to seek assistance from science event organisers or more knowledgeable colleagues in order to instil confidence in learners. It is also advisable to ensure that teachers understand and abide by safety aspects for laboratories and experiments before demonstrating or allowing learners to a hands-on environment. It is imperative to start the science club with elementary activities and then to move on to more difficult tasks. When activities involve equipment or substances that could prove hazardous, teachers must conduct these activities themselves before demonstrating it to learners. There are a number of science club activities that do not require expensive equipment and make use of everyday products that are easily obtainable. The following are guidelines (Hartley, 2012) provided to teachers that wanted to start a science club at their schools:

1. You must be prepared to put in extra time and effort. Commitment and belief in what you do is important. If you’re not sure or confident about projects, experiments, exhibits or science activities that learners could do in their science clubs, make contact with the event organisers, higher education institutions or experienced colleagues.
2. Start with a small group of learners, one class and one grade. Only start with a group of learners that you are comfortable with and that you consider manageable.
3. Work with the science club during break or after school. Make sure that you have a safe and secure environment/classroom where you can work. Avoid working with hazardous compounds in the initial stages of your science club. Safety of everyone concerned is paramount.

4. Once you are confident with doing an experiment, show learners in the science club how to do it. Stress the fact that we learn more from failed experiments than successful ones.
5. Use curriculum experiments and allow selected learners to practise the experiments after school, and then conduct/demonstrate it to other learners during the actual teaching period.
6. Read up on small experiments/exhibits (there are a number of booklets available on the Internet) that you could quickly demonstrate before starting a science lesson. This application has been successfully used by many of the participating science teachers as a way to have discipline in their classes. If learners are not quiet or paying attention, no new quick experiments will be demonstrated to start the next lesson. You will be amazed at how the learners respond.
7. Allow your science club to demonstrate the experiments at school assembly. Again, this proved to be successful, and science teachers are inundated with requests from learners to be part of the science club. You can use different criteria to manage the growth of the science club, but remember safety cannot be compromised. Find out if there are any courses on laboratory safety that you could attend.
8. Make contact with other science clubs and become part of the community of practice in establishing and expanding the notion that a healthy culture of science learning adds great value to learner performance.
9. Become of part of science club competitions or exhibitions at a local level to allow your learners (and yourself) to gain confidence in what they do. You can move from there to national competitions.
10. Learners must demonstrate an understanding of the activities that they are involved in and must be able to explain what the science activity is all about. Communication of the science is important. Initially use a designated speaker (s) that would confidently do the necessary explanation. Encourage learners to read up more about the science activities that they are involved in. They can read up more in the library, Internet or various science promotion magazines and booklets. Make sure that you plan these activities with the necessary information about the content and safety aspects of the science activity.

Funding is always mentioned as a barrier for the development of science clubs. This need not be the case as many science activities require a creative approach and an understanding that elementary products can be used as effectively as expensive equipment. Indeed in one school, learners built their own model of a vehicle and raced it against an expensive one bought in a shop. Their vehicle, put together from cardboard, elastic, straws and a balloon that provided air pressure as power source, provided greater speed and accuracy than the expensive vehicle. This type of activity spurred on learners to create their own designs and models from elementary products. Teachers were amazed of the extent of learning that took place as learners tweaked and adjusted their creations to obtain maximum efficiency. This, in turn,

provided a learning opportunity for the science teacher to exploit and expose learners to curriculum content in their own constructions and designs.

Conclusion and Recommendations

The reports from various countries and contexts identified the use of science clubs as a positive addition to the learning of science. It was also considered as an important vehicle through which science and science-related activities and careers could be communicated. One of the threads that was clearly visible throughout the various reports was the positive attitude towards science that learners develop. There was a greater sense of understanding and appreciation for scientific endeavours, including improvement in discipline. There were indications of limited success in examination and test achievement in science and mathematics but, on the whole, appear to be an upward curve. The South African experience with rural schools was a useful revelation since it brought about a culture of science teaching amongst teachers along with a pride for their subject. This situation allowed teachers as professionals to form a community of practice and setting indicators of good practice for others to follow. The development of science clubs brought about a culture of science learning as more and more learners wanted to do science. This served to put pressure on teachers to develop the science clubs even further. The science club can be an important vehicle for teachers entering the profession as it can establish them as respected educators amongst learners and their fellow teachers. Science clubs can also be used as the medium through which the dissemination of various science and science-related activities can be communicated to learners, teachers and parents.

From the above reports science clubs can indeed be recommended as an effective tool not only to promote science communication but also as a vehicle through which the teaching and learning of science subjects can be improved to increase the human resource pipeline of science students, researchers and careers.

References

- Afterschool Alliance. (2011). *STEM learning in afterschool: An analysis of impact and outcomes*. www.afterschoolalliance.org/STEM-learning-in-afterschool-analysisofimpact&outcomes.pdf
- Bennett, M. G. (1956). *United Nations Educational Scientific and Cultural Organization (UNESCO): Science clubs activities in the United Kingdom*. Paris: UNESCO.
- Feldman, A., & Pirog, K. (2011). Authentic science research in elementary school after-school science clubs. *Journal of Science Education and Technology*, 20, 494–507.
- Hartley, M. S. (2010, July). *Investigating the science-related attitudes of learners at 5 secondary schools where science clubs have been established*. A paper published in the proceedings of the 41st annual conference of the Australasian Science Education Research Association (ASERA), Port Stephens, Sydney, Australia, pp. 13–29.

- Hartley, M. S. (2011, 26–29 October). *Managing an assessment process of science educator needs in South Africa*. A paper published in the proceedings of the 8th International Conference on Intellectual Capital, Knowledge Management and Organisational Learning, Bangkok University, Thailand, Volume 1, pp. 219–226.
- Hartley, M. S. (2012). Teaching science: Starting a science club. *Quest: Science for South Africa*, 8(1), 12–15.
- Hartley, M. S., & Treagust, D. F. (2006, March). Learning physical science in a rural South African school: A case study of student perceptions of the value of computer-assisted learning. *Science Education International*, 17(1), 13–29.
- Mannion, K., & Coldwell, M. (2008). *After-school science and engineering clubs evaluation* (Research Report No DCSF-RW071). Department for Children, Schools and Families. Retrieved from http://www.shu.ac.uk/_assets/pdf/ceir-ASSEC-DCSF-FinalReport.pdf
- Mkwandawire, M. (2009). *Physical science activities and skills development in the school curriculum of Namibia* (Unpublished Master of Education thesis). UNISA, Pretoria, South Africa.
- Moore-Hart, M. A., Liggitt, P., & Daisey, P. (2004). Making the science literacy connection: After school science clubs. *Childhood Education*, 80(4), 180–186.
- Pike, A. G., & Dunne, M. (2011). Student reflections on choosing to study science post-16. *Cultural Studies of Science Education*, 6, 485–500.
- PISA. (2012). *PISA in focus*. www.pisa.oecd.org
- Shadreck, M., & Isaac, M. (2012). Science teacher quality and effectiveness: Gweru Urban Junior Secondary School students' points of view. *Asian Social Science*, 8(8), 160–165.
- Twillman, J. (2006). Science for fun? Try a high school science club. *The Science Teacher*, 73(1), 49–52.
- Viegas, A. (2004). The importance of science clubs: Methods used in a school case. *Teaching Science*, 50(4), 22–25.

Communicating Science to the Public
Opportunities and Challenges for the Asia-Pacific
Region

Tan Wee Hin, L.; Subramaniam, R. (Eds.)

2014, X, 298 p. 32 illus., Hardcover

ISBN: 978-94-017-9096-3