

Science Clubs as a Vehicle to Enhance Science Teaching and Learning in Schools

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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 paper 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.

Keywords: science clubs, science communication, teaching and learning

1. 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 available to them (Afterschool Alliance, 2011). It is also generally understood science and technology holds a myriad of employment and economic advancement pathways to future generations. It is therefore important for learners be given a solid base 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 the technology in the modern world develops and advances a 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 number of learners taking up science and mathematics decreasing on an annual basis. International tests like TIMSS 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 identifies successes of countries utilizing 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

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ensure that appropriate knowledge, skills and opportunities are conveyed to learners in 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 paper 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.

2. Reports of School Science Clubs

The following reports 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 between 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 organized 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 toward science subjects.

In a recent study 52 years after the Bennett report, Manion & 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 two 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 and 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 Mannion 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 that starting a science club with the initial ideas generated by learners and that the teacher's involvement comes in the planning and directing 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 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 & 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 practicing 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 mentored by a research professor and how they in turn mentored the learners. They found that 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 program. The results of this study is 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) summarized the evaluation reports from afterschool STEM programs across the United States and identified common trends and strengths that afterschool learning brought to STEM education. Most of the programs 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 categorized under three broad areas namely (i) improved attitudes towards STEM fields and careers, (ii) improved STEM knowledge and skills; and (iii) a greater likelihood of graduation and pursuing a STEM career. These three areas were also highlighted by Mkandawire (2009) in his study on physical science activities and skills development in the Namibian curriculum. This view was also supported Shadreck & 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 (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.

3. 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 examination achievement of learners in these disciplines in general point to a systemic challenge that requires 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 are guided in this regard including starting with a small group of learners that they are 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 is 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 a series of science clubs at both primary and secondary schools process has had a good

effect on the improving the culture of science learning amongst learners of participating schools as well as 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 challenge each other before the competition. The overall outreach project has also generated a number of smaller research projects for postgraduate students.

In one of the research projects learners that participated in the science clubs and science competitions are tracked to follow their progress from school to post-school activities. Current research data highlighted one story in particular of the first group of learners that participated in the interschool science competition. Nine of them 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 were in their final year of engineering, one was studying medicine and one had just completed a science degree. Interviews with these students illuminated an interesting take on 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 clubs competition they assumed a sense of responsibility as other learners was 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 the onset and teachers who joined 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 practicing science teachers and new teachers had to join the prevailing work ethic to be part of the group. Current research by students highlight a professional development journey of a number of teachers and the science clubs can 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 highlight the important role that the science club activities play in maintaining discipline in the science classroom. There is also a slight improvement in achievement in science by learners that actively participate in the science club.

4. Conclusion and Recommendations

The reports from various countries and contexts identify the use of science clubs as a positive addition to the learning of science. It is also considered an important vehicle through which science and science related activities and careers could be communicated. One of the threads that is clearly visible throughout the various reports is the positive attitude towards science that learners develop. There is a greater sense understanding and appreciation for scientific endeavours including improvement in discipline. There are 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 has been a good revelation since it brought about a culture of science teaching amongst teachers along with a pride their subject. This situation allowed teachers as professionals to form a community of practice and setting indicators of good practice for other 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 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 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.

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