Promoting radio astronomy in Ghana through school visits and Astronomy Clubs

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Abstract

The Promoting Radio Astronomy in Ghana through School visits and Astronomy Clubs (PRAGSAC) project was an intervention to promote astronomy education in schools in Ghana. It was initiated by a group of enthusiastic students who were trained in radio astronomy and astrophysics under a Royal Society/Newton Fund UK project termed Development in Africa with Radio Astronomy. The team's aim is to expose school children to astronomy and to increase their interest in the sciences. Approximately 800 school children from seven junior high schools were positively impacted by this project. Astronomy clubs were formed in the selected schools with practical astronomy lessons taught. The kids visited the largest single radio

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telescope in Africa at Kuntunse in Accra and were amazed about the engineering and the science that it undertakes. For the patrons of the clubs, a teacher training workshop was organised for them, so as to equip them to manage the clubs. The feedback from students and teachers was exceptionally positive, implying that the PRAGSAC project has helped inspire more students to pursue courses and consider careers within the sciences.

Keywords: astronomy, education, outreach, astronomy clubs, GSSTI/GRAO, PRAGSAC

1. Introduction

The UK Government's Newton Fund and Global Challenges Research Fund are being used to train a first generation of Africans in the high tech skills associated with radio astronomy. This is in lieu of the African continent gearing to host the world's biggest radio telescope, having a square kilometre of collecting area, dubbed the Square Kilometre Array (SKA). The SKA telescope will be co-located in Africa and in Australia. It will deliver an order of magnitude improvement in sensitivity compared to current radio astronomy facilities [1].

To make the SKA project an African inclusive project, radio telescopes would be built in eight targeted African countries to form the African Very Long Baseline Interferometry Network, with the correlator in South Africa [2] while delivering cutting edge science [3–6]. Working closely with industrial partners in the space sector the Newton Fund UK project, Development in Africa with Radio Astronomy (DARA) aims to help drive economic development in this new area and prepare African scientists and engineers for the SKA project [7]. The DARA project is a joint UK–South Africa human capital development project led by the University of Leeds to help drive economic development in Africa. Radio astronomy encompasses all of the science, technology, engineering, arts and mathematics skills that underpin the emergence of a strong developed economy. The modern astronomer needs knowledge in physics, mathematics, chemistry and computing. To develop, maintain and run radio telescopes key skills are required in technology and engineering. Ghana's president, Nana Addo Dankwa Akufo-Addo on Thursday 24 August 2017 launched the Ghana Radio Astronomy Observatory (GRAO) (see figure 1). It was a 32 m telecommunications dish that was converted into a radio telescope with the help of South Africa and UK. The launching of the telescope made Ghana, the second country in Africa to own a radio telescope [8].

The government and other organisations in Ghana are much concerned about students opting to study science, technology, engineering and mathematics (STEM). Consequently, the Promoting Radio Astronomy in Ghana through School visits and Astronomy Clubs (PRAGSAC) projects believe that there should be an increase in the number of people undertaking STEM-based degrees in Ghana. Despite the launch of the radio telescope in Ghana, not many people and for that matter school children are aware of astronomy in Ghana. The PRAGSAC project was funded by the International Astronomical Union (IAU)/Office of Astronomy for Development (OAD) and DARA to promote radio astronomy in schools in Ghana. The PRAGSAC team comprises of the various cohorts of the DARA basic radio astronomy training programme. The majority of the members participated in the West African International Summer School for Young Astronomers (WAISSYA) program held in Accra, Ghana in 2017 [9]. These experiences contributed to the formation of PRAGSAC. The team realised it was important to promote awareness of the 32 m radio telescope in Ghana and its benefits to the country. In addition, recognising that Ghana needs more STEM professionals, both to work at GRAO in future and in many other fields to aid development of the country, there is the need to inspire and encourage more students to take science subjects at high school and the universities. Therefore the team decided to form astronomy clubs in schools, where students could explore practical science activities with the focus on astronomy.

The results of this project are presented in this paper. This work is organised as follows: section 2 describes the PRAGSAC project. The intervention the PRAGSAC project made is presented in

Figure 1. The President of Ghana alongside the former Minister of Science and Technology of South Africa cutting the tape to launch the Ghana Radio Astronomy Observatory.

section 3. Next in section 4, the work is concluded and recommendations outlined.

2. The PRAGSAC project

The project commenced in August 2018 in seven junior high schools (JHS) in the Greater Accra Region of Ghana. The following are the participating schools: Kuntunse M/A Basic school 1, 2, 3 and 4, Katapor D/A Basic School in Katapor Pokuase, Jerremite International School in West Legon and Unity Baptist Academy in Achimota. The seven schools were both public and private. They were selected due to their proximity to GRAO and Ghana Space Science and Technology Institute (GSSTI). This was a pilot study hence few schools were selected. Convenience sampling technique was used. The students age, ranges from 12 to 18 years. In Ghana, JHS education comes after six years of primary education, and is followed by senior high school (SHS) which is pre-tertiary. Private schools are selective, but public schools are mostly not.

JHS students were targeted because it is in the final year of JHS that students choose the program of study they will take at SHS level, which is the pre-tertiary level in Ghana. The aim was to excite and inspire students with astronomy at JHS level, so that they are more likely to opt for the science program at SHS level, which is required if they wish to study any science-related course at tertiary level.

SHS students have already made decisions to study various subjects, hence the plan was to start with the JHS students and continue with the SHS and tertiary institutions in Ghana. See figure 2 for a map showing the schools locations. The schools are located within a 10 km radius around GRAO and GSSTI offices. The project goals included; increasing awareness about GRAO and the benefits it can bring to the local community and Ghana in general, expanding the knowledge of students on astronomy, establishment of astronomy clubs at the schools visited, increasing interest in STEM subjects among the students and encouraging more students to study STEM

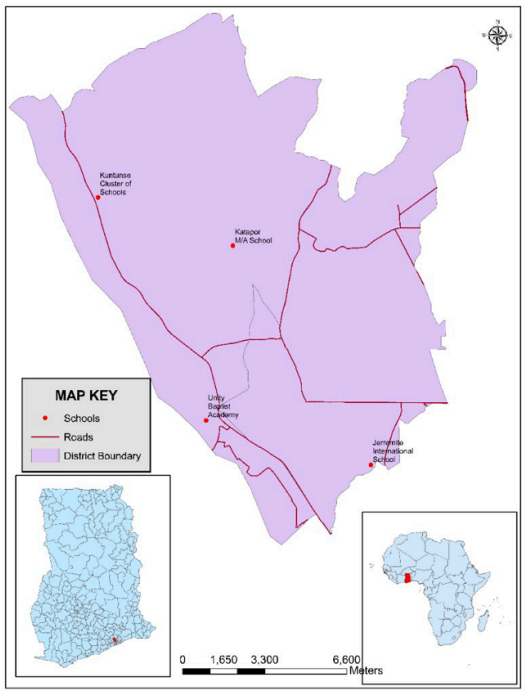


Figure 2. A map showing the approximate locations of the schools.

subjects at SHS level. The project, PRAGSAC introduced students to practical astronomy topics to build their interest in science for informed academic and career choices. It involved the design and development of teaching and learning materials, workshops, school visits, formation of astronomy clubs, setting up of a website for PRAGSAC and social media channels like YouTube, Facebook, Instagram and Twitter to showcase activities in different schools. There were plans to organise an astronomy quiz for JHS and visits to the GRAO and the planetarium in Accra. The PRAGSAC project makes outreach to the radio telescope site a possibility for the students. Curiously, these activities differ from in-school teaching, bringing industry content supplement to the kids educational curriculum. It increased learning by adding a physical and place-based learning environment where students felt at ease [10].

3. The PRAGSAC intervention

Over 800 students in total attended the initial presentation, after which astronomy clubs were formed in all seven schools. A total of 405 students in seven schools attended the first astronomy club session on Earth, Moon and Sun. Sixty-eight students in two schools attended the second astronomy club session on Solar System. The club sessions were run by the project team members, engaging the students in talks, discussions and hands-on activities. The students were engaged through an initial power-point presentation which aimed to enthuse, inspire and educate them about astronomy in general and radio astronomy in particular. The interactive presentation introduced a wide range of topics such as what is astronomy, what do astronomers do and how do they study the sky, understanding the electromagnetic spectrum and how that gives rise to the different types of astronomy including radio astronomy, and the components of the radio telescope at GRAO and their functions, which provided a take-off point in enlightening and broadening their horizons of astronomy. They were also introduced to the many amazing ways that society has benefited from astronomy research and development, and possible career paths in astronomy and space science that might be worth considering as they advance.

A group of 137 students and nine teachers from the seven schools visited GRAO, where they were engaged in hands-on activities such as building a model telescope, making a scale model of the Solar System, and an astronomy word search/quiz. They were also given a full tour of the 32 m radio telescope site. The kids were excited to see for themselves the components of a typical radio telescope and observatory that they had been theoretically introduced during the initial presentation by the PRAGSAC team. See figure 3 for the kids' day the observatory. In addition, seven teachers, one from each school, attended a one day interactive astronomy workshop at GSSTI. The aim of the workshop was to empower the teachers to be able to continue running astronomy club sessions even after the end of the project. The majority of teachers in Ghana are not exposed to astronomy, and therefore they generally only learn what they need to teach from the curriculum which includes the Solar System and eclipses. Hence teachers find it difficult to run astronomy club themselves. Some of the topics covered in the workshop included: introduction to Earth/Moon/Sun System, Solar System, Galaxies

(a) Demonstrating the distance between the planets with paper roll

(b) Kids playing with the Galileo telescope

(c) Kids building a miniature model of the MeerKAT telescope

(d) Students and their patrons in front of GRAO telescope

Figure 3. Students' open day to GRAO.

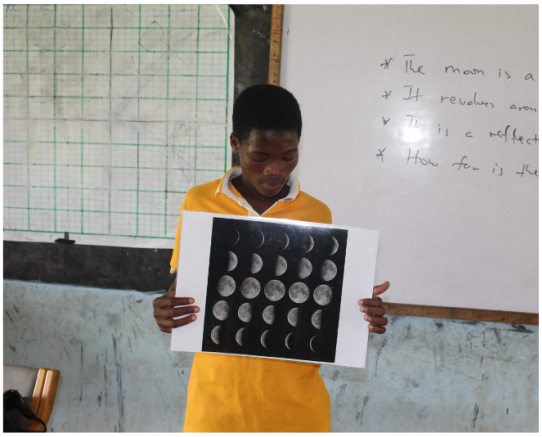
and the Universe, careers in astronomy and space science for students, opportunities for capacity building for teachers and students through PRAGSAC and GSSTI. The teachers also went through some hands-on activities such as modelling the orbits of the Sun, Earth and Moon, and creating a model of Solar System distances.

Subsequent to the main phase of the project which ran from August to December 2018, project team members kept in touch with the clubs in 2019. This was relevant in order to keep the momentum and enthusiasm of the students and teachers. Additional activities in 2019 included: 100 Hours of Astronomy event (presentations and videos about the International Space Station and astronauts followed by an astronomy quiz), Women and Girls in Astronomy Day (presentation on famous women astronomers and talks by three Ghanaian women studying/working in science and astronomy), inspirational astronomy talk with Prof. Ben Stappers from University of Manchester (a talk on the general concepts of astronomy, the importance of GRAO to the community and the country as a whole, careers in STEM with the aim to motivate and encourage students to consider STEM related programs in the future), two of the schools participated in the Eratosthenes Project, an international hands-on science project that allows students to calculate the circumference of the Earth using shadow measurements, representatives of the astronomy clubs were invited to attend the reception for the visit of the IAU President to Ghana. Unfortunately, due to lack of funds, only one school was able to send students. Those students were able to visit the Ghana Planetarium, listen to a lecture given by the IAU President,

(a) Demonstration of earth orbiting the Sun

(b) Comparison of the sizes of the planets, sun and the solar system

(c) The size of the earth is compared to other planets



(d) Explaining the lunar phases

Figure 4. Practical sessions at schools visited.

Ewine van Dishoeck, and also had the opportunity to interact with her afterwards.

Also in 2019, team had funding from the Open Astronomy Schools Teacher Training call to run a two day workshop for teachers, building on what was achieved during the initial workshop. It was attended by eight teachers, six from the original schools that had formed astronomy clubs, plus two from new schools that had heard about the project and wanted to start their own clubs. The workshop was an integration of presentations, hands-on activities discussions, demos using astronomy software such as stellarium and celestia, group projects, short videos and telescope viewing. The hands-on materials were made using card-boards, paper glue, paint, globe and tape. These materials were made from low budget stuff of approximately 180 dollars. The teachers took them away after the workshop for demonstration to their students. At the end of the workshop the teachers were tasked with developing and delivering a module to their respective clubs.

Astronomy clubs were established in all the seven schools that participated in the project. The club sessions gave the kids a solid foundation in basic astronomy. Each session featured hands-on activities to consolidate what had been learned. The clubs also offered the opportunity for kids to ask questions about the Universe and hence solidify their interest in astronomy. See figure 4 for hands-on activities at some of the schools.

The astronomy clubs are still running in the various schools. Contact/supervision is done every term with the schools and more schools have been added in other parts of the country. An intervention was made during the Covid-19 pandemic, nose masks were distributed to some of the schools and pre-recorded video lessons were developed by team members to help salvage the situation when students were not able to attend school. There are plans to add more schools in other parts of the country later this year.

It was impressive to note, the astronomy club from Katakpor Basic School were inspired to make a model radio telescope of their own. See link.

Anecdotal evidence from the students and teachers indicated an increase in interest in science and a desire to study science in future. Some are outlined here:

'Their interest has been whipped up astronomically-they ask more questions'—Patience Andoh, Science Teacher, Kuntunse M/A Basic School 'I believe that after this programme, I am going to have quite a number of kids pursuing science, unlike before.'—Catherine Amengu, Science Teacher, Kuntunse M/A Basic 2 'This program is going to debunk the notion that science is difficult … it is going to boost their interest in science … it is going to help them have the spirit to learn'—Cephas Agbai-Kude, teacher at Katakpor M/A Basic School 'Because I am so impressed about this excursion, I am expecting to become an astronomer to improve the development of this country'—JHS Student, Katakpor M/A Basic School. 'My expectation is to complete JHS and then proceed to the SHS. I will learn science and then go to the university and learn about data science, and come back and become a data scientist and help contribute to radio astronomy in Ghana'—JHS Student, Katakpor M/A Basic School. 'The patron's workshop was an eye-opener for me, it helped me to understand a lot of things we have been teaching'—Catherine Amengu, Science Teacher, Kuntunse M/A Basic 2. 'Now I know more and I am more confident'—Patience Andoh, Science Teacher, Kuntunse M/A Basic School. The PRAGSAC project also inspired the involvement of two schools in the 2019 Mercury transit [11].

4. Conclusions

The PRAGSAC project was successful in promoting radio astronomy and enthusing students about science. The astronomy clubs gave students the freedom to explore and ask questions, and used hands-on activities to consolidate learning and provide fun and practical inspiration. In addition to the regular club sessions, students greatly benefited from other events that gave them opportunities where they met local and foreign scientists and astronomers, learnt about space science and were inspired by women in astronomy, and participated in an international science experiment. These events gave them a broader view of astronomy, and what they can aspire to.

Teacher training was an important part of the project, to ensure long-term sustainability of the clubs. Teachers were appreciative of the opportunity to improve their knowledge, clear up misconceptions and try out practical activities. They committed fully to the teachers workshops, and demonstrated their enthusiasm by leading astronomy club sessions when they went back to their schools. The feedback from both students and teachers was overwhelmingly positive, and we clearly saw great enthusiasm and a thirst to learn more. We believe that this project will inspire more students to take up STEM courses and consider related careers. The astronomy workshop for the teachers proved to be one of the highlights of the project. The enthusiasm of the teachers was very impressive, they participated fully in all the sessions and felt comfortable asking a myriad of questions. It was clear that the workshop was very valuable in clearing their minds of various misconceptions and expanding their knowledge. They were happy to stay late beyond the stated hours 8:30 am–4:30 pm to 6 pm for the workshop to continue asking questions and requesting clarifications.

It was important that opportunities for additional training and development for the teachers were discussed, to motivate them to

continue learning about astronomy and running the clubs. They were made aware of programs such as WAISSYA, scholarship opportunities (Masters/PhD) and the Basic Radio Astronomy Training Program funded by DARA. We intend to continue our engagement with the schools, and even expand the project to more schools and regions of Ghana if possible, to inspire more students to contribute to the development of Ghana through STEM. The formation of school astronomy clubs, utilising discussion and hands-on activities, was found to be very successful in promoting excitement about science and astronomy, and should be continued/expanded to more schools.

Training for teachers should be an integral part of the astronomy club project, to empower and incentivise the teachers and ensure long-term sustainability for the clubs. Training sessions should take place regularly (e.g. once a term) and include plenty of ideas for hands-on activities, as well as hard copies of materials such as posters, for the teachers to take away with them.

Additional sessions such as excursions to GRAO and the planetarium, participation in hands-on science projects and talks from guest speakers including local scientists are a great way to inspire the students, introduce them to role models and broaden their horizons.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

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Conflict of interest

The authors declare that there are no potential conflicts of interest in this publication.

Ethical statement

Informed consent to participate in the study, and for the results to be published was obtained from participants (or their parent or legal guardian in the case of children under 16) for all research involving human subjects. It was carried out in accordance with the principles outlined in the ethical policy of IOP and the Ghana Education Service including studies done on teaching methods. Consent to publish was obtained for all identifiable individuals and any identifiable individuals are aware of intended publication.

Authors contribution

All authors have been involved in the PRAGSAC project. E T O O, A F, E P A, J K, S A M, K A D and F A have been involved in the outreach, as well as writing the initial drafts of the paper. E T O O and E P A worked on the final drafts of the paper.

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