Strengthening Astronomy and STEM Education in Ghana through School Astronomy Clubs

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Summary:
Ghana is well-positioned to benefit from its status as an SKA (Square Kilometre Array) African partner country, with the added advantage of hosting its own radio astronomy observatory. However, the majority of the general population are not aware of these facts, there is little astronomy on the curriculum and media reporting related to science and astronomy is generally limited. In order to stimulate more interest in STEM (Science, Technology, Engineering and Mathematics) subjects and to prepare the future running of the observatory, an outreach team was established – PRAGSAC (Promoting Astronomy in Ghana through School Visits and Astronomy Clubs).

PRAGSAC primarily focused on strengthening STEM education through astronomy by setting up school astronomy clubs and providing hands-on, practical activities (which are often absent from school science lessons) as part of the club sessions. Teacher-training was provided to give teachers the skills to independently manage the clubs and to ensure an effective learning environment.

Feedback from the participants was very positive, with a noticeable increase in student enthusiasm for science and teachers reported feeling more confident in teaching astronomy. The surveys gathered also showed an improvement in astronomy knowledge and understanding. This indicates astronomy clubs can be a powerful tool in cultivating a greater number of scientists and astronomers which is a key factor in the country's future growth and development.

Background:
In Ghana, science is commonly viewed by students as an abstract and challenging subject that lacks practical applications to everyday life. Science classes generally lack hands-on experiments and activities. At the Senior High School (SHS) level, enrollment in the General Science program is low, with only 12% of students enrolled, compared to 40% on the General Arts program and 21% on the Business program *(Ghana Statistical Service, 2012/2013 report)*. Most students have little awareness of careers in Science, apart from teaching.

The Ghanaian government launched an ambitious Science, Technology, and Innovation (STI) policy in 2017, recognizing the crucial role of STEM and STEM education in driving national development. However, the application of this policy has been hindered by various factors, including "inadequate science teaching and learning in the pre-tertiary education system", as stated in the policy document itself.

PRAGSAC (Promoting Astronomy in Ghana through School visits and Astronomy Clubs) is an initiative focussing on promoting STEM education through the use of Astronomy. The majority of the voluntary team members went through the DARA (Development in Africa with Radio Astronomy) basic radio astronomy course, and many attended WAISSYA (West African International Summer School for Young Astronomers) in 2017. These experiences inspired them to initiate the project to share their knowledge and promote astronomy for the benefit of learners.

Astronomy Clubs were chosen as the avenue as there is currently very little astronomy on the curriculum, plus a club environment gives more freedom to explore the subject at the pace of the students, with more time to explore, ask questions and carry out activities than is usually possible in a standard science lesson.

Project Objectives:

- Increased understanding and appreciation of STEM subjects in general and astronomy in particular
- Increased awareness of the Ghana Radio Astronomy Observatory (GRAO) and the benefits it can bring to the local community and Ghana in general
- Establishment of astronomy clubs at the schools visited, utilising hands-on activities to promote creativity, critical thinking and problem-solving skills
- Increased awareness of STEM careers
- Increased interest in STEM subjects among the students

Promoting Radio Astronomy in Ghana through School Visits and Astronomy Clubs: https://iopscience.iop.org/article/10.1088/1361-6552/ac832b

Astronomy Club Sessions

- Initial presentation given in 17 schools in 3 regions of Ghana, showcasing the inspirational nature of our universe and the innovative work done by astronomers
- Astronomy Clubs formed in all 17 schools
- Over 650 students impacted
- Club sessions covered a variety of astronomy topics and incorporated discussion, Q&A and hands-on activities

Club activity on Earth, Moon and Sun

Club activity on Eratosthenes experiment

Special Events

International Day of Women and Girls in Science
- special event for female students
- meet female role models in scientific fields
- learn about careers in astronomy

Eratosthenes experiment
- Participate in an international project, linking with schools across the globe
- Practical hands-on experiment to measure the Earth using shadows

100 Hours of astronomy
- presentation, videos and discussion, followed by a quiz

Meet the Astronomer
- Interaction with local and international astronomers

Teacher Training Workshops

- Empowering the teachers
- Improving knowledge, skills and confidence
- Hands-on activities accompany every topic
- Comprehensive handbook and some materials provided
- Telescope viewing
- Ensuring sustainability of the clubs

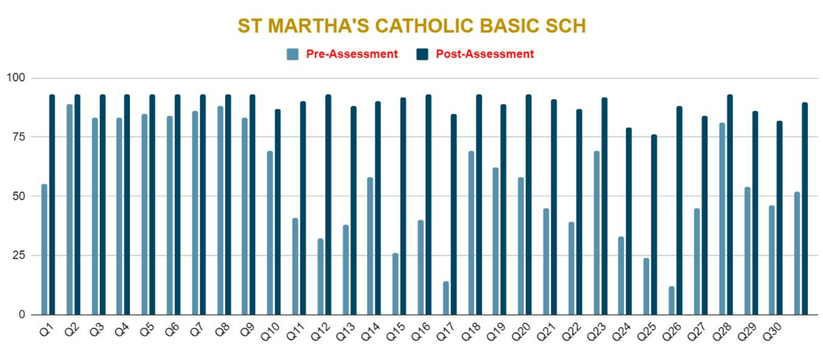
Teacher training activity on measuring the diameter of the Sun

Teacher training activity on EM spectrum

Telescope viewing during initial school visit and presentation

Assessment Results - Students

Multiple choice questionnaires were used to assess students astronomy knowledge before and after the sessions, and indicated in improvement in students understanding of the astronomy topics. As an example, results from one school are shown below.



Special event for International Day of Women and Girls in Science

Results from Teacher Training Workshop

There was a marked increase in confidence in teaching the various astronomy topics after the workshop, as illustrated below.

On a scale of 1 to 5 where 1 is not comfortable and 5 is very comfortable, how do you feel about teaching the following topics:

Pre-workshop assessment

	Percentage selecting option 5
Earth, Moon and Sun	60%
Solar System	80%
Milky Way Galaxy	60%
Galaxies in general	20%
EM Spectrum	40%
Telescopes	20%
Satellites	40%

Post-workshop assessment

Topic	Percentage selecting option 5
Earth, Moon and Sun	100%
Solar System	100%
Milky Way Galaxy	100%
Galaxies in general	100%
EM Spectrum	75%
Telescopes	75%
Satellites	100%

Conclusion

The establishment of astronomy clubs in schools, coupled with teacher training, has demonstrated a successful approach to enhancing teachers' confidence and students' involvement engagement with STEM. The practical exercises were especially appreciated, and both students and teachers exhibited great enthusiasm.
The cultivation of scientists and astronomers through astronomy clubs is an important investment in a country's future growth and development, both in terms of scientific advancement and the benefits that come from having a scientifically literate population.

Educational trip to the Ghana Radio Astronomy Observatory(GRAO)