RESEARCH ARTICLE

An initiative to develop a public engagement ecosystem in Ghana: a case of WACCBIP's High Schools' Engagement Programme [version 1; peer review: 2 approved with reservations]

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Abstract

Background: The High Schools Engagement Programme (HSEP), is a West African Centre for Cell Biology of Infectious Pathogens (WACCBIP) public engagement initiative that targets students in under-resourced high schools in Ghana. Annual programmes are directed towards providing information on prospective careers in Science and discussing the causes of and preventive measures against endemic infectious diseases. Using peer-learning strategies, post-undergraduate research trainees (graduate interns) encourage collective action against the diseases and work to inspire high school students to consider scientific research as a career, either directly or in support roles. The objective of this study was to explore the outcomes of the HSEP, specifically revealing how it met its initial objectives, and other relevant unintended outcomes.

Methods: An evaluation design, which relied on a survey and interviews of 138 high school students, 9 graduate interns, and 3 teachers who participated in the 2019 edition of the HSEP, was employed.

Results: The HSEP presented a likelihood of improving the academic performance of high school students and provided motivation for them to pursue careers in scientific research. The programme also equipped the students with requisite knowledge to contribute to the prevention of infectious diseases prevalent in their communities. As trainee scientists, graduate interns also developed awareness on the need for public engagement, the challenges of STEM education in Ghana and the need to make efforts to address these challenges, and also developed key leadership and soft skills.

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Any reports and responses or comments on the article can be found at the end of the article.

Conclusions: Overall, the HSEP could potentially be a model for developing a public engagement ecosystem in Ghana. It is recommended that the programme is scaled up to include master's degree and PhD researchers as facilitators to further widen the favorable impacts.

Keywords

Public engagement, research, ecosystem

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Introduction

The African Academy of Sciences (AAS) defines public engagement as a programme that targets a large concourse of participants who are unaffected directly by a study or research activity, and differentiates public engagement from community engagement based on the target audience. Community engagement involves a target audience who are directly affected by the research, whilst public engagement involves interactions between researchers and members of the general public aimed at fostering mutual learning towards decision-making and the implementation of research (AAS, 2019; AAAS, 2018).

Historically, public engagement evolved out of a need to clear public misconceptions around science and scientific research, which seemed to undermine the legitimacy of the work of scientists (Datta, 2011). To address this, public engagement gave scientists the means to authoritatively pass on unquestionable information to the public. This was later termed as the 'deficit model' and was criticized heavily due to its assumption of an ignorant public (Datta, 2011; Pereira *et al.*, 2013). Subsequently, democratizing scientific research became a goal and required that public engagement focuses on fostering mutual learning and teamwork between scientists and non-scientific communities. Concepts such as 'citizen science' and 'open science' evolved, which had goals of enhancing an interface between the public and scientists in determining research goals and influencing scientific outcomes (Hecker *et al.*, 2018). This placed the public, the consumers of the outcomes of science, at the centre of scientific research and increased the need for scientists to prioritize public engagement.

The West African Centre for Cell Biology of Infectious Pathogens (WACCBIP) is a World Bank funded African Centre of Excellence concerned with health research and training in Sub-Saharan Africa. The mandate of the Centre is to improve the diagnosis, prevention and control of infectious diseases and non-communicable diseases in the sub-region. In recognizing the vital role of public engagement and the need to bridge the gap between the scientific and non-scientific communities, the Centre places public engagement at the centre of its research efforts. In 2019, the Centre executed 29 public engagement activities ranging from TV and radio engagements, science fairs, workshops and outreach events. The goal is to develop a public engagement ecosystem consisting of scientists, the general public, and policy makers, by building capacity and interest of the public in scientific research, and creating the platform for scientists to acknowledge the need for public engagement in their work.

The theory of change of the Centre, which is set out in its Monitoring and Evaluation Framework, defines a pathway for public engagement. The final composite outcome of the Centre's public engagement efforts is to enhance the interest of the public in contributing to the eradication of tropical diseases in Africa. To achieve this, public engagement programmes designed by the Centre seek to equip the public with information necessary to inspire individual and communal initiatives to prevent infectious diseases and to provide a platform for collaborative

dialogue between scientists and the general public. All public engagement initiatives at the Centre are therefore either meant to provide education and information to the general public on tropical diseases that affect them or provide an opportunity for scientists to listen to the public on issues relating to tropical diseases to determine the foci of scientific research.

The High Schools Engagement Programme (HSEP) is one of many public engagement initiatives that are organized by the Centre and targets one of the largest youth groups in Ghana—high school students. The programme was designed to sensitize the students on some common infectious diseases (causes and preventive measures); inspire collective action against the diseases and provide information on the prospects of scientific research, particularly into infectious diseases, as a career (including support roles).

This paper reports the outcomes of the 2019 event under WACCBIP's High Schools Engagement Programme (HSEP) by elaborating on evaluation findings from participating students of the programme, their teachers, as well as young research scientists who facilitated the programme. The paper also offers recommendations on making the programme more effective in the future.

Public engagement with science in Africa

High importance has been attached to public engagement as far as the study of Science and the development of societies is concerned. Some of the benefits of public engagement are the ability to gather novel ideas from the public, inform the citizenry on the current trends and technologies in science, increase the probability with which the public adopts scientific research, and promote an increase in public trust (Cohen *et al.*, 2008). Notwithstanding these benefits and enhancements in scientific research outputs in Africa, the public's comprehension of science is still low in many parts of the continent (Karikari *et al.*, 2016), and therefore necessitates discussions and the development of initiatives to promote public engagement in Africa. Karikari *et al.* (2016) contributes to the discussion with the argument that the future of public engagement, as well as the closing of the gap between scientists and the African public, greatly falls on the next generation of scientists. Ndlovu *et al.* (2016) reveals that public engagement in sub-Saharan Africa is gradually gaining the attention of research scientists, university managers and the public in general, and has resulted in an increase in the implementation of public engagement initiatives. Among these initiatives is the Development Research Uptake in Sub-Saharan Africa (DRUSSA); a five-year programme which began in October 2011 and was designed to aid the efforts that have been put in place by universities within the region to ensure that research impacts on policy and practice (DRUSSA, 2012). The Southern African Research and Innovation Management Association (SARIMA) provides training to research scientists in the field of public science communication and engagement to equip African scientists with the skills to engage the public with their research output and thus close the gap between the African public and scientific researchers (Ndlovu *et al.*, 2016). The Science

Engagement Strategy by South Africa's Department of Science and Technology is one of the Department's programmes to improve public understanding of science, scientific literacy, and engagement (South Africa's Department of Science and Technology, 2015, p3), and there have been some efforts made by the AAS, particularly in the provision of specific grants for public engagement purposes to scientists in Africa (AAS, 2019).

Despite the emerging efforts to support public engagement in Africa, participation of both scientists and the public remains limited (Karikari *et al.*, 2016). To date, public engagement in Africa is constrained by scarce resources, high levels of public illiteracy, lack of institutional support, low levels of public interest, the general perception that public engagement plays a secondary role in research, and time constraints (Lukensmeyer & Torres, 2006; Ndlovu *et al.*, 2016). Research institutions and universities play important roles in curbing these constraints and promoting effective public engagement as they have the capacity to design comprehensive policies and strategic plans to direct public engagement efforts. They also have the necessary structures to attract funding to cover public engagement in their institutions (Hamlyn *et al.*, 2015). WACCBIP's schools engagement strategy would be an exemplary model for promoting public engagement as it leverages this kind of institutional capacity towards facilitating the interface between scientists and the public.

WACCBIP High Schools Engagement Programme (HSEP)

The HSEP is an annual outreach programme that sends scientists at WACCBIP to under-resourced high schools in under-served communities in Ghana to interact with students about the causes of and preventive measures against infectious diseases. Most of the outreach team members are scientists in training (i.e. graduate interns¹) but the team also usually includes postdoctoral researchers and members of the Centre's teaching faculty.

High schools in selected regions of Ghana are selected by the planning team prior to the engagement period, and the programme usually lasts for six days, with each day dedicated to one specific high school. The outreach team delivers interactive oral and practical presentations to the students, giving room for interaction, which helps foster direct inspiration to the students. The programme is designed to provide information and education to participating students on some common infectious diseases, particularly malaria, and their contribution to curbing them. The programme also takes advantage of the opportunity to educate the students on prospective career paths in science to those who desire to acquire university education. The aspirations of many science students at high school level in Ghana have been limited to medicine, engineering and computer science fields. This causes a lack of interest among other students in other areas as they

transition into tertiary education. Broadening their orientation to include the prospects of scientific research, particularly at that early stage, is likely to ensure that young people enter such areas with passion as they transition into higher levels of education. Information on post-high-school education and career prospects are very limited in rural/deprived communities due to limited access to information sources.

Early introduction to public engagement builds an interest in young scientists such as graduate interns to participate in engagement in the future. It also places educated young people in a better position to dialogue with scientists.

Methods

Ethical considerations

The study was approved by the University of Ghana Ethics Committee for Basic and Applied Sciences (ECBAS) with approval number ECBAS 033/18-19. Written consent was sought from school authorities during the commencement of formal arrangements to hold the programme in their schools. Informed verbal assent was obtained from all student participants involved in the study, and informed consent was obtained from those over 18 years. Consent was given by participants just before the survey and interviews were administered. Consent was given after the purpose and terms of the survey and interviews were verbally explained to participants.

Study design and setting

The study employed an evaluation design to explore the outcomes of the WACCBIP High Schools Engagement Programme. Since this study was the first attempt to evaluate the HSEP, an exploratory approach which relied on self-reported outcomes by participants, was employed. This was to give formative perspectives of both intended on unintended outcomes of the programme.

The study was conducted during the 2019 edition of the High School Engagement Programme, held in July 2019, in five schools across two regions in Ghana. As an outreach event, the programme saw graduate interns and facilitators from WACCBIP have face-to-face oral and practical sessions with students in the target schools. These schools included, Acherensua Senior High School, Bibiani Senior High School, Mim Senior High School, OLA Girls Senior High School, and Ahafoman Senior High School. Students from Hwidiem Senior High School participated by joining students at Achirensua Senior High School, making a total of six participating schools. A total of 1,145 students from all schools participated in the HSEP.

The study was conducted alongside the implementation of the programme. The monitoring and evaluation team at the Centre (SD and SD), together with KAB and OQ prepared the evaluation plan, which consisted of the methodology and data collection tools, prior to the implementation of the HSEP. Participants in the study included students and teachers who participated in the HSEP, and graduate interns who facilitated the programme.

¹ Graduate interns are fresh university graduates from different academic backgrounds supporting research at the Centre.

Programme delivery and activities

To achieve the objectives of the programme, two different approaches were employed. Oral presentations, which ended with interactive Question and Answer (Q and A) sessions, were delivered on key themes which were relevant to the programme's goals. Table 1 gives a summary of oral presentation themes and their descriptions.

In addition to the oral presentations, practical sessions, which allowed students to learn how to use some of WACCBIP's equipment to understand some of the scientific concepts, were employed. This was intended to practicalize some of the discussions initiated during the oral presentations. Table 2 presents the scope of the practical sessions and their description.

Data collection

In evaluating the outcomes of the programme, both quantitative and qualitative data collection approaches were used. A quantitative survey was used to assess the effectiveness of the delivery of the programme, whilst qualitative interviews were employed to gather data on the outcomes of the programme (Danquah, 2021).

After each programme session during the HSEP, an announcement was made verbally on the presentation platforms for students who were interested in participating in a survey to volunteer. Interested students came out of the crowds to the platforms to express interest. A total of 138 students across the six schools volunteered. The monitoring and evaluation team with support from graduate interns present, conducted the survey interviews through the KoboCollect platform for students, who responded strictly to a quantitative, ordinal-scale survey to assess how educative, inspiring, interesting, and understandable the presentation and practical sessions were. Out of the 138 respondents, 33 students were conveniently selected to participate in qualitative interviews to report the impact the programme had made on them, which were analyzed to derive the outcomes of the programme. The 33 students were selected from the various schools, 5 from each school, taking cognizance of gender representation. The additional 3 students were high school student leaders who represented schools in the region. Some of the student interviews were video recorded, some audio recorded, with some also taken as notes by the interviewers, depending on the level of consent given by participants. The audio and video interviews lasted an average of 10 minutes

Table 1. Oral presentation themes and description.

Presentation/Theme	Description
Science in perspective	This introduced students to the practical definition of science, some role models and the various career paths students can choose from.
Applying to universities and available undergraduate scholarships	Students were introduced to the university application process as well as the numerous courses they could choose from. Existing undergraduate funding opportunities were also presented.
About WACCBIP	This provided an exposition on WACCBIP's history, mission and vision, its operations, equipment and facilities.
Malaria	This presentation explained the origin of the disease, its symptoms, causes, preventive measures and its diagnosis (a focus on Rapid Diagnostic Tests)
Skin colour and Albinism	This presentation sought to provide scientific explanations to the variations in skin colour.

Table 2. Practical sessions and description.

Session	Description
Test for carbohydrates and proteins	Students learn how to test for the presence of carbohydrates and proteins in different food substances.
Rapid Diagnostics Test Techniques	Students learn how to use the Rapid Diagnostic test kits to quickly test for the presence of malaria in human blood
Microscopy	Students were taught how to handle the light microscope, and how to view popular organisms such as <i>Plasmodium falciparum</i>
DNA Extraction	Using saliva, students were shown that the DNA is consistent in all cells and bodily fluids
Understanding the DNA structure	Students understood the various components of the DNA and how they come together to affect the functioning of an organism

per participant, and was conducted same day as the quantitative surveys, at the premises of the 2019 HSEP events. Also, graduate interns were contacted to participate in a separate survey to report the impact of the programme on their work. Out of a total of 12 graduate interns who participated in the event, 9 participated in the survey. This was to ascertain the impact of the programme not only on the target, but also on the visiting scientists. This whole process was done with full consent from the teachers and heads of the schools.

Data analysis

Quantitative data was analyzed using descriptive statistics tools in SPSS version 16. A grounded theory (Chun Tie *et al.*, 2019) and content analysis approach (Elo & Kyngäs, 2008) were employed in analyzing qualitative data. The data were run through validation, and the broad ideas and concepts were grouped and coded to aid structuring and labelling. Authors SD (corresponding author) and SD coded the data. An open coding technique was used, as themes were derived from the data. Coding was done manually from transcription and notes of interviewers. In the presentation of respondent quotes, names of teachers and students were withheld, and graduate interns were given pseudonyms (G1, G2, G3...G9).

Results

Demographics

Table 3 presents the distribution of participants of the evaluation across the different schools who were engaged (Danquah, 2021).

With regards to gender distribution of student-participants, 59.4% of student respondents were females, with the remaining 40.6% being males. Student participants of the evaluation were distributed across 15 out of 16 geographical regions in Ghana, as depicted in Table 4.

Out of a total of 12 graduate interns who participated in the programme, 9 participated in the survey. Out of this, 4 were female and 5 were male. Three teachers also partook in the interviews.

Table 3. Distribution of participants across the schools.

	Frequency	Percentage
Acherensua SHS	22	15.9
Ahafoman SHS	22	15.9
Bibiani SHS	21	15.2
Hwidiem SHS	18	13.0
Mim SHS	34	24.6
OLA Girls SHS	21	15.2
Total	138	100.0

Assessment of oral presentations

On a 3-point ordinal scale, students were asked to assess how understandable, educative, and inspiring each presentation was. The results are illustrated in Figure 1–Figure 3:

Out of the 138 persons interviewed, Figure 1, Figure 2 and Figure 3 reveal that the proportion of participants who found presentations to be easy to understand, very educative and very inspiring ranged between 19.6 to 92.0%. Majority of the participants gave high ratings for each presentation. The only exception was the presentation on skin colour and albinism. The low ratings received by the presentation at probe was attributed to the foreign accent of the presenter which made it difficult for the students to clearly understand what was presented. The presenter for that session was a non-Ghanaian faculty member at WACCBIP.

Assessment of practical sessions

The practical session gave students hands-on experience on some laboratory apparatus in a scientific research environment. The aim of this was to make the whole experience interesting, complementing the information provided in the oral presentation. Figure 4 summarizes the scores for how interesting participants found the practical sessions. Students gave high ratings for all practical sessions, with most (range between 76.1% and 97.8%) scoring the sessions as very interesting.

Table 4. Geographical Distribution of Students Respondents.

Respondents	Region		Total
	Region	Region Total	
Senior High School Students	Ahafo	23	
	Ashanti	16	
	Bono	30	
	Bono-East	21	
	Central	6	
	Greater Accra	3	
	North-East	4	
	Northern	10	
	Oti	3	
	Savannah	7	
	Upper West	4	
	Upper-East	3	
	Volta	2	
	Western	4	
	Western-North	2	
Total Respondent (n)			138

Figure 1. Assessment of the ease of understanding of various aspects of the presentation.

Figure 2. Assessment of how educative the presentations were.

Figure 3. Assessment of how inspiring the presentations were.

Self-reported outcomes of the HSEP on participating students

This sub-section reports on the outcomes of the HSEP as reported by students who participated in the programme. These impacts are reported with direct quotes by the students and their

teachers, presenting how valuable and beneficial the HSEP had been.

The enthusiasm of students towards the pursuit of science, particularly scientific research was stirred up, particularly

Figure 4. Assessment of how interesting practical sessions were.

among the girls. The schools visited were generally under-equipped to promote the teaching and learning of science. However, the inspiration to remain ambitious, despite their limited resources and capacity, was ignited. A science teacher at Mim SHS puts it this way:

“...We have tried our best to expose the students some of these things but due to limited resources we are not able to teach them as expected even though teachers are doing their best. We do not have well equipped labs but today, the activities you’ve involved our students have made the students realize that they can do better science if they aspire to enter a better environment like WACCBIP...” – Teacher, Mim SHS

A student from Achirensua SHS stated;

“When we understand basic things like that, it inspires us to go far. I really hope the government sponsors things like this so that students all over the country benefit from it. This will help us become great scientists in the future.”- Student 1, Achirensua SHS

Especially among the girls, it was realized that the presence of the graduate interns who were women alone led to an enthusiasm towards science. A student from Hwidiem SHS shared her view:

“I think that you should go to more schools and educate us on the need for science, especially the ladies. Some of the ladies do not want to offer the science course. When you come to our class, there are only seven ladies. I believe this outreach will inspire the ladies to pursue science. I personally have been inspired just by seeing the women you came with”- Student 2, Hwidiem SHS

Students were sensitized on malaria and demonstrated willingness to contribute to its eradication. In all the schools visited, students related to how widespread the incidence and effects of malaria were in their various communities. The new information provided on the causes, symptoms, diagnosis and prevention motivated their willingness to support the

fight against the disease. Some of the students had this to say:

“...today, I have seen what I have been desiring to see all my life- the malaria parasite- under the microscope. Seeing this tiny organism being the cause of the malaria disease has just stirred up some passion to make it lose its power over Ghanaians” – Student 3, Bibiani SHS

“...again, the knowledge acquired on malaria will equip us to prevent the spread and mortality of the disease...”- Student 4, Achirensua SHS

“...this programme has helped me see the DNA structure and the form of the malaria parasite, as well as the preventive measures for malaria. I am going to spread my knowledge to make sure malaria doesn’t kill people the way it is now” – Student 5, Mim SHS

“I particularly enjoyed the discussion and practical session on malaria. I now know how the malaria diseases in caused in us.”- Student 6, Bibiani SHS

“What I want to say that you’ve done well because you’ve helped us understand how to fight against malaria.”- Student 7, Bibiani Senior High

Students were enthused about entering the university and felt inspired to perform in their academics to gain access, particularly in areas of scientific research. It was realized from the interactions with the students was that they did not have adequate information on post-SHS academics. The students revealed how the step-by-step nature of the presentation on university application and admissions, as well as available undergraduate funding options, had cleared their doubts around access to university education. In addition to this, they demonstrated interest in pursuing careers in scientific research into infectious diseases.

“This is a nice programme and I have enjoyed it. I particularly enjoyed the presentation on how to apply to the university and existing scholarship opportunities. As a student who will be completing the high school soon, getting such information is very important at this time. I suggest that more of such programmes should be held across various High schools in

Ghana. I really want to go through to become a student at WACCBIP"- Student 8, Achirensua SHS

"I will encourage the team to move to different schools. In fact, if every student in the world, I mean SHS students, would know these kinds of things we will not struggle in our final exams and even during our time in tertiary school. I really have to get into the university. Thanks for all the knowledge you have given us. Do not be weary of doing this you've started"- Student 10, Mim SHS

"After this meeting, I have resolved to become a researcher like you. My hometown has been having a lot of cases for Buruli Ulcer. I would want to spend the rest of my life rooting out that menace through scientific research"- Student 11, Bibiani SHS

Impact on graduate interns/trainee scientists

Apart from the primary beneficiaries (*i.e.* the students), the graduate interns were also asked to share their experience on how the outreach benefitted them.

Graduate interns saw the need and benefits of public engagement for emerging scientists. Interns came to the practical awareness of the need to engage the public (the community) on scientific research, as well as the need to develop effective communication skills for that purpose. In response to how the outreach has helped them, some of the graduate interns responded as follows:

"I got to appreciate how under handed some senior high schools in Ghana are with regards to teaching and learning of Science, I developed an interest in bringing science to the grassroot level"- GI 1

"This outreach helped me break down the complicated language of science into everyday language, even into our local dialects, so that students could properly understand"- GI 3

"I came to realize that doing science alone is not enough. There is a real need to be able to let the people be part of what you do by sharing your results and eliciting certain facts from them. I learnt a lot from the students, particularly on some on-the-ground issues on malaria, whiles I also provided them with information based on the science I know. This has been very fulfilling"- GI 9

Some important soft skills were better appreciated and imbibed in graduate interns. The planning, organization and execution of the outreach ensured that some practical soft skills were utilized. In response to how the outreach has helped them, interns cited the acquisition of skills including selflessness, teamwork and leadership.

Interns appreciated the challenges of science education in Ghana and were inspired to contribute to addressing them. As interns were exposed to the under-resourced nature of schools visited, including under-equipped labs, poor infrastructural facilities, and low qualification of teachers, they appreciated the need for more effort to promote the teaching

and learning of quality science at the basic level. This was affirmed by all graduate interns.

Some of the responses are presented below:

"This outreach has helped me realize that there is more to be done in Ghana concerning science education"- GI 6

"It has made me deeply aware of how much work I need to put in to make a difference in the teaching and learning of science in Ghana."- GI 7

"I have been opened to and experienced the challenges faced by science teachers in schools where facilities are scarce"- GI

Suggestions from students and graduate interns to improve the programme

The survey also captured the suggestions of students and graduate interns on what they suggested would improve the programme. The responses of students indicated a desire to see the scope of the programme broadened. They suggested an inclusion of other infectious diseases, a mentorship programme that would run after the event, and additional days besides the one day per school already allocated. The suggestions of the graduate interns indicated the need for more thoroughness in the planning of the programme, as well as the need to include more days to the event.

Suggestions from students:

- The students suggested that other infectious diseases apart from malaria should be highlighted during the outreach events. They suggested diseases such as HIV/AIDS, Hepatitis B and cholera, which they indicated were quite prevalent in their various communities.
- Students suggested that career mentorship be introduced alongside the outreach events to ensure that they are continually inspired to pursue careers in scientific research.
- Students suggested that they needed more time to get the full impact of the programme. Some suggested a boot camp, which would keep students for about three to five days in one of the schools, as they get to engage with the graduate interns and other scientists at WACCBIP.

Suggestions from graduate interns:

- Graduate interns suggested that a boot camp with a duration of at least five days would be ideal to ensure student participants have the opportunity to be fully immersed in the activities of the programme.
- Adequate information on the proposed locations should be gathered. This should detail the geography, academic performance of the school, and infrastructure to ensure that planning is adequate enough to meet the specific needs of the students.

Discussion

This study highlights the outcomes of the High Schools Engagement Programme (HSEP), conceiving it as WACCBIP's

contribution to maximizing the gains of science by inspiring scientific dialogue with the public. As indicated, the HSEP targets one of the largest youth groups in Ghana - high school students. This study sought primarily to present outcomes of the evaluation of the programme, particularly with regards to how it shapes the interest of participants to want to consider careers in scientific research and future public engagement endeavors.

It was observed that students generally gave favorable assessments for all presentations in terms of how interesting, educative, and understandable they were. Also, students valued the presence of trainee scientists at the Centre, which they saw as an inspiration to pursue careers in scientific research. Coupled with the quality and interactive nature of the presentations, participants gave high assessments, indicating the immediate success of the programme.

The HSEP proved to have achieved the objective of inspiring collective action against tropical diseases in Africa. Participating students self-reported that they were willing to share their learnings with their communities, hence, positioning themselves as an extension of public engagement in their communities. Participating students came from diverse political regions and communities in Ghana. Their desire to share their knowledge, that would indirectly spread the information and education these youths have received.

The HSEP presents a trajectory for developing a public engagement ecosystem in Ghana. The programme first has an ability to stir up awareness on a need for public engagement, particularly for graduate interns who are emerging scientists. It also is a means for introducing public engagement and its prospects to high school students, who will be a major public in the future. This positions the HSEP as a nurturing ground for 'symbiosis' with regards to the scientist-non-scientist relationship. Public engagement is still emerging in sub-Saharan Africa. To develop it, there is a need to deliberately reveal its essence to both the scientific community and the public. The graduate interns/trainee scientists identified that they saw the need for public engagement in their work in the future. On the other hand, participating students desired that such events would be held continually for them, so they get to engage scientists around other tropical diseases that affect them. This is a good indicator of the public engagement environment this initiative will be developing in the future, if its efforts are scaled and sustained.

With reference to the impact made on trainee scientists, it is recommended that master's and PhD fellows/students are encouraged to participate or organize public engagement programmes of this nature. This will extend the practical acknowledgement of the importance of public engagement with science to these group of scientists.

Conclusion

This paper has presented the outcomes of the evaluation of the High Schools Engagement Programme (HSEP), a public

engagement outreach programme organized by the West African Centre for Cell Biology of Infectious Pathogens (WACCBIP). The paper is a result of survey data gathered from the 2019 event under the programme, held in six different schools. It presented findings from 138 student respondents, 9 graduate interns, and 3 teachers.

The rationale behind the design of the programme was to reach out to one of the youngest and largest youth groups in Ghana with a strategy to inspire enthusiasm for scientific research, and also to stir up a need in them, as a non-scientific community, for engagement with science. In addition to this, the programme sought to educate students on malaria; its causes, prevention, and treatment to inspire collective action against it. It was realized that participating students were enthused about pursuing careers in scientific research, especially the girls, as they were inspired by the presence of female trainee scientists. Moreover, participants were inspired to contribute to the eradication of diseases such as malaria, and lastly, were equipped with adequate information to make decisions concerning their future career paths. Additional gains were made with graduate interns, who are trainee scientists. Graduate interns developed awareness of the need for public engagement as emerging scientists. In addition to this, they identified the challenges of science education in Ghana and demonstrated willingness to make efforts in improving it. Certain key soft skills relevant for researchers such as planning, budgeting and team skills were imparted into interns during the organization and execution process.

In the end, it was realized that the HSEP strategy is an imperative approach to developing a public engagement ecosystem for the country. Its youthful target, who are prospective members of both scientific and non-scientific communities presents an opportunity to nurture an ecosystem of both scientists and publics who have a greater appreciation of public engagement as a trajectory to maximizing the gains of science. In addition to this, the employment of trainee scientists, and their admittance of the prospective profits of public engagement to society, inadvertently has implications for robust public engagement practice in the future. However, it is recommended that subsequent initiatives with a similar strategy should expand to many more schools during subsequent programmes and must include scientists at the master's and PhD levels as a positive scale factor to expanding the general practice of public engagement in Ghana.

Data availability

Underlying data

Harvard Dataverse: High Schools Engagement Programme Evaluation Data. <https://doi.org/10.7910/DVN/1WRKW0> (Danquah, 2021).

This project contains the following underlying data:

- Graduate Intern's Survey.xlsx
- HSEP Evaluation Data – Students (student's survey)
- Qualitative Data – Students and Teachers.docx

Extended data

Harvard Dataverse: High Schools Engagement Programme Evaluation Data. <https://doi.org/10.7910/DVN/1WRKW0> (Danquah, 2021).

This project contains the following extended data:

- High school engagement programme survey.pdf

- Interview guide for participating students and teachers.pdf
- Survey for graduate interns.pdf

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

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Open Peer Review

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Ash Routen

Diabetes Research Centre, Leicester General Hospital, University of Leicester, Leicester, UK

This is an interesting and well written paper that describes an evaluation of a public engagement initiative that targets students in under-resourced high schools in Ghana.

1. In the opening paragraph of the Introduction, you describe the distinction between public and community engagement, but I don't get a sense of what the purpose of either of these is?
2. I feel the introduction needs some reordering - the aim of the paper should come at the end of this section just before the methods. I would also move the section describing the HSEP into the methods section.
3. Re consent for those students under 18 years, was this provided by parents, guardians or teachers?
4. In relation to the study design, I'm not sure what an evaluation design is. I think you need to be a bit more specific e.g. mixed-methods cross-sectional study.
5. In the programme delivery section, it would be useful to provide information on the dose and frequency of presentations in schools i.e. how many times per day/week, over how many weeks etc? Alongside the oral presentations were there also other intervention components i.e. written materials, homework etc?
6. In the data collection section, you mention the outcomes of the programme and the effectiveness of delivery, but I think the reader doesn't get a sense of what these measures are. You need to mention examples of questions used, and detail what the outcomes are not just describe general the tools/approaches used. You could point readers to the interview guide in the appendix.
7. Am I right that after every session participants took part in an interview and completed a survey? This is quite a lot for participants and I wonder if this may have impacted their

responses? Also, the fact that this was an interview survey as opposed to an anonymous paper or online survey may have influenced responses. I think this should be noted in the discussion.

8. Do you have any other information on the students that could be reported such as age etc?
9. Are the self-reported outcomes of the HSEP full qualitative themes derived from the content analysis? This isn't quite clear to the reader.
10. Some of the terms you use could be changed to be more specific/clearer. I would avoid colloquial phrases or lesser-known phrases that may be inaccessible. For example, I'm not sure what you mean by 'stirred up' or 'sensitized on malaria', I would replace 'imbibe' as the meaning is not clear.
11. In the Discussion, I think you need to discuss the results in relation to the specific objectives of the HSEP. You mention the data indicated the immediate success of the programme, but I'm not sure how if the link to outcomes is not made clear.
12. It would also be useful to contextualise the results with some existing literature i.e. what did other studies of similar programmes find?

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Ethnic minority health, patient and public involvement, health inequalities.

I confirm that I have read this submission and believe that I have an appropriate level of

expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 02 July 2021

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Deborah Nyirenda

Malawi Liverpool Wellcome Trust Clinical Research Programme, Blantyre, Malawi

The article talks about the WACCBIP's high school engagement programme in Ghana. The introduction of the paper gives a good overview of the history of Public Engagement with Science.

The methods section, results, discussion and conclusion need further work. In the study design and settings, the authors need to state that they employed a mixed methods study design rather than just call it an evaluation design.

On data analysis, it is not clear how they moved from open coding to identify the key themes presented in the paper - this needs to be articulated very well.

In the results section, issue of sociodemographic details can be moved into the methods as this is just a description of participants and not an answer to their research questions. The themes or sub headings in the results are also very wordy & need to be shortened e.g. *Students were enthused about entering the university and felt inspired to perform in their academics to gain access, particularly in areas of scientific research.*

On several instances, the authors state that 'it was reported', 'it was realised', 'it was observed' etc. - they need to replace 'it' with 'we' and other appropriate terminologies in reference to their data set.

Finally, the discussion section does not relate/compare the findings to relevant literature on public engagement. Articles by Alun Davies on Schools Engagement in Kenya & others may be relevant to discuss the findings in relation to wider literature.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Mixed methods research, Public/community Engagement, Public Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.