Jenesys Associates

International Veterinary Vaccinology Network African Schools Outreach Programme

IVVN-ASOP

Evaluation 2019-2023: Full Report

The IVVN African Schools Outreach Programme

IVVN AFRICAN SCHOOLS OUTREACH PROGRAMME

Inspiring the next generation of vaccine scientists

Prepared for:

International Veterinary Vaccinology Network

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International Veterinary Vaccinology Network

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October 2023

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1. Introduction

The [IVVN-ASOP]workshop is the best for inspiring the young generation to love and embrace science. (Teacher)

1.1. IVVN-ASOP Background

The IVVN African Schools Outreach Programme (IVVN-ASOP) was established in 2019 as part of efforts to address low representation of women in agricultural research in Africa – where on average only 24% of researchers are female[1] - by inspiring and motivating female high school students to undertake STEM further study or pursue careers in STEM.

IVVN-ASOP involves the International Veterinary Vaccinology Network (IVVN) working in collaboration with Easter Bush Science Outreach Centre (EBSOC), African Women in Agricultural Research and Development (AWARD), African Vaccinology Network (AfVANET), International Livestock Research Institute (ILRI), University of Ibadan, University of Zambia, University of Buea, University of Pretoria, Makerere University and Addis Ababa University.

The Programme provides women scientists working in veterinary and other agricultural science research across Africa with training and resources (in the form of a mobile 'laboratory-in-a-suitcase', handbook and materials) to enable them to deliver outreach workshops to schools in their own countries. The IVVN-ASOP 'lab-in-a-suitcase' outreach workshop is a 3 hour hands-on vaccinology experiment session facilitated by female scientists that uses the same analytical tools and techniques as found in professional science laboratories.

1.2. IVVN-ASOP Aims

As stated at an IVVN-ASOP Network Meeting held in Nairobi on 6th to 8th September 2023, the Programme aims to:

- Encourage greater female participation in science via school outreach workshops.
- Build local capacity for delivering outreach workshops.
- Strengthen students' scientific knowledge and analytical skills relating to infectious diseases and vaccines.
- Positively influence attitudes and negative perceptions of girls towards science courses and/or science careers.

1.3. IVVN-ASOP Activities and Metrics 2019-2023

In 2019 and 2020, two cohorts of female scientists were trained by outreach and engagement experts from the University of Edinburgh's Roslin Institute and EBSOC to deliver and facilitate the 'lab-in-suitcase' outreach workshop. Members of these cohorts subsequently cascaded this training to other female scientists in their own countries, meaning IVVN-ASOP schools outreach workshops have been delivered by scientists trained directly by Roslin/EBSOC and by recipients of cascade training. Even though the COVID-19 global pandemic curtailed planned delivery in 2020 and 2021, by September 2023 IVVN-ASOP had delivered outreach workshops in four African countries – Kenya, Nigeria, South Africa and Zambia.

[1] https://asti.cgiar.org/gender

1.3.1. Scientist Training

- 6 scientists from Kenya, Nigeria, Cameroon and Zambia trained by University of Edinburgh Roslin/EBSOC in 2019.
- 6 scientists from South Africa, Uganda and Ethiopia trained by Roslin/EBSOC, bringing the total trained to 12.
- 60 further scientists trained as outreach facilitators/mentors by IVVN-ASOP teams across Africa.

1.3.2. Outreach Workshop Delivery and Audience Reach at September 2023

- 33 'lab-in-a-suitcase' vaccinology outreach workshops delivered in 31 schools across 4 countries (primarily in Kenya and Nigeria, but also in South Africa and Zambia).
- Outreach workshops delivered to a total of 3,026 students – 2,501 (82.6%) girls and (17.4%) 525 boys.
- Additional activities:
    - Over 400 teachers and 17,000 students received 'whole school' science career guidance talks.
    - At least one Kenyan community engaged through tree-planting and related environmental activity.
    - One school visit in Nairobi co-hosted by IVVN-ASOP with partners from the National Museums and KALRO Biotech Centre.
    - Teachers and female students from 4 schools participated in IVVN-ASOP network meeting in Nairobi September 2023.

1.3.3. External Recognition and Awards

- IVVN-ASOP shortlisted in 2023 and 2020 for Nature Inspiring Women in Science Award[2].
- IVVN-ASOP celebrated at an event in the Scottish Parliament in 2019.
- IVVN-ASOP activities cited as an example initiative in Trends in Parasitology Journal article on gender equity in STEM[3].
- Kenya IVVN-ASOP team awarded a TWAS-ELSEVIER Gender Equity Climate action grant[4] in 2023 to empower women and schoolgirls in pastoral communities in climate change mitigation and adaptation.

[2] https://www.nature.com/immersive/inspiringwomeninscience/index.html

[3] https://www.cell.com/trends/parasitology/fulltext/S1471-4922%2822%2900286-0?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS1471492222002860%3Fshowall%3Dtrue

[4] https://twas.org/opportunity/twas-elsevier-foundation-project-grants-gender-equity-and-climate-action

2. The Evaluation of IVVN-ASOP

2.1. Role of the External Evaluator

The IVVN-ASOP external evaluator was appointed in July 2023 to independently evaluate the Programme as a whole. This included analysis of feedback about workshops delivered to date, as well as collecting and analysing teachers' and scientists' longer-term feedback to identify and document impacts, success factors, challenges and learning points that could be used to inform the planning and implementation of IVVN-ASOP in future.

2.2. Evaluation Methodology

2.2.1. Outreach and Training Workshops Feedback

IVVN-ASOP uses a standardised set of questionnaires to collect students' and teachers' opinions and outcomes for 'lab-in-a-suitcase' outreach workshops and to obtain scientists' feedback about their training workshops. It would have been inappropriate for the external evaluation to duplicate this data collection, so findings about workshop experiences and outcomes in this report are based on the external evaluator's analysis of all questionnaires submitted to the IVVN Network Manager prior to 1st June 2023:

- 1,563 school student questionnaires
- 46 teacher questionnaires
- 22 scientist questionnaires

2.2.2. Longer-term Outcomes, Learning and Impact

Conducted by the external evaluator in August and September 2023, this element of the evaluation drew on several data sources:

- **Teacher longitudinal survey** collected student numbers and ages and feedback from teachers on the perceived success IVVN-ASOP, plus their opinions about longer-term impacts on themselves and their students, and wishes for the future. (26 responses)
- **Scientist longitudinal survey** collected details of number of workshops delivered, any adaptations made, challenges faced and learning, as well as impacts for scientists, including intentions with regards to future outreach involvement. (21 responses)
- ***Observational visit to IVVN-ASOP Network Meeting in September 2023*** enabled the external evaluator to hear first-hand about IVVN-ASOP from country leads and partners (including IVVN team based in the UK) and to interview IVVN-ASOP team members. An 'observational checklist' was developed to provide a structured but not prescriptive way of recording information and observations about different elements of the meeting. The meeting also provided an opportunity for the evaluator to present and hear reactions to preliminary findings from the evaluation. (3 days observations)
- ***Scientist survey about the Network Meeting*** to obtain reflections on what was presented, including ideas about future direction and opportunities. (12 responses)
- ***Semi-structured face-to-face interviews and informal discussions*** were an opportunity to gain further information from participating scientists, including country leads, teachers and Roslin/EBSOC staff involved in training. Scientist and teacher

interviews focused on direct experiences, although interviewees were also asked their opinions of the Programme overall and wishes for the future. (21 interviews/discussions – 17 with IVVN-ASOP team members, 2 with teachers, 2 with other meeting attendees)

- ***Secondary sources*** of information were reviewed to obtain contextual information, they included presentation slides and display materials from the observed meeting, award submissions, and images and videos of IVVN-ASOP activities.

2.3. Evaluation Report and Data Presentation

Chapter 3 describes the student impact based on their own feedback about outreach workshops and Chapter 4 outlines teachers' views about student outcomes. Chapters 5 and 6 respectively document experiences and outcomes for teachers and scientists. Chapter 7 findings relate to processes and structure. Chapter 8 outlines conclusions and Chapter 9 makes some recommendations.

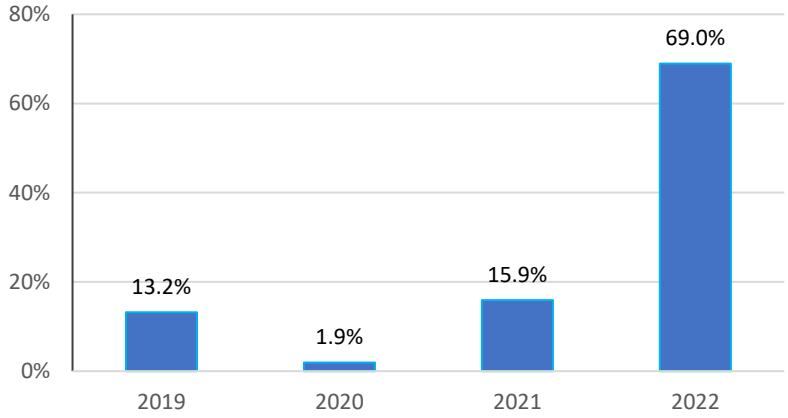
Questionnaire and survey respondents were not forced to answer all questions. Therefore the number of respondents (n=) could vary and is shown for each graph. Percentages have been rounded and when totalled may be greater or less than 100.

Illustrative quotes from school students are shown in *blue.* Quotes from teachers are in *green* and those from scientists are in *orange*.

3. Findings: Impact on School Students

This chapter presents an analysis of the feedback collected through questionnaire responses from 1,563 school students who participated in IVVN-ASOP 'lab-in-a-suitcase' outreach workshops between 2019 and 2022. Most responses (69.0%, 1,078) were dated 2022 and their distribution by year is indicative of how the COVID-19 pandemic disrupted delivery.

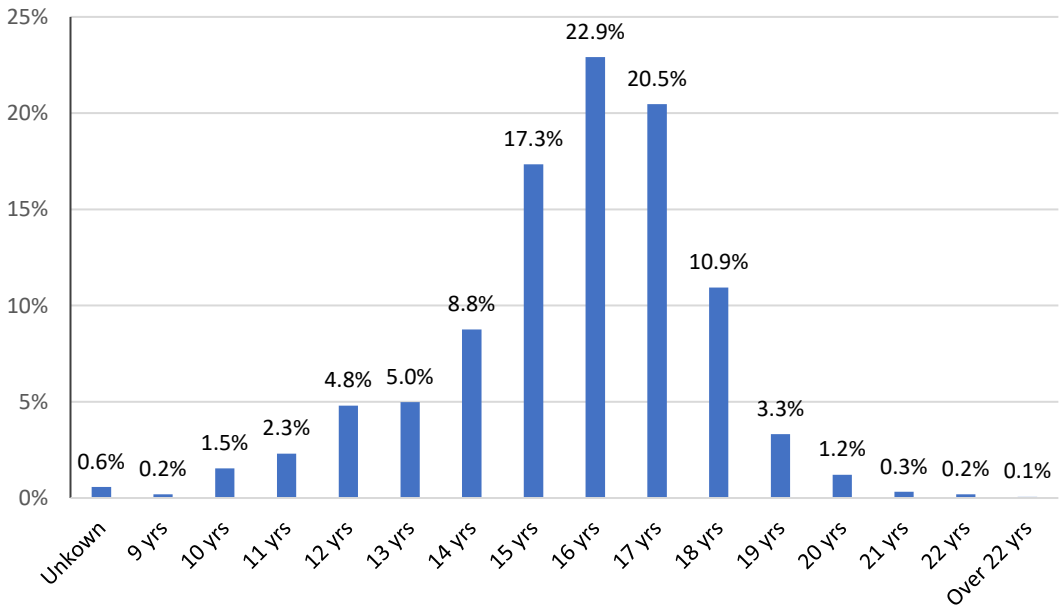
Fig. 1. Year of Student Feedback (n=1,563)



3.1. Profile of Participating School Students

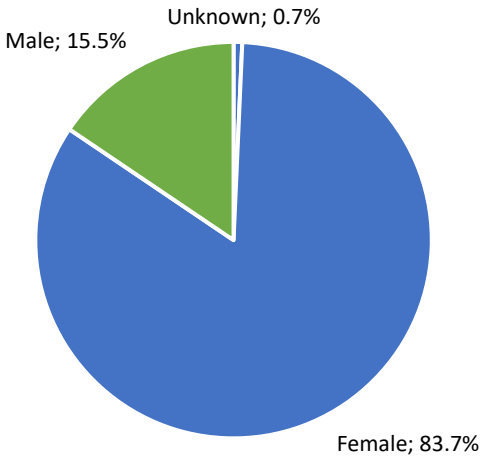
The ages of respondents to the student survey ranged from 9 years to over 22 years, which is wider than the 10 to 17 age range reported by teachers (Chapter 4), although most (83.1%, 1,299) students' responses were in the age 10 to 17 range, and the most common ages were 15, 16 and 17 years, representing 60.7% (949) of the total. Readers should be aware that teacher and student responses may refer to different outreach workshops, which could explain the variation between students' and teachers' reporting of ages.

Fig. 2. IVVN-ASOP Outreach Workshops Student Ages (n=1,563)



IVVN-ASOP outreach workshops were conceived to encourage greater female participation in science, and most of those who gave survey feedback are female (83.7%, 1,309), although male students (15.5%, 243) also responded.

Fig. 3. IVVN-ASOP outreach Workshops Student Ages (n=1,563)



3.2. School Students' Reactions to Workshops

Students were asked to choose from a list of 16 words those that best describe their experiences of the outreach workshop. The responses show that the student experience was highly positive, as illustrated by the following graph and word cloud of the 16 words. There was no correlation between the chosen words and students' ages or genders, indicating that the workshops were equally appealing across the age range and to both genders.

Fig. 4. Students' Word Choices to Describe their Experiences (base n=1,563)

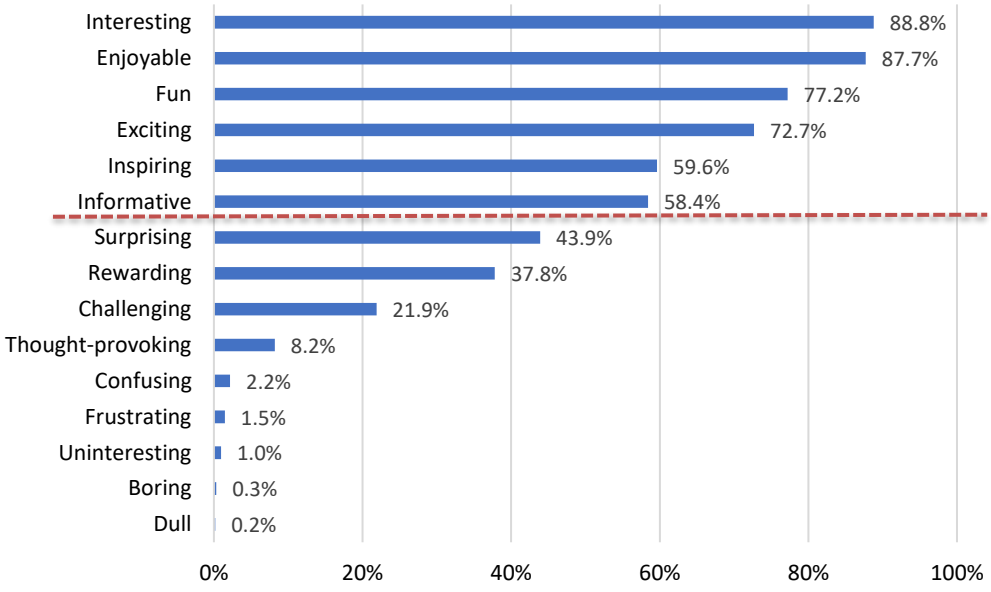
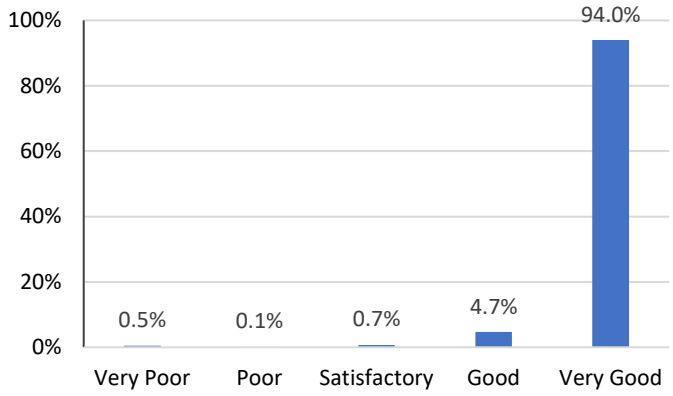


Fig. 5. Word Cloud of Students' Word Choices to Describe their Experiences (base n=1563)

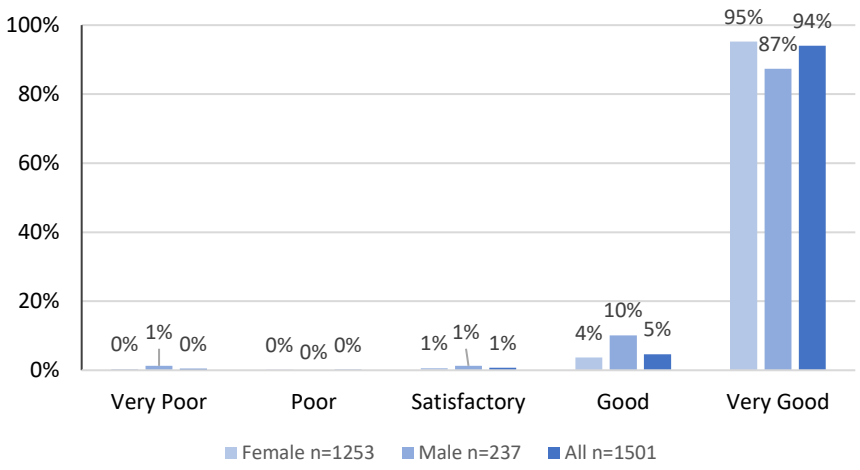
Students rated their enjoyment of the workshops very highly. Across all responses, 94.0% (1,411) selected the highest rating of 'very good', with a total of 98.7% (1,481) choosing a positive, i.e. above satisfactory, rating.

Fig. 6. Students Ratings of their Enjoyment (n=1,501)



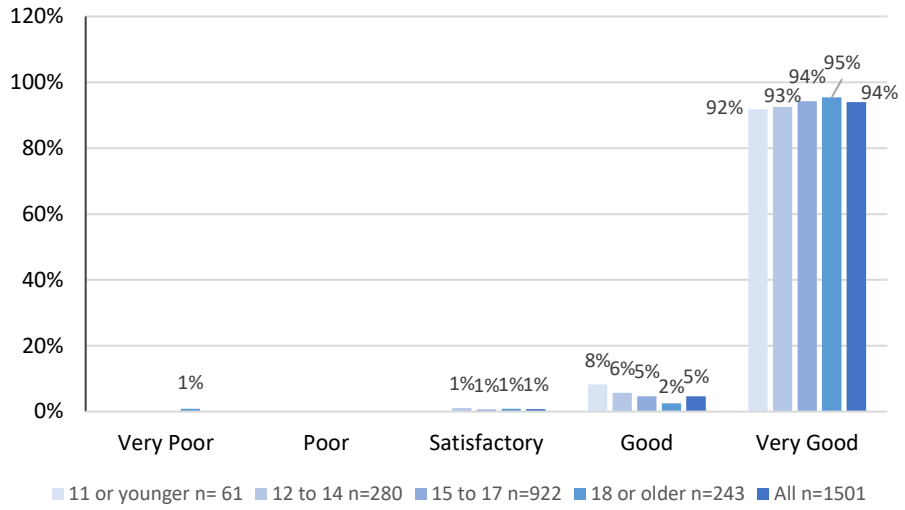
Applying the Pearson chi-square test identified a significant relationship between gender and positive ratings, as females were statistically more likely than males to select 'good'[5] 'or 'very good'[6]. There were no other statistically significant correlations between rating levels and gender (fig. 7), and no correlations between students ages and ratings. (fig. 8).

Fig. 7. Students' Enjoyment Ratings by Gender



[5] The chi-square statistic is 18.55. The p-value is .000017. The result is significant at p < .01.
[6] The chi-square statistic is 21.7487. The p-value is < .00001. The result is significant at p < .01.

Fig. 8. Students' Enjoyment Ratings by Age Groups



3.2.1. Highlights

1,404 students described their favourite part of the outreach workshops. Deductive coding analysis found that the responses fell into four main categories:

- Using professional scientific equipment (micropipette).
- Doing practical experiments.
- Meeting and being inspired by scientists.
- Observing experimental results.

Although these categories were the same for all ages and genders, students aged 13 and older were more likely to explain why something was their favourite part.

Almost one-third of responses mentioned using a micropipette. Other than simply saying this was their favourite part, students described how it was a brand new experience, as it involved different equipment to the pipettes they use in school. They also referred to the very small volumes that micropipettes enabled them to measure.

Using the pipette. Because it was my first time to use a micropipette. (Female Student, Age 14)

Is when we were using the micropipette because I have never used the type of pipette meanwhile in our school we use the long one. (Female Student, Age 15)

The part where we used the pipette was my favourite because it was my first time using it. (Female Student, Age 16)

Learning how to use the micropipette. I never knew one could measure such small amounts of samples. (Female Student, Age 17)

Using the micropipette. It was a first time thus exciting to learn a new thing. (Female Student, Age 18)

Nearly one-quarter of responses referred to the practical element or experiment that students carried out in the workshops. Comments highlighted how students found this to be a novel experience, and one that enhanced their scientific understanding or knowledge. Students also described how practical work inspired or motivated them with regards to their own science capability or potential.

My favourite part of the workshop was the experiment because I have never witnessed it before. (Female Student, Age 14)

The experiment part because it taught me thing I never know and it is inspiring and interesting. (Female Student, Age 15)

During the practical experiment, it really inspired me lot, that I too can become a scientist. (Female Student, Age 16)

Doing experiments. It help me understand a particular problem and learn how to solve it giving me a lot of courage. (Female Student, Age 17)

Doing the experiments because I was able to learn. (Female Student, Age 18)

In around one-sixth of responses, meeting or interacting with scientists was cited as the best part. This included students asking questions to scientists, hearing from them about their own studies and careers in science, and being inspired by meeting science role models.

Hearing part of our mentor's story because it has inspired me a lot. (Female Student, Age 15)

Interacting with the scientists. This is because they are all females dominating in the field of science and this inspires me very much. (Female Student, Age 16)

Asking scientists questions, because they inspired me not to give up and nothing is limited. (Female Student, Age 17)

Interrogating the scientists because they have helped me to change my attitude towards physics and they challenged me to do well. (Female Student, Age 18)

Observing experimental results featured in almost one-seventh of responses, with learning from this aspect being cited as a reason for choosing it as the favourite part.

Observing results: Colour change. (Female Student, Age 14)

Observation because I learnt how to differentiate the changes in the results. (Female Student, Age 15)

Identifying the results that show a vaccinated dog and one that is not. I was so eager to see what will be the results and I learnt something new. (Female Student, Age 17)

3.2.2. Less Favoured Aspects

Of the 1,299 students who answered a question about their least favourite part of the IVVN-ASOP outreach workshop, just over half answered nothing and around one-twentieth stated that it was the ending, because they wanted the workshop to continue.

Other than these responses, around one-tenth of responses across all ages mentioned drawing a scientist, either because students felt they cannot draw well or they found it boring.

Drawing a scientist because am not a good artist. (Female Student, Age 13)

Drawing because it is boring and I do not know how to draw. (Female Student, Age 15)

Drawing the scientist because i don't know how to draw. (Female Student, Age 16)

Interestingly, just over one-twentieth of responses mentioned using a micropipette as the least favourite part, even though this was overall the most favoured part of the workshop. All these responses were made by students aged 15 or older, who mostly attributed their choice to difficulty in using the micropipettes accurately, which many found frustrating.

When I was struggling with getting the correct measurements while using the micropipette. (Female Student, Age 16)

Using the pipette as we made several mistakes before we got the hang of it. (Female Student, Age 17)

My least favorite was pressing the micropipette. Because at first it was difficult to know up to what position I should press. (Female Student, Age 18)

Cited in one-twentieth of responses was the observation of results, which was also a favourite part. This was attributed to not achieving the 'right' or expected result, or because students found it difficult to distinguish colour differences and identify a result.

The observation part was my least favourite because it requires one to identify the real colour and be more careful. (Female Student, Age 13)

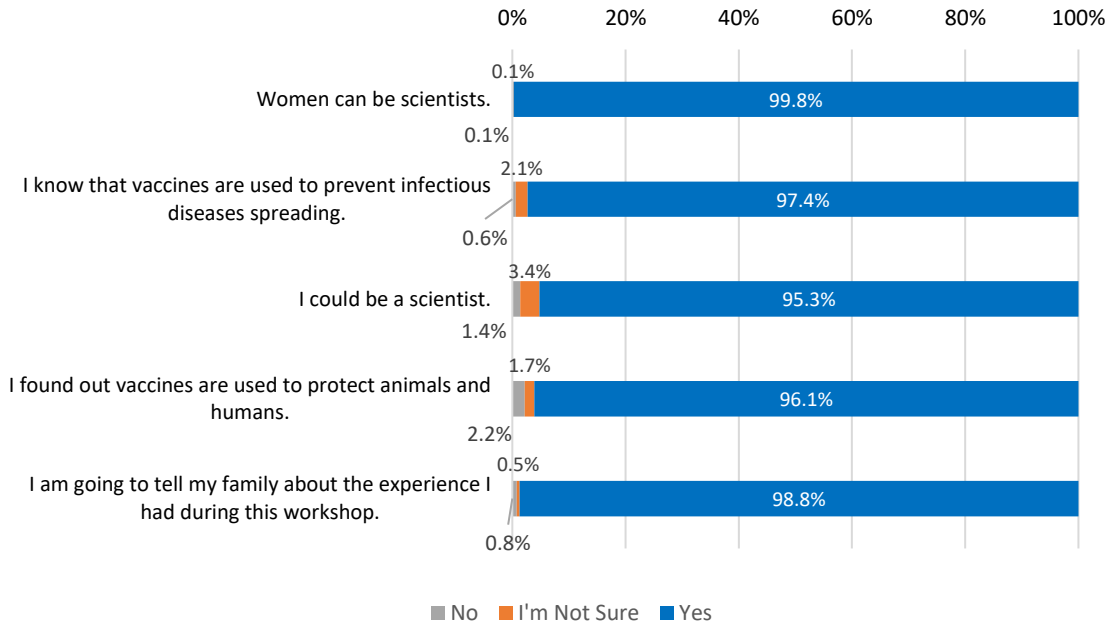
My least favorite was the result because it was too low. (Female Student, Age 16)

Observation. The samples may show the same colors or even differ. (Female Student, Age 17)

3.3. Workshop Outcomes for School Students

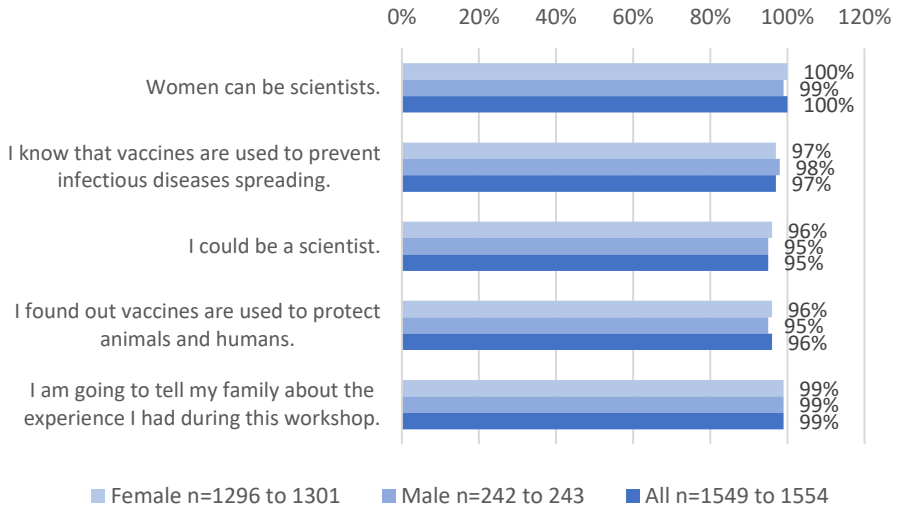
The outreach workshops successfully delivered all four intended outcomes for almost every student. Impact was highest for '*women can be scientists'* (99.8%, 1,551), where all students who selected 'no' or 'not sure' were male. This indicates that the outreach workshops successfully fulfilled their ambition to promote science careers as something that women can do.

Fig. 9. Student Outcomes (n=1,549 to 1,554)



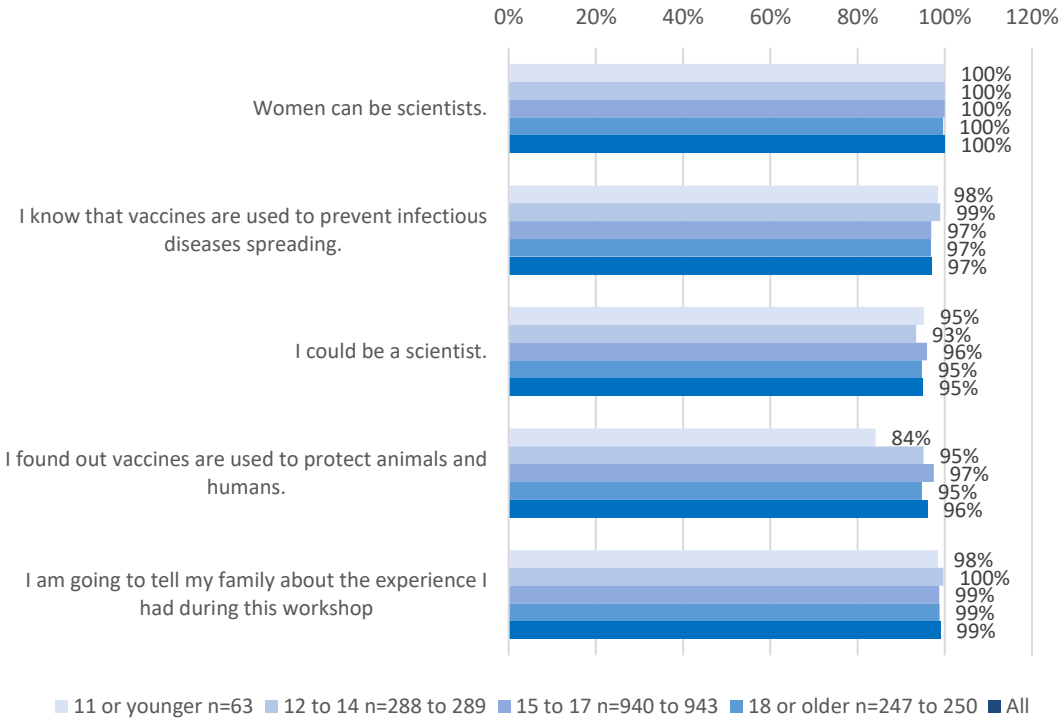
There were no statistical differences between male and female students' reporting of these outcomes.

Fig. 10. Students Selecting 'Yes' for Outcomes by Gender



There was one statistically significant difference in age group reporting of outcomes, where students aged 11 years or younger were statistically[7] less likely than other age groups to select 'yes' for *'I found out vaccines are used to protect animals and humans*'. There were no other statistically significant correlations between reporting of outcomes and age groups.

Fig. 11. Students Selecting 'Yes' for Outcomes by Age Group



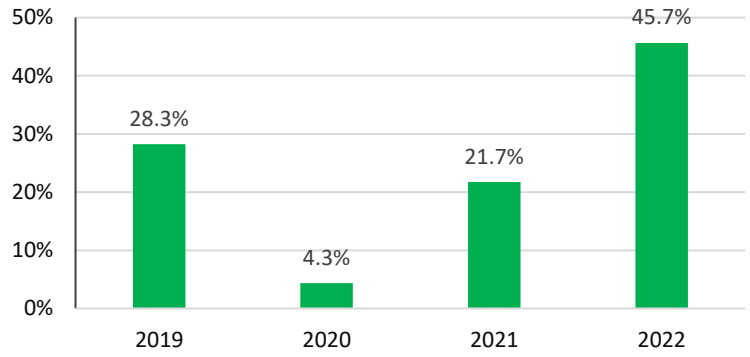
[7] The chi-square statistic is 30.1038. The p-value is < 0.00001. The result is significant at p < .01.

4. Findings: Teachers' Views of the Impact on Students

This chapter firstly presents teachers' questionnaire feedback submitted after they and their students participated in an IVVN-ASOP science outreach workshop between 2019 and 2022, followed by teachers' longer-term reflections obtained in the third quarter of 2023.

As with the students, the years in which teachers submitted feedback are indicative of disruption caused by the COVID-19 pandemic. The most common year for feedback is 2022 and the least common is 2020, when the pandemic was at its height.

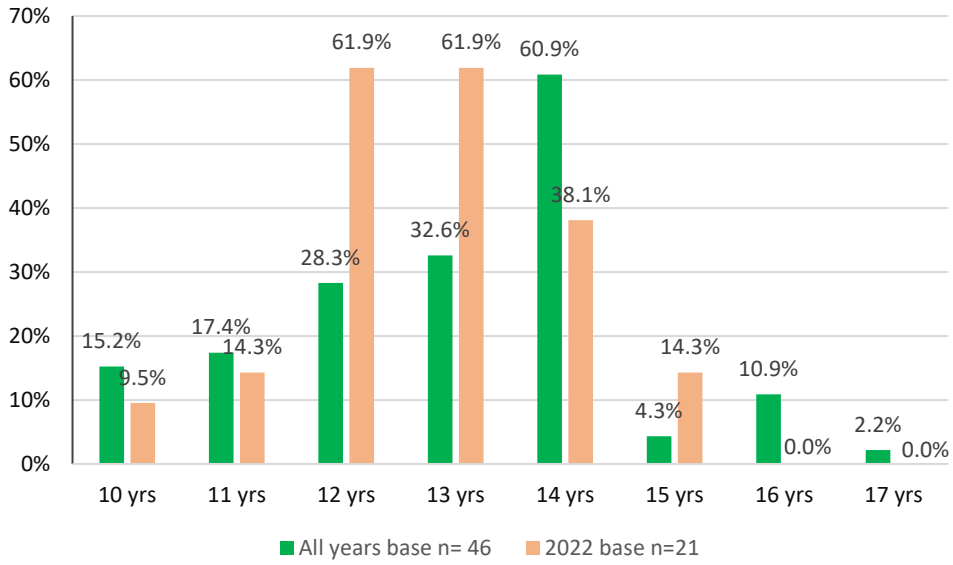
Fig. 12. Years in which Teachers' Feedback was Received (n=46)



Teachers reported that an average of 25 students attended each outreach workshop, representing a total of 1,604 with attendance ranging from 26 to 40 students per workshop.

Student ages reported by teachers ranged from 10 to 17 years. The most common age across all reporting was 14, which was also the most common age in 2019 and 2021, when the age profiles mirrored the whole cohort. For 2022,students were younger in profile than the whole cohort, and this year is the only one when ages younger than 13 were reported, with the joint most-common ages in 2022 being 12 and 13 years.

Fig. 13. Proportion of Teachers Reporting Student Ages All Years vs. 2022



4.1. Aims and Intended Outcomes for Students

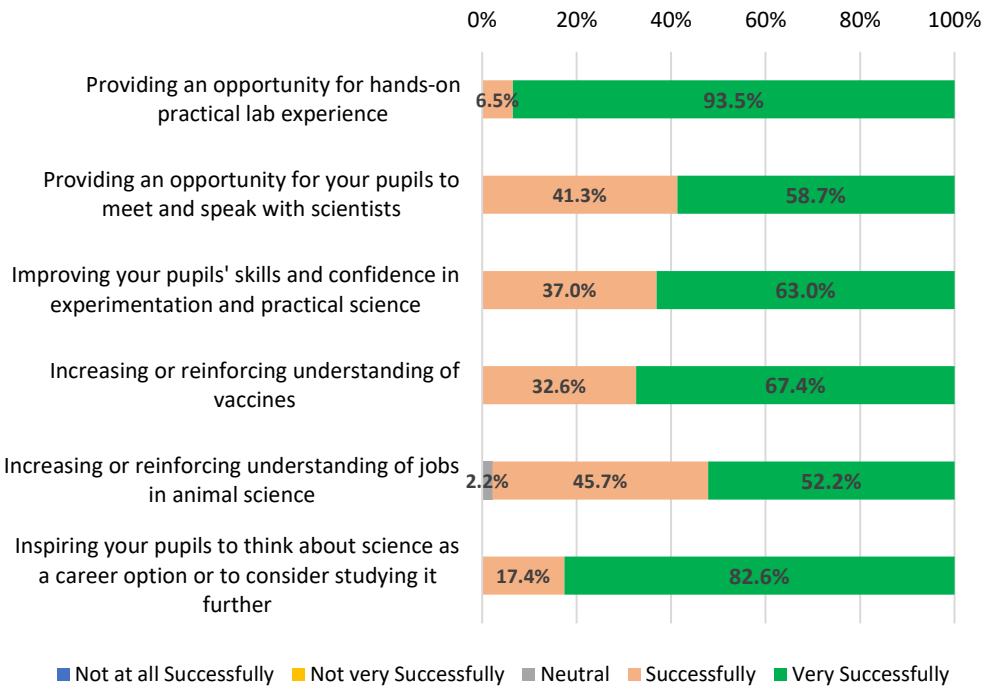
Teachers were asked to rate the outreach workshop's success in achieving IVVN-ASOP's six aims for school students. Their responses (fig. 14) show that workshops successfully achieved all these aims, in most cases 'very successfully'.

Teachers deemed the workshops to be most successful in '*providing an opportunity for hands-on practical lab experience'* (93.5% (43) 'very successfully') followed by *'inspiring your pupils to think about science a career option or to consider studying it further'* (82.6% (38) 'very successfully'). The latter is an indication of IVVN-ASOP achieving its ambition of inspiring the next generation of scientists.

A teacher who gave a 'neutral' rating for '*increasing or reinforcing understanding of jobs in animal science'* commented that more students should have access to the equipment used in the workshops.

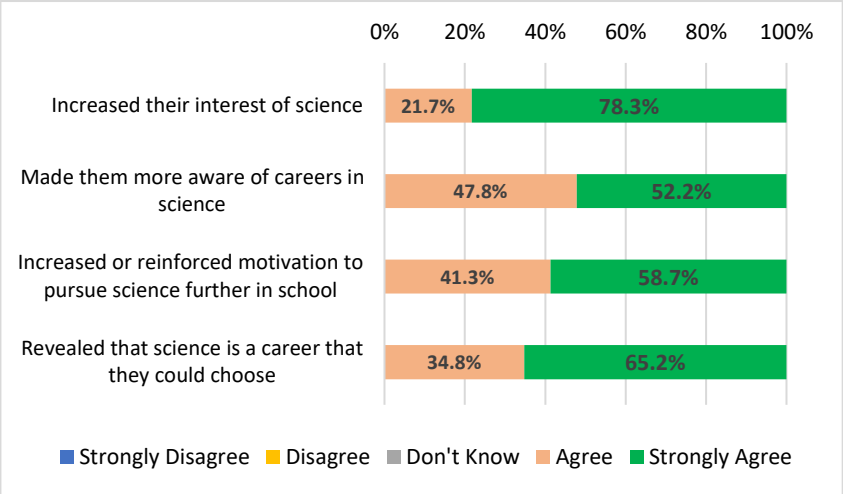
There was no correlation between teachers' feedback and student ages or workshop participation numbers.

Fig. 14. Teacher Ratings of Workshops' Success in Achieving IVVN-ASOP Aims for Students (n=46)



All teachers agreed or strongly agreed that the IVVN-ASOP outreach workshop delivered all four of IVVN-ASOP's intended student outcomes. Agreement was highest for *'increased their interest of science'* (78.3% (36) strongly agreed), followed by *'revealed that science is a career that they could choose'* (62.5% (29) strongly agreed), indicating that the workshops successfully promoted science and presented it in a way that is appealing for high school students. The outcomes were unaffected by student age or workshop participation numbers.

Fig. 15. Teacher Ratings of Workshop Outcomes for Students (n=46)

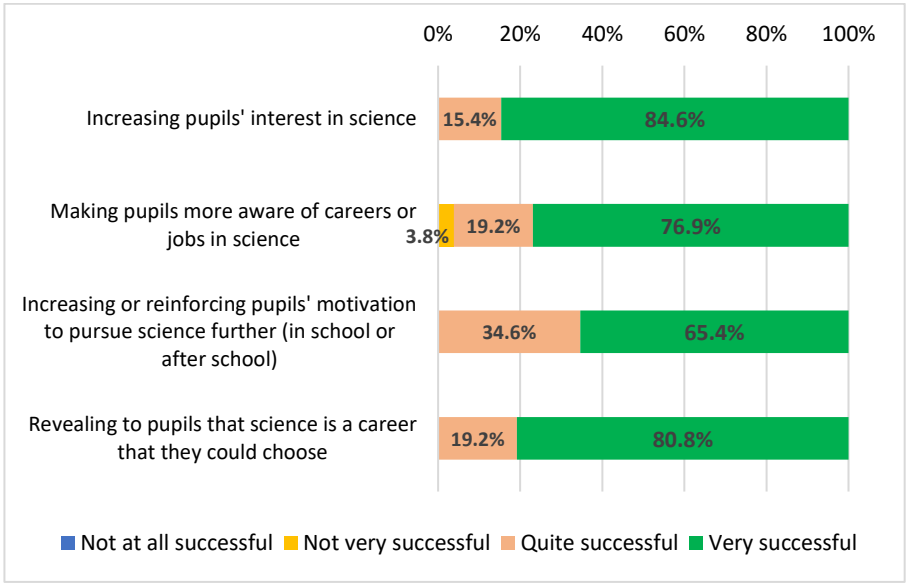


4.2. Longer-term Reflections on Student Impact

Teachers from Kenya (46.2%, 12), Nigeria (46.2%, 12) and South Africa (7.7%, 2) completed a longitudinal feedback survey in August 2023. All reported that their schools participated in IVVN-ASOP during 2022 or 2023, with three having also participated in earlier years. Their responses covered a total of 2,828 students - an average of 109 students per teacher.

Teacher's longer-term reflections on IVVN-ASOP's intended outcomes for students (fig. 16) were even more positive than their post-workshop feedback (fig. 15).

Fig. 16. Teacher Longer-term Reflections on Student Outcomes (n=26)



The Generic Learning Outcomes (GLO) Framework[8], a proven and respected tool for analysing impact in public engagement and outreach, was used to code teachers' longitudinal survey comments about golden moments and IVVN-ASOP's impacts on students. The five GLO categories are: knowledge and understanding; skills; attitudes and values; enjoyment, inspiration and creativity; and activity, behaviour and progression. Analysis identified impacts in four of the five categories.

- Knowledge and understanding
- Attitudes and values
- Enjoyment, inspiration and creativity
- Activity, behaviour and progression

Evidence of impact in the skills GLO category came in the form of students' own feedback about learning to use micropipettes and other scientific equipment, as described in Chapter 3.

Teachers' reflections indicated that impact was highest for the attitudes and values, and enjoyment, inspiration and creativity categories, which are presented first below.

Attitudes and Values

Students' greater interest or improved attitudes towards science included wanting to participate in more science sessions or lessons, particularly more 'lab-in-a-suitcase' type workshops. Teachers cited the practical nature of IVVN-ASOP workshops as a key factor in improving students' attitudes towards science.

The attitude in science has changed and many are liking the science more. (Teacher)

The photo sessions with foreign countries changed their attitude towards their approach to science subjects. (Teacher)

They are eager to have such a practical workshop again. (Teacher)

Students took keen interest in the science practical and realised science is not as hard as they thought. It changed their attitude towards science. (Teacher)

Some teachers commented specifically on students' developing positive attitudes towards females in science and the importance of greater diversity of those working science.

Girls have realised they can venture into sciences careers, mostly which are dominated by males. (Teacher)

The students were motivated and had better understanding about the diversification of people in science. (Teacher)

Enjoyment, Inspiration and Creativity

Teachers reported student enjoyment and inspiration as key outcomes. They particularly noted how students were inspired by the fun of wearing lab coats and safety glasses, and the thrill of using professional equipment.

When carrying out microscopy and lab experiments. when all of them were in lab coats like doctors. They were really inspired. (Teacher)

They were fascinated with and inspired by the scientists' kit. (Teacher)

The science equipment and attire really motivated the students. (Teacher)

Wearing lab coats and lab eye glasses. (Teacher)

[8] https://le.ac.uk/rcmg/research-archive/generic-learning-outcomes

Activity, behaviour and progression

This is often one of the hardest GLOs to achieve, but even so was widely reported by teachers as students repeating or reprising workshop experiences or further pursuing or wanting to pursue science studies.

The learners who participated are taking care of the trees they planted together with the team. The number of learners in science-based subjects increased from 30 to 72. (Teacher)

They are now trying those practicals during their free time. (Teacher)

More students are now selecting science based subjects and are now focused. (Teacher)

Some of the students are asking for the requirements for science courses. (Teacher)

Knowledge and Understanding

Teachers observed how students' learned about animal science and animal or human vaccinology, depending on whether a workshop used rabies and COVID-19 as examples. There were also suggestions of the workshops having deepened students' understanding about links between animal species and humans and enhanced their knowledge about the variety of science subjects and science career opportunities that are available.

They became more familiar with how rabies can be checked in dogs. (Teacher)

A student asked about the reason for the differences in behavior of respective animals. Since they are all animals. (Teacher)

The students had better understanding about different types of science. (Teacher)

4.3. Longer-term reflections on Success Factors

Teachers' explanations for the workshops having positive impacts for students focused on the outreach workshop's practical nature and the relative simplicity and accessibility of the experiments, coupled with the scientists' passion and engaging approach to interacting with the students.

The presenters and their approach in motivating the young. (Teacher)

The pressure experience and filling a bucket of water with water with their palms as a team. (Teacher)

It was the practical aspect. (Teacher)

The way the trainers interact with the learners. (Teacher)

The approach of first hand, practical experience for students. It was amazing. (Teacher)

I like the simplicity of the practicals. It demystifies science subjects. (Teacher)

5. Findings: Teachers' Experiences and Outcomes

This chapter draws on 46 post-workshop teacher questionnaire responses, plus teachers' longer-term feedback from 26 longitudinal survey responses and 2 interviews.

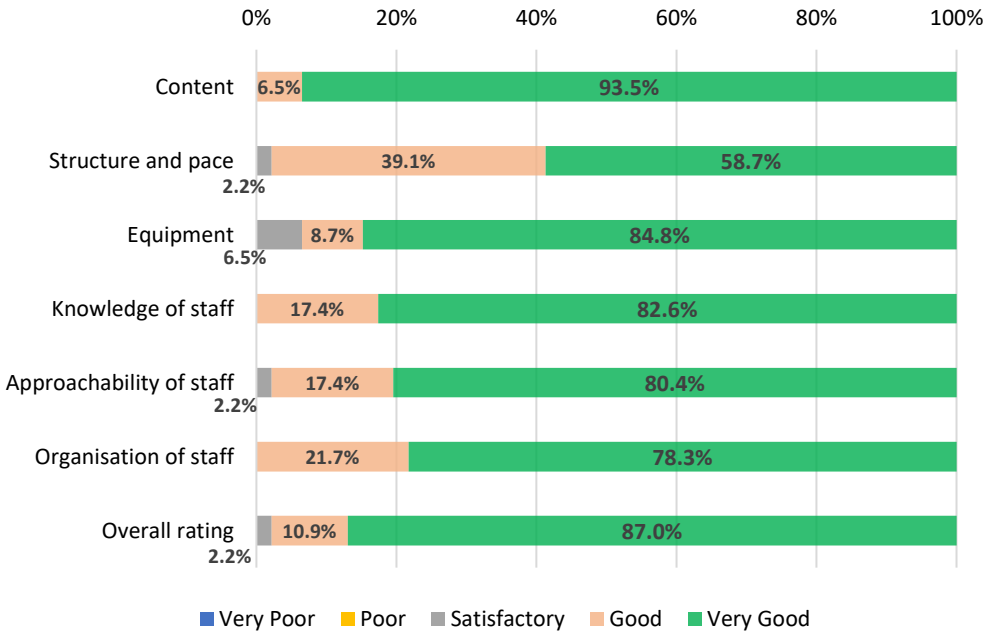
5.1. Teachers' Reactions to Workshops

Teachers rated the IVVN-ASOP outreach workshops very highly. All but one gave a positive, i.e. higher than 'satisfactory', overall rating, and ratings were high for all aspects. '*Content*' was given the highest rating (93.5% (43) 'very good') and '*Structure and pace*' the lowest (58.7% (27) 'very good'). Comments from teachers who rated the latter less than 'very good' wanted more workshop handouts for students and more science equipment for schools in general.

A teacher who gave a 'satisfactory' overall rating rated every aspect apart from structure and pace as 'very good': they felt that the workshop should be part of a continuous outreach process, rather than a one-off activity. Teachers who rated equipment 'satisfactory' wanted schools to have more science equipment generally.

Cross-tabulation identified no correlations between teacher ratings and student ages or numbers of students that took part.

Fig. 17. Teacher Ratings of IVVN-ASOP Outreach Workshops (n=46)



5.1.1. Highlights

Teachers' highlights in the form of what they particularly liked about outreach workshops fell into four main categories, which were evenly divided across responses, and thus, like ratings, were not a factor of their students' ages or workshop participating numbers.

- Workshop facilitators' professionalism and approachability.
- Being overall an inspiring experience for the students.
- Raising awareness of the importance of vaccines for humans and animals.
- Professional scientific equipment being used.

Many teachers cited multiple element of the workshops in their highlights, as these examples demonstrate.

Good organisational skills, the staff was very friendly to the student, and this enhanced active participation by the students. (Teacher)

I like the fact that the students were taught scientific investigation, observation, measurement and experiments with the use of modern equipment. Each child was well catered for too and that female students are being encouraged to become scientists. (Teacher)

The workshop was wonderful. It helped in encouraging the students to become a future scientist. And it showed how important it is to be vaccinated. (Teacher)

5.1.2. Suggestions

Six teachers reported that no changes were needed to optimise achieving IVVN-ASOP's intended aims and intended student outcomes. Other teachers' suggestions can be categorised as:

- Expanding the number of outreach workshop opportunities available to students.
- Making more science equipment available to schools.

Just under one-quarter of responses stated IVVN-ASOP should be providing more opportunities for students who have already attended workshops, e.g. activities that involve multiple interactions, rather than a one-off workshop. Teachers felt that this would expose students to more areas of science and help sustain or reinforce workshop outcomes.

By allowing students to attend more workshop like this so that more students will like to study science and choose as a job in future. (Teacher)

More workshop for the teachers and the students so as to meet with more scientists in different areas of specialization. (Teacher)

This type of workshop should be a continuous process to do more practical work on their science subjects. (Teacher)

Around one-fifth of teachers commented that schools should have more science equipment and thus greater capacity to undertake practical science. It was reported that this could help some of the workshop content to become embedded in classroom science teaching.

More science equipment should be available even for the students in every school. (Teacher)

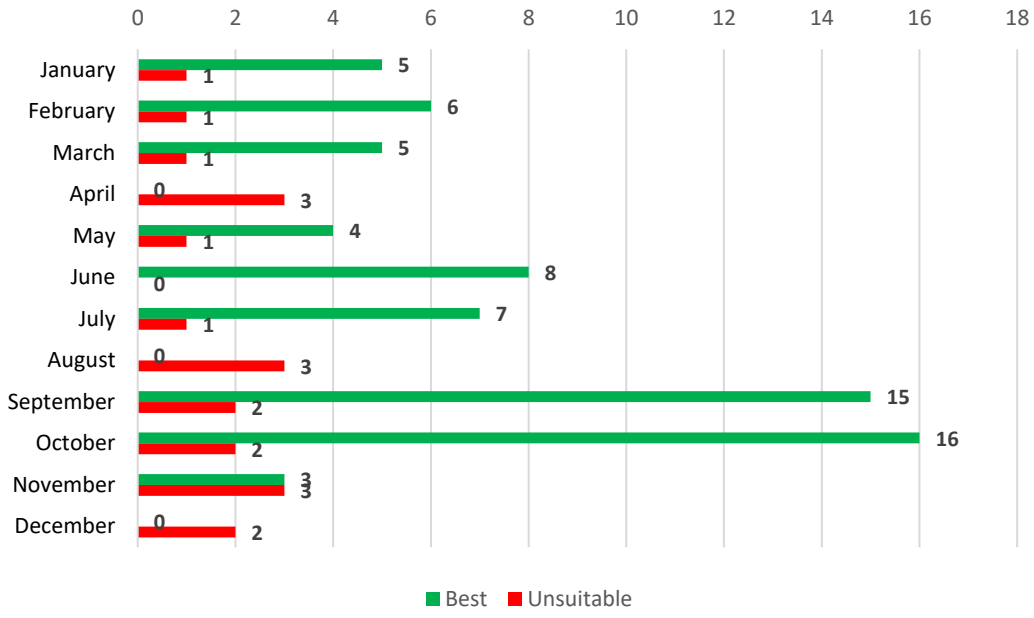
To motivate our students by always ensuring the availability of the necessary equipment needed to carry out the practical. (Teacher)

There should be more equipment in every laboratory for the knowledge learnt to be stepped down. (Teacher)

Teachers' miscellaneous suggestions were to increase the number of schools taking part; to ensure government involvement and support for science outreach workshops; and to provide more written information for students and teachers as part of workshops. Two teachers stated that they, like their students, wanted to be given lab coats, as they needed them to enter a lab in order to participate or observe the workshop experiment.

To inform future scheduling and planning, teachers were asked to name the most and least suitable months for holding IVVN-ASOP outreach workshops. The feedback indicates that September and October are generally the best months and that workshops obviously should not be held in the holiday months of December, April and August. Generally, teachers regarded the months immediately after holidays to be least suitable in term time.

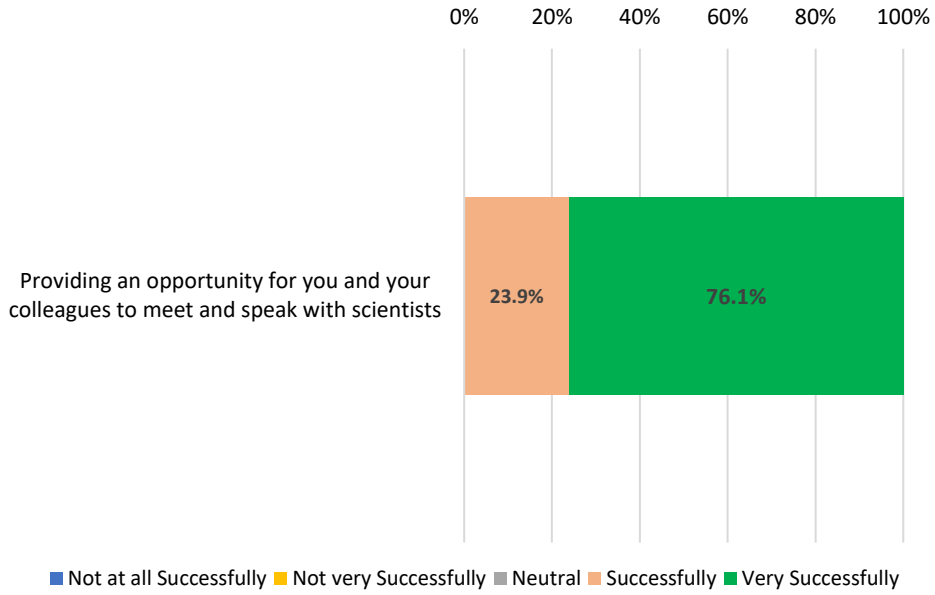
Fig. 18. Best and Least Suited Months to hold Outreach Workshops (base n=46)



5.2. Workshop Outcomes for Teachers

Teachers regarded the outreach workshops to be successful (23.9%, 11) or very successful (76.1%, 35) in achieving IVVN-ASOP's aim for them, i.e. '*providing an opportunity for you and your colleagues to meet and speak with scientists*'.

Fig. 19. Ratings of Workshops' Success in Achieving IVVN-ASOP Aim for Teachers (n=46)



Confirming the above, most (73.8%, 34) teachers stated that they talked to scientists about their research without students present. All but one of the teachers who commented on such interactions with scientists reported that they found the experience worthwhile.

Very worthwhile, got to learn a lot about vaccines & about the organisation. (Teacher)

Just over half of the teachers who did not get the opportunity to talk to scientists without the students present stated that they would have liked to talk to scientists in this way. These findings suggest that the purpose of teachers interacting with scientists could be made clearer and become a more embedded and explicit part of the outreach workshops.

Evidence of the outreach workshops' having positive impact on teachers can also be found in their post-workshop intentions:

- All but one would recommend the outreach workshop to other schools.
- All would like the outreach workshop or another similar workshop to return to their school.

The only teacher who did not intend to recommend the workshop gave no specific explanation for this answer and answered all other questions positively. They did comment elsewhere in the questionnaire that schools should provide well equipped science laboratories, suggesting that school capacity limitations may have been a factor in influencing their willingness to recommend IVVN-ASOP.

5.3. Longer-term Reflections on Teacher Impact

All teachers who responded to the longitudinal feedback survey said they want to repeat or extend the IVVN-ASOP experience within their schools. They also described how their own teaching and networks have benefitted from participating in the Programme.

Impact on Teaching Practice

In their longer-term feedback, teachers highlighted how IVVN-ASOP outreach workshops have inspired them and given them ideas for making science in school more motivating and more enjoyable for their students. They commented specifically about the benefits of the workshop format demonstrating the benefits of hands-on science and mentoring, student focused approach to education.

Teaching sciences need to be student centered with class activities involved. (Teacher)

We have realised the learners have great potential when we mentor them properly. (Teacher)

Learning can both be fun and impactful. (Teacher)

Have learnt that simple practicals make science easier and interesting to learners and they look forwards to science lessons. (Teacher)

Teachers Networking and Making Connections

Although only just over one-third (38.5%, 10) of teachers reported in their longer-term survey feedback that they had made new contacts as a result of IVVN-ASOP, some who have been able to follow up these contacts described how they were of the networking being of benefit to their students, as they have been introduced to other opportunities for further exploring science.

I am well connected with the team from UNIVERSITY OF NAIROBI and scientists from KALRO through girls mentorship trips to their labs. (Teacher)

This year , two students participated in science fair and engineering projects. (Teacher)

Otherwise, teachers described more passive forms networking, such as being sent information or having been introduced to other teachers in their local areas.

Teachers within the sub county. (Teacher)

Through them sending regular reports. (Teacher)

In interview, teachers expressed an appetite to become more actively involved in IVVN-ASOP, as they felt they could help strengthen the networking and have input to ensure activities are optimally aligned to curriculum priorities and local needs.

We need more forums for teachers to meet and discuss what we need. (Teacher)

They [IVVN-ASOP] could make more use of us to develop what they are doing and tell others about it. (Teacher)

Reflections about the Future

Other than generally wanting more IVVN-ASOP workshops in their schools and wanting a higher profile for the Programme, teachers' reflections about the future were centred on ideas that they felt could deepen interactions between scientist and students. Their suggestions included students visiting professional science environments, involving scientists in school science clubs and creating a larger cohort of facilitating scientists, which would not only make it possible to deliver more workshops, but would allow schools to build deeper and more meaningful relationships with the most relevant role models for their students and circumstances.

Science clubs in schools, facilitated by scientists, would have the most impact. (Teacher)

More time / contact hours with scientists to maximize the effects. (teacher)

Train more Scientists to interact with the students and allocate more time like a day or two. (Teacher)

By taking the students out for a field excursion to see real situations where science is done. (Teacher)

Teachers also expressed a wish to see the IVVN-ASOP approach extended to all science or STEM subjects.

If it is presented as science, let it be all of science. There are real problems with girls not choosing physics, for example. (Teacher)

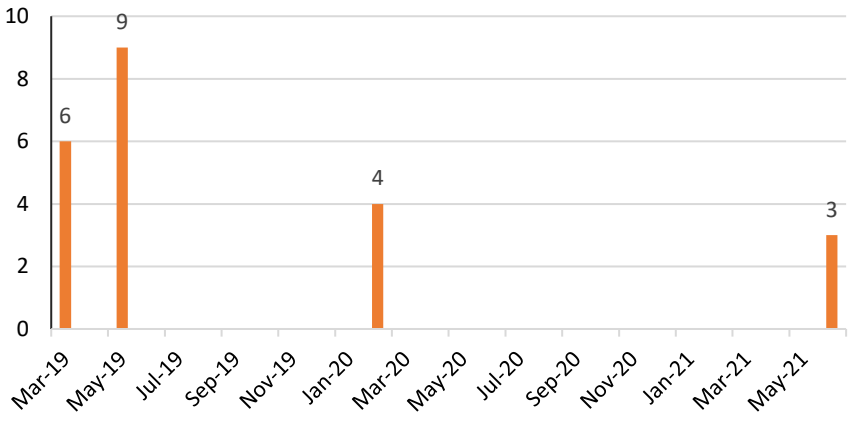
I hope it can grow to cover all STEM subjects. The girls, and boys, need to see female role models in every subject. (Teacher)

6. Findings: Scientists' Experiences and Outcomes

Feedback about IVVN-ASOP training was provided 22 scientists who completed questionnaires before and after participating in training workshops that featured delivery of an IVVN-ASOP outreach workshop. Longer-term reflections came from 21 responses to a longitudinal feedback survey in August 2023, 14 reflective interviews during the IVVN-ASOP Network Meeting held in September 2023, and 12 responses to a survey about this meeting.

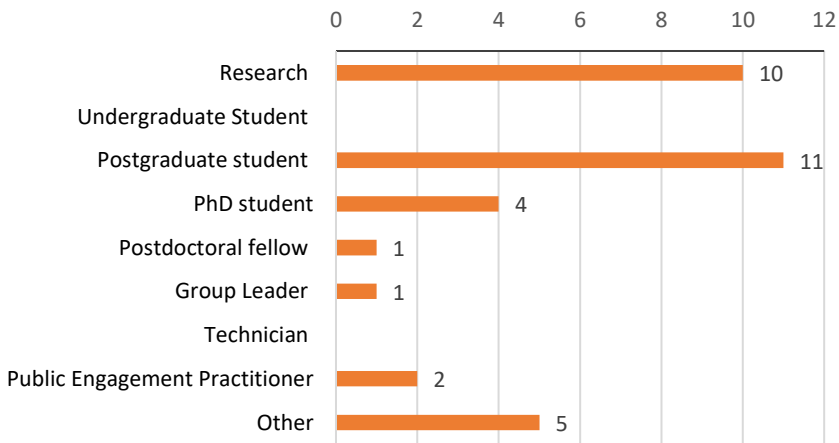
The COVID-19 pandemic disrupted delivery of IVVN-ASOP training and the majority of scientists who completed the questionnaire were trained in 2019.

Fig. 20. Scientist Training Workshop Dates (n=22)



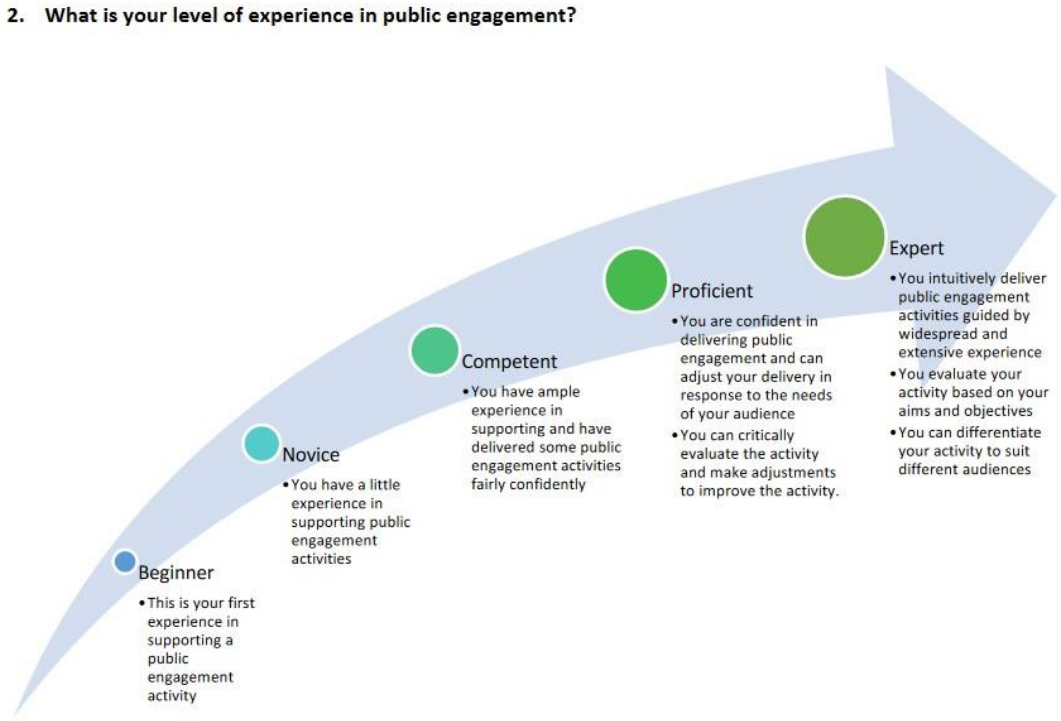
The questionnaire asked scientists to 'tell us about yourself' by choosing as many as applied to them from 10 research jobs, roles or positions. At the time of their responses, most were Postgraduate or PhD students and thus relatively early in their careers. One respondent who chose 'other' was a veterinarian, with the rest in the 'other' category also selecting 'research' and describing their 'other' roles as lecturer, research assistant, or science officer. This information indicates that IVVN-ASOP successfully attracted researchers to the training.

Fig. 21. Profile of Participating Scientists (base n=22)



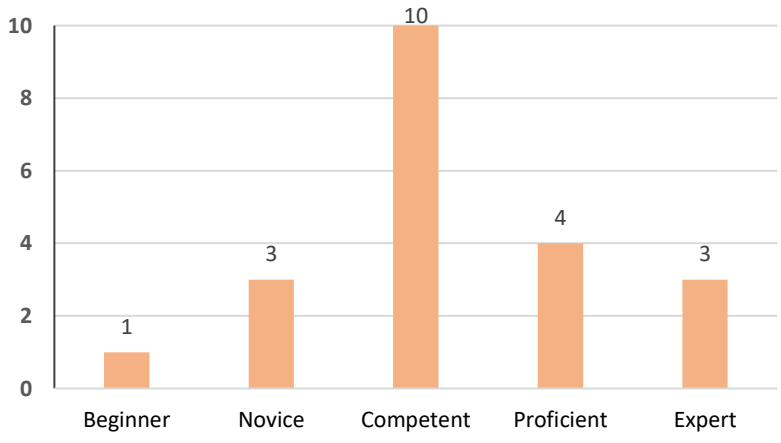
To gain insight about any impact on scientists' feelings of competence to undertake public engagement, the questionnaire asked them to select, before and after the training, their level of experience in public engagement, using the 5-point scale shown in fig. 22.

Fig. 22. Scale used to Assess Scientists' Level of Experience in Public Engagement



Using this scale, scientists reported a range of public engagement experience levels before taking part in IVVN-ASOP training, with the levels generally not dependent on seniority or type of role. Most already felt competent in public engagement, as evidenced by over three-quarters choosing a level of 'competent' or greater and one-third reporting one of the two highest levels. IVVN-ASOP training, particularly initial 2019 training workshops, has appealed to individuals with some degree of public engagement experience and who, thus, may be ideally placed to act as public engagement champions or role models in their own countries or institutions.

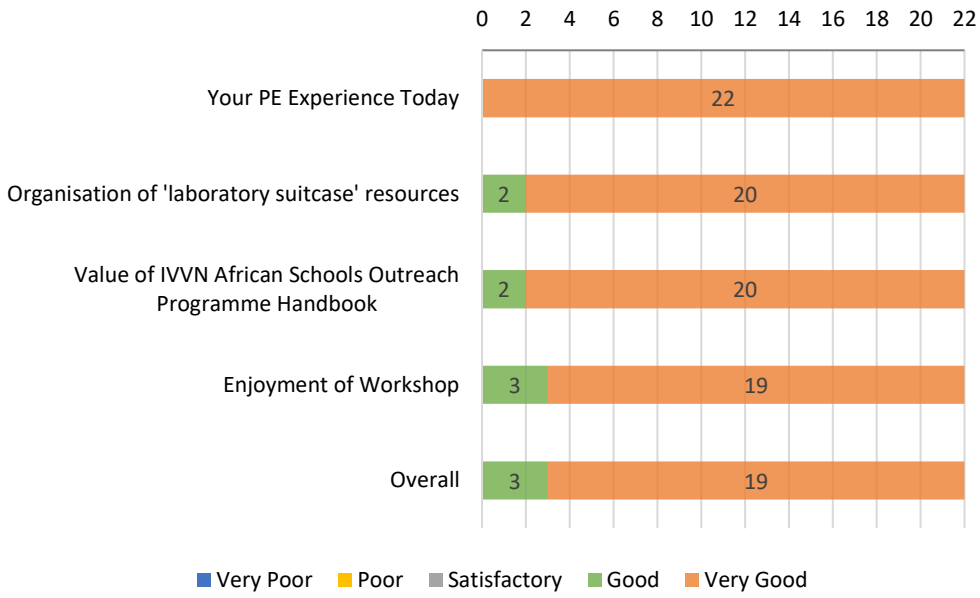
Fig. 23. Baseline Levels of Experience in Public Engagement (n=21)



6.1. Reactions to IVVN-ASOP Training

The evidence overwhelmingly indicates that taking part in IVVN-ASOP training was a positive experience for scientists. All aspects that were assessed in the survey were rated 'very good' or 'good', and in most cases given the highest rating of 'very good'.

Fig. 24. Training Experiences for Scientists (n=22)



6.1.1. Highlights

Scientists' observations of golden moments or highlights from the training focused on the reactions of school students. They endorsed the positive impact on school students, as also reported by teachers and the students themselves.

Scientists particularly enjoyed seeing students' reactions when learning how to use a micropipette, and were pleased to see teachers learning this skill alongside their students.

The girls being in awe of how the micropipette works. they expressed an 'unbelievable' facial expression and that moment was golden to me. (Scientist)

Both the students and even the teachers were learning pipetting skills. (Scientist)

Scientists described instances of students having been inspired or learning something about science careers during outreach workshops.

A student decided to be a neurologist because of what she learned today. (Scientist)

I had a great time been able to talk to the students and enlighten them on the various career paths they could venture into other than the conventional professional path everyone would like to venture into. (Scientist)

One student told me that she was told by her mother that Biochemists have no job opportunities. I explained to her the career opportunities available to Biochemists and she went 'like really'. And another telling me she wants to work with farmers. (Scientist)

6.1.2. Suggestions

When asked what could be done to improve their experience as a member of the IVVN-ASOP Programme, 18 scientists made suggestions. These fell into two main categories:

- Providing a prize or gift to students or schools who complete an outreach workshop.
- Creating opportunities to maximise reach, i.e. include more schools or a greater number of school students.

Scientists felt that the retained impact of IVVN-ASOP could be enhanced by giving a prize or award to individual students or schools, which would be in addition to any participation certificates that are already awarded to participating students.

I believe leaving the lab coats to the students as souvenir will also inspire the students. (Scientist)

Provision of equipment to leave with the learners or schools. the learners really wanted us to leave a little something to remember us by and to use as future scientists. (Scientist)

If scientific equipment of some sort would be donated to schools after each outreach, it will not only help inspire but improve the school's access to equipment. (Scientist)

IVVN should think of arranging gifts to the students and teachers as AWARD did, because this is Africa and such a thing is encouraging. (Scientist)

Scientists' ideas for extending or maximising the reach of IVVN-ASOP encompassed increasing the number of outreach workshops; inviting more than one school to participate in a single workshop; and engaging with students of all ages within a single school.

Provide more outreach opportunities, in order to reach out to more students in different communities and States in Nigeria. (Scientist)

For future events, planning can be carried out in such a way as to reach more schools per visit. (Scientist)

Organise more these outreach activities in different schools so that there is an opportunity to interact with different girls with different levels of understanding and science experience. (Scientist)

It was pointed out that working with multiple ages in a single school would not only extend the reach of IVVN-ASOP, but could provide opportunities for assessing students' progression and longer term impacts.

Facilitate outreach into more schools, where we would work in different schools with different ages, e.g. have Form 1 class in one school, Form 2 class in another school and evaluate the difference in inspiring the next generation. (Scientist)

In the context of reaching a wider range of ages, scientists felt some of the outreach workshop content would need adapting for younger students.

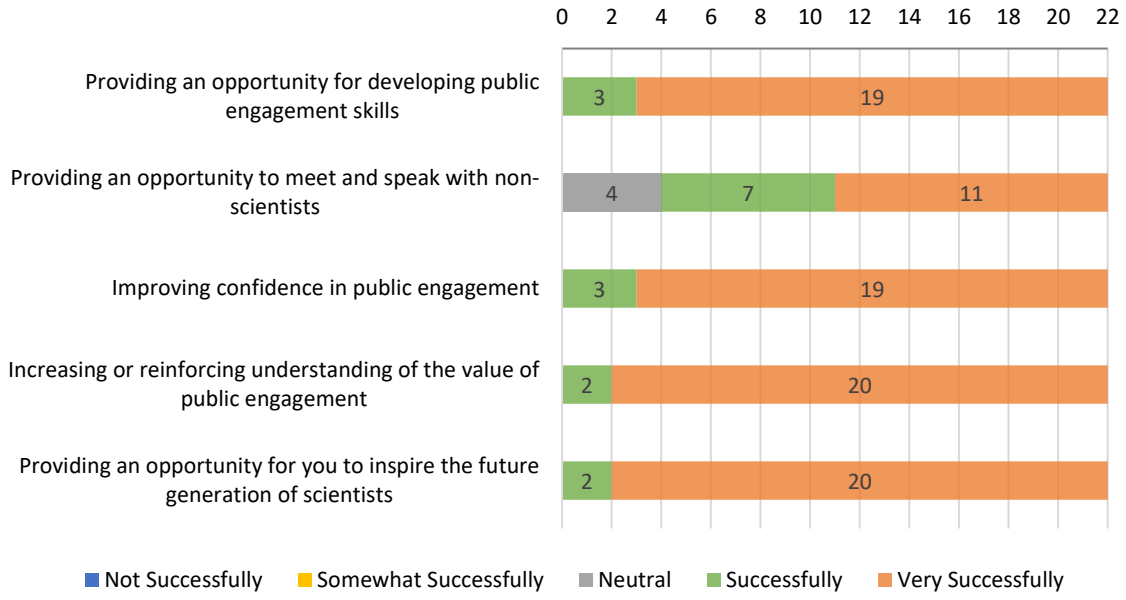
Equipment and experiment is not tailored for younger learners. perhaps a different experiment can be designed. (Scientist)

Other than these two main categories, scientists suggested training more female facilitators, particularly under the age of 30 , as they are deemed to be the most relevant role models for students; and ensuring there are adequate ongoing funding, support and resources for IVVN-ASOP to continue and develop.

6.2. Intended Outcomes for Scientists

Based on five outcome indicators, IVVN-ASOP training impacted positively on scientists' public engagement skills, confidence and appreciation. Because the training included opportunities to engage directly with school students, it also enabled scientists to inspire future scientists. Questionnaire responses show that training workshops were least successful in '*providing an opportunity for scientists to meet and speak with non-scientists*', which somewhat contradicts feedback about being able to inspire the next generation. However, it is possible that some scientists adopted an observational role during training and had less interaction with school students, or they may not have thought of school students as 'non-scientists'.

Fig. 25. Training Outcomes for Scientists (n=22)



Further evidence of training workshops' positive impact on scientists comes from their intentions:

- All would recommend a colleague to join the IVVN-ASOP Programme.
- All would return to be part of another IVVN-ASOP workshop.

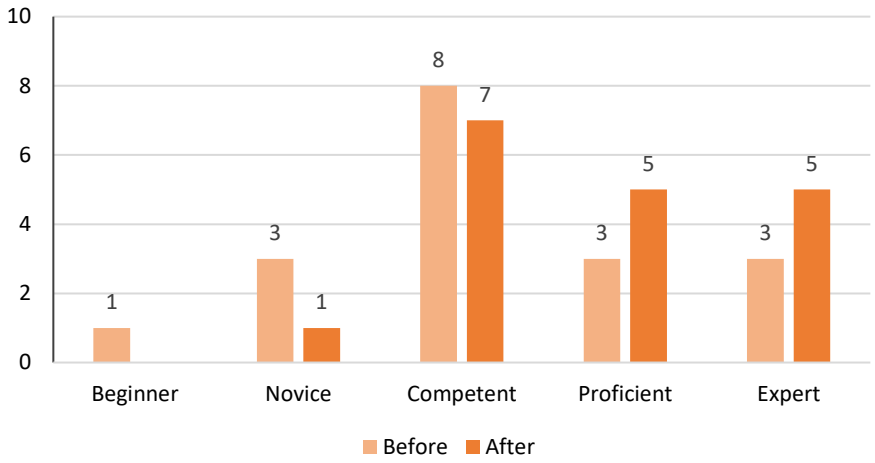
Some scientists used an 'other comments' question to confirm their intentions to continue to deliver science outreach and inspire female school students.

It was indeed an overall great experience. I look forward to reaching out to more students in science, and helping them choose a career path in science, especially the girl child in the upcoming IVVN schools outreach Thank you. (Scientist)

6.3. Impact on Scientists' Experience in Public Engagement

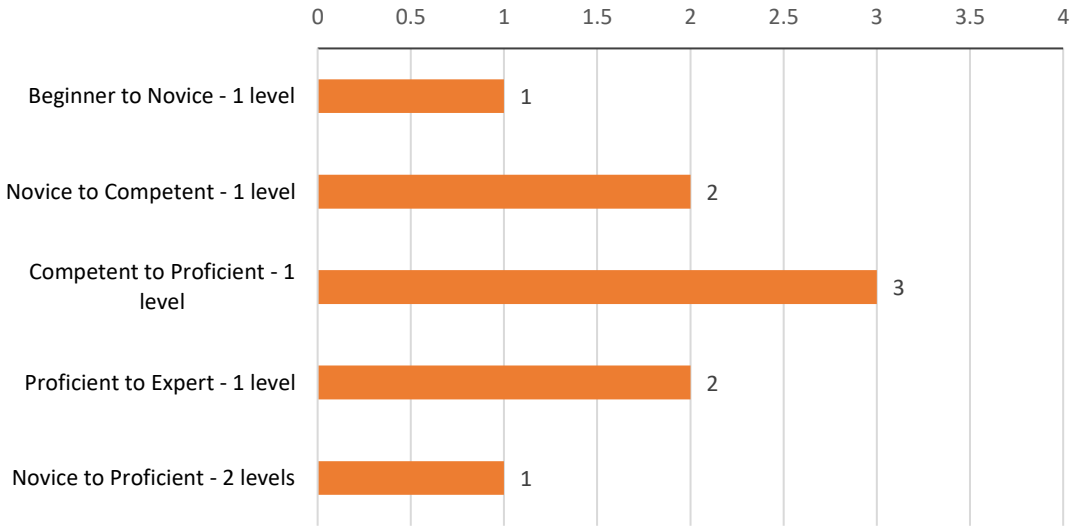
A comparison for 18 scientists who reported their levels of experience (scale in fig. 22, p. 24) before and after training shows an overall positive impact. After the training, over one-half reported a higher than competent level, compared to one-third before. Also of note is the fact that one individual who chose 'beginner' before the training was the only person afterwards who selected a level below competent, with their level having risen to 'novice'.

Fig. 26. Before and After Comparison of Reported Levels of Experience in Public Engagement (n=18)



Additional insights about positive impact on scientists' public engagement experience levels come from half reporting an increase of at least one level, one reporting an increase of two levels and no scientists reporting a reduction in levels. Other than five scientists who were 'expert' before the training, no increase was reported by four who beforehand regarded themselves to be 'competent' and one who regarded themselves 'proficient'. The practical nature of the training, which involved observing and taking part in delivering an outreach workshop, is likely to have been a factor in increasing these levels, as it offered scientists an opportunity to further their practical experience alongside developing theoretical knowledge.

Fig. 27. Increases in Levels of Experience in Public Engagement (n=9)



6.4. Scientists' Longer-term Reflections

Longer-term reflections were provided mainly by female scientists based in Kenya and Nigeria, which aligns to most IVVN-ASOP outreach workshops having been delivered in these countries.

Positive and Motivating for Everyone

Reflective interviews with scientists confirmed the positive opinions about IVVN-ASOP expressed in the training feedback. Interviewees chose words to describe their experiences that indicate they found the Programme to be rewarding and motivating. On probing, it was evident that they consider IVVN-ASOP to be impactful, rewarding and motivating for both themselves and the participating students.

Fig. 28. Word Cloud of Scientists' 'What 3 words' to describe IVVN-ASOP (base n=11)

All 21 scientists who completed the longitudinal feedback survey had been involved in the delivery of at least one IVVN-ASOP workshop. While two have each visited over 20 schools and two have visited between 10 and 20 schools, most have visited three or fewer schools. Eight had been trained by Roslin/EBSOC, with the rest having received cascade training from other IVVN-ASOP scientists.

Every longitudinal survey respondent and all interviewed scientists want to continue to deliver IVVN-ASOP workshops. All but one have already recommended taking part in IVVN-ASOP to a colleague, although there were some concerns that colleagues' involvement could be limited by school capacity to host workshops, local education policies, or lack of ongoing funding support for IVVN-ASOP.

Adaptations to Delivery

Longitudinal survey feedback clearly demonstrated how scientists have taken ownership of IVVN-ASOP outreach workshop content and associated activities and adapted them according to global and local circumstances, demonstrating flexibility and responsiveness. Content alterations include a switch from rabies to COVID-19 vaccinology as the subject of the experiment in reflection of the global pandemic, which meant workshops could promote the benefits of human vaccination.

We were able to change the vaccine story to fit in with current times eg during COVID, we taught students about COVID and how vaccines were being generated. (Scientist)

In addition, local availability of materials drove some adaptations.

We ran out of indicator in Kenya so we used litmus instead. Also, we ran out of lime juice in Nigeria, so we bought some citrus fruits squeezed out the juice and used. (Scientist)

Scientists also demonstrated how they have responded to different educational systems and policies, such as particular age groups being a priority, or teachers and schools wanting outreach workshops to feature a wider spectrum of science.

The emphasis to students in High School changed from focusing on working towards pursuing Veterinary Sciences ..to Science courses in general. (Scientist)

Due to the …high school entrance age in my country, the age 13 - 14 was not used but the classes were adapted for use. The outreach was delivered to students in the Junior High School. (Scientist)

Some of the scientists' adaptations have been a direct response to students' feedback questionnaires (section 3.2.2).

[We] ask students to indicate the age of the scientists they draw to be more specific on whether they identify themselves as scientists. (Scientist)

Scientists have added value to the outreach workshops by incorporating elements of their own personalities or their own work, with the intention of maximising student engagement and optimising the potential for student inspiration.

It was my first time and as such, I adopted the training package to begin with. Few additions came at the end and a rap song of two sentences 'I love my sciences, it's lots of fun'. (Scientist)

To bring the story to reality and enable the students relate to my topic of discussion better during meet the scientist, I take tools and materials related to my work to make it more interesting. (Scientist)

The average number of student participants in each outreach workshop has gradually risen, which has increased the audience. Where capacity has allowed, scientists have extended the one-off workshops to provide schools with multiple science interventions. This is line with best outreach practice, as research has found outreach activities consisting of multiple interventions have fewer limitations than one-off interventions on the types of impacts that can be achieved.[9] Multiple interventions provide an opportunity for more in-depth evaluation as they mean progression within a single cohort of students could be tracked over time.

Adding legacy and community activities. (Scientist)

Including visits to sites of research. (Scientist)

[9] https://uclpress.scienceopen.com/hosted-document?doi=10.14324/RFA.05.1.07

A Growing Network

14 scientists who responded to the longitudinal survey have contributed to building capacity for delivering IVVN-ASOP by training in total c.100 other scientists to facilitate outreach workshops. The same number reported that they have made new connections as a result of being involved in IVVN-ASOP, especially connections with potential research collaborators.

> *Now I have some contacts in Nigeria and Kenya and we have possibilities in working on other projects together. (Scientist)*

> *I met a cohort of early career researchers working in Vet Immunology who are potential collaborators. (Scientist)*

There were a few notable examples of connections with other scientists having benefited individuals' research or career profiles.

> *I got a new research collaborator through the opportunity I had to deliver the outreach activity to early career researchers in the UK. In short, I cannot quantify the different connections I have made through the schools' outreach program. (Scientist)*

> *I have been invited to present in an international conference where i had an opportunity to network and meet new scientists. From this interactions, i was given a sponsorship to support two female scientists to attend an international conference, which happened this August through a scholarship scheme we established with a former colleague. From the same connections, I have been invited to join two journal editorship. (Scientist)*

Other networking impacts attributed to IVVN-ASOP include scientists connecting with a greater number of schools, the IVVN team in the UK plus Roslin/EBSOC, and national and local government institutions.

> *Secondary school pupils at Canon secondary school whom l trained on mushroom cultivation. Also farming communities at Taita Taveta County in Kenya. Institutions such as University of Nairobi and Kenya Agricultural Research Livestock organization. County Governments of Taita Taveta and Kajiado Counties. (Scientist)*

> *Locally, I have managed to connect with many schools and teachers as a result of the program. (Scientist)*

> *I have also managed to interact with county government as a result of delivering the activities in different counties. (Scientist)*

7. Findings: IVVN-ASOP Processes and Structure

Analysis of all feedback from teachers and scientists, along with observing presentations and discussions at the September 2023 IVVN-ASOP Network Meeting, identified a number of consistent themes and associated learning points that relate to the Programme's operational processes and structure.

7.1. Country Leadership

Although, at the time if the evaluation, each country was at a different stage in developing its IVVN-ASOP activities, with Kenya and Nigeria having been able to make most progress, crucial to success has been the presence the leadership of a dynamic, motivated female scientist, who understands the education and funding environments in their country and inspires other scientists to get involved. Running IVVN-ASOP has created additional demands on these country leads, all of whom are working scientists, which makes their achievements more noteworthy.

She [country lead] is incredible, I am so inspired by her that I want to do my very best for the African Schools Outreach Programme. (Scientist)

Country Leadership
Learning Points
• Dedication and desire are valuable personal assets, but lead individuals also need to feel empowered and be supported. • It is essential that their employers support the country leads, helping with in-kind or financial resources and connecting them with institutions and/or individuals that can enhance and optimise ASOP, e.g. potential funders or sponsors, policy makers. • Having a vision and clear plan for developing ASOP in their country helps a lead to secure internal and external support for their activities. • Delegating operational tasks and roles, particularly as ASOP activities expand, means leads can focus on strategic matters, such as development planning and securing a sustainable future. • Employers need to be made aware of the personal and professional benefits that come from leading ASOP, to ensure country leads receive appropriate career recognition and reward and can fulfil their potential as outreach champions.

7.2. Multi-country Programme

Scientists who have taken part in IVVN-ASOP believe that being part of a multi-country programme is value-adding. They consider it to be personally motivating and rewarding, to have helped raise the Programme's profile within scientists' employing institutions, and to be attractive to certain prospective funders and partners. Countries being at a different stages of development was thought to have optimised the potential for countries to learn from one another. Network Meetings, like the one held in September 2023, not only enhance sharing

between countries but were also motivational and inspirational for scientists and provided opportunities to celebrate achievements and present them to existing and potential stakeholders, including funders and supporters. Even though the COVID-19 pandemic adversely affected plans to involve more countries in the first phase of IVVN-ASOP, an appetite remains to expand into other parts of Africa.

For it [IVVN-ASOP] to have maximum support and impacts it needs to be seen as all Africa – 'to have a face of Africa' and a plan to grow to maybe 10 countries. (Scientist)

Multi-Country Programme
Learning Points
• Networking between country leads allows best practice and learning to be shared, and helps to mitigate the risk of any mistakes being repeated. • Country leads and team members supporting one another across country boundaries aid personal development and motivation. • Geographic expansion is most likely to be successful when it is built on strong foundations and consolidated operations in other countries. • The multi-country nature of ASOP can be appealing to funders, especially corporate or multinational organisations. • Countries should not feel that their IVVN-AOP activities being less advanced or differing in any other way from the others will count against them or puts them at any disadvantage. • Network Meetings that bring countries together are inspiring for team members, help to share best practice and learning and celebrate achievements. Their value is optimised if clear action plans result.

7.3. IVVN Support

Country leads and participating scientists highly valued IVVN's support for ASOP. Naturally they appreciated the financial input, but they also ascribed great value to having access to training and knowledge, plus 'softer' support such as ongoing advice and being part of a network. They praised the financial and other resources, including expertise, that IVVN has brought to ASOP, although some uncertainties were expressed about what IVVN gains from being involved. Whilst scientists recognised that, due to funding changes, IVVN's support cannot continue at past levels, and having a stronger African identity may benefit access to local funding, they felt there should be a clear and agreed plan for managing any reduction in IVVN input as ASOP countries' ownership and responsibility for the Programme is growing.

I am afraid if funding means IVVN has to disappear, but it not just their money, the central support help to keep things moving and motivated. Any exit plan must be gradual. (Scientist)

IVVN Support
Learning Points
• IVVN support (financial and non-financial), has been essential in establishing ASOP, particularly during the early stages of setting-up within a country. • Elements could be prioritised for IVVN 'soft' support in future, e.g. help with longitudinal evaluation, assistance in building project management capacity. • Although funding is unlikely to come directly from IVVN in future, IVVN knowledge and expertise about grant funding remain valuable for the foreseeable future. • Maintaining a network of ASOP countries, and reaping any benefits that arise from this, needs dedicated co-ordination, which IVVN has provided, and that needs to be part of future plans. • Ongoing support has to respond to countries being at different stages of development and be tailored accordingly, e.g. countries where ASOP is in the initial stages needing more IVVN input than where ASOP activities are better established.

7.4. Delivery Capacity

Even in countries where sizeable delivery teams have been created and set up, IVVN-ASOP delivery has relied on motivated individuals, most of who are participating in outreach alongside their main jobs. Scientists expressed pride in their collective success and the positive and supportive operational environments that have been created, which can be built upon in future. Country leads were highly aware of the benefits of having a range of experience and representation from a variety of institutions in their teams, and have included both experienced scientists and individuals who are early in their careers. Team members have recognised the importance of delegating delivery tasks and roles to free up country leads for strategic matters. Participation in IVVN-ASOP has developed scientists' transferable skills, which has the potential to aid career progression. Whilst scientists' desire to see growth through reaching more schools and students is an admirable ambition, this has to be balanced against the potential risks of creating excessive pressures on individual members and teams as a whole. Even if activities are consolidated, rather than expanded, plans to sustain and refresh team membership will need to be considered.

I think plans about how it [IVVN-ASOP] develops and the direction it takes should be taking account of who is available not just to help run the workshops but to organise logistical matters. These could be more shared in the team. (Scientist)

Delivery Capacity

Learning Points

- Delivery teams benefit from including experienced scientists, who bring leadership experience and well-established networks, and younger scientists, who are often the most relatable and relevant role models for school students .
- Joining forces with relevant partner organisations, e.g. other research institutions or outreach partners such as museums and science centres, can enable sharing of resources, expertise and contacts to create a whole that is 'greater than the sum of the parts'.
- Partnering with researchers from science disciplines could create capacity to include a wider range of STEM topics.
- Sharing tasks and roles among team members and ensuring all members of a team understand their own and each other's roles increases individual motivation and optimises the smoothness of project delivery.
- Employers should be made aware about and encouraged to recognise and reward professional development impact on team members, e.g. developing transferable skills such as communication or team working, or raising the public profile and reputation of employing institutions.
- Prioritising plans and having realistic development objectives can prevent teams and team members becoming overburdened.

8. Conclusions

Feedback from all sources was universally extremely positive, as reflected in these conclusions, which begin with points about achieving aims and having impact, followed by summaries of success factors and potential development opportunities, and a general concluding statement.

8.1. Achieving Aims

The evaluation found evidence of IVVN-ASOP achieving all the aims stated in the September 2023 IVVN-ASOP Network Meeting:

Aim 1: Encourage greater female participation in science via school outreach workshops.
High levels of student enjoyment and the fact that 95% of all students and 96% of female students after participating in an IVVN-ASOP workshop think that they could be a scientist are, alone, indicators of achieving this aim. This is endorsed by 100% of teachers saying that outreach workshops have inspired students to think about science as a career or further study option, and 100% of teachers reporting longer term that IVVN-ASOP has revealed to students that science is a career they could choose and commenting about more students wanting to study science subjects at school. Systematically evaluating these and other outcomes (see Aims 3 and 4) longitudinally would provide stronger evidence than the snapshot that can be presented in this report.

Aim 2: Build local capacity for delivering outreach workshops.
Realisation of this aim in multiple countries was severely limited by the COVID-19 pandemic, which began immediately after initial training in IVVN-ASOP and resulted in a major loss of momentum. However, from 2022 onwards significant strides towards establishing IVVN-ASOP teams and building capacity have been made in Kenya and Nigeria, which leads from other countries have been able to experience first-hand, meaning they have had the opportunity to learn from the Kenyan and Nigerian experiences. It is anticipated that inter-country learning will continue to inform capacity building plans.

Aim 3: Strengthen students' scientific knowledge and analytical skills relating to infectious diseases and vaccines.
There is considerable evidence of these outcomes being delivered, as after participation in IVVN-ASOP workshops 97% of all students and the same proportion of female students reported that they know that vaccines are used to prevent infectious diseases, even though students aged 11 or under were least likely to report this outcome.

In addition, 100% of teachers stated IVVN-ASOP increased or reinforced students' understanding of vaccines. Students' comments about outreach workshops provide evidence of them having developed skills in using professional scientific equipment and techniques, and having learned to interpret results from a vaccinology experiment. These comments were confirmed by 100% of teachers reporting improvements to their students' skills and confidence in experimentation and practical science.

Aim 4: Positively influence attitudes and negative perceptions of girls towards science courses and/or science careers.
Although 100% of female students and 99% of male students, after an IVVN-ASOP workshop, think that women can be scientists, which is a positive outcome, the fact that 1% of males do not have this view highlights the importance of male students having exposure to experience successful female scientists and hearing IVVN-ASOP messages. Other evidence of this aim being achieved include 100% of teachers reporting immediately after workshops and longer-

term that students' interest in science has been increased and their motivation to pursue science has been enhanced or reinforced. Teachers described examples of increased numbers of female students wanting to pursue science study or select science subjects in school.

8.2. Having Impact 2019 to 2023

Evidence from all sources demonstrate that, between 2019 and 2023, IVVN-ASOP delivered important impacts for the primary target audience of female school students, as well as for male students and for teachers and scientists, and had the same three broad areas of impact in all these groups.

8.2.1. Creating opportunities, enjoyment, inspiration, interest

School students of all ages and their teachers enjoyed the 'lab-in-a-suitcase' workshops, particularly the practical, hands-on nature and the opportunity to use professional scientific equipment. Students especially enjoyed new experiences and described the workshops in positive terms as interesting, enjoyable, fun and exciting.

Students' reactions to meeting scientists were very positive, with all ages finding these interactions to be inspiring. Having scientists who are trained in delivering outreach workshops was important, as they made the content accessible and appealing for students. The fact that students ranging in age from 9 to over 22 years rated the workshops highly shows that scientists were able to adapt and tailor their delivery for different ages.

Teachers also praised the practical content and equipment featured in the outreach workshops. In addition, they highly rated the knowledge, approachability and organisational skills of scientists who delivered the workshops. They valued their own interactions with scientists, and felt the experience of meeting scientists was inspiring for students.

Scientists unanimously enjoyed the training and facilitating the outreach workshops, which they found a valuable public engagement experience. They also praised the 'lab-in-a-suitcase' resources that were issued to them during their training. Younger scientists were inspired by the more experienced role models they worked alongside when delivering IVVN-ASOP.

8.2.2. Enhancing Science Attitudes and Intentions

Students' attitudinal outcomes towards science and female scientists were particularly well-evidenced as described in section 8.1.

Teachers attitudes towards IVVN-ASOP were very positive, as shown by their intentions to recommend the workshops to other schools and their wishes for IVVN-ASOP to grow and to return to their school.

For **scientists**, the main attitudinal outcome was greater confidence to undertake public engagement as a result of participating in IVVN-ASOP, plus increased motivation and self-esteem from seeing students' reactions in workshops.

8.2.3. Learning and Developing Knowledge

Impacts around **students**' scientific knowledge and understanding were very evident with regards to greater knowledge about vaccines and their use in protecting animals and humans. Students' knowledge of science opportunities increased, as they became more aware of a range of careers in science.

For **teachers**, IVVN-ASOP developed their knowledge about mentoring and practical approaches in teaching science, which they may use in their own practice.

For **scientists**, the main knowledge impact was increasing or reinforcing their understanding of the value of public engagement. They also enhanced their public engagement skills and wider transferable skills.

8.3. Reasons for Success

This diagram summarises the main input and process success factors and resulting output characteristics that the evaluation identified as the main reasons why IVVN-ASOP has achieved its aims and delivered meaningful impact on school students, teachers and scientists.

Input Success Factors

IVVN funding, support and guidance.

Inspiring, dedicated and visionary 'country leads'.

Team members' strength of commitment and belief in IVVN-ASOP.

Employing institutions' support: in-kind resources and senior management endorsement.

Process Success Factors

Expert and practical approach to outreach training for scientists.

Building capacity through multiplier effect of cascade training.

Countries having freedom free to develop at their own pace in response to the local environment and without any judgement.

Networking between countries to share learning and experiences.

Network meetings to celebrate and showcase success and plan for the future.

Output Characteristics

Portable 'lab-in-a-suitcase' can be taken to any school.

Delivery by scientists trained in IVVN-ASOP approach to outreach.

Students and teachers get to experience:

- Hands-on experiments and experimental results that have 'real world' relevance.
- Using professional scientific equipment and techniques.
- Meaningful interactions with impressive and relatable female role models.

Flexibility to adapt in response to current priorities (e.g. global pandemic) or school wishes (e.g. whole school career talks).

8.4. Opportunities to Develop and Optimise IVVN-ASOP

Teachers and scientists unanimously expressed a strong desire for IVVN-ASOP to continue and expand, which would need resourcing. Even sustaining current activities require new funding, which is likely to be on two levels: local, country-specific funding to support delivery and local infrastructure, and international funding for continued Africa-wide coordination and to support networking activity between different countries. IVVN-ASOP's aims are consistent with many EDI (Equity, Diversity and Inclusion) and CSR (Corporate Social Responsibility) agendas and policies, which creates an opportunity to explore EDI and CSR funding streams.

Assuming funding is found for further development, then a point to consider is the possibility of developing activities where students participate in programmes of activity e.g. multiple outreach interventions, as this is likely to lead to deeper impacts. Multi-stage outreach often demands higher levels of resourcing and additional scientist training compared to one-off workshops, and therefore may not always be practical. One way to deliver multi-stage, deeper interventions is to work with fewer schools but in a more concentrated way.

IVVN-ASOP needs to determine how it will respond to teachers' wishes to see the same approach replicated in other STEM subjects. In this regard, subject expertise would have to be identified as the remit of Roslin/EBSOC, which devised the 'lab-in-a-suitcase' workshop and initial training, is focused on animal biology research. Partnerships may be one way to bring in relevant expertise, but any partners would need to adopt the IVVN-ASOP success factors and ethos to ensure ASOP's 'brand' and reputation are not compromised.

The evaluation of IVVN-ASOP could be enhanced to ensure optimal capture and reporting of impact on all parties, although this would need to be balanced against any potential risk of overburdening those who provide feedback and those who collect it. Existing questionnaires can be tweaked to ensure they are capturing the most useful information. The Programme as a whole would benefit from longitudinal impacts being tracked over time, at least for a sample of students or schools. Teachers' and scientists' feedback should continue to be included, and stakeholder impact added, e.g. institutional impact for organisations that employ participating scientists. Appendix A outlines a Logic Model Framework that summarises examples of the outcomes or changes IVVN-ASOP seeks to bring about. This framework plus SMART[10] objectives can guide future evaluation work, be revisited to determine impact, and may be useful in internal and external stakeholder communications about achievements and progress.

8.5. General Concluding Statement

The 'first phase' of IVVN-ASOP has been an undoubted success, which has achieved much in both impact and learning for the future. It can be summed up as inspirational at every level, and has received widespread praise for inspiring students, teachers and scientists.

IVVN has secured further funding from MRC that provides an 18 month timeframe in which to plan systematically how the next phase can best be developed. Country leads and the IVVN team in the UK will need to work together in this planning process to secure funding and ensure a smooth transition to a more devolved model than operated during the first phase. The next section of this report makes some recommendations, including a possible model for future delivery, that they may wish to consider

[10] Specific, Measurable, Agreed, Realistic/Relevant, Timebound

9. Recommendations

These recommendations refer to ASOP, rather than IVVN-ASOP, to reflect the shift in 'ownership' of the programme from IVVN to the countries where activities are delivered.

9.1. Over-arching Recommendation

Recommendation 1: IVVN and ASOP country leads work together to secure funding to continue with a co-ordinated female-led science outreach programme in multiple African countries.

9.2. Planning Recommendations

Recommendation 2: Develop a plan for transferring 'ownership' and coordination responsibility for ASOP to a network of African countries. Local ownership will benefit the Programme's visibility and access to local funding. However, IVVN knowledge, guidance and leverage potential should be retained at some level.

Recommendation 3: Build on the steps that have been taken to introduce a consistent vision, ethos and branding for ASOP. These help to give the Programme a strong identity and therefore a higher impact among stakeholders and potential funders, including when launching in new countries.

Recommendation 4: Adopt a gradual approach to expansion and growth. Consolidating and embedding activities before moving on to the next development will ensure ASOP remains successful and retains a high quality reputation and credibility.

Recommendation 5: Develop consistent plans for capitalising on opportunities from the strong relationship with University of Edinburgh. Opportunities such as summer schools or progression pathways could provide a continuation route for students who have participated in ASOP activities in their own countries. These opportunities should be approached strategically to ensure they are meaningful and relevant to students and match the aims of both ASOP and the University .

9.3. Networking and Stakeholder Engagement Recommendations

Recommendation 6: Seek specific funding to maintain coordination and opportunities for sharing good practice within and between countries. The levels of innovation and success in counties where ASOP is more established were impressive. Their learning and achievements need to be shared fully with others as they can not only inform plans, but are also inspirational. Coordination of inter-country networking should be retained to ensure that all countries reap the benefits outlined in section 7.2. Ideally, it would transfer from the UK to one of the ASOP countries, where it would require funding and resourcing.

Recommendation 7: Develop short, easily accessible summaries of existing evidence of ASOP success and impact tailored to specific stakeholders. These can help to raise stakeholder awareness and secure their support and buy-in. They can be informed by the stakeholder asset mapping mentioned in recommendation 9 and tailored to each stakeholder's needs. For example, teacher groups are likely to require different benefits to be highlighted compared to scientists' institutions or potential STEM partners, and policy makers in each country are likely to have their own priorities, and thus specific information requirements.

Recommendation 8: Consider a strategy for policy advocacy and engagement with policy makers to improve the environment and infrastructure for schools science. Education ministries and equivalents can support ASOP financially, but they also can support the aims in other ways. For example, their decisions affect how science in schools is resourced and therefore they have influence over schools' capacity to accommodate ASOP.

9.4. Operational Recommendations

Recommendation 9: Encourage each country to develop an ASOP local stakeholder assets map. This should include not only sources of funding and financial support (including science and non-science sources such as EDI and CSR funding) but also organisations and individuals who can provide expertise, influence policy, facilitate networking, as well as provide materials and other in-kind resources.

Recommendation 10: Use the success factors identified in this evaluation as a starting point when planning new activities and identifying potential delivery partners, including other STEM subject experts. This will help ensure that ASOP retains a strong core identity that is reinforced rather than weakened by greater variety and broadening to cover other subjects. Consideration could be given to asking partners to sign up to an 'ASOP manifesto' that commits them to the shared vison, ethos and approach that define what ASOP is and how it operates.

Recommendation 11: Explore opportunities for more involvement from teachers, taking steps to ensure they benefit optimally. Teachers are a vital route to maximising and sustaining ASOP's impact on students, meaning their buy-in is essential. ASOP countries could consider establishing panels of teachers, paid for their time and who have been involved in the Programme for consultation about activities, promotion etc. Teachers can provide insights on practical constraints and curriculum priorities, they can also champion ASOP within their peer networks.

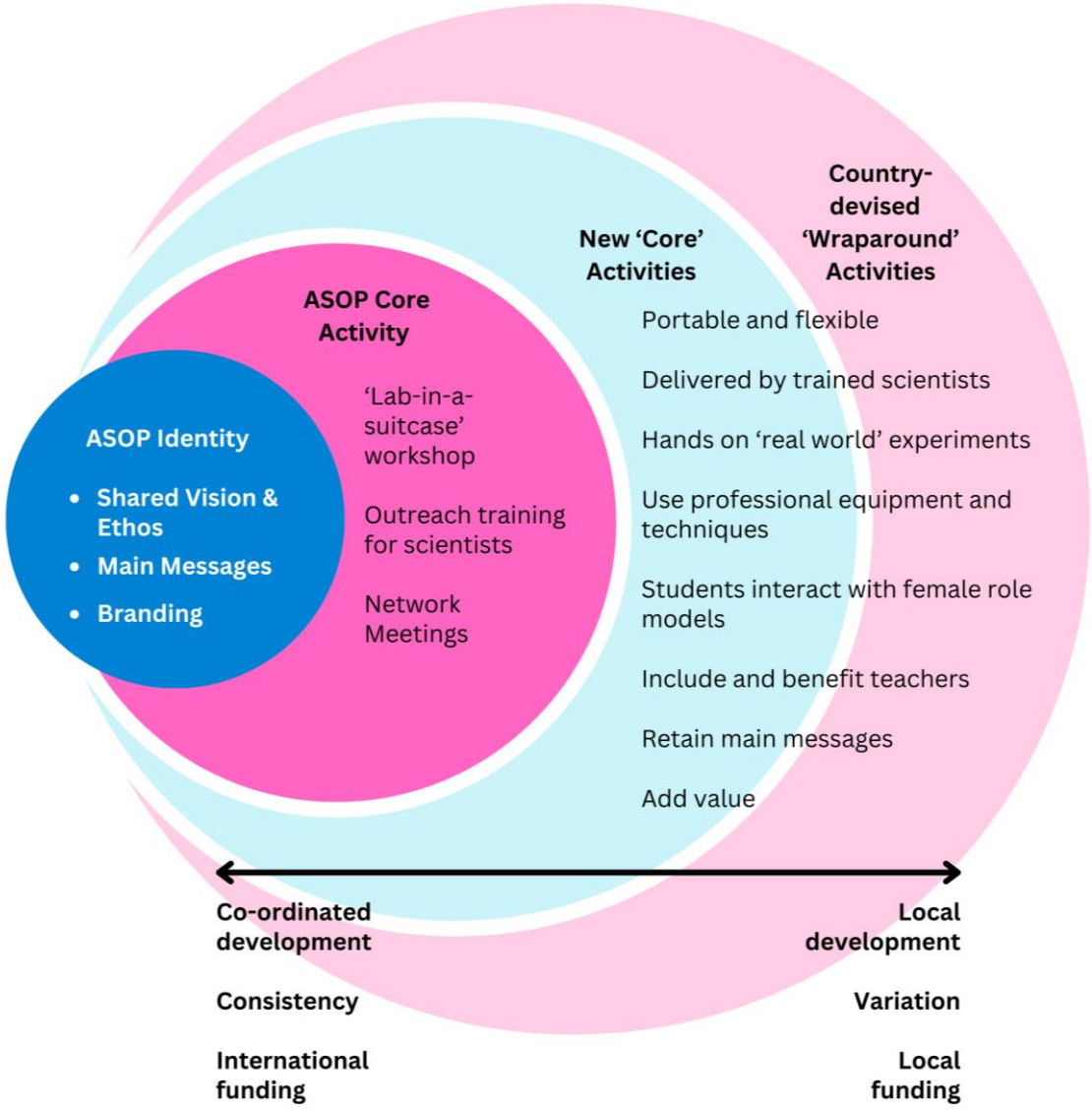
Recommendation 12: Incorporate flexibility to adapt to local interests whilst retaining the success factors and key characteristics of ASOP. Countries have addressed this by developing 'wraparound' activities such as careers talks or community tree planting to supplement the core 'lab-in-a-suitcase' workshop, but perhaps consideration could be given to including some flexibility in core activities used by every country, for example by having a modular format workshop, with options that do not require a 3 hour commitment from schools.

Recommendation 13: Explore the feasibility of offering opportunities for students to undertake a series of interactions with ASOP. Multiple interactions have the benefits of allowing more significant content to be covered and deepening student outcomes, particularly relating to positive attitudes and aspirations with regards to science.

Recommendation 14: Seek specific funding to conduct a dedicated evaluation project to track a sample cohort of students over time. This will enable ASOP to understand and report fully the nature of any longer term impacts, and is necessary if changes in actions or behaviour and educational impacts are to be recorded.

Possible Model for Future ASOP Delivery

At the centre of this model is coordination of ASOP that incorporates the vision, ethos, main messages and branding. These are delivered through three layers of activities – core existing, core new and local – all of which retain the ASOP success factors and defining characteristics.



Appendix A – ASOP Logic Model Framework Examples

This framework is based on examples of the outcomes identified in the evaluation. It is suggested that such a framework can be used to design and develop indicators and methods for evaluating the next phase of ASOP.

<table>
<tr><td colspan="2">Vision</td><td colspan="5">More females in African countries choose science careers</td></tr>
<tr><td>Inputs</td><td>Activities</td><td>Outputs</td><td>Student Outcomes</td><td>Teacher Outcomes</td><td>Scientist Outcomes</td><td>IVVN Outcomes</td></tr>
<tr><td rowspan="3">• Human resources: country leads and delivery team members
• Lab-in-a-suitcase materials, handbooks.
• IVVN coordination of ASOP.
• International and local funders.
• STEM partners.</td><td rowspan="3">• Outreach workshops & associated activities for schools and communities
• Scientist training.
• Policy advocacy.
• Stakeholder and funder engagement.</td><td rowspan="3">• No. of schools
• No. of students
• No. of teachers
• Value of funding secured.
• Value of in-kind support secured.
• Awards.
• Publications.</td><td>Short-term outcomes (during intervention)
• % with knowledge and skills gains.
• % inspired in science.
• % more positive about science.</td><td rowspan="2">• % reporting positive impacts for students
• % reporting positive impacts for themselves – inspiration and learning)</td><td rowspan="2">• % feeling inspired to do more outreach
• % enjoy the experience
• % develop communication and other transferable skills</td><td rowspan="2">• Enhanced reputation
• Increased profile
• Networks and contacts</td></tr>
<tr><td>Long-term outcomes (beyond intervention)
• % who have pursued science subjects.
• % who have progressed (improved) in science.
• % who have secured family/ community support for pursuing science.</td></tr>
<tr><td>• % making changes to classroom practice as a result of ASOP.
• % actively involved in ASOP (e.g. advising)</td><td>• % careers have benefited through involvement in ASOP.</td><td>Other Stakeholder Outcomes
• Actions that support ASOP, e.g.:
○ Funding decisions
○ Policies
○ Social actions</td></tr>
<tr><td colspan="2">Impact</td><td colspan="5">Female students feel that science is for them and pursue studies in science.</td></tr>
</table>