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From Workshops to Social Change: Building a Hands-On Science Culture Among Ghanaian STEM Teachers

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Practical Education Network

COLUMBIA | SIPA
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EXECUTIVE SUMMARY

This report provides the results of a study undertaken for **Practical Education Network** (PEN), an organization promoting practical science teaching in West Africa. In PEN Teacher Training workshops, Ghanaian science teachers learn how to use locally available material to conduct practicals in Junior High School (JHS) science lessons.

The report focuses on the development of a **social incentive strategy** to improve uptake of practical teaching methods and a formative **assessment of PEN's monitoring and evaluation (M&E) strategy**. It was prepared by a group of graduate students from Columbia University's School of International and Public Affairs (SIPA) as part of SIPA's Capstone program.

After an initial desk research and literature review, the Capstone team designed the research methodology and created an interview guide as well as a survey focusing on teacher motivation and incentives. During in-country research, the Capstone team **interviewed more than 50 stakeholders** of PEN, including science teachers, PEN trainers, Headteachers, staff of other education programs in Ghana, and the PEN staff. In addition, the research included surveys with 29 teachers specifically focusing on potential incentive strategies.

The interviews provided the following **key findings:**

Motivation: In general, teachers are motivated by seeing their students learn, but extrinsic factors, such as subsidized college education, also play a role in teachers' career choices. Teachers are motivated to apply practical teaching methods as they contend that practicals lead to a better understanding of science content. Teachers have career aspirations to move to a higher position within the current school or to teach at a higher educational level where the learning environment is better equipped.

Existing support mechanisms: Teachers perceive the quality of pre-service training at teacher training colleges as low. Peer-exchange opportunities are limited and teachers do not feel sufficiently supported through school leadership or the Ghana Education Service. Teachers value PEN workshops as training opportunities but express the need for more in-service training.

Challenges to practical science teaching: The lack of material is reported as the most common obstacle for the execution of more practicals in the classroom. Other challenges include lack of time and space, teachers' insufficient knowledge, and exam pressure.

Based on the interviews and surveys, the Capstone team derived specific incentive proposals which were assessed according to the following criteria: cost effectiveness, reach, feasibility, popularity, and strength of evidence.

The proposed **incentive strategy** focuses on four aspects: recognition, career, experiential rewards, and more support.

- **Recognition Incentives:** PEN should enhance the status of the existing Teacher of the Month incentive to attract more teachers to take part, e.g. through broader advertisement or increased selection transparency. The effects of film spots, such as the previously produced WeGo Innovate spot, can be strengthened if shown more broadly.
- **Career Incentives:** PEN should introduce tiered PEN Practicals Certificates which certify successful teachers as PEN Professional Practical Teachers. Certificates could be used as proof of teaching competency when teachers are up for promotion.
- **Experiential Incentives:** PEN should organize inter-school competitions to increase excitement around science topics among students and improve opportunities for exchanges between science teachers. Guest speakers from the science-related industries who come to the classroom can be another experiential reward.
- **More Support Incentives:** PEN trains engaged science teachers to become Circuit Trainers who promote PEN's hands-on science approach among educators in their circuits. PEN should capitalize on these Circuit Trainers by having them lead teacher learning circles. PEN should also introduce a mentorship program and utilize Peace Corps Volunteers as additional support.

With regard to the assessment of PEN's M&E strategy, the report includes **recommendations on the existing M&E framework** and its indicators as well as on **data collection and storage**. A **Data Analysis Guidebook** to assist PEN's future analysis has been created (see Appendix A). The Capstone team also set up a Salesforce Customer Relationship Manager (CRM) tool for PEN and prepared a **Salesforce Reference Guide** (see Appendix B).

In addition to the incentive strategy and M&E support, this report includes **general programmatic recommendations**. Moving forward, PEN should improve **teacher communication** and more strongly address **resource accessibility**. It is also advised that PEN includes **teaching pedagogy** in the general workshops. Lastly, PEN's development can become stronger if a **long-term strategic plan** is elaborated to guide future expansion.

ACRONYMS

BECE	Basic Education Certificate Examination
CRM	Customer Relationship Manager
CT	Circuit Trainer
CTI	Critical Thinking Index
GAST	Ghana Association of Science Teachers
GES	Ghana Education Service
GNAT	Ghana National Association of Teachers
JHS	Junior High School
M&E	Monitoring & Evaluation
MT	Master Trainer
PCV	Peace Corps Volunteer
PEN	Practical Education Network
PPC	PEN Practicals Certificate
PPT	Professional Practical Teacher
SHS	Senior High School
SIPA	School of International and Public Affairs
TLC	Teacher Learning Circle
TLMs	Teaching and Learning Materials
ToM	Teacher of the Month
ToT	Training of Trainers
USAID	United States Agency for International Development
WASSCE	West African Senior School Certificate Examination
WGI	WeGo Innovate

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1. INTRODUCTION: Practical Education Network & the Ghanaian Education Context

Following the motto “hands-on, minds-up”, Practical Education Network (PEN) trains Ghanaian science teachers to use experiential pedagogies in West African classrooms. This report presents the results of a study for PEN, focusing on strategic recommendations for a social incentive strategy and a review of PEN’s methods for monitoring and evaluation (M&E). The study was undertaken by a team of six graduate students from Columbia University's School of International and Public Affairs (SIPA) through the university’s Capstone program.

1.1 About PEN and the Context of the Ghanaian Education System

Founded in 2015, PEN has trained more than 2,500 Ghanaian science teachers. PEN offers one-day workshops in which teachers learn how to implement practical teaching methods with locally available, low-cost material. Workshop participants receive a manual which displays more than 170 hands-on activities matched to the Ghana Junior High School (JHS) science curriculum.

PEN currently operates in the Greater Accra region focusing on Junior High School public school teachers. JHS students aged 12 to 15 take "integrated science" as an obligatory subject which is part of the Basic Education Certificate Examination (BECE). Passing the BECE is necessary to proceed to Senior High School (SHS), a secondary school that leads students to the West African Senior School Certificate Examination (WASSCE), the exam which is required to enter university. The typical process to become a teacher in Ghana includes a three-year teacher training college, with two years spent in the training college and one year spent in a school as a practicum. Teacher education is subsidized and, thus, more affordable than other tertiary education.

The PEN staff currently consists of four people: the founder Dr. Heather Beem, a PhD graduate from the Massachusetts Institute of Technology, a project coordinator and impact head, an operations fellow, and a video developer. PEN is in the process of expanding to other Ghanaian regions as well as to the private education sector. A long-term objective is to expand to other West African countries.

1.2 About this Report

PEN tasked the Capstone team to address two major challenges: how to improve teacher uptake of practical teaching methods and how to effectively track, analyze, and utilize PEN's data for its monitoring and evaluation program.

In view of teacher uptake, PEN aims to create a culture around hands-on science teaching that motivates teachers who have participated in a workshop to better implement the practical teaching strategies in their everyday work. The Capstone team conducted a literature review of existing incentive strategies and undertook in-country research interviewing and surveying PEN-trained Teachers and other stakeholders during the trip to Ghana. Based on the findings of this research, the team developed a concrete social incentive strategy (see Section 2, p.3).

To address part of PEN's current M&E challenges, the Capstone team developed a Data Analysis Guidebook to facilitate future monitoring and evaluation efforts (see Appendix A) and introduced a database and Customer Relationship Manager (CRM) and an accompanying Reference Guide (see Appendix B). This report also provides a formative assessment of PEN's existing M&E framework (see Section 3, p.33).

2. SOCIAL INCENTIVE STRATEGY

2.1 Methodology

This section details the qualitative and quantitative methodology employed to research motivations, values, and incentives that may work to increase teacher uptake of hands-on science teaching practices. The section describes the study design and research instruments, study participants, geographic scope, and the methodology for analysis. The section concludes with a brief acknowledgment of the study limitations.

2.1.1 Study Design and Research Instruments

To develop strategy to increase teacher uptake of hands-on science teaching practices, the Capstone team designed a study, grounded in motivation theory put forth by Cleary et al., 1998 (see Appendix C), to guide its research conducted from March 10-17, 2018 in Accra, Ghana. The research questions that informed the study design were:

1. What is Practical Education Network (PEN) already doing to encourage teacher uptake, and which existing operations can be leveraged to improve uptake?
2. What are the main barriers preventing teacher uptake, particularly in the context of the Ghanaian education system?
3. What motivates teachers in Ghana and which existing teacher values can PEN capitalize on to offer incentives attractive to PEN-trained Teachers?

In order to validate the data, information on the research questions was gathered through three different means: (1) qualitative interviews with 52 program stakeholders, (2) surveys administered to 29 of the PEN-trained Teachers who were also interviewed, and (3) observation of a PEN Teacher Training workshop. Sample interview guides and a copy of the survey utilized can be found in Appendix D. Further information on study participants can be found in the following section.

2.1.2 Study Participants

As Practical Education Network seeks to increase teacher uptake of hands-on science teaching practices in the classroom, teachers trained by PEN were identified as a key stakeholder. As PEN-trained Teachers have had various doses of exposure to PEN Teacher Trainings, and varying levels of experience with some of PEN's existing pilot incentives, it was important to the methodology to access the perspectives of teachers with varying degrees of involvement with PEN:

- **PEN-trained Teachers:** Teachers trained by PEN from varying District teacher training cohorts 2015-2018;
- **Teacher of the Month:** PEN-trained Teachers that have been identified as actively implementing the practicals in the classroom and are featured on PEN's website;
- **WeGo Innovate:** PEN-trained Teachers that have been featured in a short video doing the practicals for dissemination outside of Ghana;
- **Circuit Trainers:**[1] PEN-trained Teachers that have attended a second Training of Trainers (ToT) workshop, and are expected to lead trainings within their Circuits of approximately five to six schools;
- **Master Trainers:** Individuals that have been identified to lead PEN training sessions and are compensated to do so.

To obtain a more robust picture of daily teaching practices, teaching challenges, and teacher motivation, **Headteachers** (school management) and **District Science Coordinators** from the Ghana Education Service (GES) were included in the study as well. In order to craft feasible incentives for PEN to employ, **PEN Staff** were also included in the study. Finally, **external stakeholders** from various government and non-profit education initiatives operating in Ghana were valuable contributors to the study.

In total, 52 individuals participated in the study (Table 1). Study participants were from diverse ethnic groups, ages, and gender[2] (Figure 1 & 2). It is important to acknowledge

[1] Circuit Trainers are selected for their role usually by the District Science Coordinator based on their propensity to do more practicals and for their command of the science curriculum.
[2] Data on age and gender only formally collected for survey participants.

that gender of the teachers that participated in the survey was skewed towards more male respondents (19 males participated compared with 10 females). This is surprising considering that the teaching profession in Ghana is heavily dominated by females. One reason this may be the case is the popularity of science among men, indicating a potential bias that encourages men to pursue science. This bias was considered in the development of the incentive strategy and should also be considered throughout the implementation to ensure equality of access, for both students and teachers, to opportunities to enhance teaching and learning practices.

Table 1: Study Participants

PEN-trained Teachers (33)[3]	
No additional PEN affiliation[4] (8)	Master Trainer (2)
Teacher of the Month (ToM) (1)	We Go Innovate (WGI) (2)
Both ToM & WGI (3)	Circuit Trainer (16)
Circuit Trainer + Other Role (1)	
Other Relevant School Stakeholders (10)	
Headteacher (8)	
District Science Coordinator (2) *No formal documented interview, but interacted with two different DSCs*	
PEN Staff (3)	
External Stakeholders (6)	
Affiliated Organizations: • Ashesi University • IDP Foundation • Sabre Charitable Trust • T-TEL	• USAID Learning Project • Science, Technology, Innovation & Partnerships, USAID • STEM Network[5]

[3] Please note that not all 33 PEN-trained Teachers completed a survey; only 29 did.
[4] "No additional PEN affiliation" refers to a PEN-trained Teacher who has only attended a PEN teacher training workshop and has not participated in the Circuit Trainer training of trainers or any other existing incentives (e.g. WGI, ToM).
[5] This is counted already by the Master Trainer who is affiliated with STEM Network.

Figure 1: Age Distribution of Survey Participants

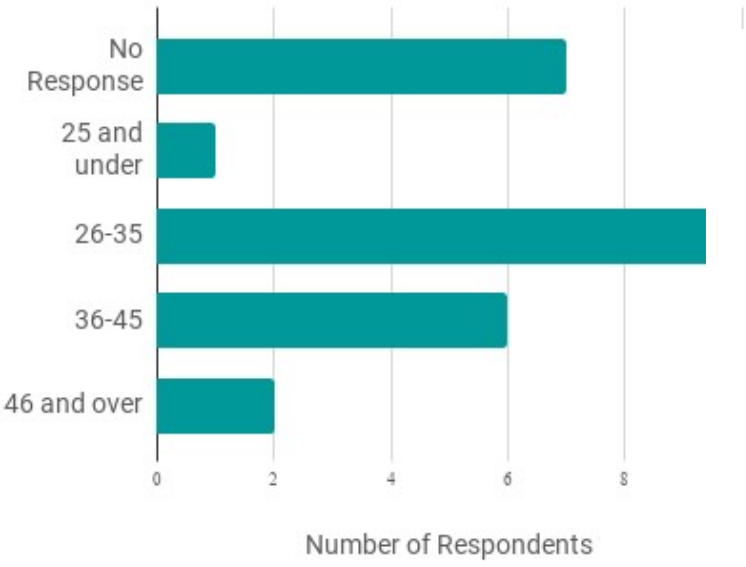
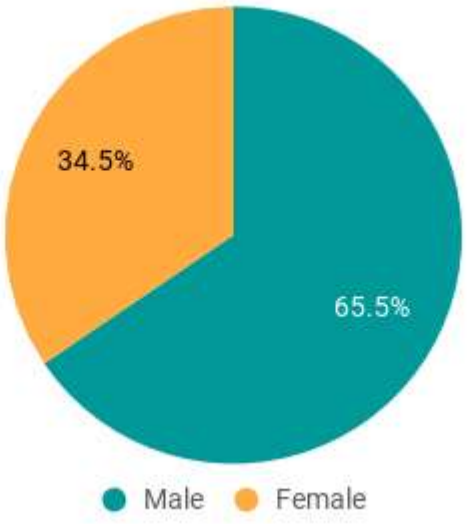


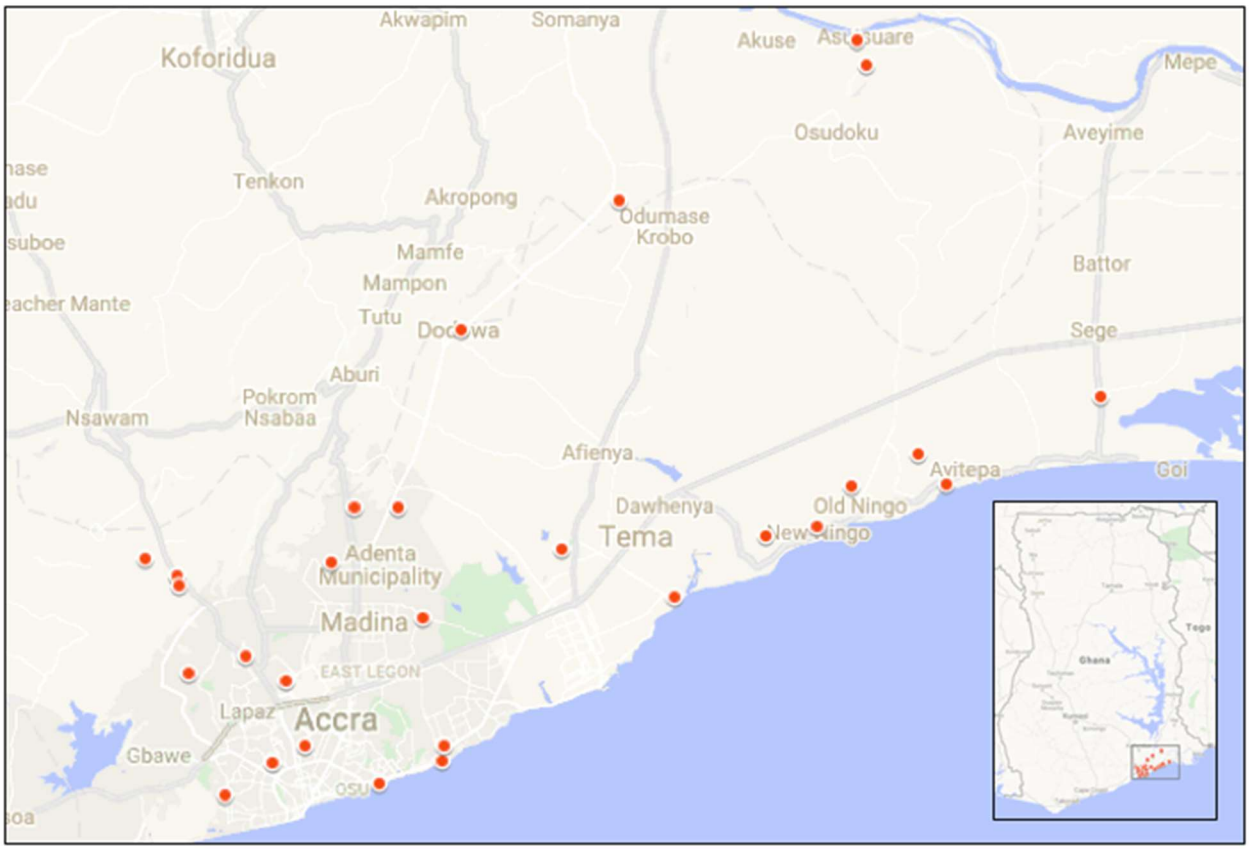
Figure 2: Gender Distribution of Survey Participants



2.1.3 Geographic Scope of the Study

As PEN currently primarily operates within the Greater Accra Region, the majority of the study participants were located in that region. The Capstone team felt it was important not only to speak with PEN-trained Teachers with varying degrees of participation with PEN, but also teachers from diverse school environments. Figure 3 illustrates the diversity of geographic locations incorporated into the study.

Figure 3: School Locations Visited for Study



2.1.4 Methodology for Analysis

All interviews were recorded, transcribed, and verified by the Capstone team. Survey responses were inputted into a Google Form which automatically populated a Google Sheets document where responses were verified. Interview responses were coded according to four overarching themes identified by the Capstone team: motivation, challenges, incentives, and context of Ghanaian education. Responses were then further categorized according to appropriate sub-themes. Survey results were analyzed acknowledging the research questions and four overarching themes. Key findings were derived from the analysis results from both sources of data (surveys & interviews). Recommendations for the proposed incentive strategy were informed by the analysis of the data collected in-country, evidence from the literature review, and are in accordance with PEN's mission, values, and capacity. The comparative assessment (see Section 2.4, p. 31) is an analysis of the various incentives proposed and how they stack up against one another. The metrics for the analysis criteria (cost effectiveness, reach, feasibility, popularity, and strength of evidence) were developed by the Capstone team based on in-country research.

2.1.5 Limitations of the Study

The Capstone team identified the following limitations to the research, primarily due to time, bureaucratic processes, and human nature. For this reason, the findings may not yield a complete picture or be generalizable, and incentives may need to be reevaluated if/when PEN expands to other regions within Ghana or additional countries in West Africa. Nevertheless, the Capstone team is confident that the incentive strategies proposed are evidence-based, and reflect a wide variety of diverse stakeholders affiliated with PEN.

Sample size

Compared with the more than 2,500 teachers trained by PEN, the sample size for this study of 52 (and of that only 33 PEN-trained Teachers), is relatively small. Per the timeline of the project, and one week allotment for in-country research, the Capstone team divided into three groups in order to reach as many study participants as possible.

Prevalence of "active" teachers

According to Ghana Education Service protocol, outside visitors may only visit a school accompanied by a GES representative. PEN-trained Circuit Trainers, Teachers of the Month, and teachers with a WeGo Innovate film spot, as they are affiliated with PEN, are exempt from this protocol. This rule made visiting Circuit Trainers and other "active" teachers much more feasible than arranging visitation with non-Circuit Trainers. Hence, data may be skewed towards the perspectives of more "active" teachers. Though more

challenging, the Capstone team was able to arrange for GES to accompany the group for two days to visit PEN-trained Teachers without additional affiliation. The findings from visits with these teachers were acknowledged as being especially valuable for adding a diversity of perspectives to the research.

Interview process

While the Capstone team developed an interview guide informed by the three research questions, different interview styles, interviewer and interviewee perceptions of key incentive areas, and natural conversation flow guided some interviews to focus on certain topics more than others. The Capstone team would like to acknowledge that certain interviewees were prompted for specific incentives more than others. For example, not all interviewees were specifically asked about Teacher of the Month or a tiered certificate scheme. For this reason, the Capstone team believes that the opinion formulated on the topic/incentive in the interview is perhaps more valuable than merely mention of it. This resulted in more qualitative and anecdotal data compared with quantitative reporting.

An additional limitation to acknowledge is that, while the majority (31 out of 33 interviews or 94 percent) of the interviews were conducted without Headteachers present, occasionally Headteachers sat in on the interviews with the PEN-trained teachers. Understandably, Headteachers felt responsible for the information being transmitted about the teaching practices transpiring at their schools and wanted to be informed about what was being communicated externally. However, this may have prevented some teachers interviewed from being especially forthcoming with their honest perspectives. The Capstone team still found the interactions meaningful and of value to the study.

2.2 Key Findings

2.2.1 Motivations

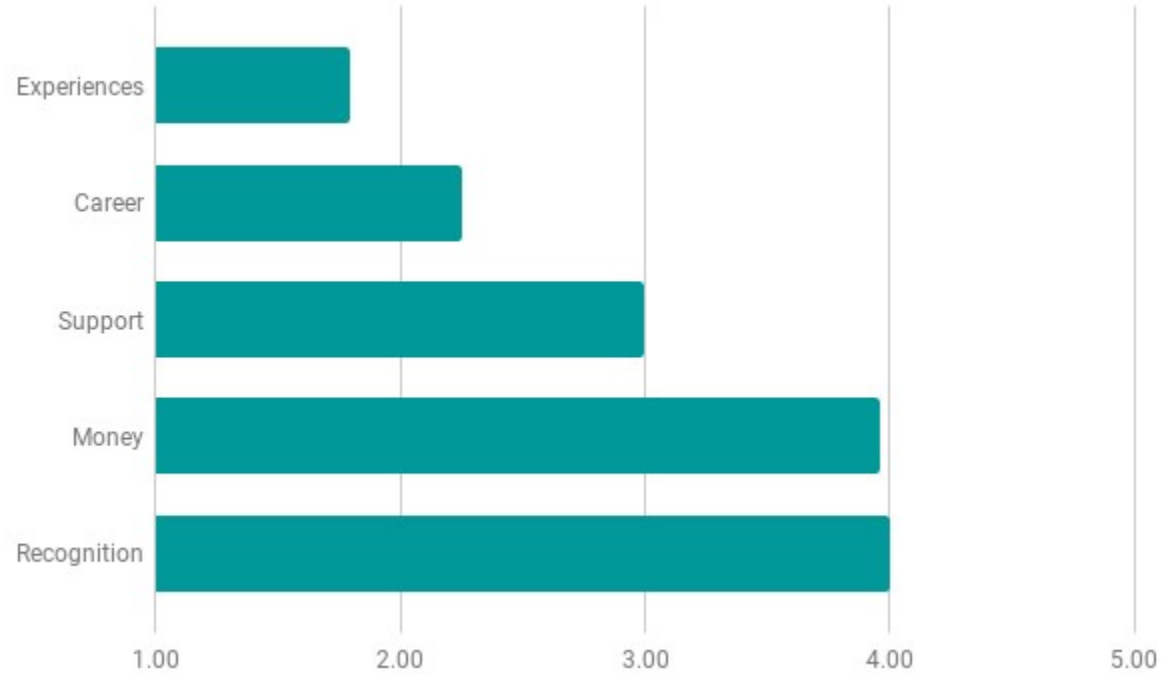
As a Teacher in General

Teachers are motivated by seeing their students learn, but extrinsic factors, such as subsidized college education, also play a role for teachers' career choices.

When asked about their motivation to become a teacher, most respondents emphasized their desire to impact children's lives. Teachers are satisfied when they see their students acquiring knowledge and making progress. In addition to these intrinsic motivators, five out of 33 respondents also indicated that financial considerations played a role when choosing their profession. They may have preferred to go to university but could only afford the highly subsidized teacher training colleges. In the survey, teachers were asked

to rank the following five motivational factors "money", "recognition", "career advancement", "feeling supported in the job" and "gaining new experiences" according to importance (1 being most important, 5 being least important). As can be seen in Figure 4, new experiences were ranked first with an average score of 1.79, followed by career advancement (2.25) and feeling supported (3.00). Against the belief among several stakeholders, money is, according to this survey, not a strong motivational factor in the teaching profession.

Figure 4: Average Value Ranking



Key: 1 = Most Important; 5 = Least Important

As a Science Teacher

Science teachers who use practicals do so because they are convinced that practicals lead to a better understanding of science content.

The main motivation for teachers to do PEN practicals is that students will understand science better, as mentioned by 20 out of 33 interviewed teachers. Teachers also value that students' interest in science is raised and that science, overall, is "demystified". Teachers are motivated to use practicals to fight the popular belief that science is the hardest subject in school. Two teachers specifically mentioned one of their happiest moments of their career was watching their students compete and succeed at science competitions.

> If the children actually see the materials, it enables them to be scientists.
>
> *- PEN-trained Teacher*

For their Future

Teachers have career aspirations to move to a higher position within their current school or to a higher educational level where the learning environment is better equipped.

When asked about where they would see themselves in five years, 12 teachers said that they want to progress in their careers: e.g. by becoming a Headteacher, earning a master's degree, or moving to a higher educational level as a teacher (e.g. Senior High School or university). The motivation to teach at Senior High Schools or university level is linked to the teachers' wish to work in a better equipped environment. Senior High Schools, in contrast to Junior High Schools (JHS), mostly have science labs.

> In Senior High School, you don't suffer too much. Teaching there increases your status.
>
> *- PEN-trained Teacher*

2.2.2 Existing Support for Teachers

Peer Support Opportunities

Exchanges with other science teachers within their own schools are limited and not much is done to encourage interaction.

While teachers at private schools typically find themselves among at least one or two additional science teachers, public school teachers are often alone at their JHS, with occasionally one additional science teacher, if it is a particularly large school. If the schools are part of a cluster, there is usually another science teacher at other primary and Junior High Schools on the compound. Efforts to facilitate interaction among these teachers are perceived as low, as is knowledge of who the other teachers are. Ten teachers interviewed said that they were in contact with another science teacher. A few teachers interviewed reported that they use the other science teacher in their cluster or school as a resource. Four teachers interviewed said they were sought out by other teachers (sometimes within

their school or cluster) to assist them with practicals. This could present an opportunity for increased interaction and knowledge sharing.

Interaction among PEN-trained Teachers varies, but despite this, the existence of PEN WhatsApp groups presents an opportunity for leveraging that communication channel.

Following PEN Teacher Training workshops, a WhatsApp group is formed with a PEN staff member present in the group to monitor activity. While WhatsApp groups were formed at each District PEN training (or each training for Private schools), and Circuit Trainers were also encouraged to form their own circuit WhatsApp groups, there have been varying levels of activity cited. Some teachers were very enthusiastic about posting, while others mentioned observing and getting ideas for new practicals to do. Several teachers had left the WhatsApp group all together:

- Seven of the 33 teachers interviewed mentioned that they had gotten a new phone and were no longer in the group.
- Seven PEN-trained Teachers reported highly active WhatsApp groups with lots of sharing of science practicals.
- Whether or not they were involved in a WhatsApp group, 11 PEN-trained Teachers noted that they had some sort of ongoing communication with at least one additional PEN-trained Teacher.

Training Support for Teachers in Ghana

Pre-Service Training:

Attendance of a teacher training institution or other tertiary education institution was widespread among teachers interviewed, but the quality of this preparation is perceived as low.

The vast majority of teachers interviewed had attended a teacher-training college. In these colleges, they typically spend two years in the college, learning the subject material and teaching practices, and then have a third-year practicum at a school, where the teacher whose classroom they are assigned to is meant to serve as a mentor. The mentorship angle has varying degrees of success, as reported by teachers. Two organizations, Sabre Charitable Trust and T-TEL, are currently working to improve the quality of teacher training college by altering both the curriculum, and the third year mentorship aspect of the practicum portion of the program.

In-Service Training:

Few in-service training workshops exist that are particularly focused on science training.

Of the teachers interviewed, the only other in-service teacher professional development opportunities for science teachers mentioned besides PEN, were GAST (Ghana

Association of Science Teachers), whom PEN occasionally partners with, and GNAT (Ghana National Association of Teachers).

Support from PEN

Teachers value the PEN Teacher Training workshops, but do not feel that a one-time training was meeting their needs or sufficient to execute all practicals.

Most teachers seemed to really enjoy the PEN Teacher Trainings, but expressed a desire to receive more in-service training. Some teachers admitted they felt comfortable with the practicals learned at the training, but struggled to execute other practicals not demonstrated at the workshop. Out of 33 interviews with PEN-trained Teachers, 13 expressed the desire to have more trainings. Four teachers interviewed specifically requested for trainings at least once per term.

> Some need training to learn how to use material, [...] some skip topics, because they don't know it well, but the curriculum builds, so if you skip a topic, you will confuse children. Encouragement and trainings will help them to do better.
>
> *- Headteacher*

Teachers would like additional support from PEN beyond the Teacher Training workshops

Though teachers identified the PEN Teacher Trainings as valuable in-service teacher professional development opportunities, many teachers expressed a desire for the support to continue beyond the scope of the training. Out of 33 interviews with PEN-trained Teachers, only eight teachers specifically mentioned feeling supported by PEN. Interestingly enough, of those eight, six teachers mentioned feeling directly supported by PEN CEO, Dr. Heather Beem. For purposes of scaling up, a support system hinged on one person is not realistic. However, the appeal of Dr. Heather Beem as the expert might be something to capitalize upon for an incentive strategy. Additionally, four teachers interviewed expressed dissatisfaction with the amount of support received from PEN, in the sense that they wished it was amplified. This should not be interpreted of a criticism of PEN, but rather teachers identifying value in the support PEN provides, and wishing to receive more of it. When asked about what kinds of responsibilities their role should entail, a few Circuit Trainers admitted that they should follow-up with the teachers trained in trainings they have led but that they have failed to do so.

Institutional Support

School-level Support:

Headteachers are not necessarily viewed as a barrier to implementing practicals, but are not taking any action to enable teachers to do more practicals either.

Perceptions of support from Headteachers were varying:

- Only six teachers interviewed said that they thought their Headteacher really understood the practicals and what PEN's mission was trying to achieve.
- Six teachers reported that their Headteacher observed them in the classroom in some capacity.
- Only two teachers interviewed reported that their Headteacher was able to provide some sort of technical guidance on how to conduct practicals.
- Two teachers mentioned that their Headteachers would come up with materials to make Teaching and Learning Materials (TLMs).

The overall sentiment was that Headteachers do support teachers in conducting practicals, engaging in hands-on learning, and attending trainings to improve instructional practices, but they may not have the capacity to support the teachers in the ways that they would like.

District Level Support:

In general, teachers do not feel especially supported by the Ghana Education Service (GES).

There seemed to be varying levels of perceived support from GES, with perceptions of support declining among teachers posted in more rural locations. Three teachers reported that GES did not visit them. However, six teachers reported that District Science Coordinators had specifically been a source of support to them. One teacher noted that the GES positions are changed fairly often, which may have an impact on conducting timely visits. Conversations with District Science Coordinators made it seem like visiting schools in very rural districts was challenging, and a barrier to more frequent visits. One teacher mentioned that previously there had been a District Resource Officer, but that they are now unable to access them.

2.2.3 Challenges Regarding the Implementation of PEN Practicals

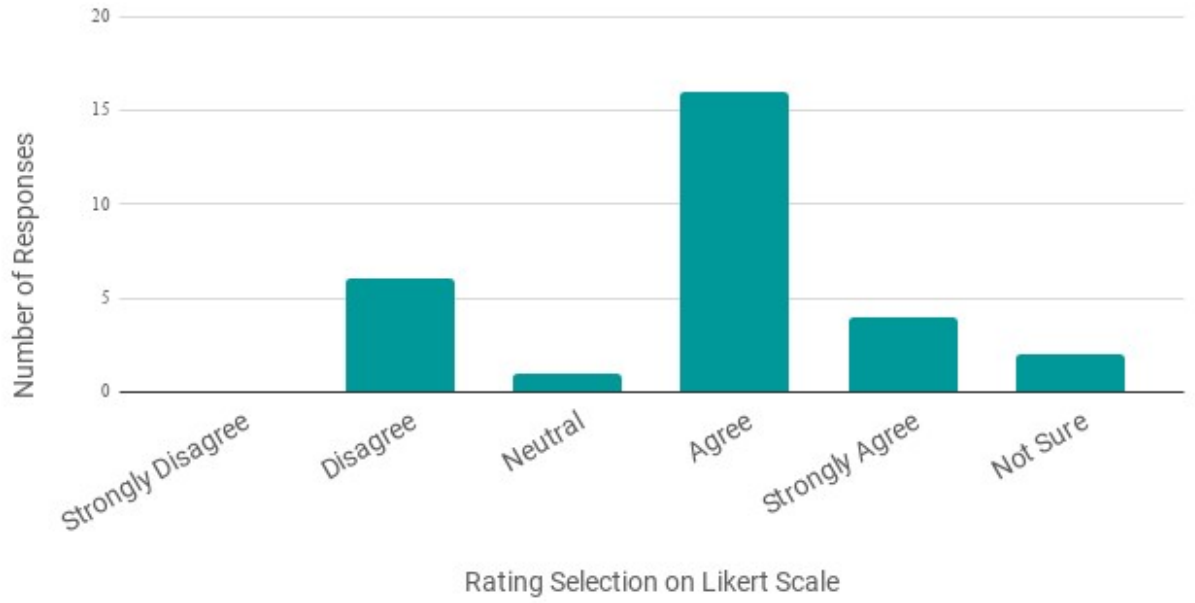
Lack of Material

Teachers complain about the lack of material in general, but find that they have what they need to implement PEN practicals.

In the interviews, 26 out of 33 teachers mentioned the lack of material to be a major obstacle for doing PEN practicals. Cost and local availability were a problem especially in more rural communities who face challenges in obtaining some materials (e.g. balloons). Several teachers asked their students to bring material to class, but few did. However, as

displayed in Figure 5, in the survey, most individuals (69 %) agreed that they had sufficient materials to implement the PEN practicals in the classroom (16 out of 29 agreed, four strongly agreed). Only six individuals (21 %) reported that they did not have the necessary material. One potential explanation for this contradiction may be that, in general, teachers have the initial reaction to identify material as their main obstacle for better teaching, yet when specifically thinking about PEN practicals, teachers may actually have the materials for the exercise. Another explanation may be that teachers misunderstood the survey question about PEN material: they may have referred to the PEN manual rather than the actual material for the specific practicals.

Figure 5: PEN-trained Teachers' Perceptions of having the Material to do the Practicals



Limited Class Time

Some teachers find that the 70-minute long science classes are not sufficient to do practicals.

Eleven teachers stated that having too little time to do the practicals is a large hurdle. The class duration of 70 minutes to prepare, implement, and discuss a practical is, according to some teachers, not sufficient. Two teachers also pointed to the lack of time for preparation before the class starts.

Class Size

Large class sizes prevent teachers from doing practicals more often.

Class size is an obstacle mentioned by five teachers. PEN's approach to have students themselves interact with the material is challenging given classes of 90 to 100 students. Supply of material may not be sufficient to meet the needs of several student groups. Additionally, classroom management and the associated fear of losing control due to an exciting practical, is also a challenge.

Lack of Space

Eight teachers reported that the lack of space is a challenge to do practicals.

The small classrooms (relative to the number of students), as well as the classroom setup with small individual tables, makes it hard for teachers to arrange group tables to do practicals. In addition, most schools lack a science lab space, which some teachers perceive as necessary for effective practical teaching.

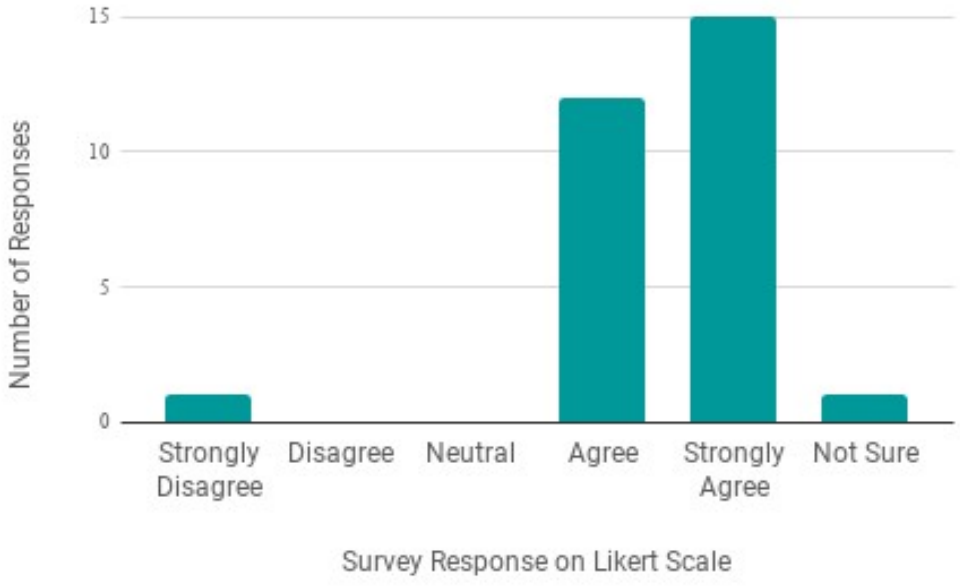
Insufficient Knowledge

While teachers are generally confident in implementing PEN practicals, they still identify insufficient knowledge as a barrier for doing more varied activities.

- Seven teachers mentioned they lack knowledge to do more practicals.
- One teacher mentioned that the PEN workshop should even start at a more introductory level so that everyone can follow.
- Another teacher said that she is only comfortable with the PEN activities presented in the workshop and lacks the knowledge and confidence to do others from the manual.

Figure 6 displays the levels of confidence when implementing practicals as indicated by the teachers in the survey: 12 teachers agreed and 15 teachers strongly agreed that they feel confident trying PEN practicals in the classroom. Only two teachers were not sure or disagreed with that statement. These findings may indicate that teachers, overall, feel confident with PEN practicals, but that there may be certain topics where the teachers feel their knowledge does not suffice to confidently implement practicals in the classroom.

Figure 6: Agreement with Confidence Implementing Practicals



Exam Pressure

Frequent testing may prohibit teachers from implementing more PEN practicals.

Two teachers identified the pressure to prepare specifically for exams as a reason why they cannot do more practicals. Teacher success and evaluation is based on how their students perform on the BECE exam, which is why teachers have an incentive to focus on very specific exam preparation rather than experimenting with more creative teaching and learning strategies, as one Headteacher pointed out. The UK aid-funded T-TEL initiative works on improving teacher training programs in Ghana and advocates for a change of success metrics which are not solely focused on how many students pass the exams.

2.3 Incentive Strategy Proposal

Based on a literature review and in-country research, the Capstone team derived the following specific incentive recommendations and implementation ideas to improve uptake of hands-on teaching practices.

2.3.1 Recognition Incentives

Literature Review

While other incentives, like financial rewards, have been studied extensively, evidence on the effectiveness of recognition rewards is scarce. According to the World Bank Report on Learning, suggestive evidence only exists from other sectors (World Bank, 2018). One example is a study on health workers in Zambia, whose performance improved significantly after the workers' achievements were recognized publicly (Ashraf et al., 2014). A smaller case study of a teacher training program in Indonesia has shown that the positive effects of the training had "longer-lasting effects when the participants were recognized for their work" (Cha et al. , 2017, p. 26).

Incentive Proposal 1: Enhance the Status of the Teacher of the Month

Teachers who succeed in doing many practicals are selected as PEN Teacher of the Month (ToM) and are featured on PEN's website. The ToM is already a valuable motivating tool PEN employs. Teachers who were familiar with it considered it a desirable achievement. Refining the implementation of this incentive could be beneficial to enhance the status of the ToM and therefore increase its potential effect on teacher motivation.

Advertise the possibility to become ToM at the workshop

Eight out of 33 interviewed teachers had never heard about ToM. Acknowledging that the Capstone team mostly interviewed CTs, who by definition have a stronger PEN affiliation, this number seems very high. By explaining the ToM challenge at the workshops, teachers may leave the workshop with higher motivation to participate in it.

Make the ToM selection criteria more transparent

When asked about their impression of ToM, four teachers pointed out that it was very unclear to them how the ToM was selected. Teachers may only be motivated to try to become a ToM if they have the impression that the selection process is transparent and fair. It is therefore crucial to clarify the selection process. It is important to consider that the existing process (number of pictures of practicals posted on the WhatsApp group) puts teachers in rural areas with weak mobile network at a disadvantage[6].

How to Measure

Count if more teachers apply to become a ToM by posting more activities on the WhatsApp group after selection criteria have been communicated clearly, publication was expanded to local communities, and a prize was introduced. It may also be useful to count the reactions to ToM announcements on the WhatsApp-Group (e.g. how many people congratulate).

Publish ToM in teachers' local environment

Posting the ToM on PEN's online channels helps recognize the teachers within the PEN community. However, three teachers mentioned they would like to see the ToM results published more broadly so their local community would also see it. One suggestion may be to print a flyer or poster which could be displayed in the school so that the PEN ToM receives special acknowledgement by students, parents, and other teachers. One teacher suggested that ToMs could be featured in the Daily Graphic newspaper, which is frequently read by teachers. Another idea would be to create a WhatsApp profile photo frame which the ToM could use to inform his/her (WhatsApp) network about his/her accomplishment[7].

Introduce a small prize for ToM

The value of becoming a ToM may increase if a small prize was attached to it. Two teachers and one PEN staff member have suggested this. A prize could, for example, be a material kit, which has the potential to encourage teachers and students to continue doing practicals. Another useful prize may be a PEN t-shirt or another visual signaler with PEN's logo that could help the PEN teacher show his/her success in the school environment, and may spark conversation about PEN as an organization.

[6] Yet, it still is possible for rural teachers to participate, e.g. by uploading their pictures when going into a larger community with internet access.

[7] An initial trial of WhatsApp frames by PEN showed that the frames are successful in creating attention.

Incentive Proposal 2: Strengthen the Effect of (WeGo Innovate) Film Spots

Film spots about individual PEN-trained Teachers can be a method to recognize successful teachers and also offer the potential to increase the visibility of PEN. The teachers who were featured in the WeGo Innovate spots expressed that they felt appreciated for their work. More importantly, however, they valued the opportunity for their students to participate in an exciting experience, like a film shooting.

> "Being filmed [...] made me feel like finally my work is being appreciated."
>
> *- PEN-trained Teacher*

Make the WeGo Innovate selection criteria transparent

Similar to ToM, being featured in a WeGo Innovate film spot may be something teachers aspire to. However, to be fully motivated to work towards obtaining this reward, clear and achievable selection criteria are necessary.

Share the WeGo Innovate videos broadly and in local communities

To enhance the recognition of both teachers and students featured in the spot, PEN should ensure the film reaches local communities. The film could be shared via cord or USB on local devices to be viewable offline. One Headteacher suggested sharing the spot with other schools to show what PEN and ambitious teachers make possible. Video sharing may also help teacher uptake in those schools where the videos are screened. An agricultural initiative called "Digital Green," which operates in India and Ethiopia, shows best practice videos made by local farmers to their peer local farmers. Research on this model found that "because farmers tend to trust their peers more than outside experts, Digital Green's model has led farmers to adopt better methods at very high rates" (Annan & Dryden, 2016, p.iv). Showing videos by Ghanaian STEM teachers to their peers may have similar effects.

> "If a peer can do it, they can also do [it], and that enhances the teachers' confidence."
>
> *- Headteacher*

Partner with IDP Foundation & Sesame Workshop for a hands-on science film spot

IDP Foundation, as part of their Rising Schools Program, has partnered with Sesame Workshop to design ten 10-minute videos for teacher education in Ghana. Sesame Workshop is a nonprofit organization that produces multimedia educational learning resources such as Sesame Street in the United States. IDP's videos, for example, focus on topics like classroom management and student-centered learning in English literacy. The set of videos does not yet include an episode on hands-on science teaching. Given the existing contact to IDP Foundation, partnering with the organization, and thereby leveraging the reach of PEN's concept may be a valuable addition to the existing WeGo Innovate spots.

How to Measure

Measure how many people viewed the WeGo Innovate film spots (e.g. on YouTube) or how often they come up in WhatsApp group conversations.

2.3.2 Career Incentives

Literature Review

Two case studies in the educational context support the notion that teachers are motivated by the possibility for career advancement. In the study mentioned above about a teacher training program in Indonesia, it was found that teachers were motivated to participate in the training and change their practices because it would provide credentials to show to stakeholders and the local government (Cha et al., 2017). Another study about educational volunteers in India found that a strong reason for participating in the volunteering program was career advancement - both because the volunteers' engagement would be valued by employers in future applications and because the skills developed in the program may help the volunteers succeed in interviews and other professional situations (Haro & Montgomery, 2017).

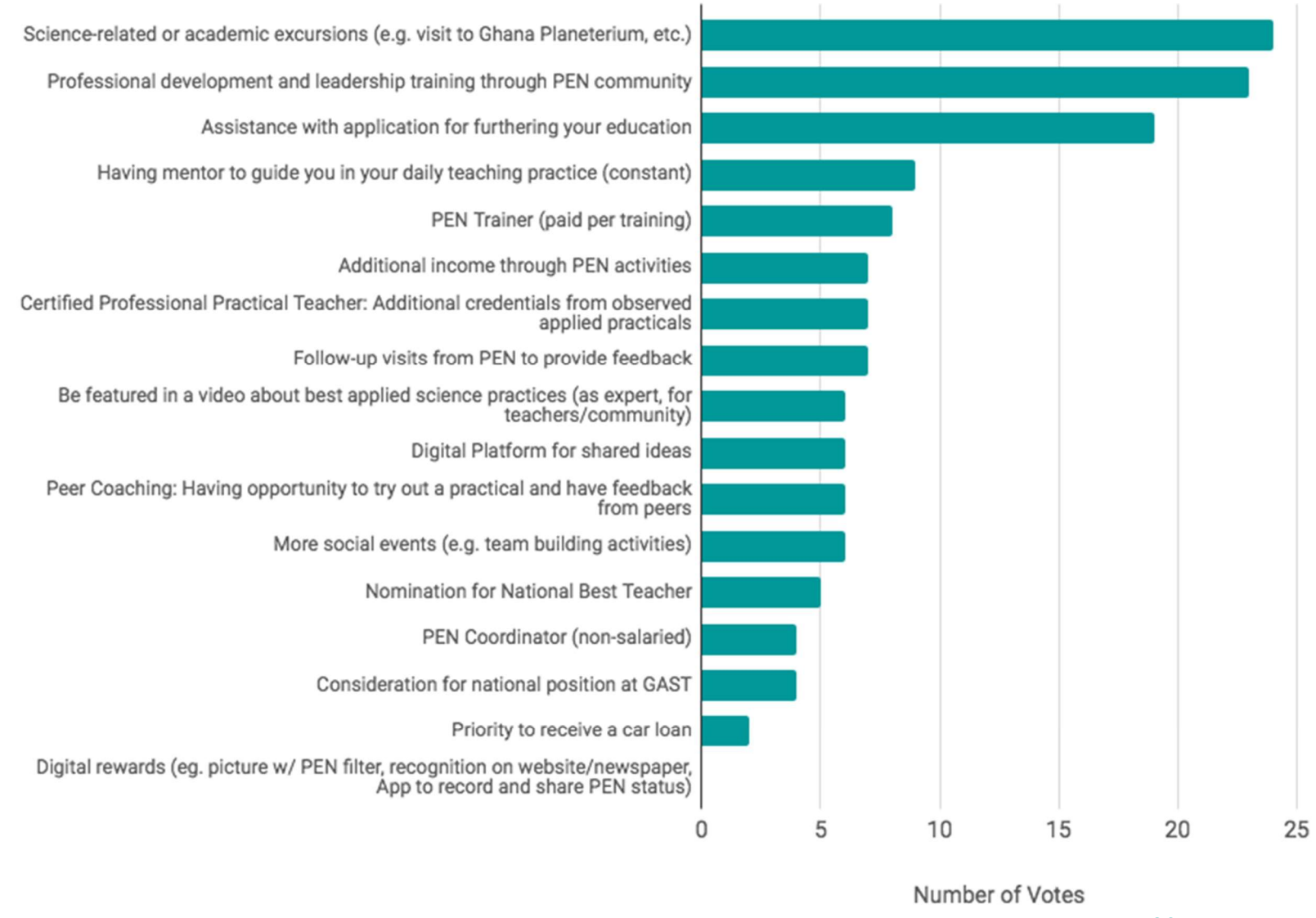
Incentive Proposal 3: Introduce PEN Practicals Certificates

PEN could issue PEN Practicals Certificates (PPCs) to teachers who successfully complete a certain number of PEN practicals in their classroom during one academic year. The number of completed practicals could be validated through pictures posted in a teacher's Circuit WhatsApp group. Eleven teachers expressed that certificates would be valuable to teachers as they could be used as supporting evidence when going for promotional interviews. If PEN succeeded in being recognized by GES as a high-quality training

provider, the PPCs could become a very desirable proof in these interviews. Beyond the certificate for having participated in the PEN workshop, the PPCs would be proof of the long-term effect of the training. A certificate holder could be referred to as a "PEN Professional Practical Teacher".

During in-country research for this report, career advancement was an important theme in the interviews and surveys. As stated above, in the surveys, "career advancement" was ranked as the second most important factor in teachers' lives (after "gaining new experiences"). As Figure 7 displays, "additional credentials from observed applied practicals" was only selected as a desirable incentive by seven respondents. However, this relatively low number may be caused by a lack of explanation of what is meant by this certification, which is why the Capstone team suggests the introduction of PPCs, despite the relatively low selection rate on behalf of the respondents.

Figure 7: Most Popular Incentives



Award tiered PPCs for completing a certain number of practicals per academic year

The PPC could include different levels:

- Bronze-level Certificates for 15 successfully completed practicals
- Silver-level Certificates for 25 successfully completed practicals
- Gold-level Certificates for 40 successfully completed practicals

By awarding tiered certificates accounting for conducted practicals within one academic year, their effect could be longer-lasting as it is not a one-off goal to reach. Exclusiveness is a major factor to make the PPCs valuable.

How to Measure

Count how many pictures PEN-trained Teachers post on the WhatsApp group in order to qualify for PPCs. Ask teachers whether they take PPCs as supporting documents in promotional interviews.

Accompany PPCs with a prize

The next career promotion for a certain PEN-trained Teacher may be some time away, which is why it is important to also attach an immediate benefit to the PPC, as also suggested by three interviewees.

Suggestions for potential prizes are:

- Bronze-level Certificate: Material kit
- Silver-level Certificate: PEN t-shirt + visit of a guest speaker (for guest speaker idea, please see Section 2.3.3, p. 21)
- Gold-level Certificate: Award-giving ceremony with Dr. Heather Beem to take place in the teacher's community and experiential reward
    - Experiential reward - lower cost option: visit to the planetarium with other Gold-level teachers to promote peer interaction
    - Experiential reward - higher cost option: visit to the planetarium with students of Gold-level teacher to increase how much the teacher is acknowledged in his/her local environment

2.3.3 Experiential Incentives

Literature Review

The existing literature supports experiential rewards as a viable incentive strategy for teachers. Research on two different education non-government organizations have identified experiential rewards to be attractive to teachers, especially when they present an opportunity to build or establish relationships. The opportunity for social interactions and to be a part of a team was cited by young adults in India as a motivator for them to become community education volunteers with Indian NGO Educate Girls. Volunteers noted establishing new communications channels, i.e. connections/friendships as a motivation factor (Haro & Montgomery, 2017). Research from another education

initiative, RuBI in Indonesia, not only found new social opportunities as a motivator to be a part of RuBI teacher training and knowledge sharing, but that the new relationships formed led to more knowledge sharing (Cha et al., 2017).

Incentive Proposal 4: Organize Inter-School Competitions

Inter-school competitions not only promote student learning, but have the added benefit of fostering interaction among science teachers. The Capstone team envisions that the inter-school competitions could have a hands-on science task (i.e. replicating the circulatory system, or building a rocket), and one winner chosen based on a set of predetermined criteria.

Evidence from the literature and the research conducted in Ghana suggests that teachers would be interested in inter-school competitions. When asked to select five of 17 incentives proposed on the survey, "science-related or academic excursions (e.g. visit to the Ghana Planetarium, science conferences, present a paper at a conference)" was selected more than any other incentive offered, selected by 24 of the 29 teachers surveyed (see Figure 7, p. 20). Given concerns of feasibility expressed by PEN staff for more extravagant gatherings, and ideas expressed in the interviews, the Capstone team identified inter-school competitions as a viable incentive.

There was specific interest for inter-school competitions expressed by teachers during the interviews. Some teachers mentioned inter-school competitions as a great incentive and shared anecdotal evidence. For example, one ToM does competitions within his school and suggests to start inter-school competitions as it "would bring seriousness to the students." One CT mentioned having a student who participated in a JHS science competition and came in 5th place out of 150 students. The CT noted that this made him very proud. This incentive ties in with another critical motivator for teachers, which is seeing their students doing well (see Section 2.2.1, p.8), as this is viewed as a reflection of how well the teacher performs is in his/her role. Another teacher suggested organizing showcases where schools can present what they were able to do. Showcases could be another event organized by CTs for the schools in their circuits (or even within individual schools), where the focus is less on competition, but more on appreciation for achievement in science.

Communicate to Circuit Trainers the Inter-School Competition idea
The competitions would be held first within a circuit and organized by the Circuit Trainers. This additional role should be communicated to Circuit Trainers at the Circuit Trainer Training of Trainers workshops, published on the PEN website, outlined in a section of the PEN manual, and communicated in WhatsApp groups.

Circuit Trainers, by demonstrating community buy-in, can qualify for additional locally-sourced materials provided by PEN
The Circuit Trainer, by designing the implementation plan and demonstrating local in-kind contributions by GES and the community for the event, could qualify to have a few additional locally-sourced materials donated for the event. Plans should also demonstrate that students have a responsibility to find at least one locally-sourced material. Teachers can take a picture of their written plan and upload to the WhatsApp group to apply. By posting to the WhatsApp group, other Circuit Trainers can become motivated to host their own inter-school competitions. Criteria for these plans should be consistent, well-communicated, and easily accessible.

How to Measure

After defining and establishing communication channels to communicate the opportunity effectively, measure after each term over a year how many inter-school competitions have taken place, how many community buy-in plans have been submitted, along with digital credentials issued. Be sure to compare circuits that experienced new ToTs where this opportunity was formally announced with other older circuits that may have missed this direct communication opportunity.

Provide digital credentials for Circuit Trainers that have hosted Inter-School Competitions
Following successful execution of an inter-school competition, Circuit Trainers would qualify for a digital credential in the form of a WhatsApp filter. The digital credential would be downloadable to publish on other forms of social media (similar to the suggested WhatsApp filter for ToM) and would serve to identify the Circuit Trainer as a "PEN Hands-on Science Competition Coordinator." The inter-school competition would be verified by a photo posted to WhatsApp, featuring at least three science teachers and the student winner with winning science project.

Winners of Circuit Trainer Competitions qualify to attend yearly District-wide Competition hosted by Dr. Heather Beem
The winners from each circuit within a year could qualify for a yearly District-wide competition led by Dr. Heather Beem. This would be structured like the circuit-wide inter-school competitions.

Incentive Proposal 5: Invite Guest Speakers from Science-related Industries

The Guest Speaker from a science-related industry is intended to not only bring fresh, new ideas into the classroom, but can also serve to bridge the connection between what students are learning in the classroom and a career in a science-related industry. Visits from Ghanaian professionals are likely to be a meaningful experience for Ghanaian students, and has potential for other positive benefits for students.

Source a volunteer guest speaker from a science-related industry to speak to a JHS science classroom of a Silver-level PEN Professional Practical Teacher

Opinions expressed by PEN-trained Teachers supported the idea of having a classroom visitor as a popular motivator: "interest is aroused if there is another teacher from time to time." The goal of the guest speaker is for students to understand what science-related careers and opportunities are available for them. The guest speaker could be an accomplished professional working in a science-related profession in Ghana, or someone from Dr. Heather Beems's class studying engineering. Whoever the guest is, they should have expertise in science and spend a class period with teacher and students. The guest speaker idea would be a low-cost option for PEN as the speaker would attend the class on a pro-bono basis and should not require transport costs to be covered. While there is evidence that the injection of fresh ideas into the classroom could spark both student and teacher motivation for hands-on science, this could be leveraged to incentivize more practicals by making the visit a prize for Silver-level PEN PPT (see Incentive Proposal 3, p. 19).

How to Measure

After one year and after two years, count the number of teachers that are silver-level certificate holders, and how many teachers posted pictures of the guest speaker in the District WhatsApp group. It could also be beneficial to count the number of Bronze-level certificate holders, and to see if this is more prevalent in Districts with more Silver-level certificate holders posting guest speaker events in the WhatsApp group.

Communicate to Silver-level PEN PPTs expectation to share photo of guest speaker event

PEN PPTs should understand that in order to receive the guest speaker, it is their responsibility to document the visit to share with other teachers on the District WhatsApp group.

2.3.4 More Support Incentives

Literature Review

Of all the different ways to incentivize teachers to adopt a particular teaching style, the strongest evidence exists for providing additional teaching support to teachers.

> "Our analyses show that teachers working in more supportive professional environments improve their effectiveness more over time than teachers working in less supportive contexts."
>
> *- Kraft & Papay, 2014, p. 476*

There are many different forms this support can take, whether it be a classroom visit and coaching, a teacher learning circle (TLC) where teachers can collaborate to solve challenges and share best practices, or a mobile mentorship program. Research by the World Bank (2018) has shown that follow-up visits can work for encouraging implementation. Research by Burns & Lawrie (2016) supports the idea that increased teacher collaboration can lead to an increased willingness to attempt new practices in the classroom. Additionally, peer coaching can serve to reinforce teaching practices learned during teacher training workshops (Showers & Joyce, 1996). Evidence of the efficacy of these support mechanisms is also cited by several education interventions: Educate Girls in India, RuBI in Indonesia, Sabre Charitable Trust in Ghana, and Teachers for Teachers in Kenya (Haro & Montgomery, 2017; Cha et al., 2017; Wolf, 2017; Mendenhall, 2017).

The in-service science teacher training that PEN provides was found to be one of a few opportunities teachers have for professional development. Other in-service training opportunities mentioned by teachers were trainings from GAST and GNAT, but were identified as infrequent. While PEN's teacher training is important not only for its content and as one of few professional development opportunities, as research by Burns & Lawrie (2015) has revealed, it is the multi-faceted teacher professional development programs that truly have the strongest impact on teaching practices.

> Research also demonstrates that teacher professional development (TPD) that includes peer coaching, study teams, peer visits, feedback and reflection, has generally an 80-90 percent implementation rate, versus a 5-10 percent implementation rate for TPD that is focused on theory and 10-15 percent implementation rate for TPD focused on practice without coaching or support.
>
> *- Burns & Lawrie, 2015, p.85*

Given that most teachers have grown up in an education system that has limited in-service support mechanisms, and that the pre-service mentorship offering for teachers is identified as weak by Sabre Charitable Trust and T-TEL, it may be difficult for teachers to conceptualize what a teaching environment with many of these support mechanisms could look like. For this reason, the Capstone team suspects that the reason for the low level of interest in support mentioned in interviews is due to lack of exposure rather than a lack of desirability.

Incentive Proposal 6: Capitalize on Circuit Trainer Role

The Circuit Trainer position presents an excellent opportunity to leverage that position to provide more peer support to teachers. Circuit Trainers (CTs) can lead activities within their circuits of five to six schools to promote implementation of practicals. Evidence of Circuit Trainers feeling motivated by their role was found in the interviews: three CTs mentioned that being a CT makes them feel recognized and honored within the community. One CT mentioned that he gained confidence by teaching other teachers in the circuit and views the opportunity as an honor.

Circuit Trainers lead a teacher learning circle within their circuit at the beginning of each term
Once a term, at beginning of term, Circuit Trainers can lead a teacher learning circle with other teachers in their circuit to practice five new practicals they are expected to do in the upcoming term. The expectation for this activity should be made clear at the Training of Trainers for Circuit Trainers, with responsibilities documented in the PEN manual. The hands-on science that PEN promotes is often new for the teachers. The reality of the

school environment is that the PEN-trained Teachers are often the only teacher trying to introduce this new student-centered, hands-on teaching style. Arguably, the best way to make teachers feel more comfortable implementing practicals is to create the space for them to collaborate and support one another to do so (Burns & Lawrie, 2016).

As mentioned in Key Findings on Support (see Section 2.2.2, p. 10), out of 33 interviews with PEN-trained Teachers, 13 expressed the desire to have more trainings, and four teachers interviewed specifically requested for trainings at least once per term. Furthermore, PEN-trained Teachers interviewed expressed confidence conducting the practicals learned during the PEN workshop, but sometimes felt unsure about how to conduct practicals not learned during the workshop. The TLC would be a great place for teachers to collaborate to learn new practicals.

PEN can send a WhatsApp message or text to remind Circuit Trainers to conduct TLCs

Considering the curriculum, PEN can send out a WhatsApp or text reminder suggesting five new practicals to practice prior to the next term. Ideally, these should be practicals that correspond to the topics JHS science teachers should be covering in the following term, but remind Circuit Trainers that they have the freedom to practice whichever five practicals the group of teachers within their TLC have identified as their priority. Encourage CTs to set a date and post pictures of their TLCs in the District WhatsApp group. The USAID Learning Project has found WhatsApp and text message reminders to be effective.

How to Measure

Track activity among Circuit Trainers and see if there is a correlation between increases in number of TLCs held and increases in applications for ToM, and PPCs.

Provide Circuit Trainers with a "PEN Circuit Trainer" logo-ed item to elevate status

Circuit Trainers may benefit from a visual cue to heighten their status (vest, t-shirt, etc.) that they can wear during the Teacher Learning Circles. Evidence for recognition as a viable incentive is further discussed in the Incentive Strategy Proposal on Recognition (see Section 2.3.1, p. 16).

Facilitate Headteacher & Science Coordinator involvement

Engage Headteachers and District Science Coordinators in arranging time and space for the Teacher Learning Circles. If teachers perceive TLCs as an activity that is also supported and encouraged by their superiors, they may be more likely to take on an added time commitment to practice the practicals.

Incentive Proposal 7: Mobile mentorship with Gold-level PEN Professional Practical Teachers

Capitalizing on the PEN Practicals Certificate incentive, this incentive proposes a mobile mentorship program between Gold-level PPTs (who have obtained the Gold-level certificate for more documented experience implementing practicals), and Bronze-level and Silver-level certificate holders (for more details on the PEN Practicals Certificates see Section 2.3.2, p. 19).

Gold-level teachers mentor Bronze-level and Silver-level teachers via cell phone

Gold-level teachers can provide one-on-one support via cell phone (WhatsApp, text messages, calling) to two or three mentees. The idea is that this Gold-level teacher can be a resource for Bronze-level and Silver-level teachers if they have any questions about doing a practical. Arguably, because Gold-level teachers should have more experience conducting practicals, they can serve as an otherwise needed resource for Bronze- and Silver-level teachers. Gold-level teachers should be encouraged to reach out and check in periodically, on a weekly basis, to encourage teachers and ask if they need guidance on any practicals.

How to Measure

At baseline, after one year, and after two years, count the number of Bronze-level and Silver-level certificate holders that have made it to the next level and the total number that become Gold-level certificate holders.

Analysis of the in-country interviews with teachers identified a gap in human resources for teachers regarding easily accessible support for help with practicals. This incentive would help facilitate connections that may make solutions for overcoming some of the challenges of implementing practicals more accessible.

Facilitate matching and introductions between Mentor & Mentee

PEN can facilitate the matching between Gold-level teachers, the mentors, and the mentees. Once the first cohort of Gold-level PEN Professional Practical Teachers has been established (at the end of the academic year), they should be matched to Silver- and Bronze-level PPTs to begin mentorship program and the beginning of the following academic year. PEN can help to facilitate the relationship by making the introductions via WhatsApp or Text, depending on teacher preference. On a monthly basis PEN can remind both Gold-level PPTs to reach out to mentees, and mentees that the Gold-level PPT is a resource available to them.

Provide a small stipend in call credit to encourage communication

PEN may provide a small stipend in the form of call credit to encourage more communication among mentors and mentees. The same amount should be provided to both the mentor and mentee. The stipend is a fairly low-cost way to support the initiative.

Incentive Proposal 8: Capitalize on Peace Corps Volunteers for Ongoing Support

One way to tap into more continuous ongoing in-service support without PEN needing to expend resources conducting trainings, is to outsource some of the work to Peace Corps Volunteers. Peace Corps Volunteers are educated US Nationals working on grassroots development projects throughout the world, including Ghana. As PEN has already identified, improving science education is one of Peace Corps Ghana's priorities. Pending confirmation that improving science education is still one of their country office's goals, it is highly likely that Peace Corps Volunteers can and would be willing to plan additional in-service trainings and may be able to provide co-teaching and peer coaching support in the classroom (based on contextual knowledge of other Peace Corps Country Office Education Programs). Though Peace Corps Volunteers typically serve two-year project commitments, all projects are implemented in collaboration with a local community member, known as the Project Partner. Additionally, typically three cycles of volunteership (a duration of six years), are carried out in a community. Despite volunteer turnover, the Project Partner will remain in the community and can carry on activities started together with the Peace Corps Volunteer. If PEN is in contact with a highly motivated community member, they might even propose them to Peace Corps as a potential Project Partner.

Tapping into volunteers to extend support for hands-on science may not end with Peace Corps Volunteers. Several stakeholders mentioned the emergence of Teach for Ghana, and the eagerness of those volunteer teachers to impact education. This may be another potential collaboration to explore.

Train Peace Corps Volunteers in Education Sector to support teachers to promote hands-on science

Peace Corps Volunteers (PCVs) can collaborate with Circuit Trainers, District Science Coordinators, Headteachers, and other PEN-trained Teachers to host additional trainings throughout the school year and to develop co-teaching and peer-teaching programs to

promote implementation of hands-on science. As PEN has already made contact with Peace Corps Ghana, PEN can reach out to establish an extended collaboration. If the Peace Corps education sector focuses on science (as was identified by PEN through a previous hands-on science engagement), this could be a great *primary* project for volunteers. Primary projects are projects executed within the volunteer's assigned sector to meet sector goals. If not, it could be a potential *secondary* project; it is very common for volunteers to seek out additional capacity building initiatives to implement, even outside of their primary project goals. As PEN has already conducted one hands-on science training with PCVs, this would likely be a training to be held regularly (once or twice a year) with the incoming cohort of PCVs that will work in the education sector, dependent on intake cycles of PCVs.

PCVs to initiate PEN Teacher Training Workshops

Collaborating with community members, PCVs can help lead the organization of additional teacher training events. As PEN-trained Teachers mentioned in the interviews, the amount of in-service training is not enough. This effort would help to provide additional ongoing training support to teachers in hands-on science.

PCVs to implement Co-Teaching and Peer Coaching Programs

Peace Corps Volunteers design and implement their own projects and are expected to be resourceful. PCVs can choose to implement Co-Teaching and Peer Coaching Programs, whereby PEN-trained Teachers and PCVs work on developing lesson plans together, model activities and pedagogy, and then provide feedback to one another. They can then develop actionable next steps for how to incorporate that feedback into the next lesson plan.

How to Measure

Ask Peace Corps after each quarter for Peace Corps' own M&E results on hands-on science activities. Ideally, they should be collecting data on science teaching practices and opportunities to share best practices.

2.3.5 Monetary Incentives

Literature Review

The empirical evidence for financial rewards is highly mixed. Financial incentives have had success in countries with high teacher absenteeism, such as India or Kenya (World Bank, 2018). These financial incentives were only effective in making teachers come to school, however, had nothing to do with a change in teaching practices. In other contexts, where financial incentives were not primarily used to increase teacher presence, they had adverse effects: teachers taught specifically to the test and neglected holistic learning. Cheating, by both students and teachers, increased (World Bank, 2018).

Findings from Surveys and Interviews

In the survey, "money" ranked last out of five potential answers in the question about what matters to teachers. Seven survey respondents were interested in the opportunity to gain additional income through PEN activities. However, external stakeholders were not convinced of the effectiveness of monetary rewards. One interviewee who also worked on teacher trainings said, "teachers should not be bribed into a program". Another stakeholder suggested that if money mattered, it was more important to focus on reducing costs of participation or cost of material rather than handing out cash.

Given the weak evidence and strong feasibility concerns due to PEN's limited resources, monetary incentives are not a strategy worth pursuing. If any implementation recommendation was to be made at all, PEN could offer a discounted rate for teachers who wanted to voluntarily participate in a second workshop.

2.4 Assessment and Ranking of Proposed Incentives

The Capstone team has developed a matrix to help PEN better understand the pros and cons for each incentive option. In order to conduct a comprehensive evaluation of each incentive, the matrix consists of five categories. The Capstone team also developed metrics to determine the ratings. The five categories are listed below and the indicators can be found in Appendix E.

Rating Category	Description
Cost Effectiveness	How much cost PEN has to bear to implement this incentive
Reach	How many teachers are possibly reached through this incentive
Feasibility	How much administrative support is necessary (including external public relations support and internal administrative support)
Popularity	Level of popularity according to in-country research
Strength of Evidence/ Certainty of Impact	Level of strength of evidence from existing literature

Figure 8: Incentive Assessment Matrix

Category	Incentive	Cost Effectiveness	Reach	Feasibility	Popularity	Strength of Evidence/ Certainty of Impact
Recognition Incentives	Enhance the Status of the ToM	✓✓	✓	✓✓✓	✓	✓
	Strengthen the Effect of (WeGo Innovate) Film Spots	✓✓✓	✓	✓	✓	✓
Career Incentives	Introduce PEN Practicals Certificates	✓✓	✓✓✓	✓✓	✓✓	✓✓
Experiential Incentives	Organize Inter-School Competitions	✓	✓✓	✓	✓✓✓	✓✓
	Invite Guest Speakers from Science-related Industries	✓✓	✓	✓✓	✓✓✓	✓✓
More Support Incentives	Capitalize on Circuit Trainer Role	✓	✓✓	✓	✓	✓✓✓
	Mobile mentorship with Gold-level PEN Professional Practical Teachers	✓✓✓	✓	✓	✓✓	✓✓✓
	Capitalize on Peace Corps Volunteers for Ongoing Support	✓✓✓	✓✓	✓✓	✓	✓✓✓

3. MONITORING & EVALUATION REVIEW AND ASSESSMENT

3.1 Overview

In 2017, Practical Education Network (PEN), with the help of a Columbia University student, created a Monitoring and Evaluation (M&E) framework, including a theory of change, indicators, and data collection tools (Cha, 2017). The Capstone team was asked to conduct a formative assessment of the framework and tools, and provide recommendations for improvement. To maintain organization of both previous and future data collected, the Capstone team was also asked to create a method to organize, store, and analyze PEN's data, which is now collected with the new M&E framework. Lastly, the Capstone team was tasked with researching and initiating a method for PEN staff to track teacher and trainer progress, and improve communication between PEN staff and stakeholders (PEN-trained Teachers, Circuit Trainers (CTs), Master Trainers (MTs), and Ghana Education Service (GES) representatives).

3.2 Methodology

This section details the methodology employed to research and set up data storage and analysis, and a method for tracking teachers over time as well as managing these relationships.

3.2.1 Customer Relationship Manager (Salesforce)

To track PEN-trained Teachers and Trainers over time, the Capstone team identified that a Customer Relationship Manager (CRM) would best serve this purpose.

The desired criteria provided by PEN for an effective database platform included (Cha, 2017):

- *Storage space for up to 5,000 individual contacts;*
- *Interactive, two-way communication. Ability to provide appropriate alerts/flags for follow-up;*
- *Ability to track teacher progress over a period of time, as well as track history of interaction;*
- *Ability to gather, integrate, store information from various sources at aggregate and individual levels;*
- *Ability to work across various other platforms (Excel, Google, etc.) and external web services;*
- *Ability to organize by campaigns/projects;*
- *Integrated services, including data collection (mass email, mass message);*
- *Complexity that allows for potential scaling and growth in depth of information simple enough for intuitive ease of use and control;*
- *Less than $400 USD per year (ideally, free).*

The Capstone team conducted extensive research on existing CRM platforms including Salesforce, Appspot, Knack Software, OneSheet CRM, Insightly, Synergy, Granity, Microsoft (Dynamics CRM Online), and Infusionsoft. After researching each company and consulting with Professor Gregory Falco at Columbia SIPA, the Capstone team selected Salesforce as the best option. One critical reason for this decision was the approval of PEN for the Salesforce "Power of Us" Program, that the Capstone team applied for on PEN's behalf. This approval granted 10 free Salesforce licenses to PEN, without expiration. Additionally, Salesforce is a large company and reliable platform, which the Capstone team believed was an important factor to consider when identifying the ideal CRM for PEN.

The Capstone team took on the initial setup of Salesforce for PEN, and applied to the Salesforce Pro-Bono Program in hopes of receiving additional support to further tailor Salesforce capabilities to PEN's needs. Initial meetings for this application took place in March of 2018, with uptake of the project currently pending on behalf of the Salesforce Pro-Bono team.

To facilitate a smooth transition from initial setup to ongoing management, the Capstone team worked with PEN staff to train them on using and managing Salesforce. In addition, the Salesforce Reference Guide was created to further support PEN staff (see Appendix B).

3.2.2 Data Storage/Organization

Prior to the creation of the M&E Framework, PEN conducted data collection at various points since its founding, which has produced a significant amount of raw data and information from WhatsApp chat activity. In order to facilitate better organization and analysis of the data, the Capstone team re-organized PEN's Google Drive (see Appendix F). The Capstone team chose Google Drive after exploring other potential platforms such as Kimetrica and Synergy Indicata. Currently, PEN is using multiple platforms, including Dropbox, and it is recommended that PEN migrate all their data to Google Drive to ensure no data is lost. All data collected prior to the created of the new M&E framework will be organized solely by year as the type of data collected varies. With the addition of a CRM program, some of the information currently stored in Dropbox, such as Circuit and Master Trainer tracking, will now be stored in Salesforce. The goal of the new, streamlined organization is increased efficiency in M&E activities.

3.2.3 Data Analysis

The Capstone team conducted research on existing data analysis platforms that could serve PEN's needs (in addition to those of a CRM) and found that most programs, such as Kimetrica, were costly and outside of PEN's budget. To address this, the Capstone team considered free alternatives that would equip PEN to fulfil its data analysis needs.

To enable PEN to quickly analyze and visualize its data, the Capstone team designed a Data Analysis Guidebook (see Appendix A). This guide covers several components of the necessary data analysis process, including disaggregating data by key variables, creating Data Dashboards within Google Sheets for easy data visualization, and how to use a long-term tracking tool to observe PEN's impact over time (with regard to its eight key indicators). In addition to this guide, the Capstone team created six Data Dashboards to accompany each of the existing survey tools (Classroom Observations, Interviews with Teachers, Remote Survey with Teachers, Interviews with Headteachers, and two for Student Focus Groups). These dashboards serve as a master template in which survey results can be embedded, allowing for instant data analysis and visualization. The Capstone team also created the "PEN Long-Term Tracking Tool" to visualize the changes of PEN's eight key indicators over an initial four-year period, which can be easily modified to meet PEN's future needs.

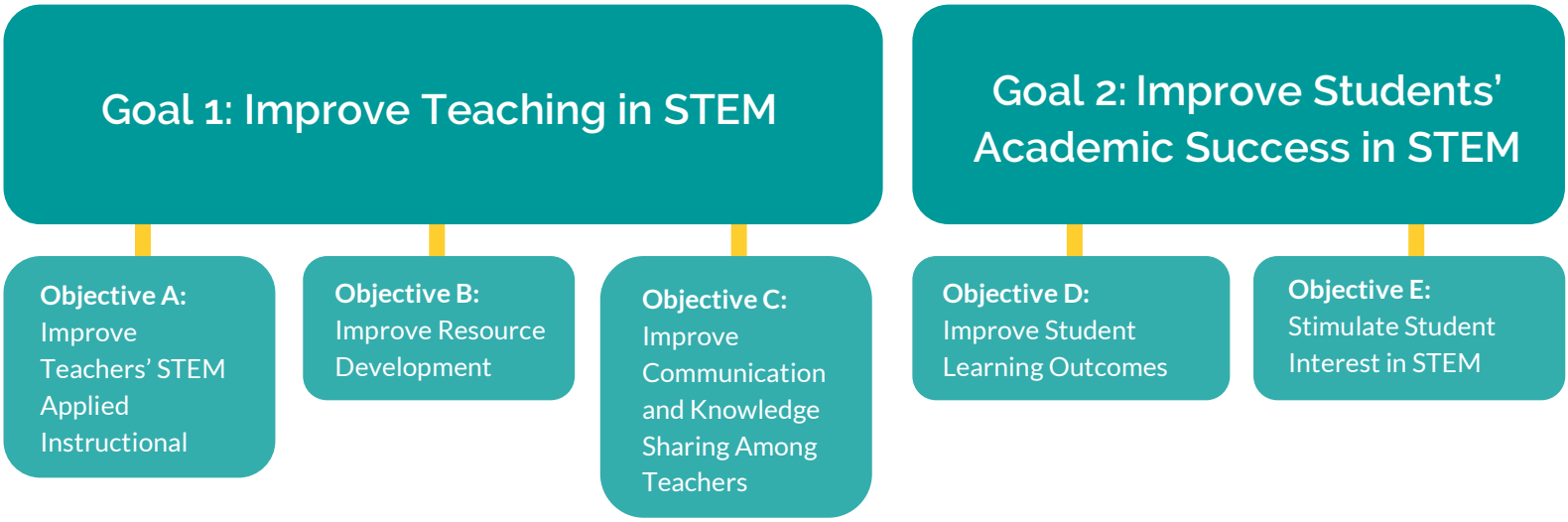
3.3 Recommendations

This section outlines the recommended changes to the existing M&E Framework and data collection tools as well as general M&E programmatic recommendations.

3.3.1 Framework

To further improve the M&E Framework that was developed and tested in 2017, the Capstone team incorporated challenges provided in the original framework as well as other research, to provide recommendations for further improvement of the framework, specifically the indicators and data collection tools (Cha, 2017).

Based on the existing framework, **the indicators were divided into two goals and five objectives:**



The two goals are based on teachers and students having different outcomes.

Some of the changes made to the indicators, as shown in Appendix G include:

- *Proportion of teachers employing practical activities **more frequently.** → Proportion of teachers employing practical activities **at least once per week**.* It is important to define what 'more frequently' means. This is also because there is a limit on the number of practicals a teacher can conduct in one week and at a certain point, a teacher won't be able to conduct practicals more frequently. PEN has set a goal of at least one practical activity per week.
- *Number of resources **and** opportunities supplied by PEN. → Number of resources or opportunities supplied by PEN **(per teacher)**.* It is important to separate resources and opportunities as they are different. Currently, resources include the PEN manual and opportunities include trainings, however, this might change as PEN expands. In

addition, as the number of teachers trained by PEN increases, the number of resources and opportunities supplied will automatically increase. With a goal of having well-equipped teachers, it is important to know if some teachers are more equipped than others, which will be shown by recording the information per teacher. All measurement tools noted in the Incentive Strategy Section of this report (see Section 2.3, p.16) under the 'How to Measure' sidebars should be recorded as part of this indicator.

3.3.2 Data Collection Tools

Recommendations were made to each data collection tool as described below and can be seen in Appendix H.

Student Survey

As the general data collection recommendations describe in this section, it is key to survey the same students more than once in an academic year. Thus, to maintain anonymity, but ensure the same students are surveyed, each student should be randomly assigned a number as an identifier. In addition, students will have trouble remembering all the practical lessons they did in a term, thus it is recommended students are asked to recall only practicals conducted in the last month.

The only tool yet to be developed by PEN is the ***Critical Thinking Index*** (CTI). After extensive desk research, the Capstone team suggests the questions posed in Appendix H. The majority of existing critical thinking assessments are provided by private testing companies at a cost. In addition, the same assessments are geared for upper secondary school or university level students in the United States and Europe (Ennis, 1993). The Capstone team created new questions based on the topics teachers conduct practicals for as provided in the PEN manual. A few questions were adapted from an existing CTI (The Critical Thinking Workbook) and contextualized to the Junior High School (JHS) in Ghana (The Global Digital Citizen Foundation, 2016).

In order to gain helpful insight into the effectiveness of PEN's programs, the Critical Thinking Index needs to be administered to students prior to their teacher attending a PEN training or immediately after attending a training (pre-test), and again a few months after the PEN training (post-test). It is key the same students are tested as responses may vary greatly by school due to other inputs that may affect a student's performance on the assessment (Sarigoz, 2012).

While separated from the main student survey in Appendix H, the CTI questions should be added to the end of the student survey with an introduction to the new section as

provided in Appendix H. Responses to the CTI should be graded according to the answer sheet in Appendix H. Measurement of success will depend on the percentage increase in a student's score on the CTI.

The Capstone team recommends that the CTI be piloted and tested to ensure students understand the questions being asked. There are currently nine questions in the CTI. The Capstone team recommends that after piloting and editing the questions, PEN chooses five questions to be administered to students. In addition, it is important to record the number of times a teacher conducts practicals in classroom of survey participants to triangulate any potential effect of PEN practicals on students' critical thinking.

Teacher Survey

Several changes were made to the teacher survey, including asking for Year of Birth instead of Age. As PEN tracks teachers over time, teachers' ages will change each year. Recording year of birth ensures a teacher's age will not be out of date or incorrect. When entering year of birth, a teacher's age will be accurately reflected, even after a few years of being in the CRM. While also included in the Teacher Interview Guide, the Capstone team recommends asking teachers what specific practicals were conducted in the classroom in the last term. The survey reaches more teachers through mobile phone dissemination and understanding which practicals are conducted more than others is valuable information to improve PEN's program.

Teacher Interview Guide

The only change made to the Teacher Interview Guide is to specifically ask how many practicals were conducted in a term. This information is important for validating the information derived from the student's Critical Thinking Index.

Headteacher Interview Guide

The recommendations for the Headteacher Interview Guide come from the in-country research conducted by the Capstone team in March. The Capstone team discovered many Headteachers had either never heard of PEN or knew very little about the organization. Because of this, it is recommended that the Headteachers first be asked if they know of any practicals or collaboration their science teacher has done, rather than ask for a specific number of practicals. An additional question added is whether or not Headteachers observe science classes. The question will help ensure the quality of data in the interview. For example, if Headteachers have never observed a science class, they shouldn't be able to answer if they have seen a change in lesson delivery of their science teachers. This ensures that PEN is collecting accurate data and responses.

Classroom Observation

Because part of the Classroom Observation involves some subjective questions, it is important to note who conducted the observation in case there are any discrepancies or questions. In addition, two questions have been added. The first is concerning how well the teacher is explaining and conducting the practical. This is important to note as the delivery of the practical can have an effect on how well the students understand the concept. The second question asks if a teacher provides opportunities for students to participate in the practical. PEN's mission of promoting hands-on science learning not only refers to how teachers teach, but also to whether students have an opportunity to get engaged in the practicals themselves.

3.3.3 General Data Collection

Taking into consideration the new M&E Framework and the tools that have been utilized since Summer 2017, the Capstone team has a few recommendations for PEN's general monitoring and evaluation program, specifically focusing on data collection.

Visit the same schools each term

Due to the small sample size for data collection (10 schools), it is important that the same schools (students, teachers, Headteachers) participate in data collection each year. Because the context of each school can vary quite a bit, extrapolating data from 10 schools to the entire PEN program has limitations. Thus, observing any change in one school over time will provide valuable insight into the effect of PEN's program.

Vary demographics of schools visited

In order to have diversity among the results of the data collection, it is important to vary the demographics of the schools where data collection is conducted. For example, rural and urban schools or small and large class sizes. This ensures the data collected provides a representative sample of all PEN-trained Teachers and beneficiaries.

Expand remote teacher survey collection

Given PEN has trained over 2,500 teachers, it is vital to reach as many teachers as possible in data collection. While there are a number of barriers to reach a great number for the student survey, interviews, and classroom observation, the success of the remote teacher survey should be capitalized on. PEN staff should encourage all teachers to complete the survey in order to increase the volume of data.

Use consistent language

To avoid confusion or mix-up of data, it is important to be consistent in the naming of tools. For example, the Student Survey should be called Student Survey rather than

Student Focus Group. This is also to ensure all persons working on M&E for PEN (staff, volunteer, intern, etc.) understand the type of tool being used. When onboarding new staff, PEN should conduct a 'PEN M&E 101' to ensure all staff understand the terms and definitions used in M&E. A survey is conducted individually by the participant (student or teacher). A focus group, which is currently not a part of PEN's data collection tools, is a guided discussion with multiple participants at a time. An interview is a one-on-one discussion with guiding questions.

4. GENERAL PROGRAMMATIC RECOMMENDATIONS

The following recommendations, though not directly related to incentives for teacher uptake of hands-on science teaching, may serve to cultivate an enabling environment through which the execution of the incentive strategy may be amplified.

1. Improve teacher communication

Better communication with teachers trained by Practical Education Network (PEN) may improve teachers' understanding of PEN's expectations for uptake of practicals and roles which may help to enable success of the proposed incentive strategy. The following sub-recommendations may serve to bolster the communication strategy:

a. **Clearly define roles and processes**
   Create documents detailing the processes by which teachers can obtain elevated status roles (i.e. PEN Practicals Certificate holder, WeGo Innovate, Circuit Trainer, Teacher of the Month, etc.) and what the responsibilities and expectations for these roles are. **They can be included in future editions of the PEN manual, available on the PEN website, promoted during M&E visits, communicated at all PEN trainings (including by Circuit Trainers), and on social media and other communications platforms**.

b. **Send Text & WhatsApp reminders**
   Send out text and WhatsApp reminders to teachers to remind them which practicals they should be doing that term, to highlight a tip for a cool practical, or to encourage teachers to do more practicals. This could be tailored to specific tiers of PEN-trained Teachers, for example Bronze-level Certificate holders could receive a message *"Just a few more practicals until a visitor like [insert exciting guest speaker] could come visit YOUR classroom."* Other organizations like the USAID Learning Project have found text and WhatsApp reminders effective in encouraging engagement with promoted teaching practices.

c. **Give teachers that have left WhatsApp an option to opt back in**
   Make sure to periodically monitor District WhatsApp group membership. When a member drops out of the group, give that member an option to opt back in. As mentioned in the Key Findings (see Section 2.2.2, p. 10), seven of the 33 teachers interviewed mentioned that they had gotten a new phone, and were no longer in the group. Many of these teachers expressed interest

in re-joining the group, but did not know how to do so. PEN may also wish to provide contact information for someone to contact publicized in the PEN manual, should a teacher wish to rejoin the group.

2. Improve resource accessibility

Twenty-six interviewed teachers and Headteachers commented on the lack of teaching and learning materials. The following two sub-recommendations are feasible steps PEN can take to improve resource accessibility without providing materials:

a. **In PEN trainings, emphasize *how* to find more resources locally**
For example, teachers can brainstorm alternatives as a group and discuss where they might be able to source various products. Teachers can have the opportunity to share "success stories" where teachers found material or were creative. SABRE Charitable Trust, an organization focused on teacher professional development in Ghana, has found spending time in the training on how to gather material to be successful.

b. **Leverage the Ghana Education Service (GES) Resource Officer Role**
A few teachers mentioned a GES Resource Officer that had been helpful in the past, though the same teachers were uncertain if this role currently existed. There could be potential to develop resource libraries at each GES District Office with information on where to source products locally to do the practicals, and some materials in stock for teachers to rent out. T-TEL, through their Challenge Fund Program, was able to sponsor the development of a resource lending library at a teacher training college.

3. Training content to include teaching pedagogy

Two of the biggest challenges/barriers to doing practicals cited by teachers was the limitation of time (cited by 11 of the 33 teachers interviewed) and class size (cited by 5 of the 33 teachers). Training content should incorporate a new emphasis on pedagogy (e.g. classroom management) with a session on how to write a lesson plan (with the opportunity to write one, present it, and receive feedback). This should be accompanied by an acknowledgement that until students become accustomed to a new way of learning, there might be initial classroom management challenges that can be overcome by repeating activity with consistent procedures. Better lesson planning and classroom management skills may enable teachers to feel more comfortable implementing student-centered teaching practices, such as practicals.

4. Improve connections and status with GES

Improving connections and status with GES may not only increase the ability of PEN to engage with more teachers, but can also increase the value of PEN Teacher Training as a brand. This will be important for adding value to the certificates obtained from trainings, and the PEN Practicals Certificates. One interviewed teacher commented that when he went to interview for his promotion, he did not include his PEN certificate in his portfolio because he was not sure if it would be important to GES. If PEN wants to capitalize on teachers motivated by career promotion, certificate validation by GES (and/or accreditation through the National Teaching Council as suggested by Miracule Gavor of USAID) may be a necessary step. Improved connections with GES may also enable PEN to build stronger relationships with District Science Coordinators, whose roles can be leveraged to support PEN promotion of hands-on science teaching. Lastly, nationwide expansion that will come from legitimization from GES and the opening of doors to new districts, will also be beneficial for certificate status as PEN becomes a more renowned brand.

5. Develop long-term strategic plan

One piece that the Capstone team identified as both missing and instrumental for driving PEN forward, is a long-term strategic plan. PEN may find it helpful to document its long-term and short-term goals and to identify its biggest priorities moving forward. This could be a great project for a future graduate student intern or short-term consultant.

5. CONCLUSION: The Report as a Basis for Future Expansion

This report can serve as a basis for Practical Education Network (PEN)'s efforts to effectively address its current challenges, such as teacher uptake and impact measurement. The incentive proposals as well as the recommendations on the Monitoring and Evaluation (M&E) strategy are ready to be implemented and can support PEN during its expansion process - both to other Ghanaian regions and eventually other West African countries.

PEN has grown impressively fast, having trained more than 2,500 Ghanaian teachers in less than three years. For the upcoming expansion, it may be beneficial to focus on a deeper connection with trained teachers, e.g. by implementing the incentive proposals and scaling up teacher support. The ultimate effectiveness of PEN's workshops depends on the teachers' long-term willingness to adapt teaching practices. Through a stronger sense of PEN community, continuous support and targeted incentives, this willingness can be enhanced. The incentive proposals are evidence-based and with the concrete implementation steps ready for introduction. The effectiveness of the incentives should be tracked (e.g. using the "How to measure" tools listed in the report) in order to identify potential needs for amendments.

Efficient data collection, storage, and analysis become particularly crucial as PEN's program expands. The newly introduced CRM can help PEN maintain more regular strategic communication with trained teachers. Therefore ensuring that the CRM is always up-to-date and includes all relevant contact information should be a priority. Frequent data collection and analysis based on the Data Dashboards and the Data Analysis Guidebook should accompany the expansion process in order to assess its success.

PEN started the initiative to revolutionize science teaching in Ghana. With a stronger focus on teacher motivation, utilizing the incentive structures identified in this report, an efficient M&E strategy and a clear vision for its own organizational development, PEN will be well equipped to continue working towards its mission and to further spread practical science teaching in West Africa.

REFERENCES

Annan, K., & Dryden, S. (2016). Food and the Transformation of Africa: Getting Smallholders Connected. *Foreign Affairs*, *94*, ii-vii.

Ashraf, N., Bandiera, O., & Jack, B. K. (2014). No margin, No Mission? A Field Experiment on Incentives for Public Service Delivery. *Journal of Public Economics*, *120*, 1-17.

Burns, M. & Lawrie, J. (2016). *7 Recommendations to Improve Teacher Professional Development in Fragile Contexts.* Retrieved from https://www.globalpartnership.org/blog/7-recommendations-improve-teacher-professional-development-fragile-contexts

Burns, M. & Lawrie, J. (Eds.). (2015). *Where It's Needed Most: Quality Professional Development for All Teachers*. New York, NY: Inter-Agency Network for Education in Emergencies.

Cha, T. (2017). *A Monitoring and Evaluation Framework for The Practical Education Network.* Shared upon Request.

Cha, T., Ema, H., Kovachi, K., Malik, T., Papageorge, H., & Shurab, L. (2017). *The Indonesian Teaching Movement and its Knowledge Sharing Initiative: A Formative Review of RuBI.* Retrieved from https://indonesiamengajar.org/riset/

Ennis, Robert. H. (1993). Critical Thinking Assessments. *Theory into Practice. 32(3)*, 179-186.

Global Digital Citizen Foundation. (2016). *The Critical Thinking Workbook: Games and Activities for Developing Critical Thinking Skills.* Retrieved from https://globaldigitalcitizen.org/free-download-critical-thinking-workbook.

Haro, L. & Montgomery, S. (2017). *Uncovering Motivations and Incentives to Attract and Retain Highly Engaged Community Education Volunteers.* Shared upon Request.

Kraft, M. A. & Papay, J.P. (2014). Can Professional Environments in Schools Promote Teacher Development? Explaining Heterogeneity in Returns to Teaching Experience. *Educational Evaluation and Policy Analysis*, *36(4)*, 476–500.

Mendenhall, M. (2017). *Promising Practices in Refugee Education Case Study: Strengthening Teacher Professional Development: Local And Global Communities Of Practice In Kakuma Refugee Camp, Kenya.* Retrieved from https://static1.squarespace.com/static/583af1fb414fb5b3977b6f89/t/59bdbadc8419c21c1bd35570/1505606367450/11_PromisingPractices_Teachers+for+Teachers_WEB.pdf

Sarigoz, O. (2012). Assessment of the High School Students' Critical Thinking Skills. *Procedia-Social and Behavioral Sciences*, *26*, 5415-5319.

Wolf, S. (2017). *The Impacts of Fast Track Transformational Teacher Training in Ghana.* Retrieved from https://www.poverty-action.org/sites/default/files/publications/FTTT%20Preliminary%20Results%20v2-2.pdf

World Bank. (2018). *World Development Report 2018: Learning to Realize Education's Promise.*

Appendix

Appendix A

The Practical Education Network

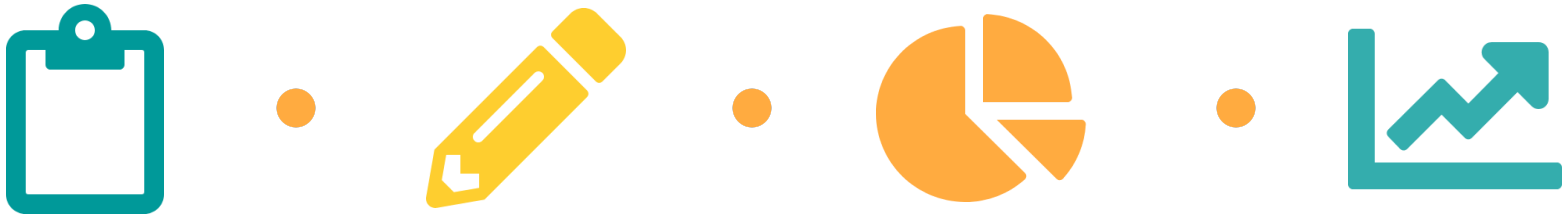
Data Analysis Guidebook

May 2018

PEN Data Analysis Guidebook

Table of Contents

Introduction



The **PEN Data Analysis Guidebook** should serve as a useful reference for PEN when determining how to best analyze and visualize its data. This is relevant for both immediate results following a data collection round, as well as tracking PEN's long term progress over time (in accordance with its key indicators). This guidebook covers a few main themes and tools that have been created for PEN, each of which are listed below with links to their Master Templates for easy reference.

1) Student Focus Group
2) Student Focus Group (with Coding)
3) Classroom Observations
4) Interview with Headteacher
5) Interview with Teachers
6) Teacher Remote Survey Responses
7) PEN Long-Term Tracking Tool

This guide discusses important considerations and useful codes for creating a data dashboard that will allow for modifications as needed, or the creation of an entirely new data dashboard if new survey tools are utilized. This guidebook also covers key variables to consider when analyzing data, as well as additional recommendations for PEN to reach its full capability and use its data to inform its future work.

Analyzing & Visualizing Survey Data

PEN collects relevant data during each term of the academic year, in accordance with its indicators, using several survey tools. The survey platform used, Google Forms, exports its results to a usable format through Google Sheets. Google Sheets offers great potential for analyzing and visualizing data that should be fully utilized by PEN, as a free substitute to a data analysis platform.

Using Google Sheets for Data Dashboards

For each survey, a Google Sheet has been created that can function as a **Master Template** to directly paste form responses to yield immediate analysis results and accompanying visualizations. As mentioned in the introduction, seven data dashboards have been developed in accordance with PEN's current survey tools. These include **four key tools associated with in-person surveys** or observations, and **one tool associated with remote teacher surveys**. The **final tool is an example of how coding can be integrated** into form responses and therefore the data dashboard, if PEN decides it has the capacity and desire to code its open-ended survey responses.

Each of the data dashboard templates should be copied as needed, to analyze survey results for certain populations. These responses can also be collected and aggregated into one dashboard over time, potentially housing thousands of survey responses. These can be used to analyze the data of a specific survey round or can be used for a specific group of individuals (for example, just the survey responses of teachers from a certain district, regardless of time period).

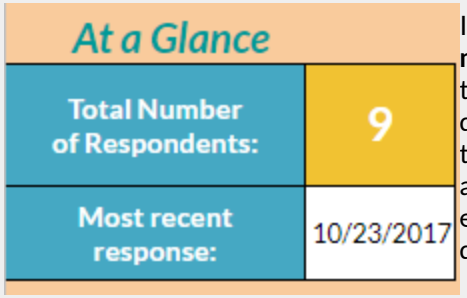
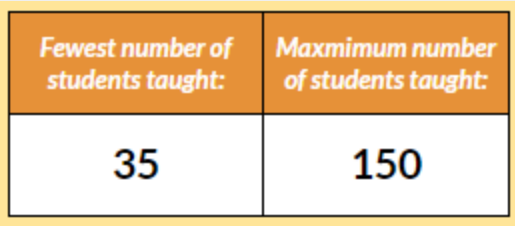
Data Dashboards each have two tabs:

1) A **"Form Responses"** tab, which should appear to be in the same format as the responses tab generated by each survey
2) A **"Data Dashboard"** tab which analyzes and visualizes the data

Each of the dashboards contain similar Excel formulas and aspects. They can be easily modified and replicated using a combination of formulas and visuals, pulling directly from Google Forms responses.

Relevant Excel formulas include the following listed in the table below.

Note: In nearly all of the following formulas, `"Form Responses 1"` refers to the name of the sheet where the dashboard is pulling the information from, and `!A2:A3000` refers to the range being looked at. The column will change depending on the question being analyzed, but the "Form Responses 1" portion should remain that same as the tabs in all dashboards are named this. The range should always have a large ending number to ensure that no responses are missing from the range being analyzed by the formula (in this case, 2999 responses will be looked at, as Row 1 is the header row).

Formula Reference Name	Formula Description	Formula & Component Description
→ Number of Unique Responses	It is extremely important to each dashboard that the number of responses that have been collected are accounted for. To ensure this is populated within each dashboard, the "Count Unique" formula can be used to scan timestamps. This is because no two timestamps will be identical, as even the second of submission is collected in Google Forms.	**`=COUNTUNIQUE('Form Responses 1'!A2:A3000)`** **`=COUNTUNIQUE`** is the actual formula that must be included before referring Google Sheets to the relevant location. Column "A" should generally always be the column used, as this is where the timestamp in Google Forms automatically populates.
→ Most Recent Response Date	 It is important to include the **most recent response**, so that anyone viewing the dashboard knows whether the current term has been added, etc. which can be easily identified given the date that populates.	**`=max('Form Responses 1'!A2:A3000)`** When looking at dates, the "maximum" function retrieves the latest date in the relevant data source (which in this case, is Column "A", as this is where the timestamps populate in Google Form responses).
→ Minimum & Maximum	 Displaying minimums and maximums are significant, especially when displaying ranges that have open-ended beginnings and ends (such as "80 or more", where responses counted can be 81 or 801). More details are explained in "Determining Ranges and Categories".	**`=min('Form Responses 1'!G2:G1000)`** The above will populate the minimum number in a range of responses. **`=max('Form Responses 1'!G2:G1000)`** The above will populate the maximum number in a range of responses.

→ Counting Relevant Words

How do you usually communicate with other teachers?	
Phone calls	3
In-person	5
Text messaging (WhatsApp/ SMS)	1
Emails	0

To create a chart with responses that are fixed (or are in the form of radio buttons, where a response is selected based on a list of predetermined responses), counting the number of times this responses appears allows for easy analysis of survey responses.

```
=COUNTIF('Form Responses 1'!O2:O1000, "*Text*")
```

The **=COUNTIF** formula counts the number of times a specified word or words appear. In this instance, the formula counts the number of times the word `"*Text*"` appears, and populates the number in the chart accordingly.

→ Creating a Range

What is the total number of students that you teach?	
49 or fewer	2
Between 50-74	1
Between 75-99	1
Between 100-124	3
Between 125-149	1
150 or more	1

Ranges are important for numbers that are not generally fixed. For example, there are only nine possible scores that students can receive in the B.E.C.E. exam, making it easy to account for each possible score. However, teachers have varying class-sizes and it may not always be necessary to have the exact count of students, but to rather classify these varying class-sizes according to their range. For example, the difference between having 76 or 77 students may not be significant in categorizing class-size but it may be more helpful to understand the percentage of classrooms that have between 100-124 students. Determining ranges is discussed in more detail below ("Determining Ranges and Categories").

```
=COUNTIFS('Form Responses 1'!G2:G5000, "<=49")
```

=COUNTIFS counts desired responses based on one or more condition. `"<=49"` refers to "Equal to or less than 49".

```
=countifs('Form Responses 1'!G2:G5000, ">=75",
'Form Responses 1'!G2:G5000, "<=99")
```

This formula allows for counting based on multiple conditions, creating a range if structured possible. `">=75"` counts those responses that are "Greater than or equal to 75, while `"<=99"`counts those "Less than or equal to 99". The range in the Form Response portion (`!G2:G5000`) must be identical, or the formula will respond with an error.

```
=COUNTIFS('Form Responses 1'!G2:G5000, ">=150")
```

This formula counts "Greater than or equal to", in this case "Greater than or equal to 150".

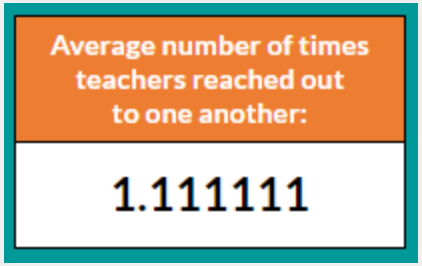
Basics (View additional formulas in Google Help here)

→ Sum

A very basic Excel formula that adds all designated numbers.

```
=sum(C51:C54)
```

Simply specify the range that you would like the formula to summarize.

➔ Average		A very basic Excel formula that takes the average of a designated range of numbers.	`=average('Form Responses 1'!N2:N500)` The average formula analyzes all of the numbers in the designated range, in this case `!N2:N500` in the `'Form Responses 1'` tab, and calculates the average.

These are just some of the relevant Excel formulas that can be used, and as PEN collects more data (with varying levels of complexity), these dashboards can be revisited to take more complete advantage of what Excel and Google Sheets has to offer.

Accounting for "Other"

In recording survey responses into a Google Form, **it is important to explicitly type the word "Other" before the relevant response** (for example, if a response is outside of the categories already provided). This is to account for these responses in large sums of data, as they may otherwise not be counted or reflected in the data analysis. As more responses that fall into the "Other" category are recorded (as the number of "Other" responses grows), these responses should be reviewed to identify trends in responses that could lead to entirely new categories. This could be on behalf of the survey itself (in the case where the responses are via radio button) or on the side of PEN staff, who may have coded responses while leaving out an emerging or important category.

Determining Ranges and Categories

It is important to ask "What trends do you see in the data?". Depending on what is significant to group together, ranges should be created to make data analysis more feasible and useful. For example, when considering the number of students that a teacher has in a classroom, it would not be relevant to include a point on a graph for each number of students that a teacher has in their class. Instead, depending on the variation of class sizes, ranges that include many potential class sizes will be more relevant.

Because it may be challenging to identify outliers as data is collected over long periods of time, a "minimum' or "maximum" value should be added (as relevant). For example, if it is decided early-on that the last category designated for class size should be "40+", creating a "maximum" value can help identify when a potential additional category is useful. If the maximum value is "85", more

than double your current final threshold, it might be relevant to add additional categories that allow for your data dashboard and associated visualizations to tell a more accurate story. Previously developed ranges should be revisited after significant periods of time (at least once per year) to ensure that they are still depicting data in a non-skewed way.

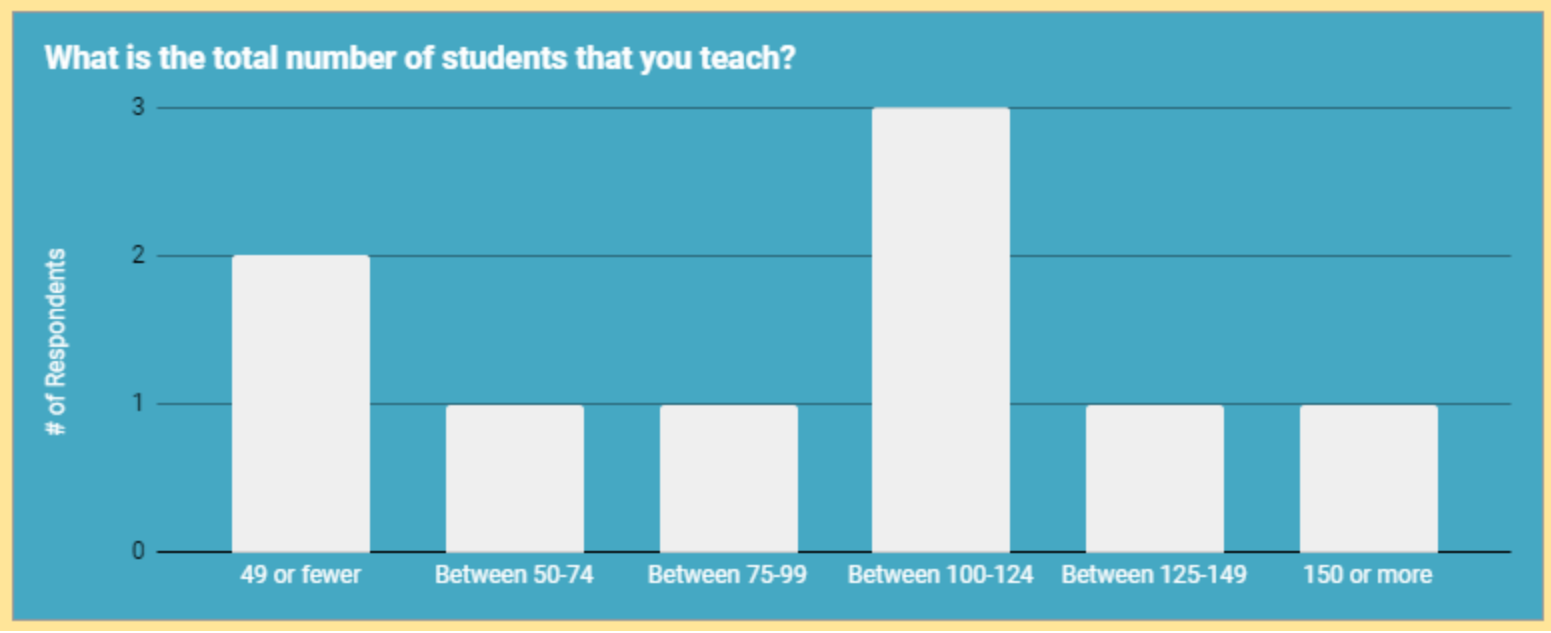
What is the total number of students that you teach?	
49 or fewer	2
Between 50-74	1
Between 75-99	1
Between 100-124	3
Between 125-149	1
150 or more	1

Fewest number of students taught:	*Maxmimum number of students taught:*
35	150

A similar scenario is featured in the "Interview with Teachers" dashboard. Because there are ranges on both ends that might fail to capture the true variation in responses, a minimum and maximum has been added accordingly. If the "49 or fewer" category begins to grow, it may be viable to separate this category into two brackets (perhaps "24 or fewer" and "25 to 49"). Ranges should always be decided after viewing the variation in a set of responses and selecting the ranges that are most relevant to the data.

Besides the first and last category, it is a good rule of thumb to have those categories which fall between the first and last share the same width of range. For example, in this situation, each category has a range of 25 students ("Between 50-74", "Between 75-99" and so on). However, an individual can determine ranges however they best see fit, depending on the data.

The below is an example of how this can be easily visualized according to the manually developed ranges:



Ranges can be adapted as needed. If certain segments of a range becomes extremely dense, it is important to consider how further breaking down these segments might better capture the data in an analysis. This would be significant if, for example, a segment is 15 units wide, yet the bulk of the data falls within a range of just 5. This is only relevant in the case of certain questions. For example, it might not be relevant if a teacher has 60 rather than 75 total students (meaning that there is no reason to further break down this range), however it might be relevant to PEN if teachers are doing 20 practicals, yet not 35. This is entirely within the discretion of the Impact Head, but may arise and should be considered.

Creating a New Chart or Graph

To create a visual (bar graph, pie chart, etc.) based on a table of information, highlight the relevant data, locate "Insert" on the top menu bar and select "Insert Chart". Google Sheets will automatically select a suggested chart type, which you can easily modify as prompted. For more details, visit Google's help site on charts and graphs.

Disaggregating Key Variables: Important Questions to Consider

While analyzing survey data, it is important to consider how distinct groups might be responding differently to PEN's work. The below should serve as examples that can be revisited over time in an attempt to capture these differences, allowing PEN to identify what effects this might have on achieving its goals.

As PEN collects and accumulates larger numbers of survey responses, disaggregating data to better interpret findings is significant. While looking through data, it is important to keep an eye out for important variables that may be affecting PEN's work, which are not limited to the below. For the purposes of this guide, variables concerning two main stakeholders, students and teachers, are looked at in depth.

Teachers

Frequency of Communication:

- Do teachers who maintain more communication with others conduct more practicals in the classroom?
    - Consider creating thresholds of "High", "Medium" or "Low" levels of communication. An example might be teachers that communicate five or more times per month being considered "High" level teachers in terms of communication. Then, this data can be analyzed by asking: "Do teachers who maintain 'High' levels of communication conduct more practicals in the classroom?"

Rural versus Urban:

- Do rural teachers see different levels of frequency in communication when compared to teachers in more urban settings?
- Do rural teachers use practicals more or less often than teachers located in an urban setting?

Experience Level and General Teaching Factors:

- Does the number of years of teaching experience impact how likely a teacher is to use PEN practicals? Or, are teachers with more or less experience conducting more practicals on average? What might be causing this? Also consider how categories determined by a range of years might be relevant to consider this (are "new" teachers those with less than two years of experience? When is a teacher considered "experienced"?)
- Do teachers who teach more subjects in addition to science see varying levels of usage in regards to using practicals in the classroom?
- Does age have a significant impact on the number of practicals being used in the classroom? (Potentially different than disaggregating by teaching experience, if teachers entered the teaching profession later in life, meaning they may have fewer years of experience but are older in age).

Additional Factors to Consider:

- Do private schools see different outcomes than public schools?
- Does gender have any visible impact?
- Does class size have an impact on how many practicals are being conducted in the classroom?
- Do teachers from varying school districts show different levels of practical usage in their classrooms? Why might this be and what role might the District Science Coordinator potentially play in this?
- Do teachers who have access to mentors (potentially through the PEN Professional Practical Teachers incentive) conduct more practicals in their classrooms?

Students

When looking at student outcomes including test scores and critical thinking skills, it is important for PEN to obtain information on their respective teacher in terms of practical usage in the classroom. The assumption is that students who are taught using more practicals (i.e. increased *dosage* of the PEN "intervention"), will see impacts on their scores and more. Beyond solely following the way students might change over time as PEN practicals are used in the classroom, the **number of practicals** used is also significant. It should also be noted that the practicals counted should not be the same practicals conducted several times, but rather a variety.

Based on Practical Frequency

- Do students whose teachers conduct more practicals have higher test scores?
- Do students whose teachers conduct more practicals have higher scores on the Critical Thinking Index?
- In reality, all major variables, including students' desires to study STEM post-JHS, can be in part attributed to their teachers' usage of practicals. Identifying if their teacher is more active in using practicals would be relevant to look at when measuring all student variables (where possible).

Rural versus Urban:

- Do students from rural areas have higher or lower average test scores when compared to those in urban areas? How did PEN's work affect this, if at all?
    - This can also be thought of in the following way: Does PEN's work have the same effect in rural and urban areas? Or, does PEN's work have a greater impact in one setting when compared to another?

Gender

- Do students have varying levels of interest in STEM when gender is considered? How might this affect students' desire to choose to study science in SHS? Currently, gender is not collected in the survey collection tools, and this should be considered in the future, if relevant in the Ghanaian context. This should also be revisited in expansion (as other countries may have varying barriers for women and girls who would like to pursue STEM).

Mixing variables (two or more) is also important.

- For example, do girls in rural areas see different levels of interest in STEM than those in urban areas (significantly different than just comparing rural areas and urban areas?). How does this vary as a result of PEN's work?

All such relevant factors should be considered to appropriately evaluate how PEN's work is reaching varying populations and what variables might be affecting PEN's impact. This will be especially feasible as PEN accumulates large amounts of data.

To easily disaggregate data and compare groups to one another, copies of the relevant data dashboard can be created to quickly analyze and visualize results. From here, striking differences can be recorded, allowing for PEN to consider how different groups might react to its programming, and how unique challenges might be mitigated through alternative programming approaches. For example, if new rural teachers are struggling to implement practicals regularly, what actions can PEN take to better support them?

As PEN expands, it will be important to disaggregate by country, regions within countries, or any other geographic attribute that might have an impact on the effectiveness of PEN's work. PEN should also consider how survey structure might change to capture these details accordingly, such as an additional question being added prior to the main survey questions to include relevant country information or region of Ghana. The data dashboards are able to respond to shifts in columns without modifying the data visualizations (which makes modification fairly simple). However, as new tools are created, PEN should consider how to create new and easy data dashboard templates to make future data analysis more quick and simple.

Coding Open-Ended Survey Responses

Currently, open-ended data responses serve as supplemental information for the Impact Head to consider while looking through data. On the data dashboard templates, responses that are open-ended with the potential to be coded are highlighted in **Yellow**. Additionally, the **Student Focus Group (with Coding)** dashboard provides a layout with coding columns added, along with coded responses to serve as suggestions of how to code each aspect of the corresponding survey's open-ended responses. This is simple to modify or add to any dashboard, using the Excel formulas and processes detailed earlier in this guide.

If it is determined that all open-ended (or some) will be coded, it must be noted that responses sheets should always be expanded in their original Google Sheet before being transferred to the data dashboard "Form Responses" tab. This is to ensure that the responses align with the proper column, and does not create confusion. For example, if column "D" is serving as a coding column, column "D" in your original form responses should be shifted one column to the right. Once columns are correctly adjusted to align with the data dashboard coding template, they can be transferred over accordingly.

Note: In the "Student Focus Group" data dashboard, the responses to the question "What do you want to become in the future" have been **counted based on what was reported by students at the time of dashboard development. This column of the survey responses should be revisited from time to time to identify new trends in desired career paths.** Additionally, it is possible to categorize those careers which are mentioned less frequently as "Other".

Note: In the "Student Focus Group" data dashboard, favorite subjects should also be reviewed to ensure cohesion in naming (within the formulas listed in the table). **New responses should be reviewed to ensure the wording is the same as those in the codes (for example R.M.E. versus Religious and Moral Education)**. Subjects should also be revisited if new favorites are reported by students. Those not listed in the table should have "Other" explicitly written in front of the response to ensure it is accounted for.

Aggregating and Tracking Data Over Time

Overview: The PEN Long-Term Tracking Tool

This tool has been designed to measure and track PEN's eight key indicators over several years. The current tool is measuring from 2018-2021, but this can also be used to reflect on past data (by copying the sheet and simply changing the Academic Years listed in Row 1 on the "Data" sheet). Any changes made in the "Data" tab (including the "Academic Year" and "Term" information), will automatically change the corresponding information in the "Analysis & Visualization" tab.

The PEN Long-Term Tracking Tool has two sheets: "Data" and "Analysis & Visualization"

- **"Data Tab":** This tab will involve nearly all key inputs of data, listed by Academic Year and Term. Note that some indicators are only measured twice per year, or once per year. The appropriate cells have been noted accordingly. All notes on these cells should be reviewed, as they specify what type of number to enter (an average, a percentage, etc. based on what is appropriate, with percentages sometimes being calculated in the "Analysis & Visualization" tab).
- **"Analysis & Visualization" Tab:** This tab automatically analyzes and visualize the data that is entered into the "Data" tab.
    - ***Note:*** The only data that will be directly entered into the "Analysis & Visualization" tab, due to them being data points external from PEN, are:
        i. **Indicator 6: Percentage increase in students' STEM exam scores, "Regional Average" (Row 147):** Enter the regional averages for students' B.E.C.E. exam scores, if obtainable, to compare to the scores of students in PEN-Trained Teacher classrooms.
        ii. **Indicator 8: Proportion of Form 3 students in a given year choosing to study STEM after JHS "Regional Average" (Row 199):** The regional averages of students choosing to enter SHS for STEM categories should be entered directly into the appropriate cells (based on the proper academic year).
    - ***Note:*** Rows shaded light grey in the "Analysis & Visualization" tab are not visualized, though are still calculated as the information is relevant.

As PEN grows, this tool can be adapted to analyze in-country progress, regional progress, and more depending on what is being observed and measured. For example, this tool can be used for **country-wide programming in Ghana** (leading to "Regional Average" being replaced with "National Average"), and can also be copied and used as a tool for each region, closely monitoring how PEN-Trained Teachers and students in their classrooms perform in comparison to relevant similar groups.

Measuring Each Indicator

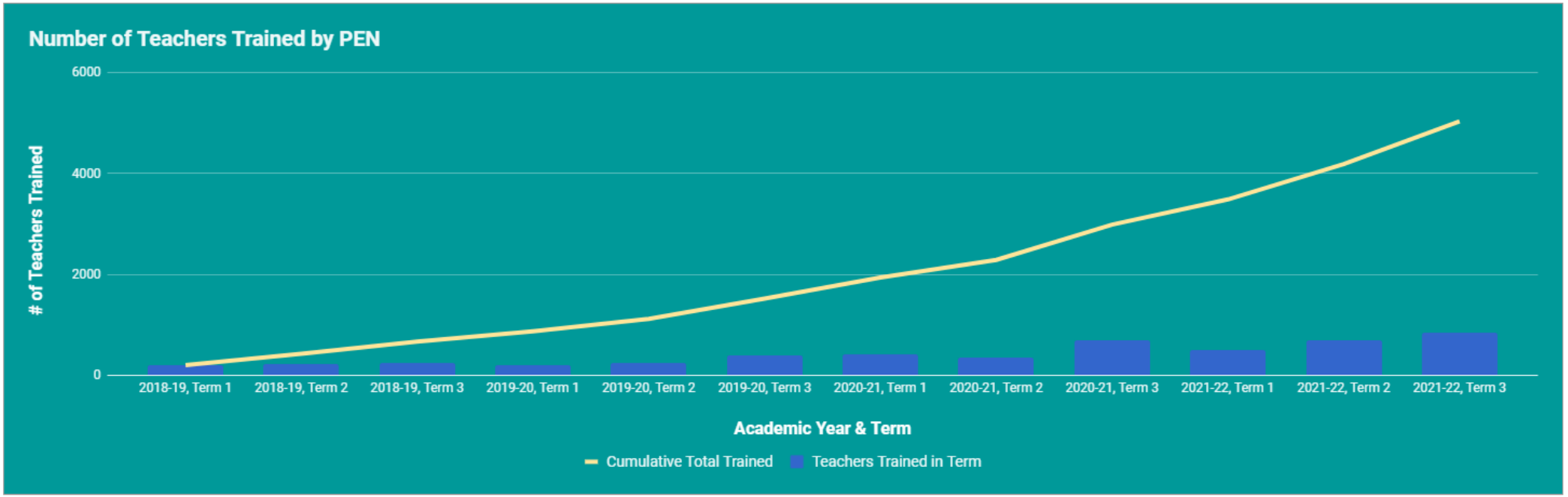
Each of PEN's eight indicators have a section in the "Analysis & Visualization" tab. Each indicator has an associated table, with data being pulled directly from the inputs on the "Data" tab. Calculations are automatically populated in the tables according to what is significant to consider for each indicator. Additionally, directly following each table is at least one relevant visualization to see how PEN's impact has varied over a multi-year period.

Note: These indicators may not directly align with the indicator numbers listed on the survey instrument tools, as the indicators have been reordered by theme (though the language remains the same).

Indicator 1: Number of Teachers Trained by PEN

Data Source: PEN's General Recordkeeping (Rosters of teachers who attend every training)
Input Frequency: The number of teachers trained should be aggregated **once per term**, and input in the "Data" tab accordingly.

Indicator 1: Number of Teachers Trained by PEN												
Academic Year, Term:	2018-19, Term 1	2018-19, Term 2	2018-19, Term 3	2019-20, Term 1	2019-20, Term 2	2019-20, Term 3	2020-21, Term 1	2020-21, Term 2	2020-21, Term 3	2021-22, Term 1	2021-22, Term 2	2021-22, Term 3
Teachers Trained in Term	200	222	245	200	250	400	420	350	700	500	700	850
Cumulative Total Trained	200	422	667	867	1117	1517	1937	2287	2987	3487	4187	5037
% Change (from prior term)	0.0%	11.0%	10.4%	-18.4%	25.0%	60.0%	5.0%	-16.7%	100.0%	-28.6%	40.0%	21.4%

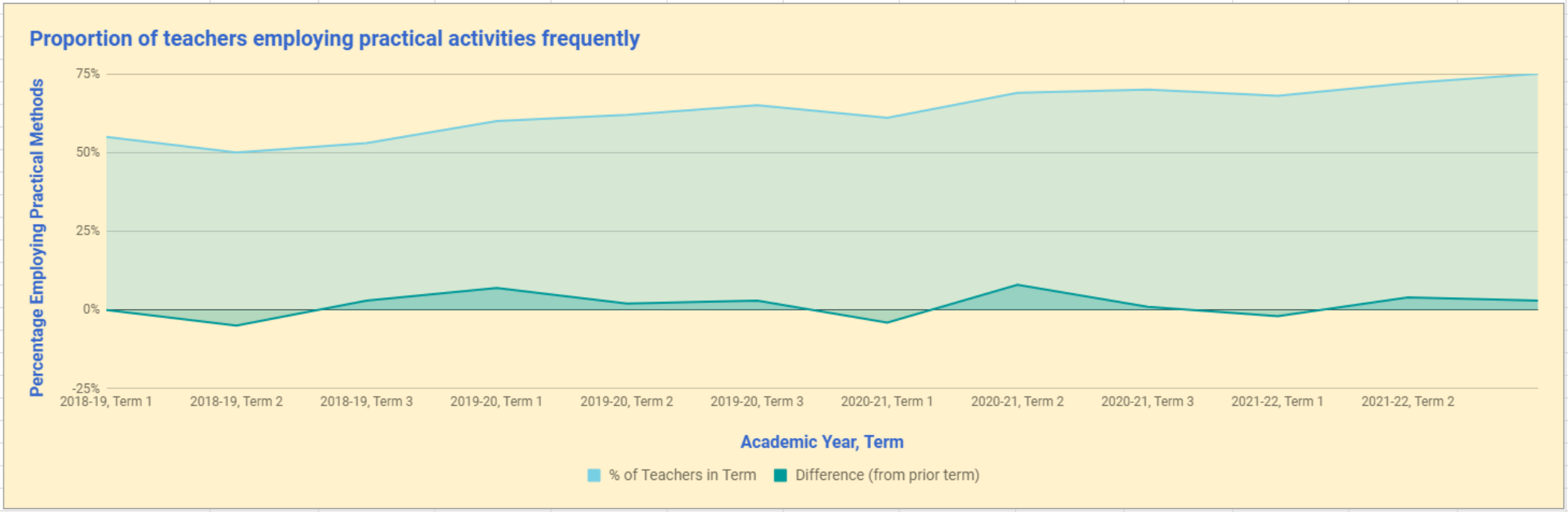


In tracking the number of teachers trained by PEN, it is relevant to include both the number of teachers trained in a given term, as well as the number of cumulative teachers over time. This can be visualized either in the same graph as shown above, or separate graphs. The "Cumulative Total Trained" is automatically calculated based on what has been entered in the "Data" tab. The "% Change (from prior term)" is currently not visualized, and is shaded in light grey in the table.

Indicator 2: Proportion of teachers employing practical activities more frequently

Data Source: Survey Responses (Teachers)
Input Frequency: Once per term

Indicator 2: Proportion of teachers employing practical activities more frequently												
Academic Year, Term:	2018-19, Term 1	2018-19, Term 2	2018-19, Term 3	2019-20, Term 1	2019-20, Term 2	2019-20, Term 3	2020-21, Term 1	2020-21, Term 2	2020-21, Term 3	2021-22, Term 1	2021-22, Term 2	2021-22, Term 3
% of Teachers in Term	55%	50%	53%	60%	62%	65%	61%	69%	70%	68%	72%	75%
Difference (from prior term)	0%	-5.00%	3.00%	7.00%	2.00%	3.00%	-4.00%	8.00%	1.00%	-2.00%	4.00%	3.00%

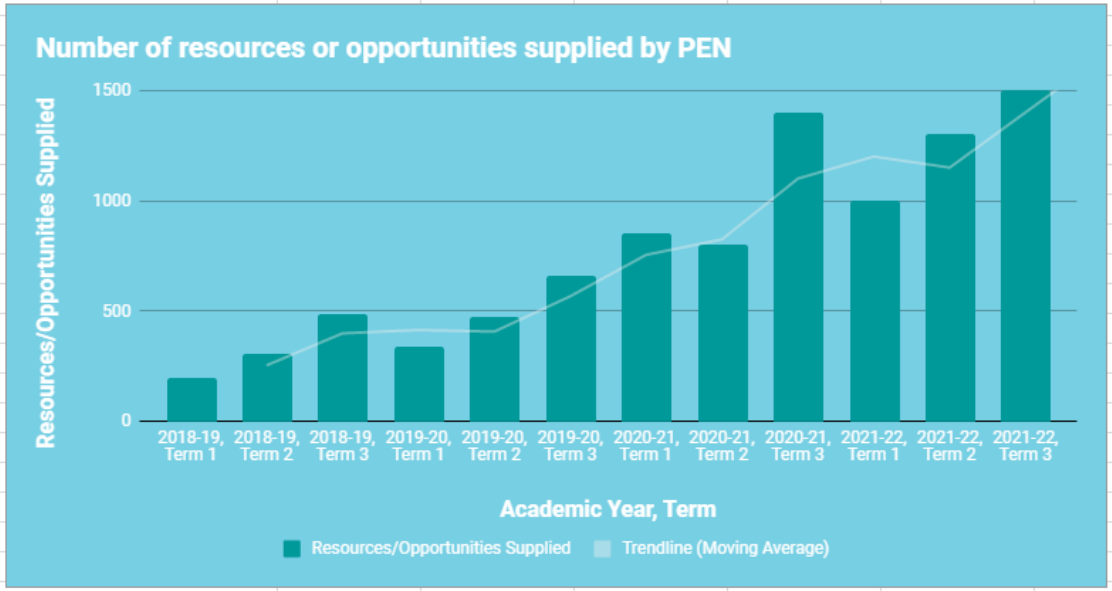


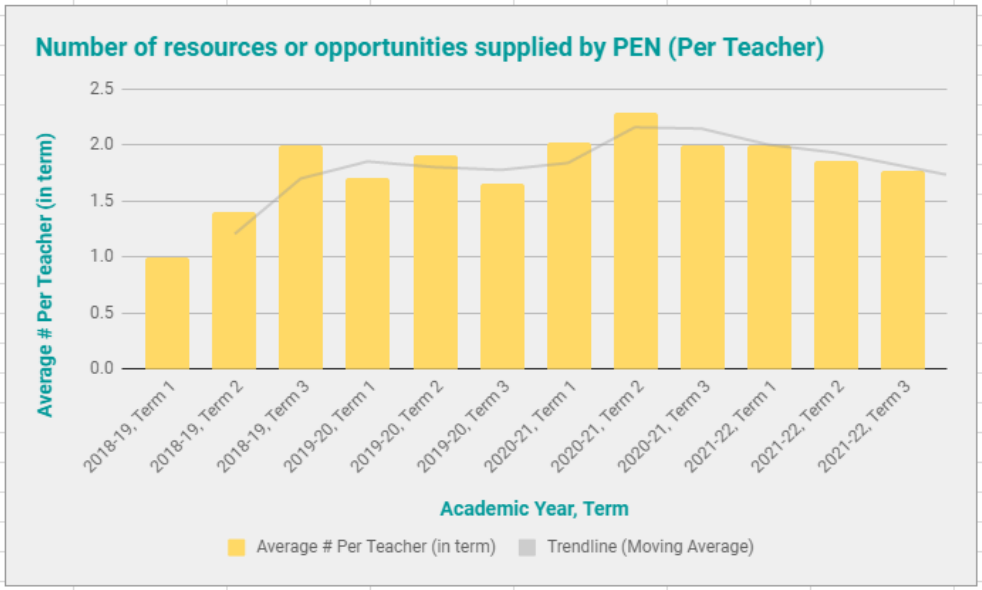
This number should be calculated externally, with the proportion of teachers using methods "more frequently" (however defined by PEN, or as a designated frequency, such as "at least 8 practicals per term") entered as a percentage on the "Data" tab.

Indicator 3: Number of resources or opportunities supplied by PEN

Data Source: General Recordkeeping
Input Frequency: Once per term

Indicator 3: Number of resources or opportunities supplied by PEN												
Academic Year, Term:	2018-19, Term 1	2018-19, Term 2	2018-19, Term 3	2019-20, Term 1	2019-20, Term 2	2019-20, Term 3	2020-21, Term 1	2020-21, Term 2	2020-21, Term 3	2021-22, Term 1	2021-22, Term 2	2021-22, Term 3
Resources/Opportunities Supplied	200	310	490	340	475	660	850	800	1400	1000	1300	1500
Average # Per Teacher (in term)	1.0	1.4	2.0	1.7	1.9	1.7	2.0	2.3	2.0	2.0	1.9	1.8
% Change (from prior term)	0.0%	39.6%	43.2%	-15.0%	11.8%	-13.2%	22.7%	12.9%	-12.5%	0.0%	-7.1%	-5.0%





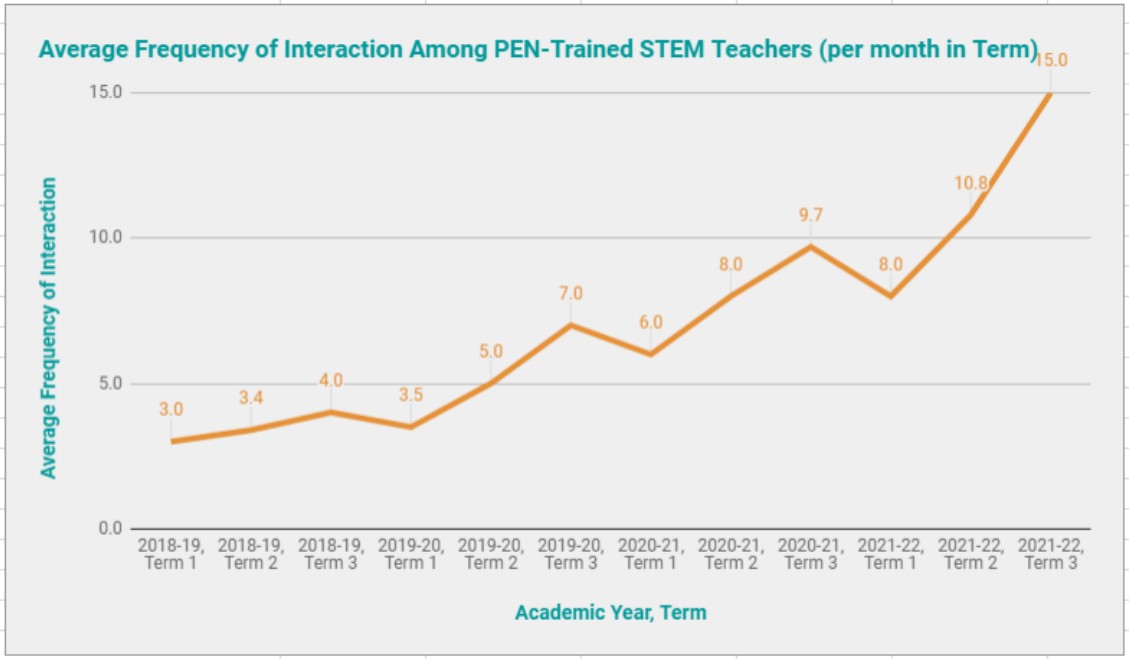
PEN should be considering not only the hard number of resources and opportunities supplied to teachers in a given term, but how this number compares to the number of teachers trained during that same period. The number of resources per teacher trained in a given term is automatically calculated based on the information entered for Indicator 1. This number can also be compared to the cumulative number of teachers trained, in the case that PEN provides a significant number of resources to teachers trained prior (even several years ago, etc.). For now, it has been assumed that resources are mostly allocated to the most recently trained teachers (such as by giving them the manual, by offering certificates, and more). An additional chart can be added to account for how the number of cumulative teachers trained compares to the number of resources given in the current term, if desired.

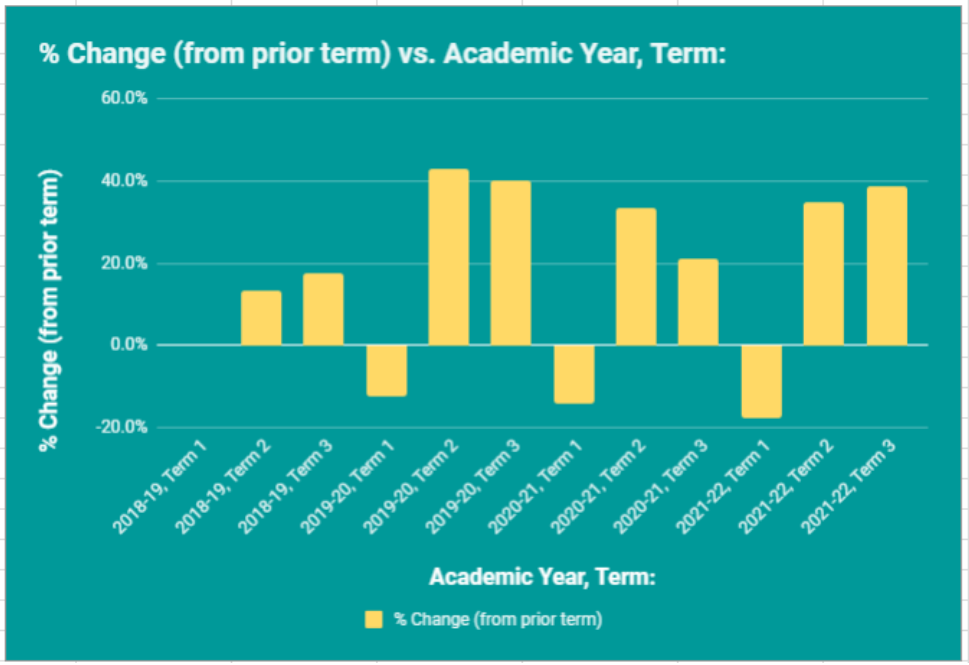
Indicator 4: Percentage increase in frequency of interaction (referencing and sharing) among PEN-trained STEM teachers.

Data Source: Survey Responses (Teachers)

Input Frequency: Once per term

Indicator 4: Percentage increase in frequency of interaction (referencing and sharing) among PEN-trained STEM teachers.												
Academic Year, Term:	2018-19, Term 1	2018-19, Term 2	2018-19, Term 3	2019-20, Term 1	2019-20, Term 2	2019-20, Term 3	2020-21, Term 1	2020-21, Term 2	2020-21, Term 3	2021-22, Term 1	2021-22, Term 2	2021-22, Term 3
Average Frequency of Interaction	3.0	3.4	4.0	3.5	5.0	7.0	6.0	8.0	9.7	8.0	10.8	15.0
% Change (from prior term)	0.0%	13.3%	17.6%	-12.5%	42.9%	40.0%	-14.3%	33.3%	21.3%	-17.5%	35.0%	38.9%



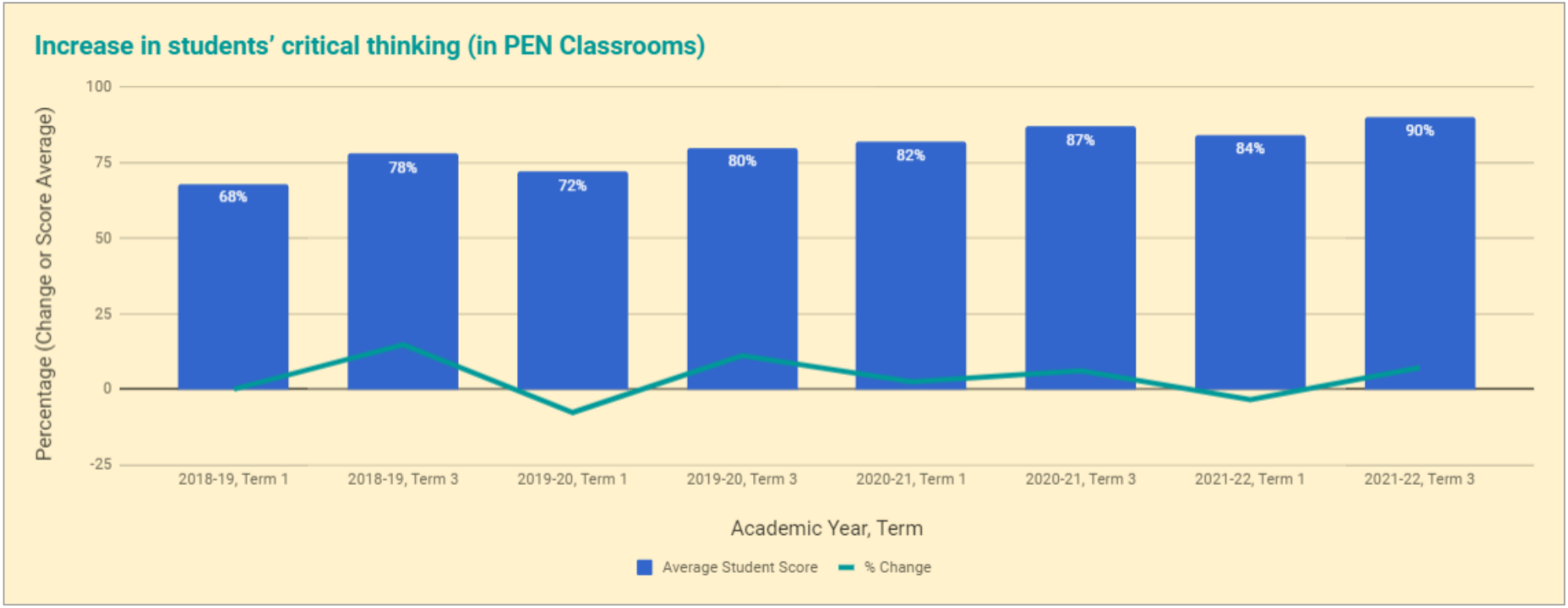


Due to the varying lengths of Terms during the Academic Year in Ghana, frequency of teacher communication should be looked at in terms of *monthly averages*. This allows terms to be compared to one another without skewing the frequency of interaction (as a longer term may appear to have greater frequency in raw number, but actually have lower frequency on average due to the extended length of time). Teacher survey responses will give an average per term, and depending on the term length, a "per month" average can be determined and appropriately entered into the "Data" tab.

Indicator 5: Percentage increase in students' critical thinking.

Data Source: Student Focus Group Responses; Critical Thinking Index
Input Frequency: Twice annually (Term 1 and Term 3 of each Academic Year)

Indicator 5: Percentage increase in students' critical thinking.								
Academic Year, Term:	2018-19, Term 1	2018-19, Term 3	2019-20, Term 1	2019-20, Term 3	2020-21, Term 1	2020-21, Term 3	2021-22, Term 1	2021-22, Term 3
Average Student Score	68%	78%	72%	80%	82%	87%	84%	90%
% Change	0.0%	14.7%	-7.7%	11.1%	2.5%	6.1%	-3.4%	7.1%



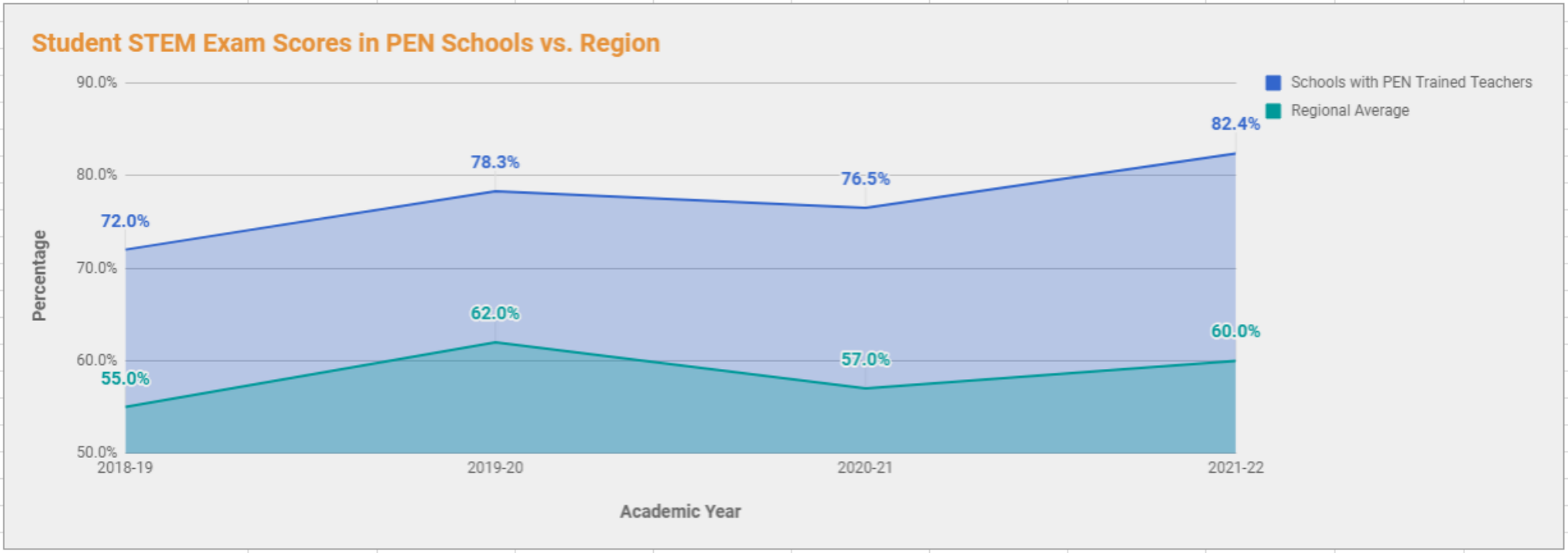
Due to the nature of collecting data by using a "Critical Thinking Index", obtaining this data twice per year is most feasible. **The same students should be tracked, especially given the small sample size.**

Indicator 6: Percentage increase in students' STEM exam scores

Data Source: Survey responses (Teachers)

Input Frequency: Once per year

Indicator 6: Percentage increase in students' STEM exam scores				
Academic Year:	2018-19	2019-20	2020-21	2021-22
Schools with PEN Trained Teachers	72.0%	78.3%	76.5%	82.4%
Difference in PEN Schools (from prior Academic Year)	0.0%	6.3%	-1.8%	5.9%
Regional Average	55.0%	62.0%	57.0%	60.0%
Difference in Scores (PEN vs. Non-PEN Schools)	17.0%	16.3%	19.5%	22.4%



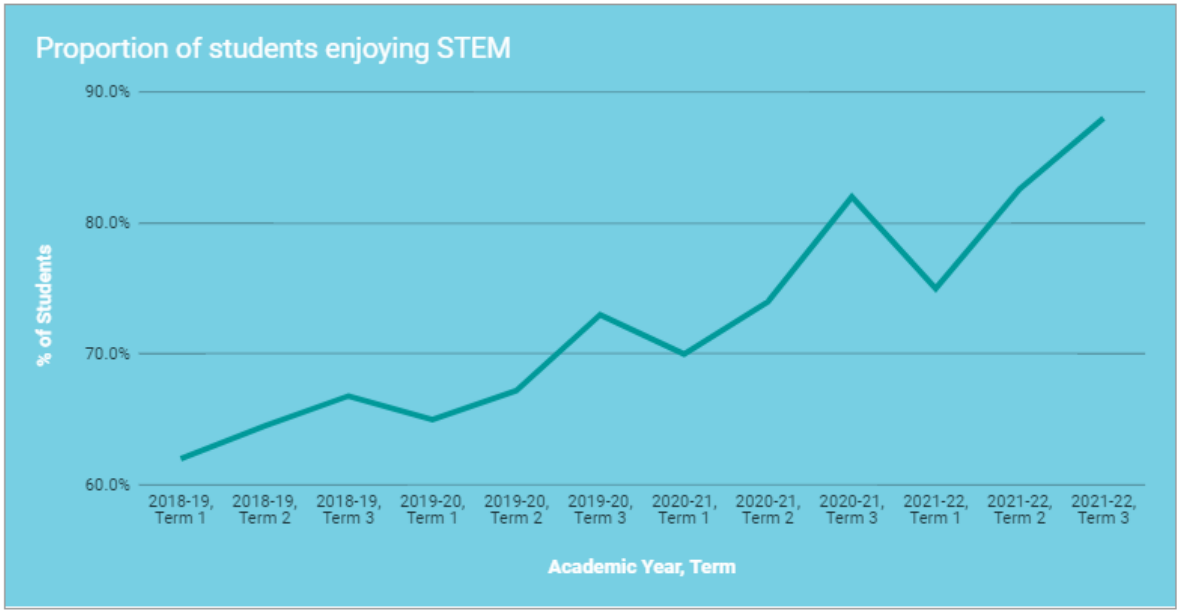
Teachers report their students' B.E.C.E. scores from the past year, which can be useful in tracking how these scores compare to averages in the region. Because this exam is given just once per year, alternate exam scores from teachers can also be collected and compared by term (from before a student is exposed to PEN practicals, to after the student has become accustomed to engaged hands-on science in the classroom). For these purposes, the same students should be tracked over time, and cannot necessarily be compared from one class to another (in the case that the tests are created by their teachers with naturally varying levels of difficulty as a result). The B.E.C.E., being a standardized exam however, can be compared across groups.

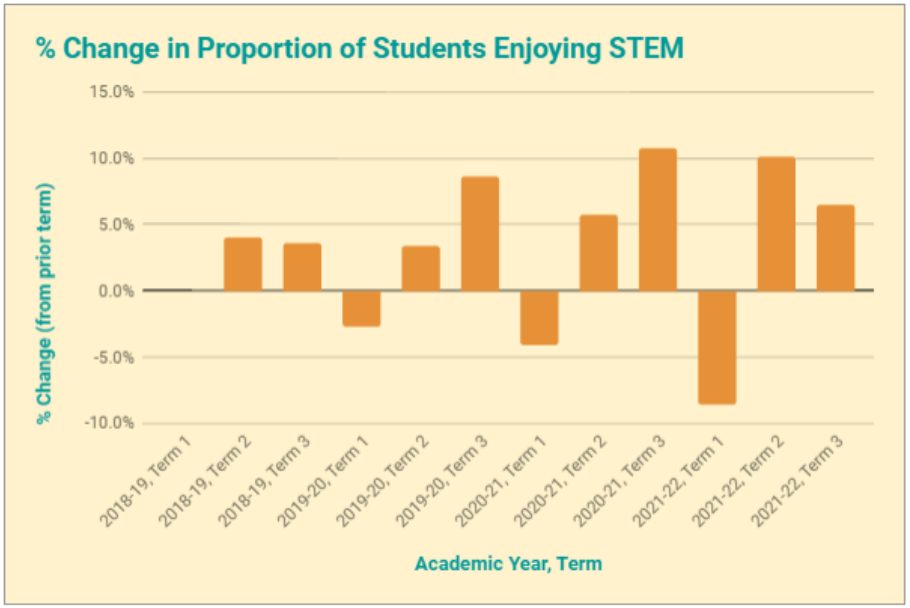
Indicator 7: Proportion of students enjoying STEM

Data Source: Survey Responses (Student Focus Group)

Input Frequency: Once per term

Indicator 7: Proportion of students enjoying STEM.												
Academic Year, Term:	2018-19, Term 1	2018-19, Term 2	2018-19, Term 3	2019-20, Term 1	2019-20, Term 2	2019-20, Term 3	2020-21, Term 1	2020-21, Term 2	2020-21, Term 3	2021-22, Term 1	2021-22, Term 2	2021-22, Term 3
Proportion of Students	62.0%	64.5%	66.8%	65.0%	67.2%	73.0%	70.0%	74.0%	82.0%	75.0%	82.6%	88.0%
% Change (from prior term)	0.0%	4.0%	3.6%	-2.7%	3.4%	8.6%	-4.1%	5.7%	10.8%	-8.5%	10.1%	6.5%





With PEN's current tools, students report their favorite subjects, as well as respond to the question "I really enjoy learning science". The latter best indicates student enjoyment in the Student Focus Group tool, as students self-rank their enjoyment level. For the purposes of the Long-Term Tracking tool, it can be decided that either students selecting "Strongly Agree" or both "Strongly Agree" and "Agree" be counted to calculate the proportion of students enjoying STEM. This is most valuable to Indicator 7.

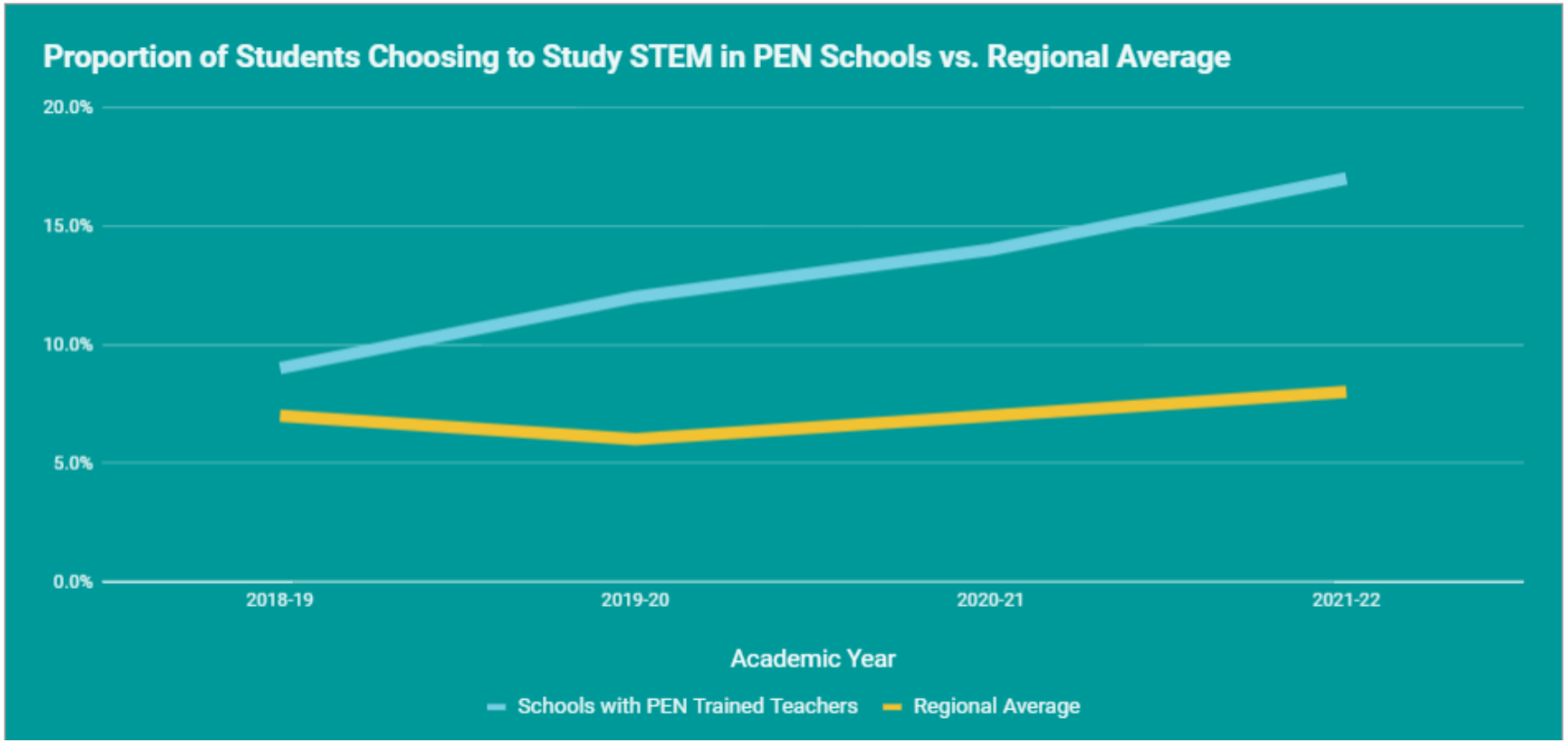
Teachers' reporting of students' enjoyment of STEM can also be included (though not as accurate as student self-reporting). Similarly, the Classroom Observations tool can be used, but this is subjective on behalf of the observer, who may not be fully aware of the students' general engagement and participation levels in the classroom. For this reason, it is suggested that this indicator is mostly weighted by the students' self-reporting of enjoyment of STEM as asked in the Student Focus Group survey tool.

Indicator 8: Proportion of Form 3 students in a given year choosing to study STEM after JHS.

Data Source: External resource; PEN records

Input Frequency: Once per year

Indicator 8: Proportion of Form 3 students in a given year choosing to study STEM after JHS.				
Academic Year:	2018-19	2019-20	2020-21	2021-22
Schools with PEN Trained Teachers	9.0%	12.0%	14.0%	17.0%
Difference in PEN Schools (from prior Academic Year)	0.0%	3.0%	2.0%	3.0%
Regional Average	7.0%	6.0%	7.0%	8.0%
Difference in Scores (PEN vs. Non-PEN Schools)	2.0%	6.0%	7.0%	9.0%



Beyond observing the percentage of students in PEN-Trained Teacher classrooms that choose to study STEM and how this might change over time, it is important to consider how this compares to the regional average.

Next Steps: Creating Goals to Track Progress Against Targets

The Long-Term Tracking Tool developed for PEN provides a way for PEN to track its long-term progress over several years, and as such can help inform PEN on the goals that it can develop and strive to achieve. **Based on what is feasible for a science education intervention in Ghana (which can be identified through research), and considering baseline information for schools that PEN has not yet entered, PEN can create realistic goals.** These goals may see a stable percentage increase each year (for example, a 10% increase in the number of teachers trained per year), or these goals may see an increasing rate of change each year (for example, a 10% increase for 2019, a 15% increase in 2020). PEN should reflect on its goals for overall programming growth and expansion, and create either steady or increasing goals accordingly. With this information, PEN will be better able to track its achievements in accordance with its eight key indicators. **Goals should be created to align with each individual indicator.**

Additional Recommendations

Integrate Goals with a Long-Term Tracking Tool
Either in the current tool developed to track PEN's long-term progress, or in a separately created tool, PEN should enter its new goals into a Google Sheets-based tool that can allow for PEN to track its achievements in an easy way. This will allow for all staff members to access the information and identify where PEN is falling in terms of its goals.

As PEN expands, creating country-specific or region-specific goals will also be valuable. Instead of solely aggregating and tracking progress over time, it will be important to consider how PEN is progressing on a country-specific and region-specific level.

Comparing Individuals Over Time
Due to small sample sizes, it is recommended that the PEN team survey the same teachers in a given academic year, and similarly track the same students. As ten individuals are not necessarily representative of "the average PEN teacher" or "average student in a PEN-trained classroom", it is important that the data collected tell an accurate story that can be compared across terms in a given academic year. The nature of PEN staff visiting may appear to be an added incentive for teachers to conduct more practicals, which should also be considered.

Making Data-Driven Decisions

As an ongoing initiative, PEN staff should consider what this data means for its programming, revisiting any key issues or negative trends that are spotted. Is teacher frequency of using practicals decreasing in a certain area? Why might this be? Who can be contacted to better understand certain challenges being faced? Understanding what is significant to keep an eye out for can help PEN react more quickly and effectively to challenges that the data might reveal. As PEN expands to new regions, watching changes in data and having a keen eye for trends will likely prove important in ensuring that PEN's program maintains a desirable level of quality. If changes in technology, quality of trainings or more vary over time, it should consider how it can respond to these in conjunction with trends that data reveals to make informed decisions.

Appendix B

The Practical Education Network

Salesforce Reference Guide

&

May 2018

PEN Salesforce Reference Guide

Table of Contents

Introduction

Salesforce is the world's #1 Customer Relationship Management (CRM) system, designed to meet the needs of private, public and nonprofit entities. CRMs allow organizations to track customers over long periods of time, follow changes that may occur, and respond to these changes in a sufficient manner. For the purposes of the Practical Education Network (PEN), Salesforce allows for the organization to manage the relationships of two key stakeholders:

- Teachers - By effectively storing information on the teachers that PEN has trained, the team can better manage relationships with these individuals and track their progress over time. Given the large number of teachers trained at this moment and the few number of staff members, it is likely that only select teachers will be followed up with on a regular basis; however Salesforce is still the tool to effectively manage and track this.
- Trainers (both Circuit Trainers and Master Trainers) - Because the role of trainers is so crucial to implementing and expanding PEN's work, tracking these relationships is critical. When possible, understanding the reach and frequency of Circuit Trainer (CT) trainings will help PEN respond to any inefficiencies, and as PEN expands beyond Greater Accra, following Master Trainers (MT) will also be important. As will be discussed in further detail, Salesforce allows PEN staff to create reminders to reach out and receive updates from both CTs and MTs on a regular basis, and allows for valuable conversation tracking and note taking on progress or challenges faced. Additionally, PEN can more accurately understand the number of trainings taken place, at this time especially by CTs, as well as ensure follow up with CTs to receive their registration documents for input into Salesforce.

This guide discusses the relevance of the pieces involved to each of these stakeholders' Salesforce records, as well as how to effectively ensure that data is properly stored within the system. Additionally, information on how to import new contacts from Excel "Comma-Separated Values" (.csv) files, as well as how to extract and clean information from the system.

Salesforce has many capabilities that PEN can slowly adapt to using, however for now there are a few main components that should be regularly maintained to ensure effective data storage and tracking of both teachers and trainers. Updating and editing Salesforce should not be a frequent occurrence, but as programs expand, new stakeholder types emerge and more, making changes to the backend of Salesforce may be required. This guide provides the steps necessary to modify the main components used by the PEN team within the Salesforce platform.

Additionally, this guide refers staff to the many online resources provided by Salesforce, with their corresponding links and purposes. Training hosted by Salesforce is a great way to better understand the capabilities and best uses of the platform, as well as how to engage with the many additional applications that the company has to offer.

Main Salesforce Components

Based on the relevant capabilities of Salesforce for PEN's current needs, there are two main components that will house most of PEN's important data: Contacts and Accounts. These components are linked to one another, but have different page layouts and suggested fields that should be entered across all contacts to ensure consistent and complete data.

Contacts

Sections Overview
There are several sections affiliated with each contact, not all of which will be relevant to every contact. However, the more that each of the fields are utilized, the more complete information can be stored and retained for PEN's organizational memory. **Every database is only as good as the data that is stored within it! Accuracy is key.**

Note: Most fields are self-explanatory, however some are reviewed below for clarification.

Contact Details
This section contains a general overview of the individual. Account Name is linked to the name of the individual's school district, as is further reviewed in the "Accounts" section of this guidebook.

- **"Birthdate"** should be collected and stored rather than "Age", as birth date is fixed, while age changes from year to year. Salesforce currently only stores date of birth.
- **"PEN Title"** should be standardized across the system to ensure that the number of individuals can be counted that are of the same title (whether in an Excel sheet or within Salesforce itself).
- **"Date Last Updated"** should be added during the initial import of contacts, and should be changed as information is updated. If information has not been updated for a long period of time, outreach to the individual may be necessary to obtain more relevant information. This is the case for all sections with "Date Last Updated" fields.

Contact Information
This section covers the specific details on how to reach this individual. An "Additional Notes (Communication)" section allows for any user to mention specific notes about a contact (perhaps, "Call Headteacher first," or anything of the sort).

School Information

- **"Date Last Updated"** should be added during the initial import of contacts, and should be changed as information is updated. If information has not been updated for a long period of time, outreach to the individual may be necessary to obtain more relevant information. This is the case for all sections with "Date Last Updated" fields.
- **"Additional Notes & School Directions"** are important given the potential difficulty in locating schools (especially those in rural locations). Adding information that can help locate schools is helpful, where possible.

Teaching Information

- Similar to "Birthdate", **"Teaching Since"** information should be in the form of a stable date, rather than a changing "Number of Years Teaching". Based on the information that the user has, a date can be derived from the "Number of Years Teaching" and the date in which this information was collected.
- **"Date Last Updated"** should be added during the initial import of contacts, and should be changed as information is updated. If information has not been updated for a long period of time, outreach to the individual may be necessary to obtain more relevant information. This is the case for all sections with "Date Last Updated" fields.
- **"Additional Notes (Teaching)**" allows users to add anything relevant to the contacts' specific teaching information that is not captured in the section's other fields.

PEN Involvement

- **"PEN Level of Involvement"** allows for a user to manually add a level of activity on behalf of a contact. This should be defined by the staff depending on a number of characteristics such as the contact's activity level in their WhatsApp group, number of photos submitted for Teacher of the Month, number of practicals used, and more. This field can help PEN staff track those who are at "Superstar" level, as well as users who have become "Inactive".
- **"ToM"** is a checkbox that should be ticked if the individual has ever received PEN Teacher of the Month. If so, the corresponding **"ToM Date"** should be completed. This is similar to the **"WeGoInnovate Feature"** checkbox and **" WGI Date"**.
- **"Date Logged (Practicals)"** is specifically relevant to ensure that the "Approximate # of Practicals" field is up to date, and should be noted in addition to "Date Last Updated" for the section.
- This section can be adapted to include PEN Professional Teacher (PPT) status by recording an individual's level (bronze, silver and gold), as well as incorporate other incentives that might be added over time.

Trainer Information

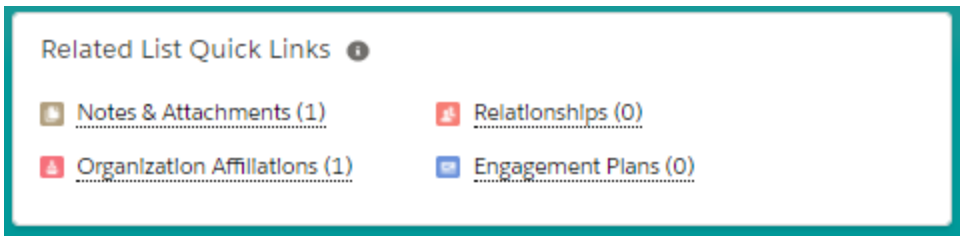
This section is only relevant to those contacts that are Circuit Trainers or Master Trainers.

Additional Information

As requested by PEN staff, this optional section allows for a user to attribute personal aspirations, as well as a contact's aspirations for their students, where known.

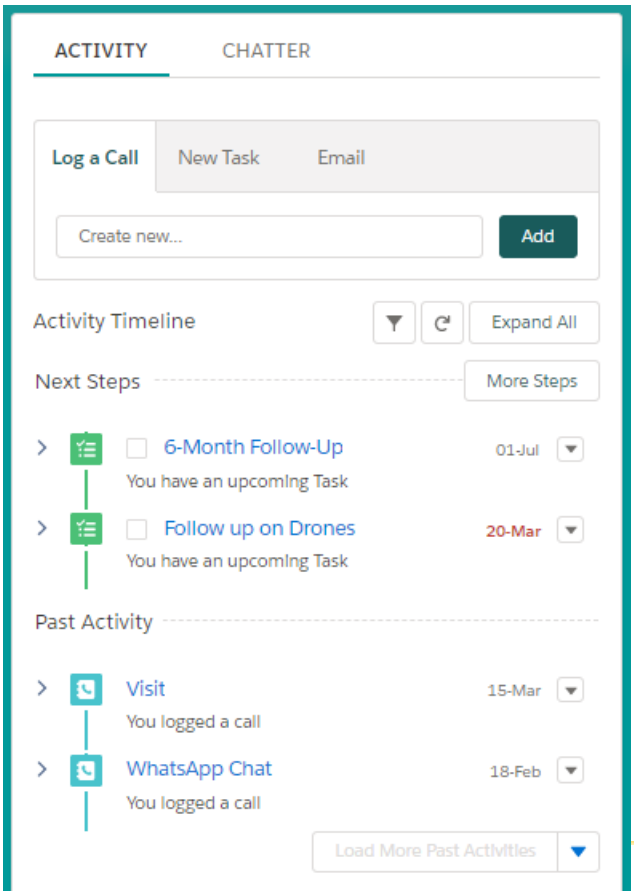
Organization Affiliations (as reviewed in "**Accounts**" section) can also be viewed under the "Related List Quick Links" portion of the contact profile.

Notes & Attachments



Notes & Attachments allow for multiple users to add notes, photos and more to a specific contact or even account. This can be used for recording photos of practicals sent for ToM or PPT, WhatsApp conversations and more. When naming photos, the date of the relevant event should be included, though a date will also appear on each note or attachment based on date "last modified".

Activity Tracker (Past Activities & Follow-Ups)



The **Activity Tracker** allows a user to:

1) Log past interactions with a contact, by selecting **"Log a Call"**, and name the subject according to the topic covered and form of communication. Comments on the conversation itself can also be recorded. This ensures that various staff members can also view when the last time another staff member has been in touch with the individual. To change the date of the interaction to a date other than the date being logged, save the "call", click on the interaction and select "Change Date". A follow-up task can also be created from within this menu by simply clicking "Create Follow-Up Task".

2) Create a **"New Task"** that will set a reminder to the user ensuring follow-up with the contact. Include details and comments as helpful. Tasks can be marked as complete by simply ticking the checkbox next to the event.

Accounts

Contacts are always affiliated with an account. Accounts can be thought of as affiliates to the contact, and accounts can have several individuals linked to it. Based on PEN's current structure, contacts should be affiliated with School District as its primary account. **Accounts are also referred to as "Organizational Affiliations" and "Primary Affiliations" depending on what part of Salesforce you are viewing** (however, the information remains exactly the same). This is important to consider when modifying components in the backend, setting up an initial profile and affiliating individuals with multiple accounts.

Important Notes:

- If no account or organizational affiliation is listed, Salesforce will automatically create an account name that is solely the contact's last name. This is not particularly helpful, as the individual will already be identified by their name. Because of this, the "account" function can be used much more valuably by linking this individual to a main affiliation, where other relevant individuals can also be linked.
- **Individuals can (and in PEN's case, *should*) be connected to more than one "account".** In Salesforce, the "Primary Affiliation" should be the most important account relevant to this individual. In PEN's case this is school district, however individuals can also be affiliated with several other groups. For PEN's situation, this can additionally be their circuit, WhatsApp group based on date(s) of trainings and more. There are fields listed within the account page to allow for this to be captured, depending on the "account" type.
- **The "Account" page layout has the potential to serve more than one account type.** As a result, PEN staff should only complete the fields relevant to the account type that they are creating. For example, when creating a WhatsApp group, it is not relevant to include the information of the District Science Coordinator.
- It is important that fields are entered and used consistently, to ensure that any data exported is cleaner and more manageable on behalf of the PEN staff member utilizing the data.

Primary Affiliation: School District

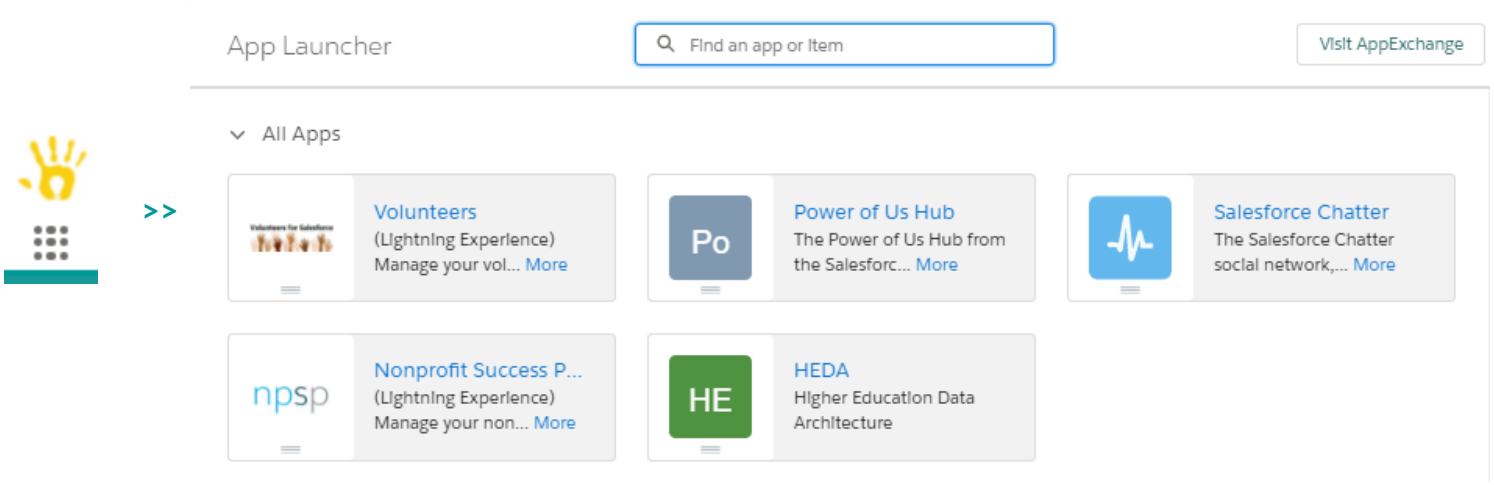
To best serve PEN's needs, teachers should be affiliated with their school district as their "Primary Affiliation". This account type is recommended due to its size, which is not too small to be insignificant (as PEN continuously expands), but is not too large for this moment in PEN's work. In the future, expanding to "region" could be feasible, but being that PEN works in Greater Accra, counting the school districts as the main affiliation for teachers and trainers makes the most feasible sense. "Location", in this situation, should be affiliated with the relevant government office for the school district (potentially the office of the District Science Coordinator).

Additional Affiliation: WhatsApp Groups

An additional "Account" or affiliation that is relevant to teachers is their WhatsApp group associated with their training(s). In the case that a teacher has attended multiple trainings, teachers can be affiliated with this WhatsApp group. If wanting to track a teacher and the groups they might be present in, having this information stored somewhere is relevant. Additionally, transcripts, activity levels and more from these groups can be stored on their affiliated WhatsApp Group account page, to ensure that no information is lost in time. "Location of Training" should be the only location part completed (therefore disregard the "Location" piece below this component, as this is restricted to school district information).

Homepage (NPSP)

When logging in, a user is automatically directed to their Homepage, which is designated by the Nonprofit Success Pack. To access the Homepage at any time, select the nine-dot icon (or "App Launcher") on the upper-left hand of your screen, and select "Nonprofit Success Pack",

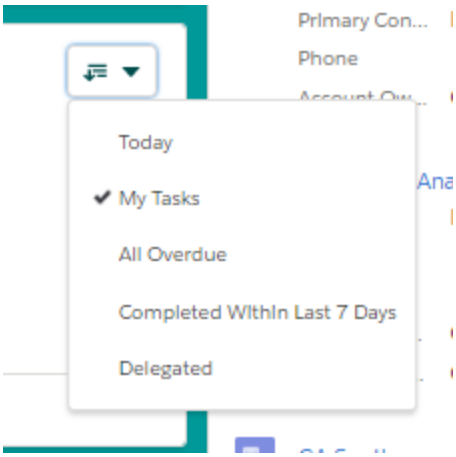


The homepage visible to all PEN users, and features a users' most recent items and records, as well as "Today's Events" and "Today's Tasks".

Today's Events

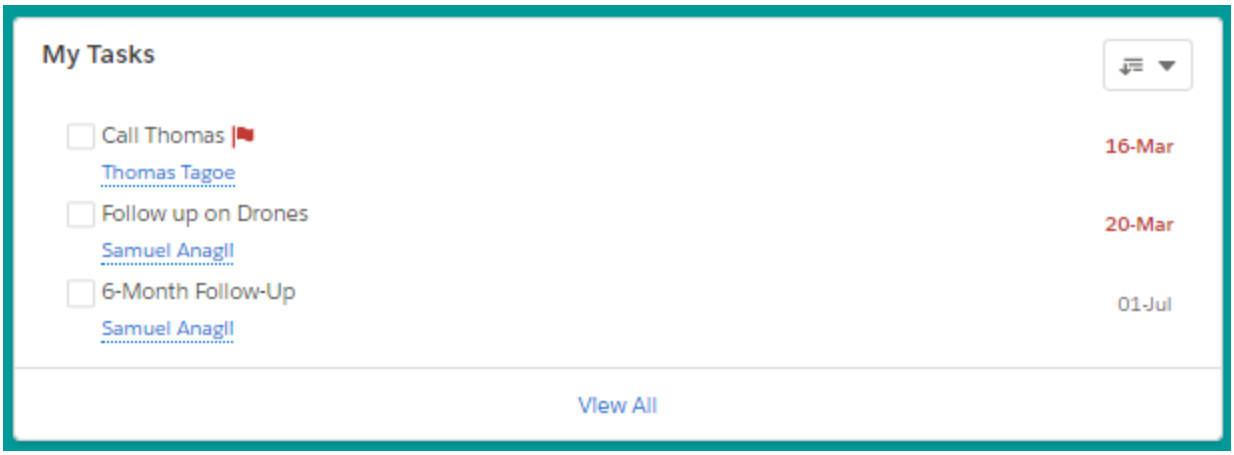
Clicking **Today's Events** gives a user access to their own private calendar. New events can be created according to contacts and accounts within Salesforce, with space to include the time, location, and description. Upon entering calendar, a user can select to view the day, week or month as desired.

Tasks



The "Tasks" feature is great for keeping track of follow-ups with relevant individuals. The tasks box on the homepage can feature "Today's Tasks", "My Tasks", "All Overdue", "Completed Within Last 7 Days", or "Delegated".

It is recommended that "My Tasks" is the selected standard, displaying all upcoming and previous tasks that the user should be paying attention to. The relevant contact is linked to the event. Once completed, the checkbox on the left-hand side of the task should be ticked. Any tasks that appear in **red** are overdue.



Editing Salesforce (Backend Management)

Making modifications to Salesforce involve entering "Setup" mode, which can be accessed by clicking the "Gear" icon on the top-right hand side of the homescreen. This will open a new window in which you can perform all of the required backend editing.

Object Manager

The Object Manager will be the main source of backend management required on behalf of PEN staff. The two main components to be edited in Object Manager are "Contacts" and "Accounts".

Fields & Relationships

A detailed how-to create and edit Fields & Relationships can be viewed here, that covers the step-by-step procedure for editing in Object Manager.

There are many fields and relationships, most of which are not relevant to PEN's contacts. The fields viewable on a contact profile have mostly been manually created and added to the Fields & Relationships tab. They generally have "PEN_" prior to the "Field Name" as seen in the example below:

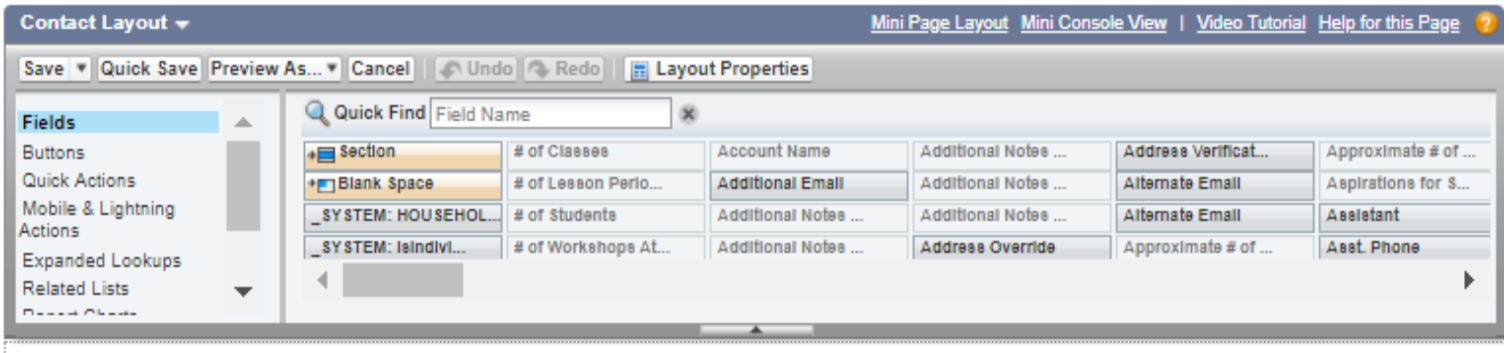
FIELD LABEL	FIELD NAME	DATA TYPE
# of Classes	PEN_Classes__c	Number(18, 0)

Fields that have been manually created for PEN can be modified, however most fields that have come with the Nonprofit Success Pack cannot be modified. If desired field is not modifiable and needs to have changes made to it, it is recommended that a new field be created and modified accordingly.

Page Layout

The only "Page Layout" in use is the "Contact Layout" type. To make any changes to this, selected the layout and enter the layout editor.

Fields can easily be dragged and dropped to make modifications as desired. New sections can be added by selecting the appropriate field from the "Field Selector" at the top of the page.

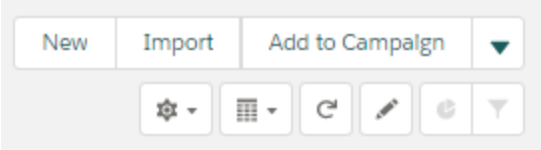


Search for your field name in the Quick Find bar to avoid searching through the many options designated with the Nonprofit Success Pack. Note that these are viewable only by "Field Label" and not "Field Name", meaning that the coded name assigned to the field is not visible (only the field that will explicitly be listed on the contact profile is visible). This means that if you have coded all unique fields to have "PEN_" conveniently written in front of it, it will not be searchable by that name in the Contact Layout Editor.

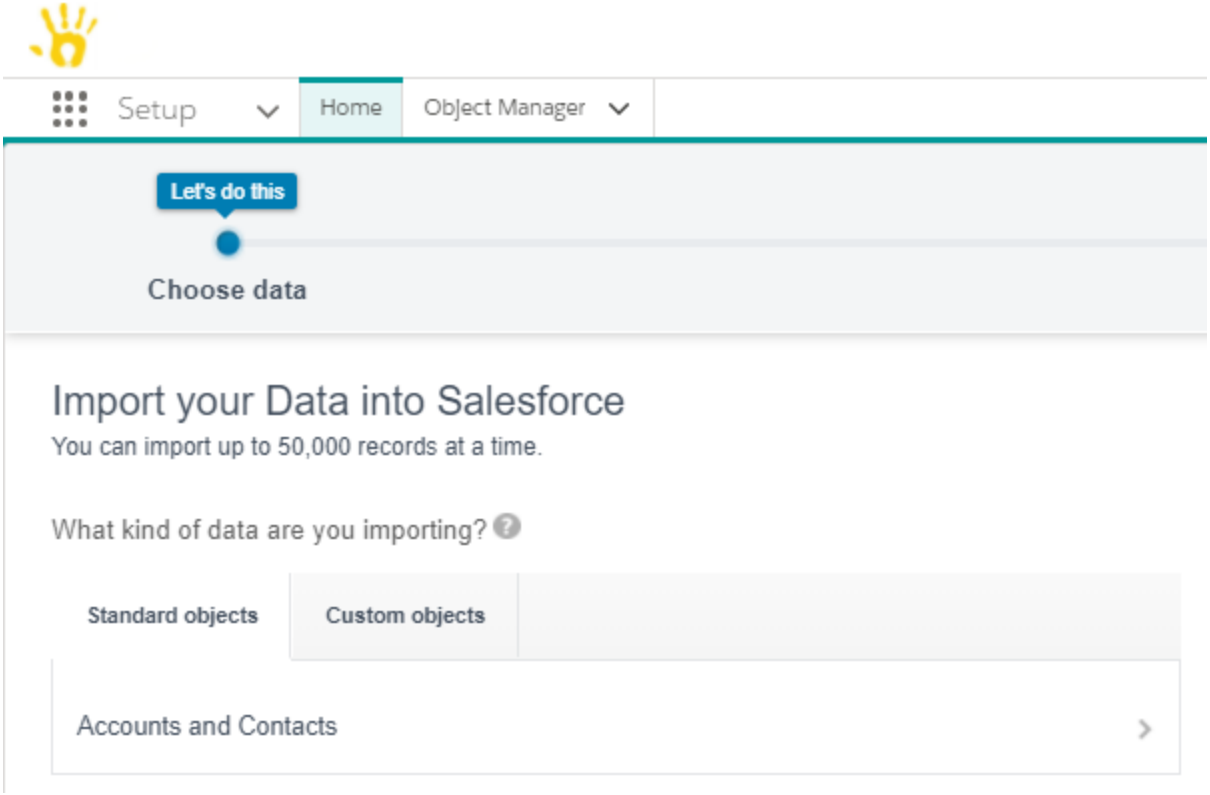
Exporting & Importing Data

Importing Data

- To import data, enter the "Contacts" tab, and click "Import".



- You will be redirected to the settings Import Wizard.



- Click "Accounts and Contacts" and select "Add new records".
- You will be prompted to upload a CSV file accordingly. If your data is not currently in CSV format, it can be easily converted and saved as CSV in Excel.
- Then click "Next".
- Next, depending on the data being uploaded, map the appropriate fields to the columns in your Excel CSV file. All fields that you would like saved to your contacts should be mapped, or they will not be uploaded into Salesforce.

Note: Ensure that "Contact Name" does not also include "Account Name", as this should be mapped to the **school district**.

Exporting Data

Recommended:

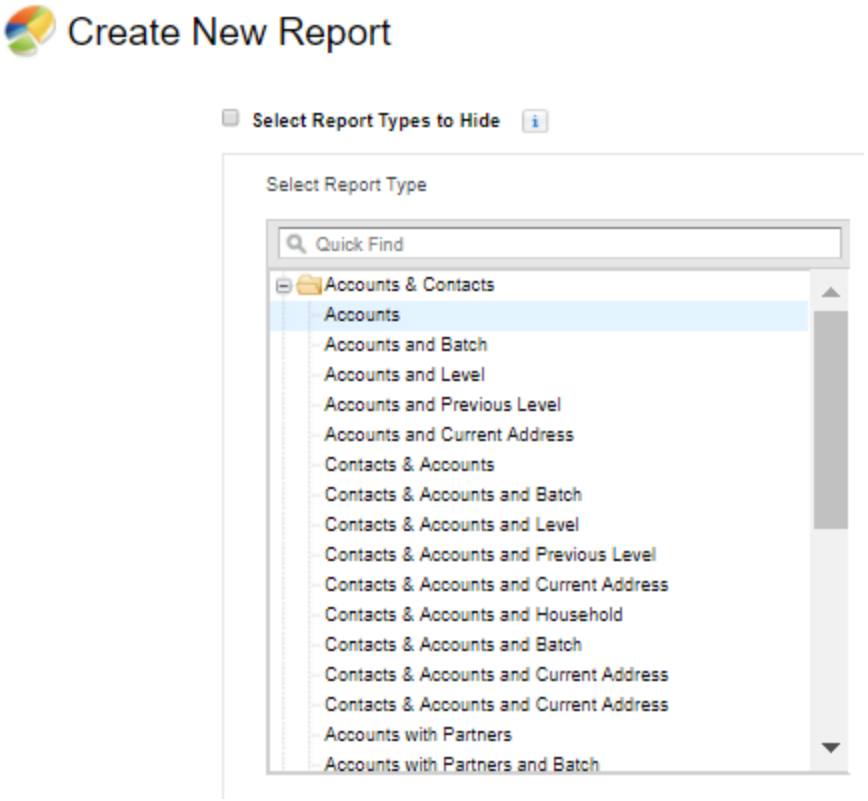
To have a spreadsheet of ALL fields of data for every contact prepared and emailed to the account associated with a user's Salesforce login, review the steps written on this Salesforce help page. This is recommended as all fields will be exported, though the spreadsheet will need to be cleaned due to the number of fields that exist within Salesforce but are not included in the Contact layout. This is the simplest way to receive a list of all contacts, which can then be filtered through as needed.

Alternate Way to Export:

To export a particular fields of contact data, you can also choose to run a report, though this is more complicated as each field has to be individually selected and assigned to your report.

To export contacts this way, access "Reports" tab located on the menu at the top of your screen.

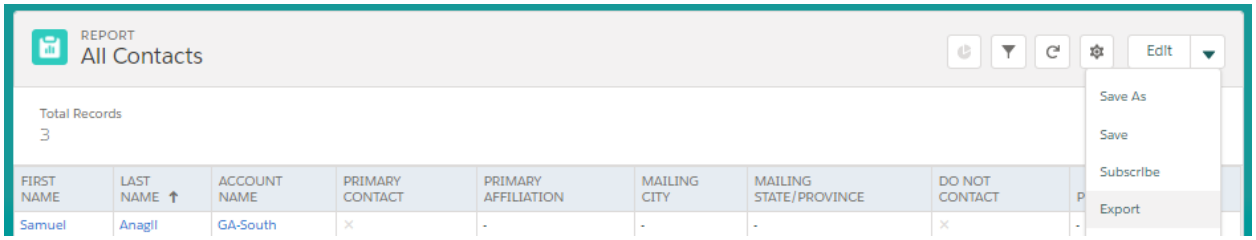
Create a New Report and select "Accounts & Contacts". Then select "Contacts & Accounts" from the expanded menu.



You can then select the relevant fields to display. The order that these are displayed will be the exact order that they are dragged into the report layout.

Because of the many fields within Salesforce, this can be more complicated to ensure that you aren't missing any important piece of data. Additionally, certain fields such as "Date Last Updated" appear multiple times, and must be associated with the correct facet of information (for example, the last date that a teachers' number of students was updated), otherwise the data will not be accurate.

A spreadsheet within Salesforce of relevant data will then appear, which can be exported and used in Excel.

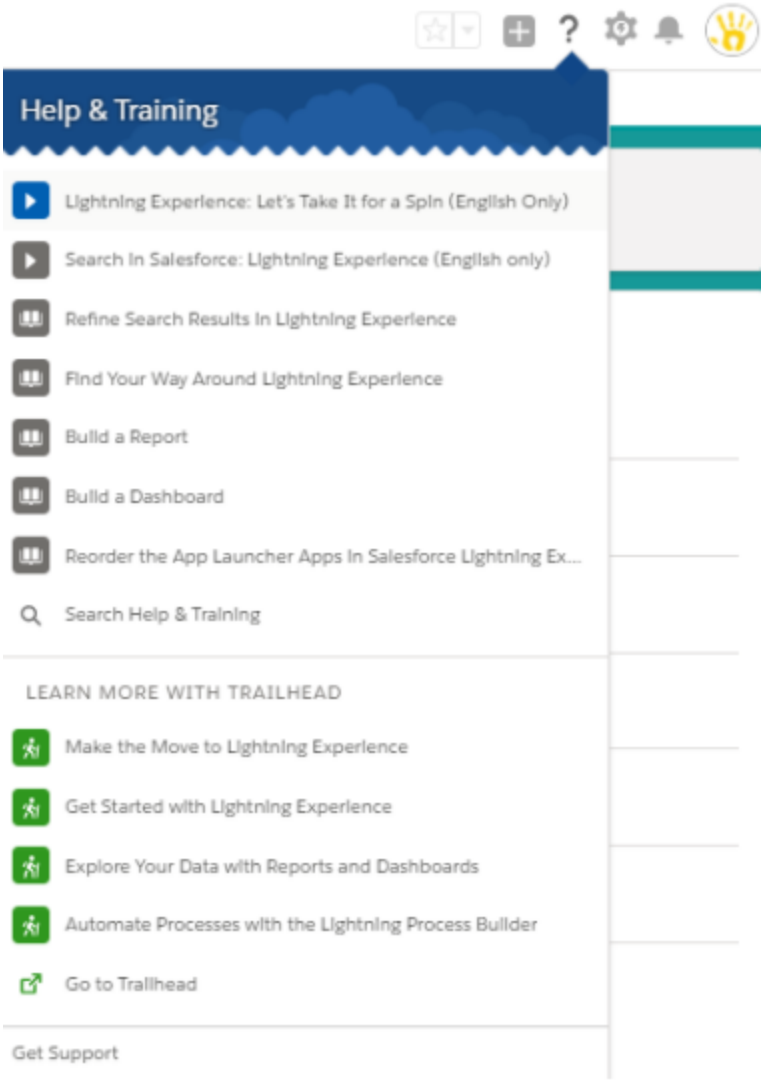


The spreadsheet will then be saved to your computer. Once a report is set up, it will be usable an unlimited number of times, automatically updating as new contacts are added into Salesforce.

By selecting the **Filter** Icon, you can also choose which types of contacts you would like to export (those entered into the system during a certain time period, or other similar variables). Exporting full data sheets and manually cleaning data in Excel is also feasible, however.

Additional Resources

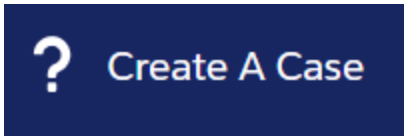
"Help & Training" can be accessed by clicking on the question mark on the top-right hand corner of any screen.



Adding Users & Opening a Case

PEN has access to 10 free licenses, which can be assigned to new individuals by "Opening a Case" within "Help & Training".

By selecting **"Get Support"** towards the bottom of the menu, Salesforce will automatically open a new tab on your browser.



Within the new support page, an option to "Create a Case" will be visible. When creating a case, complete the necessary prompts,

which only takes a few moments, and include the names and email addresses for the users that should also receive full access to Salesforce. Different permission levels *can* be designated, in which case this should be prompted to the Salesforce Case Agent. However, assigning different roles and accesses to individuals can be tasking. Once a new case has been submitted, a Salesforce agent is generally in touch within the next business day or so. The new user will be sent a verification email prompting them to set up their account. For users who need short-term usage, the following login information can be used:

Username: info@practicaleducationnetwork.com
Password: PENcapstone18
Security question: 'In what city were you born?'
Answer: Accra
** Please note that this user will have full access to backend management and more with this account.*

Cases can be opened based on any issues or challenges that arise in PEN's use of Salesforce. However, because a support package is not purchased, it is likely that the response on behalf of a Case Agent will be to provide links to relevant online material that Salesforce has pre-populated in attempts to enable individuals to solve the issue themselves. Beyond adding licenses, there are limited tasks that the agents will help with as a result of free usage and no support package.

Trailhead

Salesforce provides a number of online resources, for free to their user community. One resource the offers step-by-step training on a number of uses of Salesforce is **Trailhead**. Trailhead can be accessed by any PEN user with their regular log-in information. Additionally, Trailhead tracks individual progress over time, as more trainings are completed.

Trailhead has over 300 modules to choose from, on themes from "Lightning Experience Basics" (the version of Salesforce that PEN uses) to "Trust and Influence". There are many valuable modules that are relevant to PEN's work, and Trailhead should be taken advantage of as a great free resource.

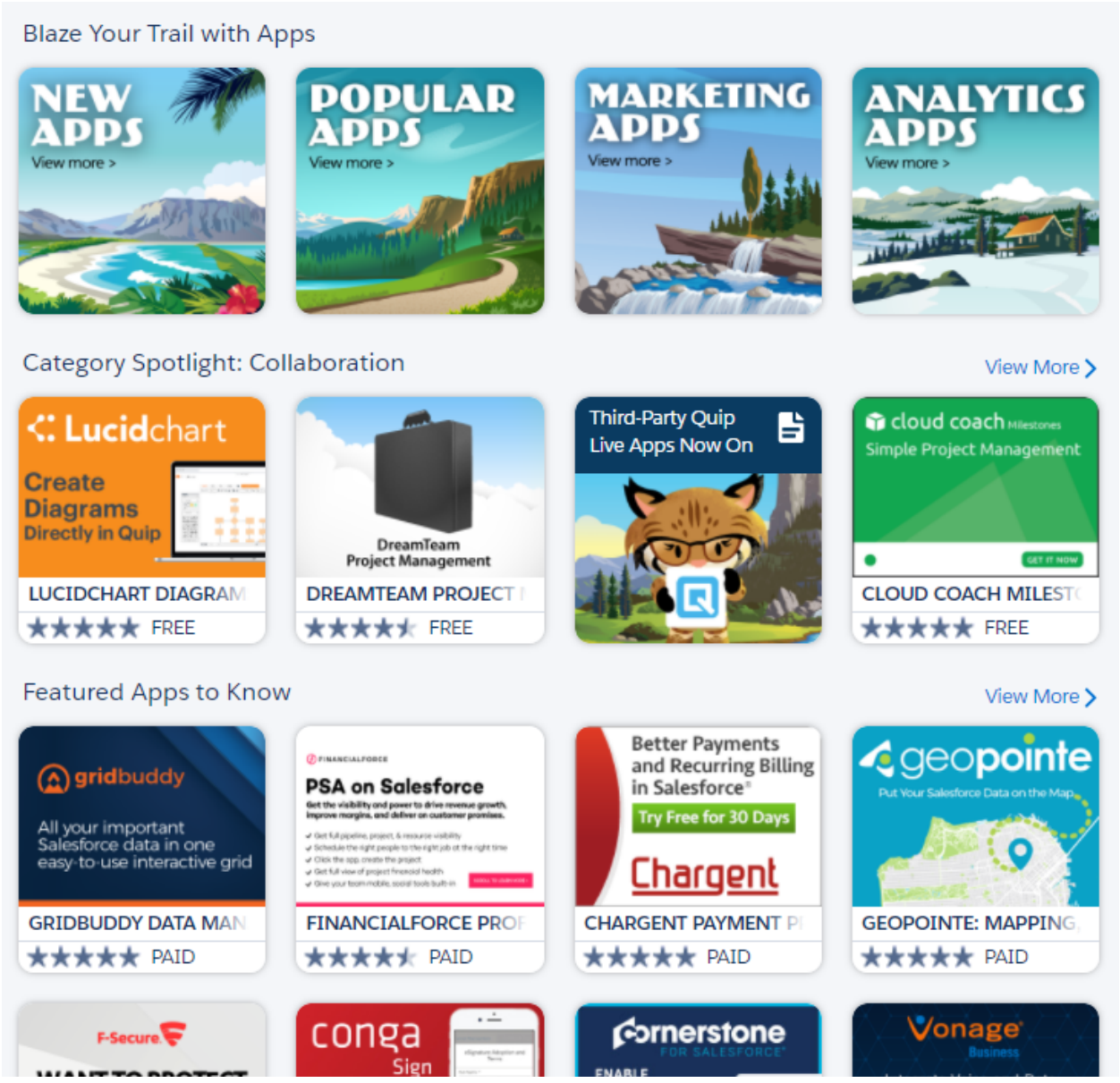
Trailblazer Community

Given the complexity of Salesforce, the **Trailblazer Community** was formed to provide guides, forums and a community space for Salesforce members to answer one another's questions and collaborate. If ever having difficulty using a specific aspect of Salesforce, a user can enter a specific question into the search bar, and step-by-step guides will populate accordingly. "Answer Leaders" are regular users who are recognized for supporting members of the Salesforce community.

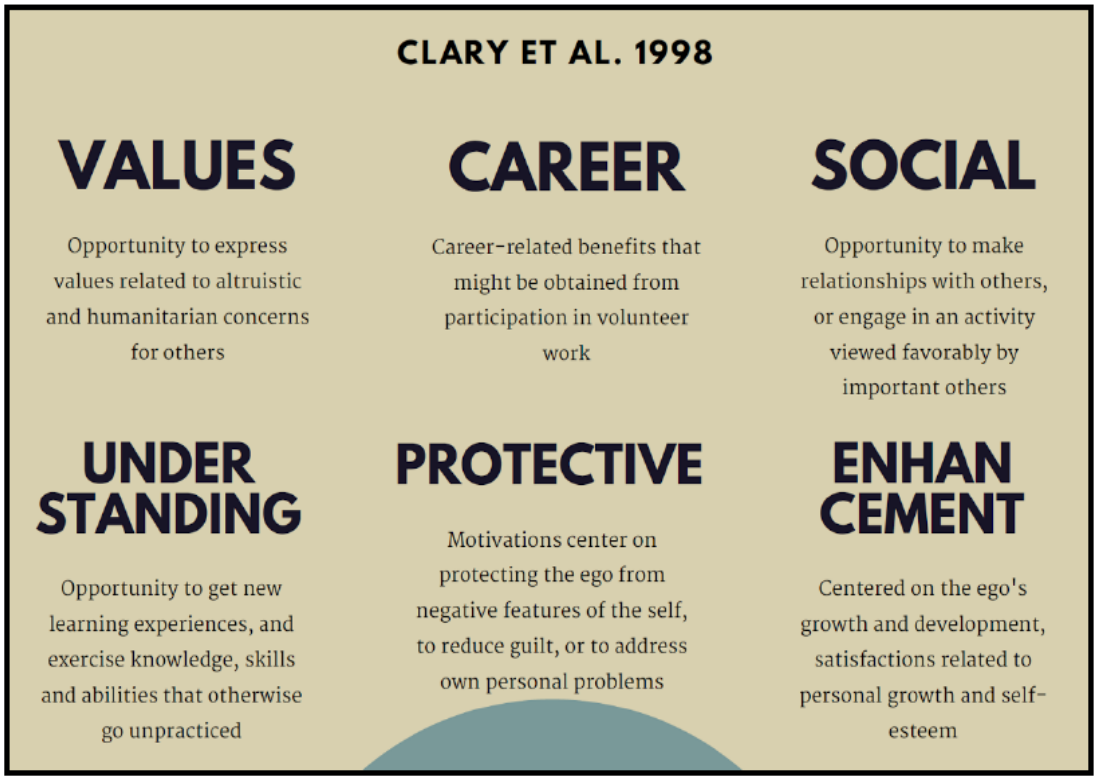
AppExchange

In addition to built-in components from the Nonprofit Success Pack that are embedded in the version of Salesforce that PEN has access to (such as campaigns, leads and more), there are a host of other applications that can be downloaded into PEN's Salesforce setup. These applications can either be developed through PEN itself, or an external partner who develops the applications that are then vetted and included to customers via AppExchange. Categories of applications include "Marketing Apps", "Analytics Apps" and much more.

AppExchange has hundred of applications that can be embedded into Salesforce, some with monthly or annual fees (reaching as high as $11,000 per year to access) and others that are entirely free. AppExchange should certainly be explored and followed to ensure that PEN is able to utilize the tools that are made available to them for Salesforce.



Appendix C: Motivation Theory Framework



From:
Clary, E. G., Snyder, M., Ridge, R. D., Copeland, J., Stukas, A. A , Haugen, J., & Miene, P. (1998). Understanding and Assessing the Motivations of Volunteers: A Functional Approach. *Journal of Personality and Social Psychology 74(6).* 1516.

SIPA Interview & Survey Guide

The following document contains conversational guides for interviews and an online survey structure, all of which are to be utilized during the SIPA Team's fieldwork in March of 2018.

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Sample Interview Introduction

Thank you for taking the time to speak with us. We know that [INTERVIEWEE ROLE] requires a lot of dedication and time, and we are grateful that you are able to take some of that time to share your experience. This interview should last no longer than 45 minutes. We are conducting research with a team of graduate students from Columbia University to better understand how PEN can better enable teachers to adopt hands-on science teaching practices (practicals) in the classroom. Your answers will help us to improve the PEN program, and hopefully other teacher training programs around the world.

This interview is confidential and your name will not be recorded with your response. Your individual answers to our questions will not be shared with PEN, only our recommendations based on input *all* [INTERVIEWEE ROLE] interviewed. We only record your name to be able to identify number of responses and organize our data. Your answers to these questions will not in any way affect your relationship with PEN. This is a safe space for you to share your experience and we hope that you will feel comfortable. If at anytime you do not wish to answer any questions asked, please let us know. Thank you again for taking the time to be here. Let's get started.

Interview Guide: Teachers

Name:

Location:

Date:

Teaching & Values

1. Why did you decide to become a teacher?
2. Tell us about one of your happiest experiences teaching.
3. How do you view your role in your students' lives?
4. What kinds of support are available for you as a teacher?
    a. Human resource (coaches) & Professional Development
    b. Ministry, school-provided or other?
    c. What support would you benefit from that you don't already have?

Science Teaching & PEN

5. How is science education viewed in Ghana?
6. Has the PEN teacher training changed the way you teach in any way?
7. How do your students react to the PEN practicals?
8. Following your PEN workshop, what has the interaction been like with the other PEN teachers?
9. Do you feel like there is a PEN community? Explain.
10. What would better enable you to do more PEN practicals?

Existing Incentives & PEN Structures

11. Why do you think it is important to participate in the PEN workshops?
12. What do you know about the PEN Teacher of the Month? What do you think about that title?
13. What do you think about the Circuit Trainer position? Do you aspire to be a Circuit Trainer? Why or why not?
    a. What about the Master Trainer position?
    b. How do you think the Master Trainers obtain that position?
14. Have you heard of the WeGoInnovate film spots for TV? What did you think of that?

Motivations & Future Expectations

15. Where would you like to see yourself five years from now?

Questions for WeGoInnovate Teachers:

1. How did it make you feel be chosen for the filming?
2. Why do you think you were selected?
3. How did other teachers around you react?

Questions for Teacher of the Month:

1. How did it make you feel to be chosen to be ToM?
2. Why do you think you were selected?
3. How did other teachers around you react?

General Survey: Teachers

This survey will be administered **via paper survey questionnaire to all teachers, following their in-person survey with a SIPA Team member. Part 1 will be completed by a SIPA Team member, and handed off to the teacher to complete Parts 2 - 4.*

Part 1: General Information *[SIPA Team to fill in during the interview portion]*

Name: _____**Sex:** [m / f] (circle one) **Age:** _____

Name of School: _____

District: _____

Number of years teaching: _____

Teacher Training College attended? [Y / N] (circle one)

If Yes, Where? _____ [Write name of college]

In what subjects were you trained to teach: _____

What subjects do you teach: _____

Besides teaching, do you have any part-time jobs? [Y / N]

***(If Yes)* What other ways to earn money do you have (if more than one, list all):**

_____

_____

_____

Which of the following PEN activities have you participate in (check all that apply):

[Check the box]

- ❑ Teacher of the Month
- ❑ WeGoInnovate
- ❑ Circuit Trainer
- ❑ Master Trainer

<u>Part 2: Involvement with PEN</u> *[Teacher to individually complete]*

- Number of PEN teacher training workshops attended: [pick one]

- ❑ 0
- ❑ 1
- ❑ 2
- ❑ 3
- ❑ 4+
- ❑ Prefer not to answer

- How many practicals have you done in your career as a science teacher? [pick one]

- ❑ Less than 5
- ❑ 5-10
- ❑ 11-15
- ❑ More than 15
- ❑ Prefer not to answer

- Number of practicals attempted in the classroom in the past two weeks: [pick one]

- ❑ 0
- ❑ 1
- ❑ 2
- ❑ 3
- ❑ 4+
- ❑ Prefer not to answer

How much do you agree with the following statements:

- I have the material to do the PEN practicals in the classroom: [circle one]
Strongly disagree Disagree Undecided Agree Strongly Agree Not Sure

- I feel confident trying PEN practicals in the classroom: [circle one]
Strongly disagree Disagree Undecided Agree Strongly Agree Not Sure

-I have the support I need from PEN: [circle one]
Strongly disagree Disagree Undecided Agree Strongly Agree Not Sure

- I feel like I am part of a community of science teachers: [circle one]
Strongly disagree Disagree Undecided Agree Strongly Agree Not Sure

Part 3: Values *[Teacher to individually complete]*

- Please rank the following in order of importance to you (1 being the most important, 5 being the least important) [write a number 1-5 on the line, only use each number one time]
___ **Money** (making more money)
___ **Recognition** (being recognized in the community)
___ **Career** (advancing my career)
___ **Support** (feeling supported in my job, having enough guidance to do my work effectively)
___ **Experiences** (gaining new experiences, being able to travel to learn/share new things)

Part 4: Incentives *[Teacher to individually complete]*

- Please select the top five incentives (listed in random order) of what would most motivate to do more practical activities in your classroom: [select only 5 total, by checking a box]

- ❑ Additional income through PEN activities
- ❑ Priority to receive a car loan
- ❑ PEN Trainer (paid per training)
- ❑ PEN Coordinator (non-salaried)
- ❑ Science-related or academic excursions (eg visit to Ghana Planetarium, science conferences, present a paper at a conference)
- ❑ Consideration for national position at Ghana Association of Science Teachers (GAST)
- ❑ Nomination for National Best Teacher
- ❑ Professional development and leadership training through PEN community
- ❑ Certified Professional Practical Teacher: additional credentials from observed applied practicals (eg certification of practice)
- ❑ Assistance with application for furthering your education (eg. guidance for applying for a Master's degree etc.)
- ❑ Digital rewards (eg. picture with PEN filter, recognition on website, feature in Junior Graphic, App to record and share status as PEN member)
- ❑ Be featured in a video about best applied science practices (as expert, for other teachers and/or community)
- ❑ Having a mentor to guide you and help you in your daily teaching practice (constant)
- ❑ Peer Coaching: having an opportunity to try out a practical and have feedback from peers
- ❑ Follow-up visits from PEN to provide feedback (dependent on capacity)
- ❑ Digital platform for shared ideas
- ❑ More social events (eg team building activities)

Of the five selected on the previous page, rank in order of preference (1 being the most important, and 5 the least important): [Write one incentive per line, in order of importance]

1. _____
2. _____
3. _____
4. _____
5. _____

Is there anything else you think would help you to do more practicals that we haven't listed here? [Write your response]

_____

_____

_____

END OF SURVEY

Interview Guide: Headteacher

Name:

Location:

Date:

School Administration and Management

1. Tell us about your professional experience before your role as headteacher? Were you a teacher before? Can you recall what was your most rewarding moment as a teacher?
2. Do you provide recognition or rewards to teachers who perform well as a way to motivate them?
3. How do you view your role as headteacher in terms of inspiring or motivating the teachers at your school?
4. Have teachers requested specific incentives or support from the school administration? If so, what?
5. What kinds of support are available for teachers in your school?
6. What motivated you to support your teachers participating in a PEN workshop? Have you supported your teachers to participate in other workshops?

Science Teaching & PEN

7. How is science education viewed in Ghana?
8. How do you believe science should ideally be taught in the classroom?
9. What does the rest of the school community think about PEN teachers?
10. What would better enable you to encourage teachers to do more PEN practice?
11. What kind of benefits are you looking for in the PEN program for your school?
12. How do you define success for a science teacher?
13. How do you feel about hands-on practice in science education in the classroom?

Motivation & Future Expectation

14. What motivated you to support your teachers participating in a PEN workshop?

Interview Guide: Trainer (Master or Circuit)

Name:

Location:

Date:

Master / Circuit [Circle one]

Teaching & Teacher Trainer Role

1. Why did you decide to become a teacher?
2. Tell us about one of your happiest experiences from the PEN teacher training where you were a Master/Circuit Trainer.
3. What kinds of support are available for teachers?
    a. Human resource (coaches) & Professional Development
    b. Ministry, school-provided or other?
4. When did you become a Master/Circuit Trainer?
5. How do you view your role in the other teachers' development?
6. What sorts of benefits do you get for being a Master/Circuit Trainer?
    a. What additional benefits would you like to have come from this position? How could it be enhanced?
    b. What kinds of challenges do you face in your role as a Master/Circuit Trainer?
7. How has becoming a Master /Circuit Trainer changed you?

Science Teaching & PEN

8. How is science education viewed in Ghana?
9. How do your students react to the PEN practicals?
10. What motivated you to take part in a PEN workshop?
11. Has the PEN teacher training changed the way you teach in any way?
12. What would better enable you to do more PEN practicals?
    a. What would better enable the trained teachers to do more PEN practicals?
13. What kind of benefits are you looking for in the PEN program?

Existing Incentives & PEN Structures

14. What do you know about the PEN Teacher of the Month?

    a. What do you think about the ToM? Do you think this helps to motivate teachers? How could it be improved?

15. Have you heard of the WeGoInnovate film spots for TV? What did you think of that?
16. What other incentives do you think might motivate teachers to use more PEN practicals?

Motivations & Future Expectations

17. How would you like to see yourself five years from now?

Final Q: Is there anything else we should know about PEN, teacher motivation and incentives, and teaching STEM subjects in Ghanaian classrooms?

Interview Guide: PEN Staff

Name:

Location:

Position:

Years with PEN:

Being Part of PEN

1. What motivated you to join the PEN team?
2. Have you been a teacher at some point in your life?

PEN teachers and workshop

3. From your experience interacting with PEN teachers, what are some barriers that keep them from applying PEN practicals in the classroom?
4. How is science education viewed in Ghana?
5. What do you think about the relationship between PEN and PEN teachers? Are they socially well connected with the organization or with one another?
6. What kind of benefits do you think the teachers are looking for in the PEN program?
7. Which do you think would have influential impact on PEN practice in the classroom? School policy? Parents' feedback? Or students response?

Existing incentives

8. Do you think PEN is currently providing enough support for the PEN teachers? What ideas have you had on what PEN can do to offer more support? What ideas do you have for how PEN can stimulate more practicals in the classroom?
9. What do you know about the PEN Teacher of the Month? Are PEN teachers excited about it?
10. What do you think about Master Trainers position? Are PEN teachers excited about it? How do you think this role could evolve or expand?
11. How do you become a Circuit Trainer?
12. What you think about the Professional Practical Teacher idea? What kinds of benefits do you envision for this role?
13. What do you think about WeGo Innovate program? Are PEN teachers excited about it? Why or why not?

Interview Guide: Sabre Charitable Trust

Name:

Location:

Position:

Science Education and Challenges

1. What are some of the challenges for teachers to implement best practices learned at the teacher training?
2. How is science education viewed in Ghana?
3. Is there anything specifically challenging about implementing practical science activities?

Teacher Motivation & Sabre's Approach

4. What do you think motivates teachers in Ghana?
    a. How did you leverage that for the FTTT?
5. What made the FTTT so successful for implementation of best practices?
    a. What could FTTT have incorporated that it didn't?
    b. Has Sabre continued to follow up with the teachers? What is that process like? What systems are in place for this?
    c. What could FTTT have done better?
6. How does Sabre create sustained interest and implementation?
7. How does Sabre continue to monitor teacher implementation?
8. How does the Sabre name influence teachers' willingness to implement teaching practices?
    a. How teachers respond to being a Sabre-trained teacher?
    b. Do you think being a Sabre teacher is part of how they identify?

Final Q: Is there anything else we should know about Sabre, teacher motivation and incentives, and teaching in Ghanaian classrooms?

Interview Guide: STEM Network

Name:

Location:

Position:

Introduction, Science Education and Challenges

1. How does the STEM Network operate?
    a. Who are the members?
    b. What are their goals?
2. How is science education viewed in Ghana?
3. What are some of the challenges that you might have heard of for teachers to implement the practicals learned at the teacher training?
4. What is the relationship between STEM Network & PEN?
    a. What kind of shared objectives do you have for the STEM field?
    b. How do your objectives differ?

Teacher Motivation & the STEM Network

5. What do you think motivates teachers in Ghana?
6. How can PEN create sustained interest in and implementation of science practicals?
7. How can the STEM Network collaborate with PEN to motivate teacher uptake of best practices for science teaching?
    a. What would STEM Network's role be?
    b. Could STEM Network offer any incentives to teachers? What kind?
8. How do you think PEN can continue to monitor teacher implementation?
9. How can PEN leverage its brand/name recognition to influence teachers' willingness to implement teaching practices?
    a. What about leveraging its status as part of the STEM Network?
        i. Is this something teachers' might respond to?

Final Q: Is there anything else we should know about STEM Network, teacher motivation and incentives, and teaching STEM subjects in Ghanaian classrooms?

Interview Guide: Impact Hub

Name:

Location:

Position:

Science Education and Challenges

1. How is science education viewed in Ghana?
2. How does Impact Hub view science education?
3. Do you think there might be anything specifically challenging about implementing practical science activities in Ghanaian classrooms?

Teacher Motivation & the Impact Hub

5. What do you think motivates teachers in Ghana?
6. How can PEN create sustained interest in and implementation of science practicals?
7. How can the Impact Hub collaborate with PEN to motivate teacher uptake of best practices for science teaching?
    a. What would interest teachers about Impact Hub? And have you worked with teachers before?
    b. What would Impact Hub's role be?
    c. Could Impact Hub offer any incentives to teachers? What kind?
8. How do you think PEN can best monitor teacher implementation?
9. How can PEN leverage its brand/name recognition to influence teachers' willingness to implement teaching practices?
    a. What about leveraging its status as part of a project or training with Impact Hub?
        i. Is this something teachers' might respond to?

Final Q: Is there anything else we should know about Impact Hub, teacher motivation and incentives, and teaching in Ghanaian classrooms?

Interview Guide: Ghana Education Service (GES)

Name:

Location:

Position:

Science Education and Challenges

1. What are some of the challenges for teachers to implement best practices (like the science practicals) learned at the teacher training?
2. How is science education viewed in Ghana?
3. Is there anything specifically challenging about implementing practical science activities?
4. Does the teacher training teachers receive adequately prepare them for teaching in the classroom? Why or why not?
5. What are some of the big changes in GES that might impact teacher implementation of best practices in the classroom?

Teacher Motivation & GES's Approach

6. What do you think motivates teachers in Ghana?
7. What kinds of incentives do you think would best enable teachers to implement best practices in the classroom?
8. How does GES motivate teachers?
    a. Are there any systems or activities in place?
9. What kind of mentoring/coaching support does GES provide to teachers?
10. What are the Fast-track Transformational Teacher Training program's (implemented with Sabre Charitable Trust) greatest strengths?
    a. What did that program fail to accomplish? Why?
    b. What could have been done better?
    c. Does GES still track/follow-up with those teachers? How?
11. What kind of system or processes does GES employ to monitor teacher implementation?
12. How do you think the PEN name might influence teachers' willingness to implement teaching practices?

Final Q: Is there anything else we should know about GES, teacher motivation and incentives, and teaching in Ghanaian classrooms?

Appendix E: Incentive Assessment Matrix Indicators

Cost Indicators

Level 1	Level 2	Level 3
Minimal human resources cost	Mid-level human resources cost	High-level human resources cost
Minimal operational cost	Mid-level operational cost	High-level operational cost
Minimal material cost (prizes)	Mid-level material cost (prizes)	High-level material cost (prizes)

Reach Indicators

Level 1	Level 2	Level 3
Less than 10 teachers are addressed	10-100 teachers are addressed	Over 100 teachers are addressed

Feasibility Indicators

Level 1	Level 2	Level 3
Complete reliance on the support of GES	Partial reliance on the support of GES	Minimal reliance on the support of GES
Complete reliance on the support of other organizations and partners	Partial reliance on the support of other organizations and partners	Minimal reliance on the support from other organizations and partners
Low usage of PEN capacity	Medium usage of PEN capacity	High usage of PEN capacity

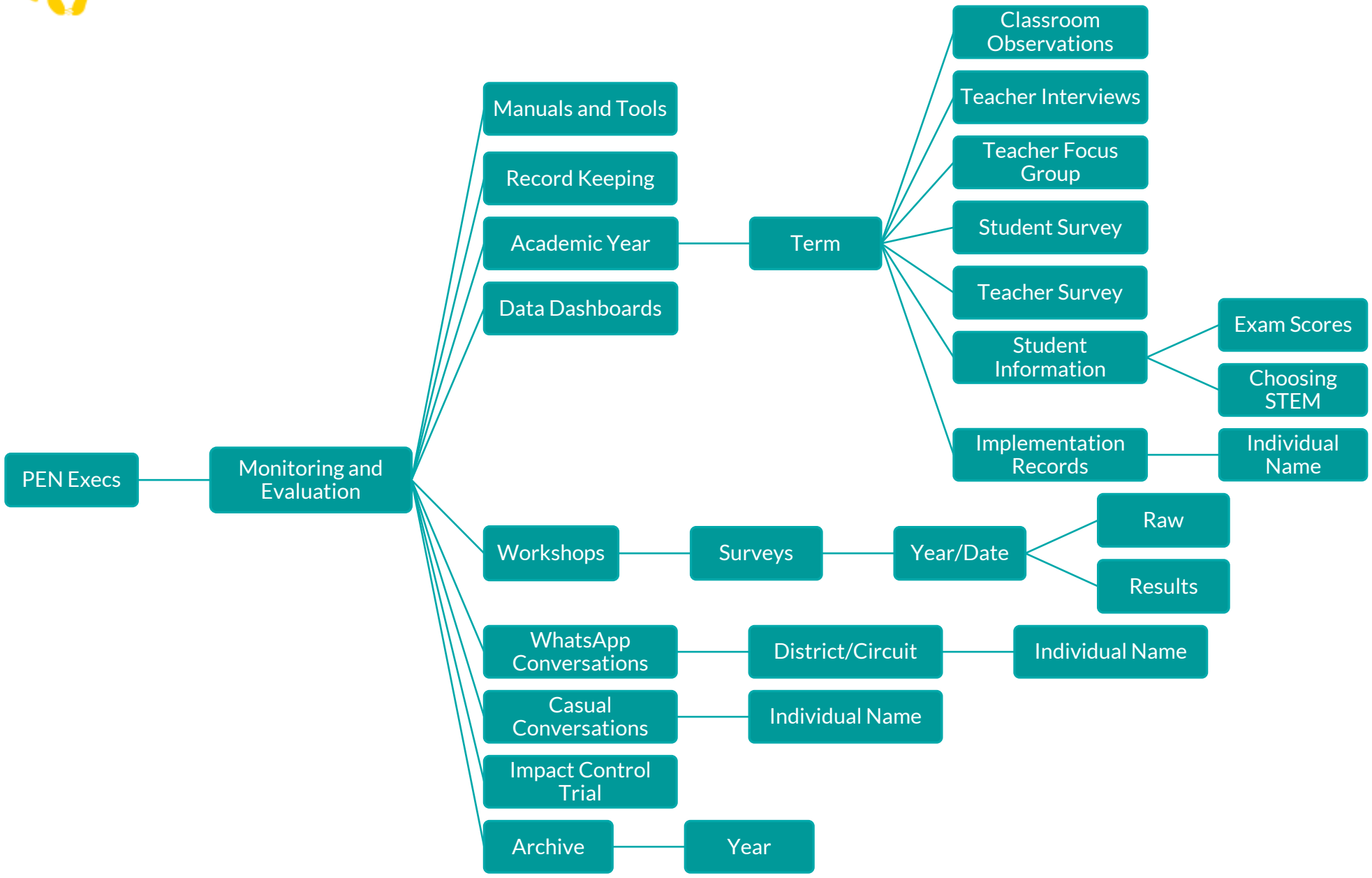
Popularity Indicators

Level 1	Level 2	Level 3
Rank after #10 in the "incentive" question of the survey	Rank between #3 to #10 in the "incentive" question of the survey	Top 3 in the "incentive" question of survey
Rank #4 and #5 in the "value" question of the survey	Rank #3 and # 2 in the "value" question of the survey	Rank #1 in the "value" question of the survey
Rarely mentioned in the interviews	Mentioned in 30% of the interviews	Mentioned in 50% of the interviews

Strength of Evidence Indicators

Level 1	Level 2	Level 3
Low level of clarity of the evidence	Medium level of clarity of the evidence	High level of clarity of the evidence

Appendix F: M&E Google Drive Folder Organization



Appendix G: M&E Framework Rework

Original Framework:

Indicator	Definition	Instrument
1. Number of resources and opportunities supplied by PEN.	Phase 1 Workshops, Phase 2 Workshops, PEN manuals, videos, activity boxes, practical activities mapped, alternative materials identified, WhatsApp groups created, Teacher of the Month submissions, etc.	1. Record-keeping
2. Number of teachers trained by PEN.	Teachers trained in PEN Phase 1 & 2 workshops.	1. Record-keeping
3. Proportion of teachers employing practical activities more frequently.	Teachers' report of employing practical activities more frequently. Number of projects, activities, practicals done by teachers in a period of time. Headteachers' perceptions. Students' perceptions.	1. Surveys 2. Observations (both direct and indirect) 3. Interviews 4. Focus Groups 5. External resource
4. Percentage increase in frequency of interaction (sharing/referencing) among STEM teachers.	Teachers' reported responses of frequency of interaction among STEM teachers over a period of time. WhatsApp logs and conversations.	1. Record-keeping 2. Surveys 3. Observations 4. Interviews
5. Proportion of students enjoying STEM subjects.	Students' reported response of enjoyment. Number of students engaged in STEM-related extracurricular activities, perceived level of interaction and enjoyment in classrooms.	1. Surveys 2. Observations 3. Focus Groups
6. Percentage increase in students' critical thinking.	Critical thinking, measured on an index of dimensions	1. Surveys 2. Observations 3. Tests
7. Proportion of Form 3 students choosing to study STEM after JHS.	Actual percentage of graduating JHS students choosing/intending to study STEM after JHS.	1. External resource
8. Percentage increase in student STEM exam scores.	Actual student test scores (class tests, school tests, BECE, WAEC).	1. External resource

New Framework:

Goal 1: Improve Teaching in STEM

Objective	Indicator	Instrument
A. Improve Teachers' STEM Applied Instructional Practice	1. Number of Teachers trained by PEN.	1. PEN record-keeping
	2. Proportion of teachers employing practical activities at least once per week.	1. Teacher Survey 2. Classroom Observation 3. Proof of Implementation via WhatsApp 4. Teacher Interview
B. Improve Resource Opportunities	3. Number of resources or opportunities supplied by PEN (per teacher).	1. PEN record-keeping
C. Improve Communication and Knowledge Sharing Among Teachers	4. Percentage increase in frequency of interaction (referencing and sharing) among PEN-trained STEM teachers.	1. Teacher Survey 2. Teacher Interview

Goal 2: Improve Students' Academic Success in STEM

Objective	Indicator	Instrument
D. Improve Student Learning Outcomes	5. Percentage increase in students' critical thinking.	1. Critical Thinking Index
	6. Percentage increase in students' STEM exam scores.	1. Student Exam Scores (Basic Education Certificate Examination)
E. Stimulate Student Interest in STEM	7. Proportion of students enjoying STEM.	1. Student Survey 2. Classroom Observation
	8. Proportion of Form 3 students in a given year choosing to study STEM after JHS.	1. Data from teachers/schools

PEN Data Collection Tools

Table of Contents

**Note:* *Questions in teal are edits or additions to the original data collection tool.*

Student Survey

1. Student Number
2. Name of School
3. Class/Form
4. This term, which science topics have you done so far?
5. Which practical lessons have you done during science class in the last month?
6. What is your favorite subject in class?
    a. Why is it your favorite subject?
7. I really enjoy learning science.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

6a. If you chose agree or strongly agree, why?

    f. It's easy to learn
    g. It's easy to pass
    h. The subject feels interesting to me
    i. We sometimes do practicals
    j. Other

8. Which course will you choose for SHS?
    a. Science
    b. General Arts
    c. Business
    d. Technical Skills
    e. Home Economics
    f. Other
9. What do you want to become in the future?
10. What must you study in the Senior High School to become that?
    a. Science
    b. General Arts
    c. Business
    d. Technical Skills
    e. Home Economics
    f. Other

Critical Thinking Index (CTI)

Note to PEN staff: The CTI needs to be piloted and tested with students before it is combined with the general student survey. The questions provided below are more than what should be administered to students. It is recommended that five questions are chosen from the ones below (after piloting and editing) to combine into the general student survey. In addition, please include the paragraph below as a description for the students to understand the CTI.

Note to Students: For many of these questions, there are many possible answers. This is not a test, your teacher will not see your answers, and it will not affect your grade in any way. Answer as many questions as you can. You won't be penalized for leaving a question blank.

1. Read each statement and then circle whether it is a fact or opinion. If it is a fact, explain how it can be proven.
    a. I can see the mountains from my window.

       Fact Opinion How can this be proven?_____

       _____

    b. Earth is the third planet from the sun.

       Fact Opinion How can this be proven?_____

       _____

    c. Yesterday's math test was difficult.

       Fact Opinion How can this be proven?_____

       _____

2. Look at the objects and words on the page for 1 minute. Next, try to write down everything you remember seeing and reading on the page.

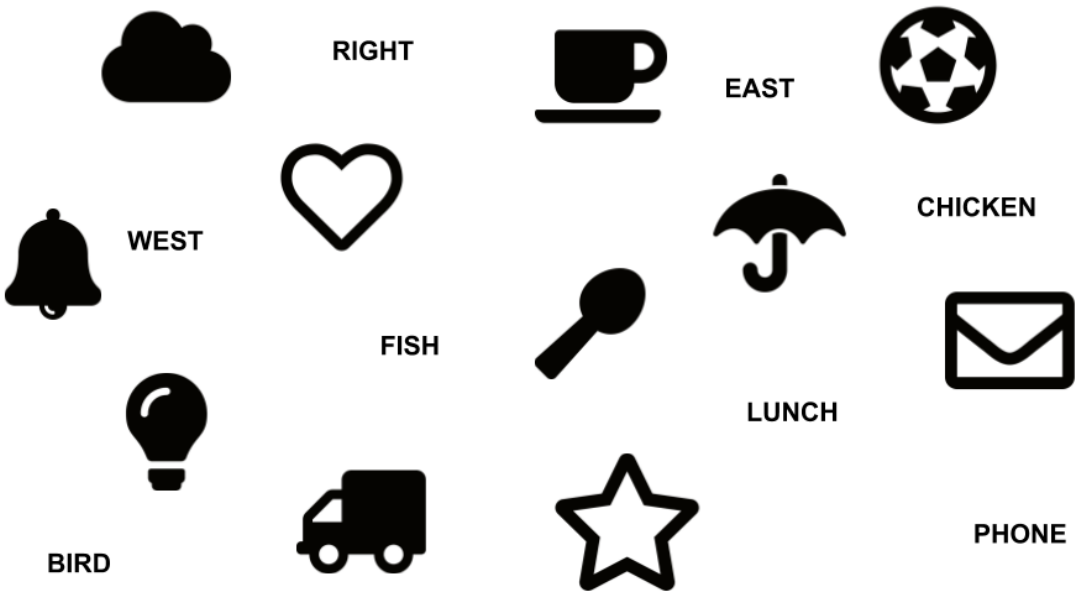
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

_____ _____

_____ _____

_____ _____

_____ _____



Note to Survey Administer: The image above will need to be printed out separately and provided to the student once they reach this question. They are provided the image for 1 minute, at which time you will take away the image. The student does not have a time limit to complete the question.

3. The Red Bus stops every 10 minutes. The Green Bus stops every 20 minutes. Both busses stop at Landsome Road. The Red Bus has twice as many stops as the Green Bus.

   The two busses never stop at Landsome Road at the same time.

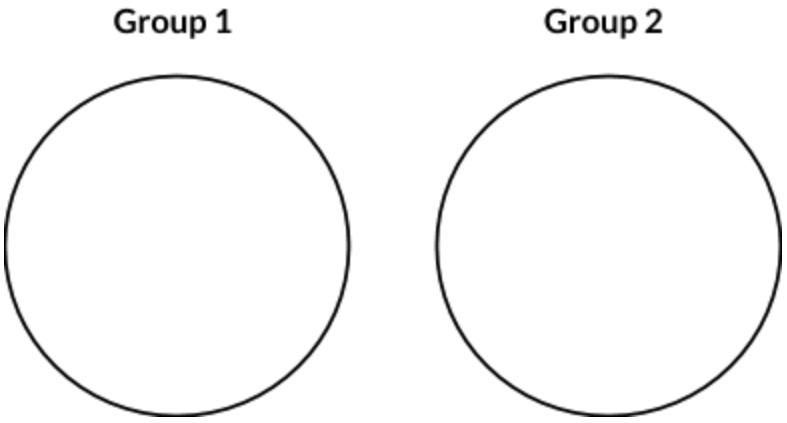
   a. True
   b. False
   c. Not enough information

4. Plants need water and sunlight to survive (based on principles of photosynthesis). Explain how you would prove this in 3 steps.

   1. _____
   2. _____
   3. _____

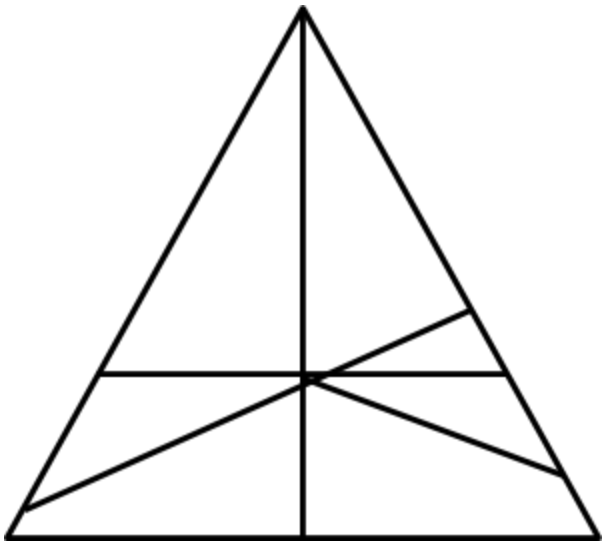
5. Sort these human organs into two categories based on any classification of your choice. Please explain why you classified them as such.

Brain	Lungs	Heart	Bladder	Liver
Large Intestine	Small Intestine	Pancreas	Stomach	Spleen



Reasoning: _____

6. How many triangles are present in the picture below?



7. In the space provided below, state what person in your school (or community) serves a similar function to the organelle in the plant cell. Then, explain why you chose that person.

Plant Organelle & Description	Who at your school has a similar job?	Reason
Cell Wall: strengthens the cell		
Cell Membrane: controls movement of substances in and out of the cell		
Nucleus: controls the activity of the cell		
Chloroplast(s): absorbs light for photosynthesis		
Mitochondria: provides energy for the cell		

Note to PEN: Select 3 from the list of 5 organelles (based on piloting) to use on the final version of the survey.

8. Use the information you already know and what the author is telling you to make a prediction about what will happen next.
    a. The storm began suddenly. The lightning lit up the sky and the thunder roared loudly. The electricity was blinking on and off quickly.

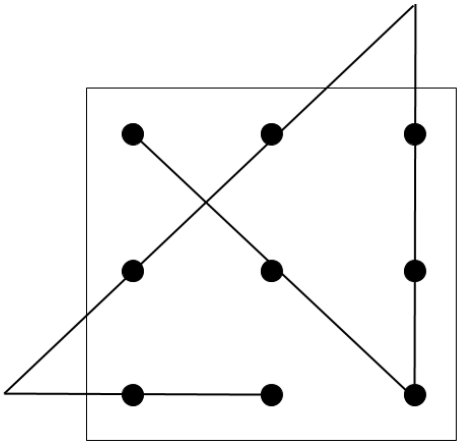
       Prediction: _____

9. Connect these 9 dots using only 4 lines and without lifting your pencil from the paper. (Hint: think beyond real and imaginary boundaries with this puzzle.)

Answers to and Grading of the Critical Thinking Index

The maximum number of points for the CTI will depend on which questions are chosen for the final version. Sample answers are provided for some of the questions, however, there can be many ways to answer the question and it is up to the grader to decide.

1. [2 points] 1 point for correctly answering Fact or Opinion and 1 point for a logical explanation of how the statement can be proven.
    a. Fact (ex: look out the window)
    b. Fact (ex: look at an image of the solar system)
    c. Opinion
2. [19 points] Count the number of correct words/items listed.
3. [1 point] 1 point for correct answer: Not enough information
4. [3 points] 1 point for each step explained. (ex: a: don't water a plant, b: put a plant in the shade/no sunlight, or c: don't water and put plant in the shade
5. [2 points] 1 point for sorting, 1 point for a reason. (ex: divided by which side of the body they are on)
6. [1 point] 1 point for correct answer: 12 triangles
7. [6 points] 1 point for each correct job (3) and 1 point for each explanation (3) (ex: Cell Wall: administration, Cell Membrane: security, Nucleus: Headmaster, Mitochondria: cooks, Chloroplasts: students)
8. [1 point] 1 point for writing any logical prediction.
9. [1 point] Correct drawing:



Teacher Survey (Remote)

1. Basic Information
    a. Date
    b. Name
    c. Phone Number (we need this to contact you just in case you win a prize)
    d. Gender
        i. Female
        ii. Male
    e. Year of Birth
    f. Name of your school
    g. What is your highest level of education?
        i. Senior High School
        ii. Teacher Training College
        iii. Diploma (HND)
        iv. Degree (Bachelor's)
        v. Degree (Masters)
    h. What is your teaching experience in years?
    i. How many classes do you teach?
        i. 1
        ii. 2
        iii. 3
        iv. Other
    j. What is the total number of students you teach?
    k. How long is a lesson period in your school? (eg: 45 minutes)
    l. How many lesson periods do you spend with one (1) class every week?
2. Have you conducted any hands-on activity this term?
    a. Yes
    b. No

2a. If yes, what were some of the activities?

3. In this section, please provide data on the number of practical activities you have conducted in each of the classes you teach for this term:
   0-5, 6-10, 11-15, 15-20, above 21, not applicable
    a. JHS 3
    b. JHS 2
    c. JHS 1
    d. Primary 6
    e. Primary 5
    f. Primary 4
    g. Primary 3
    h. Primary 2
    i. Primary 1

4. In this section, please provide data on the number of topics you have covered in each of the classes you teach for this term
   0-5, 6-10, 11-15, 15-20, above 21, not applicable
   a. JHS 3
   b. JHS 2
   c. JHS 1
   d. Primary 6
   e. Primary 5
   f. Primary 4
   g. Primary 3
   h. Primary 2
   i. Primary 1
5. Does the size of your class or the number of classes you teach affect the number of practical activities you would include in your lesson?
   a. Yes
   b. No
6. This term, how many times have you reached out to another science or math teacher to discuss science related content?
   a. 1-5 times
   b. 6-10 times
   c. 11-15 times
   d. Other
7. How do you usually communicate with other science and math teachers?
   a. In person
   b. Phone Calls
   c. WhatsApp/SMS
   d. Email
   e. I don't communicate
8. What are some of the things you discuss with other science and math teachers?
   a. Practical lessons
   b. School community
   c. Science content
   d. I don't communicate
   e. Other
9. If I don't understand a particular concept, I would most likely
   a. Talk to my head teacher
   b. Ask another science teacher
   c. Talk to my science coordinator
   d. Write it down and bring it up in the next science teacher meeting
   e. Search the internet
   f. Other

10. I feel connected to my local community of science and math teachers
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

11a. Why do you feel this way?

11. I feel supported by my local community of science and math teachers.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

12a. Why do you feel this way?

Teacher Interview Guide

1. Background Info
    a. Name
    b. School Name
    c. School District
    d. Teaching experience in years
    e. # of classes taught
    f. Total number of students
    g. Number of lesson periods with each class per week
2. Have you conducted any practical lesson this term?
    a. Yes
    b. No

2a. If yes, how many?

3. Out of all the practical lessons you have conducted this term, briefly explain how you carried out the simplest one.
4. If you were to teach acids and bases, what type of practical could you do? Be as specific as possible.
5. Which science topics have you covered in your classroom this term?
6. This term, how many times have you reached out to another science or math teacher to discuss science related content?
7. How do you usually communicate with other science and math teachers?
    a. Phone calls
    b. Text messaging (WhatsApp/SMS)
    c. In-person
    d. Emails
    e. Other
8. What are some of the things you speak with other science and math teachers about?
9. If you don't understand a particular concept, what would you most likely do?
    a. Discuss it with a colleague
    b. Talk to the District Science Coordinator
    c. Do more research on the topic
    d. Other
10. Do you feel connected to other science and mathematics teachers in your area (circuit, district, or region)?
    a. Yes
    b. No
11. Do you feel supported by other science and mathematics teachers in your area (circuit, district, or region)?
    a. Yes
    b. No

12. If you were to rate your students' enjoyment of science on a 7-point scale, with 1 being the least enthused and 7 being the most enthused, how would rate them?
13. What was the average score of your students in science for the B.E.C.E this year?

Headteacher Interview Guide

1. Basic Information
    a. Name
    b. Name of School
    c. School District
    d. Length of time as Headteacher at this school
    e. Number of JHS science teachers at the school
2. Do you make funds available for practical lessons in science?
    a. Yes
    b. No
3. If yes, do your science teachers take advantage of this provision?
    a. Yes
    b. No
4. Do you know if your science teacher has conducted any practical lessons this term?
    a. Yes
    b. No

4a. If yes, do you know how many?

5. Do you know if your science teacher collaborates with other teachers within your school in handling challenging topics? What about teachers at other schools?
    a. Yes
    b. No

5a. If yes, how often do they collaborate?

5b. If yes, what form does this collaboration take?

6. How many professional development workshops have your science teachers attended this term?
7. Do you know how the teachers transfer their knowledge gotten from the workshops to other science teachers who couldn't make it?
    a. Yes
    b. No

7a. If yes, how do they transfer their knowledge?

8. How often do you observe science classes?
9. Do you notice a change in lesson delivery after the science teachers attend workshops?
10. Do you see any change in student engagement after these professional development workshops?
11. Are the students enjoying science lessons?
    a. Yes
    b. No

11a. If yes, why? If no, why not?

Classroom Observation

1. Name of Observer
2. Basic Information
    a. Name of School
    b. Name of Teacher
    c. Form
    d. Lesson
    e. Number of Students
3. Is the teacher using practical activities in his/her classroom?
    a. Yes
    b. No
4. Does the teacher have some materials stored away for practical lessons?
    a. Yes
    b. No
5. Are there any hand drawn diagrams of science experiments or models?
    a. Yes
    b. No
6. If the teacher is conducting a practical, rate how well they are explaining and conducting the practical. With '1' being least effective and '5' being the most effective.
7. Does the teacher give students an opportunity to participate in the practical?
    a. Yes
    b. No
8. Are the students asking questions?
    a. Yes
    b. No
9. Rate how involved the students are in the lesson. (Consider their interest and excitement in the lesson) "1" being least involved and "5" being most involved.
10. Please provide any additional feedback.

Annex

Summary of Incentive Strategy Proposal

The following is a summary of the incentive strategy proposal prepared for Practical Education Network. The strategy is comprised of eight incentive proposals that follow four key motivations for teachers in Ghana: recognition, career, experiences, and more support. The incentives were developed based on in-country research in Ghana and are evidence-based. For more information on how the incentives were created, additional implementation instructions, and supporting literature, please refer to Section 2 in the report.

Recognition

Incentive Proposal 1: Enhance the Status of the Teacher of the Month (ToM)

Teacher of the Month is awarded to the teacher that demonstrates that he/she has completed the most hands-on activities in the classroom that month

1. ***Advertise the possibility to become ToM at the workshop***
2. ***Make the ToM selection criteria more transparent***
3. ***Publish ToM in teachers' local environment***
   Community (via poster displayed publicly or flyer), Daily Graphic, WhatsApp (with special downloadable profile photo frame)
4. ***Introduce a small prize for ToM*** E.g. material kit or t-shirt

Incentive Proposal 2: Strengthen the Effect of (WeGo Innovate) Film Spots

WeGo Innovate film spots film students conducting practicals

1. ***Make the WeGo Innovate selection criteria transparent***
2. ***Share the WeGo Innovate videos broadly and in local communities***
   Share via cord or USB on local devices to be viewed offline
3. ***Partner with IDP Foundation & Sesame Workshop for a hands-on science film spot***

Career

Incentive Proposal 3: Introduce PEN Practicals Certificates (PPCs)

PPCs are awarded to teachers who successfully complete a certain number of PEN practicals in their classroom during one academic year. Validated by pictures posted on the District WhatsApp group.

1. ***Award tiered PPCs for completing a certain number of practicals per academic year***
   - Bronze-level Certificates for 15 successfully completed practicals
   - Silver-level Certificates for 25 successfully completed practicals
   - Gold-level Certificates for 40 successfully completed practicals
2. ***Accompany PPCs with a prize***
   - Bronze-level Certificate: Material kit
   - Silver-level Certificate: PEN t-shirt + visit of a guest speaker
   - Gold-level Certificate: Award-giving ceremony with Dr. Heather Beem to take place in the teacher's community and experiential reward
     - Experiential reward - lower cost option: visit to the planetarium with other Gold-level teachers to promote peer interaction;
     - Experiential reward - higher cost option: visit to the planetarium with students of Gold-level teacher to increase how much teacher is acknowledged in his/her local environment

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Experiential

Incentive Proposal 4: Organize Inter-School Competitions

Inter-school competitions could have a hands-on science task (i.e. replicating the circulatory system, or building a rocket), and one winner chosen based on a set of predetermined criteria

1. ***Encourage Circuit Trainers to initiate inter-school competitions***
2. ***Circuit Trainers, by demonstrating community buy-in, can qualify for additional locally-sourced materials provided by PEN***
3. ***Provide digital credentials for Circuit Trainers that have hosted inter-school competitions***
   Downloadable WhatsApp filter that teachers can make profile picture
4. ***Winners of circuit competitions qualify to attend yearly district-wide competition hosted by Dr. Heather Beem***

Incentive Proposal 5: Invite Guest Speakers from Science-related Industries

The guest speaker from a science-related industry is intended to bridge the connection between what students are learning in the classroom and a career in a science-related industry

1. ***Source a volunteer guest speaker from a science-related industry to speak to a JHS science classroom of a Silver-level PEN Professional Practical Teacher***
2. ***Communicate to Silver-level PEN PPTs expectation to share photo of guest speaker event***

More Support

Incentive Proposal 6: Capitalize on Circuit Trainer Role

Circuit Trainers (CTs) lead activities within their circuits of five to six schools to promote implementation of practicals

1. ***Circuit Trainers lead a teacher learning circle (TLC) within their circuit at the beginning of each term***
   Teachers can focus on practicals that they are expected to teach in the upcoming term
2. ***PEN can send a WhatsApp message or text to remind Circuit Trainers to conduct TLCs***
3. ***Provide Circuit Trainers with a "PEN Circuit Trainer" logo-ed item to elevate status***
4. ***Facilitate Headteacher & Science Coordinator involvement***
   To ensure that teachers feel like their superiors support the initiative

Incentive Proposal 7: Mobile mentorship with Gold-level PEN Professional Practical Teachers (PPTs)

Gold-level PPTs (who have obtained the Gold-level certificate for more documented experience implementing practicals) to mentor Bronze-level and Silver-level certificate holders

1. ***Gold-level teachers mentor Bronze-level and Silver-level teachers via cell phone***
   They can encourage them to do more practicals and serve as a knowledge resource
2. ***Facilitate matching and introductions between Mentor & Mentee***
3. ***Provide a small stipend in call credit to encourage communication***

Incentive Proposal 8: Capitalize on Peace Corps Volunteers for Ongoing Support

Outsource ongoing in-service support to Peace Corps Volunteers (PCVs)

1. ***Train PCVs in Education Sector to promote hands-on science***
2. ***PCVs to initiate PEN Teacher-Training Workshops***
3. ***PCVs to implement Co-Teaching and Peer Coaching Programs***

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Awards

Bronze-level PEN Practicals Certificate

To PEN Professional Proctical Teacher

_____

for implementing 15 practicals in the classroom during the school year of_____

By conducting practicals with students, this Bronze- level PEN PPT is promoting hands-on science and stimulating critical thinking among students

_____

Heather Been (PhD) - C.E.O & Founder
Practical Education Network

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Awards

Silver-level PEN Practicals Certificate

To PEN Professional Proctical Teacher

_____

for implementing 25 practicals in the classroom during the school year of_____

By conducting practicals with students, this Silver - level PEN PPT is promoting hands-on science and stimulating critical thinking among students

_____

Heather Been (PhD) - C.E.O & Founder
Practical Education Network

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Awards

Gold-level PEN Practicals Certificate

To PEN Professional Proctical Teacher

_____

for implementing 40 practicals in the classroom during the school year of_____

By conducting practicals with students, this Gold - level PEN PPT is promoting hands-on science and stimulating critical thinking among students

_____

Heather Been (PhD) - C.E.O & Founder
Practical Education Network