IMPROVING EDUCATION PERFORMANCE IN MATH & SCIENCE IN THE GAMBIA

An overview of the Progressive Science Initiative and Progressive Math Initiative (PSI-PMI) and its implementation in The Gambia

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Acknowledgements

THIS REPORT was prepared by Ryoko Tomita and Tanya Savrimootoo. Support, advice and comments were provided by Meskerem Mulatu, Robert Goodman, Rosanna Satterfield, and Jeffrey Waite. The team wishes special thanks to the Ministry of Basic and Secondary Education of The Gambia and New Jersey Center for Teaching and Learning for the close collaboration of designing and implementation of the pilot program.

Finally, the team gives thanks to Laura McDonald for her excellent quality assurance and editing work.

Acronyms and Abbreviations

GABECE	Gambia Basic Education Certificate Examination
HTC	Higher Teachers Certificate
IDA	International Development Association
IDF	Institutional Development Fund
IWB	Interactive White Board
MoBSE	Ministry of Basic and Secondary Education
NAT	National Assessment Test
NJCTL	New Jersey Center for Teaching and Learning
PDO	Project Development Objective
PSI-PMI	Progressive Science Initiative and the Progressive Mathematics Initiative
PTC	Primary Teachers Certificate
PTI	Progressive Teaching Initiative
READ	Results for Educator Achievement and Development Project
SSA	Sub-Saharan Africa
SSS	Senior Secondary Schools
STEM	Science, Technology, Engineering and Mathematics
UBS	Upper Basic Schools
WASSCE	West African Senior School Certificate Examination

PART I.
Introduction

THE LOW QUALITY OF EDUCATION IN SSA COUNTRIES is well-documented, including the poor performance on science, technology, engineering and mathematics (STEM)-related subjects in school leaving examinations. The reasons behind the low learning outcomes are many - lack of adequate textbooks or equipment, low teacher quality, outdated curricula, among others. On the other hand, effective and efficient solutions to this issue are less forthcoming. This report documents the implementation of the Progressive Science Initiative® and Progressive Math Initiative® (PSI®-PMI®) in The Gambia, a program which seeks to enhance teacher performance, and thereby improve student learning in science and mathematics through an integrated approach. The program, which originated in New Jersey, United States, was founded by Robert Goodman, Ed. D., and has been very successful, gaining traction within and outside the country. The Gambia is the first SSA country to implement this program.

There are an increasing number of International Development Association (IDA) funded projects in Sub-Saharan Africa (SSA) that focus on supporting improved learning outcomes in mathematics and science. This stems in part from the growing demand from client countries to help ensure that the education system is aligned with the needs of the labor market and that the system is capable of building a competitive and productive workforce. At the same time, there is an increasing focus on the need for the development of soft skills among the workforce. This includes the ability to communicate, collaborate, and to be creative in problem-solving. The PSI-PMI approach is designed to do both- ensuring educational content is relevant and that the pedagogical methods applied foster the soft skills needed.

The PSI-PMI pilot project in The Gambia was a direct request by The Ministry of Basic and Secondary Education (MoBSE), stemming from concerns about students' performance on national and international examinations. Before this program, the MoBSE already had plans to tackle the issues of improving learning outcomes in English by providing intensive training to early grades (Grades 1-3) English teachers. It was also looking for ways to support improvements in

the quality of science and mathematics education. In the National Assessment Test (NAT), a limited number of students reached the minimum requirements. The situation was particularly worrying in grade 5 math and sciences, with average success rates of just 20 percent.
Results at the upper basic and senior secondary levels were scarcely better. Before the project, 76 percent of candidates failed to obtain a credit in any of the four core subjects of the grade 9 national examination, The Gambia Basic Education Certificate Examination (GABECE), and only 4 percent achieved a credit in all 4. Results were poorest in math, with only 7 percent of candidates obtaining the credit. GABECE results determine which Senior Secondary Schools students can enroll in. On the grade 12 regional examination, West African Senior School Certificate Examination (WASSCE), The Gambia was far behind other participating countries. In mathematics, the pass rate was just 3.2 percent, compared with 47 percent in some countries.

Given the issues noted above, the Gambian government obtained US$491,860 in July 2012 from the Institutional Development Fund (IDF) through the World Bank to implement the Teaching Math and Physics through e-learning project (P129888). This pilot project implemented the PSI-PMI with support from the New Jersey Center for Teaching and Learning (NJCTL) in a total of 24 schools, comprising 11 upper basic schools (UBS) and 13 senior secondary schools (SSS) (Annex Table 3). Regions 1 and 2 are in the central areas and Region 5 and 6 are in remote areas of the country.

The Project Development Objective (PDO) of the project was to build the MoBSE's capacity to develop a secondary education teacher training program in physics and math based on international best practice. The second objective was to train current, or prospective, UBS and SSS physics and mathematics teachers, to create a cadre of highly effective teachers of mathematics and physics, and therefore improve the quality of education provision and student learning. The third objective was to evaluate the effectiveness of this approach and to identify its impact and any issues related to implementation. This was useful in determining whether this pilot program should be scaled up in The Gambia.

Objectives of this report

The objective of this report is to describe how the innovative PSI-PMI pilot program was designed and implemented in The Gambia, to document the challenges faced during this process, how these were overcome, and to present the preliminary results of the pilot program in terms of improvements in students' learning outcomes. This can serve as valuable background information for programming of future projects in the SSA region that aim to improve mathematics and science learning outcomes in the region. The Gambia pilot program has garnered much interest within the World Bank (WB), and as such it will be useful to have a report that summarizes the program.

In addition, recently the WB initiated a regional technical assistance program, namely the Mathematics and Science for Schools in Sub-Saharan Africa (MS4SSA). Its objective is to reinforce the WB's support of the efforts by countries in SSA to improve mathematics and science learning outcomes in schools. This program will use a model that is similar to the PSI-PMI model in selected SSA countries. Therefore, it will also be useful for those countries that are interested in participating the MS4SSA program to learn how the PSI-PMI pilot program worked in The Gambia.

The report is organized as follows: Chapter II provides a brief overview of the philosophy, methods and practices behind the PSI-PMI program; Chapter III outlines the implementation process in The Gambia, including the challenges faced during implementation; Chapter IV presents findings on the effect of the pilot program on student learning; and Chapter V outlines the next phase of the project in The Gambia.

PART II.
Overview of the Progressive Teaching Initiative Approach

The Progressive Teaching Initiative (PTI)[1] seeks to transform how education and content knowledge is delivered, learned and assessed. It represents, in the words of its founder, a true paradigm shift- an overhaul of the *status quo* in educational practice which has proven to yield greater levels of student learning and teacher effectiveness, both of which are relevant concerns in education in SSA today. There are four key aspects that define the transformative nature of the PTI approach, and the PSI-PMI program in particular: (i) the integration of technology in the classroom, (ii) a new pedagogy and approach to teaching, (iii) a new approach to how students participate, learn and are assessed, and (iv) a new sequencing of STEM subjects that is organic and better aligned with course content.

Integration of Technology in the Classroom

Under the PSI-PMI approach, technology in the classroom is an essential tool that serves as a facilitator for both the teacher and the students. At its core is the Interactive White Board (IWB) software which is a platform that allows the creation of digital course content by experienced teachers. This enables the teachers to create courses that are targeted, accurate and coherent. Once developed, the course modules are available online, at no cost. As such, an unlimited numbers of teachers are able to access and adapt the materials. There is no Internet required at the school level as all the modules are downloadable onto computers. This virtual collaborative work platform helps improve the accuracy, clarity and alignment of the material to the course objectives by the teachers in their field. In doing so, teachers then have access to lesson plans that have been peer reviewed and which can be used and adapted as needed. A fundamental step in the PTI approach, and one of the unique features of IWB, is the use of student responder technology. This allows each student to have a student responder (polling device) which they use to answer mini quizzes on the material being taught during the class. The IWB shows on the screen what percentage of students answered A, B, C, or D, for example, so that the teacher will immediately know how well the students understand the materials and lessons, and also allow the students to check their understanding of the material. Under the PTI approach, Student Response questions are built into the lessons and presentations.

[1]Progressive Teaching Initiative is the umbrella term which regroups any course like PMI and PSI which is based on the same set of guiding principles.

Teaching Approach

The integration of technology into the PSI-PMI approach alters the role of the teacher, from the course preparation process to the delivery of course content in the classroom. Lesson planning using this approach does not consume as much of an individual teacher's time, while it also ensures that the course content is coherent, accurate, clear, and aligned with the overall objective. Further, as the lessons are shared with teachers in the same school, district and beyond, it ensures a fair degree of consistency in the quality of education provided. This also means that new teachers or less experienced teachers can access materials that have been refined by more experienced teachers, breaking down some of the barriers to teachers' learning as well.

This approach also impacts the role of the teacher in the classroom. Through the formative assessments and use of Students Responders, teachers are able to know in real time if students understand the material and, if not, they are able to adjust their teaching accordingly. Also, because the format of class alternates between brief direct instruction and formative assessments (using Student Responders), the teacher can identify those students that need help the most, as well as any subject-matter which requires additional attention. On this basis, students are then given the opportunity to discuss their understanding of the material in a small group where the teacher can listen and provide input. In this way, a good teacher is no longer so much dependent on their prior knowledge of the subject itself, but their skills as a teacher – that is their ability to convey ideas and knowledge and as well as to motivate students, be creative, and foster collaboration. In fact, the PTI model suggests that any teacher with good teaching skills be able to learn any course content and teach a related course successfully, regardless of their original training or field of study. This approach significantly broadens the pool of teachers available to teach each subject, including STEM-related ones, while ensuring high standards are maintained.

Under this program, teachers who wish to teach PSI-PMI courses are first certified by the NJCTL. They participate in training courses delivered by the NJCTL to ensure that they have mastered the course content, and are familiar and comfortable with the pedagogical methods used in the program. Upon completion of their training, teachers receive a certificate confirming that they have met the requirements in terms of mastering the PTI approach as well as the specific course content.

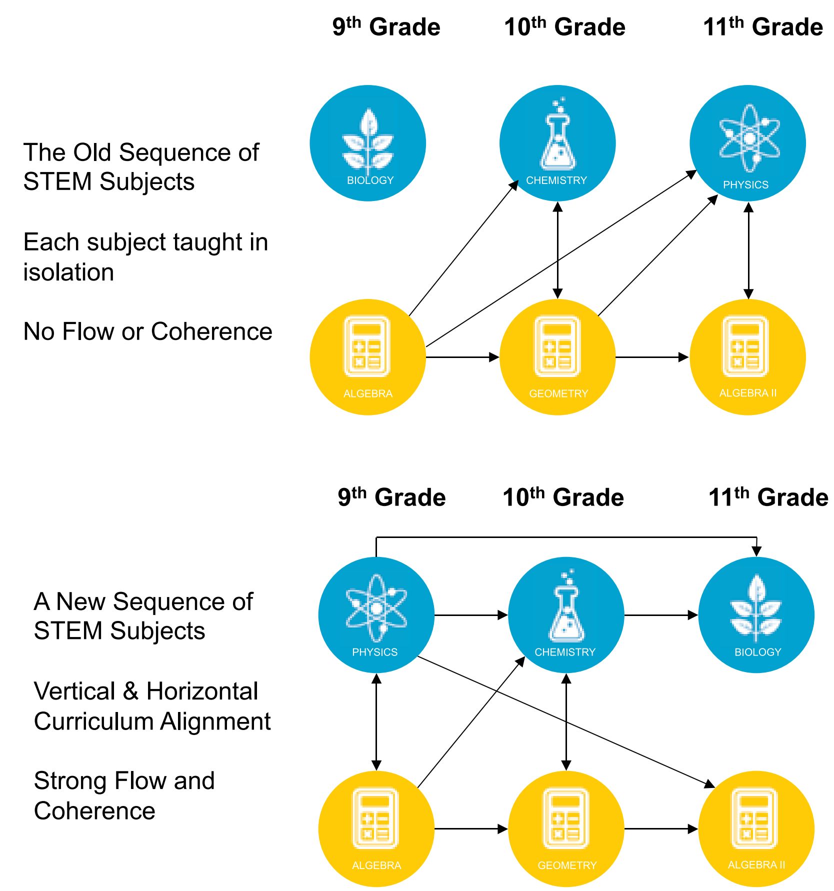
Student participation

Under the PTI approach, the classroom is a student-centered environment where interactive participation, which aims to stimulate learning, is key. Ideally, classrooms are equipped with round student tables which are about five feet in diameter around which students gather and where discussions related to student response questions are encouraged. This is believed to foster constructive social interaction, one of the principles of underpinning the PTI approach. Moreover, since the IWB presentations replace textbooks and are available to students online and in print, the student no longer needs to spend classroom time writing down notes mechanically. Instead, the focus becomes on absorbing, understanding and testing their comprehension of the material taught in real time. As described earlier, students are encouraged to discuss questions with their peers and to work together on resolving them. Top students have the opportunity to verbalize their thought process, reinforcing their understanding of the material, while weaker students are exposed to alternative thinking and approaches on how to tackle a question or a problem, which also allows them to progress. Top students are also encouraged to provide after school tutoring to their peers.

Content, sequencing of subjects, and assessment

The PSI-PMI approach pays close attention to the sequencing of the mathematics and science courses in the curriculum and this sequencing is an essential feature of the program. In particular, the PSI program uses a Physics-Chemistry-Biology sequence which is coupled with a parallel curriculum in Mathematics (Algebra- Geometry- Algebra II- Pre-Calculus/ Calculus) spanning grades 9 to 12. This sequencing was developed to ensure that mathematics and science courses were taught in a way that reinforced each other, resulting in an organic progression of STEM courses. For example, grade 9 Algebra is either taught right before or at the same time as Physics (which is Algebra-based) which allows the material taught and learned in the mathematics class to be applied immediately in the science class. This is different from traditional course sequencing which begins with Biology (grade 9) Chemistry (grade 10) and Physics (grade 11). As such, Algebra (taught in grade 9) does not become relevant until Chemistry in grade 10 and Physics in grade 11 (Figure 1). Using the PSI-PMI approach, the sequencing ensures the curriculum is relevant and applied.

Figure 1: Traditional course sequencing (top) and simplified sequencing under PSI-PMI (bottom) from grades 9 to 11



Source: NJCTL presentation, October 2015

Assessments and homework serve a new purpose- under the PTI approach, homework becomes a formative assessment tool where answers are provided immediately and where students are able to retake and redo the assignment until they are sure they have understood the material. As such, homework is no longer tied to the students' grade, and instead becomes part of the learning process. This is also logistically possible for teachers since assignments are made available online and do not require individual grading. At the same time, assessments are designed to build up to the end of course test and therefore ensure that the material taught and learned is feeding into the content being assessed at the end of the course. This ensures greater alignment between the continuous assessments during the year and the end-of-course test.

PART III.
Implementation of the PSI-PMI Pilot program in The Gambia

THE FOLLOWING PROVIDES AN OVERVIEW OF THE KEY ASPECTS of the implementation of the Program in The Gambia including the timeline, description of training activities, as well as some of the challenges encountered.

Timeline

The IDF grant, which supported the PSI-PMI Pilot Program in The Gambia, was signed in July 2012 and became effective immediately. The three-year program closed in July 2015. The Pilot was implemented in 24 schools. Training was first provided to teachers in August and December of 2012[2] (training is provided over the course of the entire Pilot program during school holidays and this aspect of the Pilot is described in greater detail below).

The Program was initially rolled out to a total of 12 upper basic schools (UBS) and senior secondary schools (SSS) in regions 1 and 2[3] beginning in January 2013. In these 12 schools (Cohort 1), the PSI-PMI approach was used to teach Algebra I and Algebra-Based Physics in January 2013 (halfway through the school year which spans September to June). This meant that students had been studying for four months using the traditional curricula when the PSI-PMI approach was introduced. Between the spring of 2013 and the fall of 2014, the PSI-PMI approach was rolled out to another 12 UBS and SSS in regions 3 through 6[4] for Algebra I and Algebra-Based Physics (Cohort 2). The first cohort focused on Regions 1 and 2 because it was logistically easier to start there. As the participating schools were close to teach other, the teachers were able to communicate with each other and discuss the PSI-PMI courses and classroom sessions. Figure 2 shows the timeline of main events during the implementation phase of the program. Following this Pilot Program, the Government has supported teacher training for another group of teachers (cohort 3) in the same 24 schools supported under this Pilot Program using its own resources.

[2] It was decided, together with the MoBSE, that the initial teacher training would focus on Algebra I and Algebra-Based Physics because teachers were teaching general science but their content knowledge on physics was low, and this would be in line with the program's approach.

[3] Regions 1 and 2 are those central areas near or in the country's capital city, Banjul.

[4] Regions 3 through 6 are those areas that are farther from the capital, with the higher number indicating a greater distance from the capital.

In January 2013, the teachers for Cohort 1 began teaching Algebra I and Algebra-Based Physics to grades 9 and 10 students. In the 2013/2014 school year, students in grades 10 and 11 in these Cohort 1 schools continued with these courses[5] while new students in grades 9 and 10 began learning Algebra and Algebra-Based Physics using the PSI-PMI approach. Since the delivery of the SMART interactive projectors and Student Responders was delayed (only being provided to Cohort 2 schools in March 2014), the start of the program was delayed in some of these schools. Some however, began the program using the student copies and a blackboard in the Fall of 2013 – to avoid further delays. In the 2014/15 school year, teachers began also teaching physics and math (Algebra I and Geometry) in September, 2014. The first group of students to participate in the PSI-PMI program (beginning in January of 2013) sat for the WASSCE physics and math exams in June of 2015 (Annex Figure 6).

Under the original design, the Pilot Program was to be implemented in only 12 schools. However, cost savings were realized due to: (i) a reduction in the price of the equipment (e.g., IWBs and Student Responders); and (ii) cohort 2 teachers were trained by the best performing teachers from cohort 1, under the supervision of the NJCTL- implying lower training fees. As a result of these savings, it was decided that the Pilot Program would be scaled up to 24 schools. All teachers in the 24 schools were given the option of participating in the PSI-PMI program and each participating teacher was given a *per diem* compensation during each of the trainings.

The NJCTL provided continuous support throughout the implementation of the Pilot Program. At the very beginning of the Pilot Program in August 2012, NJCTL participated in: (1) the launch of the program, (2) conducting pre-test of teachers, (3) discussing the traditional Gambian curriculum and the NJCTL curriculum and assessment of students' learning, and (4) the training of teachers for 5 days including one day session to master the technology needed for PSI-PMI to be successfully implemented. In terms of the curriculum and assessment, the MoBSE, the WB and the NJCTL discussed and determined which courses the teacher trainings would cover. Further, additional topics which are not part of the PSI-PMI curriculum but are covered in the GABECE, national examination at grade 9, were identified for inclusion in the curriculum (additional details are discussed in the Challenges section). The support of the NJCTL throughout the process was crucial in ensuring the approach was adequately implemented at all stages of the Program.

Prior to the teacher training, the NJCTL reviewed the mathematics and science curricula used in The Gambia and determined that they were similar to those used by PSI-PMI, with 90 percent of The Gambian curriculum covered by the PSI-PMI program. Therefore, the adaptation of the PSI-PMI program to The Gambia's curricula was minimal.

Teacher Training

As described above, teacher training for Cohort 1 schools/teachers began in August 2012, only one month after project effectiveness. Training for Cohort 2 schools/teachers began in August 2013. Cohort 1 training continued even after Cohort 2 training started. Throughout the project,

[5] In The Gambia, Grade 9 and 10 students complete Algebra I in a little less than two years and then move on to geometry, as opposed to the US, where students learn the same subjects in one year. This is due to the difference in contact hours between the two systems. In The Gambia, the contact hours is about 60 percent of that in the US, so it takes longer to complete each course.

the NJCTL provided important support to training activities – travelling to The Gambia seven times in August 2012, December 2012, April 2013, August 2013, April 2014 and in December 2014 (though this mission focused primarily on planning). The following provides detailed information on training provided to each cohort across the life of the Pilot Program.

Cohort 1

Five teacher trainings were held for the first cohort during school holidays. Training was held for two weeks in August 2012, one week December 2012, 5 days in April 2013, 10 days in August 2013 and 5 days April 2014. Forty-six teachers participated in the August 2012 training (about 50 percent in each subject). The number of teachers who attended the trainings varied slightly each time, however, most of the teachers remained in the training for the whole period (from the August 2012 training to the April 2014 training). The first year of trainings focused on Algebra I and Algebra-Based Physics. Since these courses are taught at the same time using the PSI-PMI approach, it is useful to teach teachers in both subjects at the same time. In the second year, this cohort completed training in Geometry and started Advanced Physics.

Cohort 2

Due to funding constraints, it was not feasible for NJCTL to train Cohort 2 teachers entirely. However, NJCTL trained teachers such that best performing teachers could become teacher-trainers for subsequent cohorts. As such, a *'train-the-trainer'* model was implemented, where two of the best math and two of the best science teachers were selected from Cohort 1 to train Cohort 2. The NJCTL trainers supervised the training sessions conducted by these teachers. This helped build sustainability for the project as the country created ownership of the project, and eventually be able to train teachers without external support. The only drawback was that these four teachers could not attend the Cohort 1 training, which was still ongoing by the NJCTL staff when the Cohort 2 training started. Cohort 2 teachers are from remote regions, i.e. Regions 3 through 6 so their content knowledge and computer skills were lower than that of Cohort 1 teachers and they learned about 80 percent of what Cohort 1 teachers learned.

Cohort 3

In 2016, the MoBSE supported a third cohort of teachers in the 24 schools which were targeted by this Pilot – without support from the WB or NJCTL. Training was provided to cohort 3 teachers after the project closed. So far, one week of training has been held (during Easter holiday in 2016) in which 91 teachers were trained (38 math teachers and 53 science teachers in the same 24 schools). This training was conducted by the same four teachers who had taught Cohort 2 teachers.

Detailed Information on Teacher Trainings Activities

The following provides details of each teacher training undertaken throughout the implementation of the Pilot Program and a diagram describing the training is also provided below (Figure 2). The cohort 1 training was provided by NJCTL while the cohort 2 training was provided by the best performing teachers trained in Cohort 1 (and supervised by NJCTL). Attendance was monitored by the MoBSE. Training was held either at a regional training site and/or at the schools themselves.

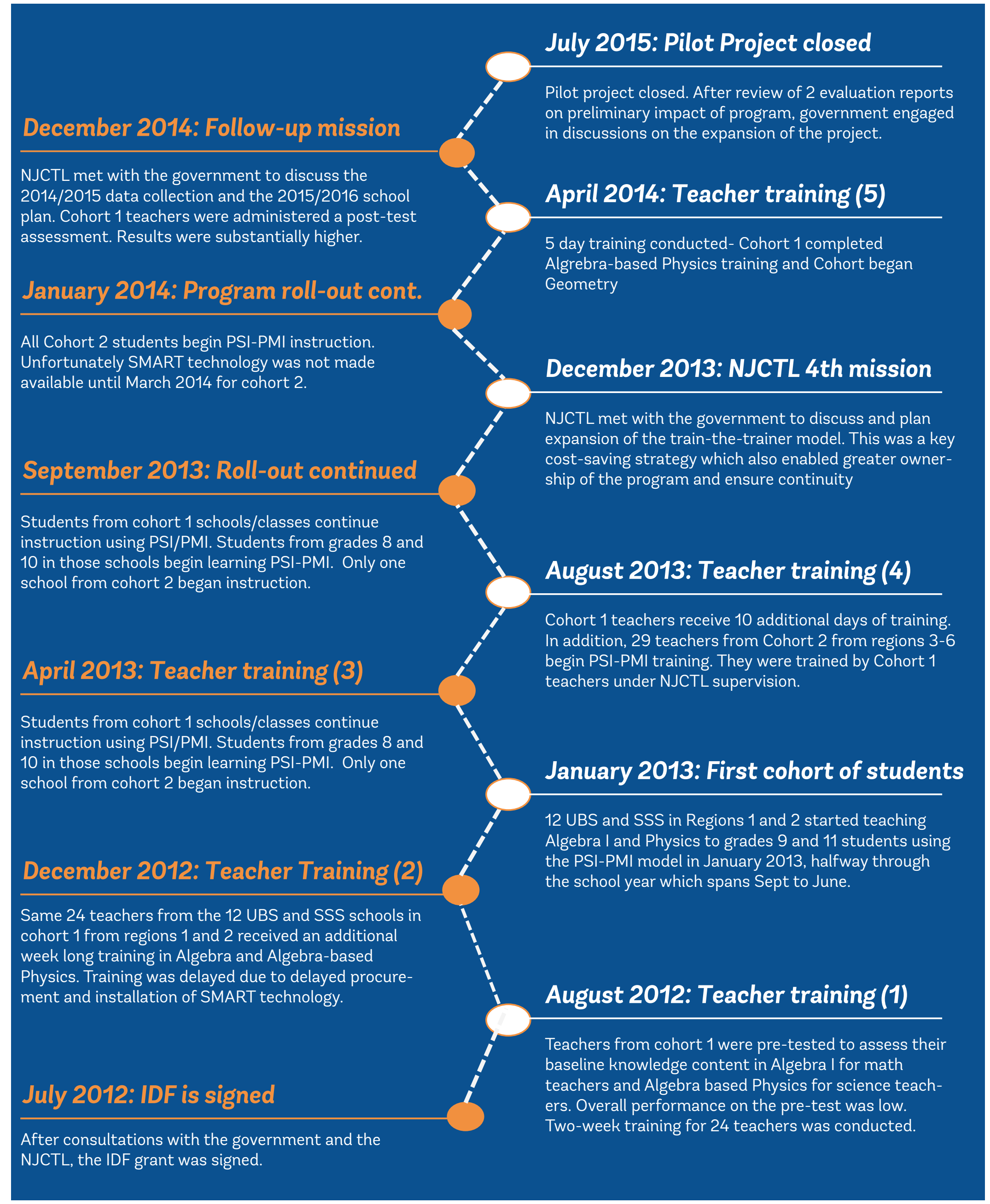
AUGUST 2012 TRAINING: At the start of the training, teachers took a pre-test to gauge their academic ability in the subject they were teaching (math or science). These pre-tests were the Algebra I final exam and the Algebra-Based Physics final exam which are given to grade 9 students when they have completed the course. The results on these pre-tests were much lower than expected. The average scores on the Algebra test was 50 percent and on the Algebra-Based Physics test was 28 percent respectively. Follow-up discussions held by NJCTL with the teachers after the test, confirmed the teachers' limited subject knowledge, so the NJCTL decided to focus on identified areas of weakness during the training.

DECEMBER 2012 TRAINING: This was the last training prior to the start of the program in January 2013. The majority of teachers which participated in the August 2012 training, participated in this training (18 in Algebra-Based Physics and 17 in Algebra I). The tests were undertaken again after the December 2012 training. A notable increase in the average scores in Algebra I and Algebra-Based Physics were observed – increasing to 93 percent in Algebra I and 90 percent in Algebra-Based Physics.

APRIL 2013 TRAINING: Of the 18 teachers trained for the Physics course in December 2012, four of them did not continue in the April 2013 training. However, they were replaced by two teachers so a total of 16 teachers participated in the Physics training during this session. Of the 17 Algebra I teachers who participated in December 2012 training, only one did not join the April 2013 training. An additional teacher participated – maintaining a total of 17 teachers in Algebra I training. During this training, the Cohort 1 Algebra-Based physics teachers were trained in the first half of the Algebra-Based Physics course (covering the mechanics portion of the course) and tested on this. In the training which followed in August, they were given a midterm assessment. Analysis of results found a strong correlation between the average grade in the Mechanics portion of the course and the average grade on the midterm assessment in August.

AUGUST 2013 TRAINING: Cohort 1 continued training in Algebra-Based Physics focusing on the Electricity and Magnetism sections of the course. At the end of the August 2013 training, Cohort 1 teachers took the test on Electricity and Magnetism and the mean score was 90 percent. The training for cohort 2 started at this time, with training in Algebra I and Algebra-Based Physics. Twelve physics teachers and 14 math teachers participated in this training. NJCTL, on the basis of teachers' performance in training and exams, identified four teachers to be teacher-trainers for cohort 2. At this training, cohort 2 teachers had the opportunity to practice the PSI-PMI approach using the IWBs and student response system - although the power supply at the training center was not reliable and electricity was only available for part of the training. They also had the opportunity to learn course content. Assess-

Figure 2: Timeline of Project Implementation



Source: Author's presentation

ment of teachers participating in the training (cohort 2) found that the four Gambian trainers were effective in teaching physics and math content to the new group of teachers.

DECEMBER 2013: This mission was largely devoted to organizing the trainings for the spring and summer of 2014 training, as well as to discuss potential scale up of the program using the effective Train-the-Trainer model.

APRIL 2014 TRAINING: The four selected Gambian trainers from Cohort 1 returned again to teach the Cohort 2 teachers. During this training, teachers had more opportunity to practice using the interactive technology and adopting the pedagogy, taking turns "micro-teaching" portions of the material. Cohort 1 Algebra-Based Physics teachers returned to complete the Algebra-Based Physics course training and took the final exam and Cohort 1 teachers were also trained in Geometry. At this time, cohort 1 teachers were awarded certificates of completion. The mean scores of Cohort 1 teachers' exams in Geometry and Physics (Waves and Lights) were 93 percent and 94 percent, respectively. Cohort 2 teachers were trained in Algebra I and Algebra-Based Physics. Cohort 2 teachers' took tests at the end of this training (covering what had been taught during this month's training) and the mean scores on the exams for Algebra I and Algebra-Based Physics were 83 and 86 percent, respectively.

DECEMBER 2014: During this planning-focused mission, NJCTL and MoBSE staff discussed data collection for the 2014-2015 school-year and plan scheduling and pacing for the 2015-2016 school-year. A post-test was also administered for Cohort 1 Algebra I and Algebra-Based Physics teachers.

Technology, Equipment and Facilities

The technology for the training site for the first cohort was installed just before the training course began. For cohort 2, technology was installed in 9 of the 12 schools over the course of the training whereas 3 schools required further improvements prior to installation of the technology. Moreover, in a number of the schools (cohorts 1 and 2), minor rehabilitations were required to reinforce the security of the classrooms so that the equipment would be secure and protected from dust. Delays in the reinforcement of security (e.g., protected windows) resulted in delays of the delivery of the equipment to schools.

Although small round tables (around five feet in diameter) without legs around the perimeter would have been ideal for students to flexibly move around the table to work in groups, procuring such tables proved difficult and so classrooms used those tables that were available to them. In some instances, students' desks would be placed together so that students could face each other. Others used rectangular tables that were available in the schools. Most schools in the Pilot Program (like most schools in The Gambia) had a very limited, if any, connection to the internet. However, this limitation was addressed through the use of flash drives which could be used to install the PSI-PMI modules. Further, only an initial internet connection is needed to install the SMART Notebook software.

Challenges in Implementation

Some of the challenges identified in the implementation of the Pilot Program include the following:

Differences in The Gambia's math and science curriculum and the PSI-PMI curriculum and ensuring that the curriculum responds to The Gambia context.

- Alignment of the PSI-PMI curriculum with the GABECE. All grade 9 students in The Gambia take the GABECE. This is a very important exam because admission to SSS is based on passing the core subjects - English, Mathematics, Science, and Social and Environmental Studies. There were discussions for students in UBS who are studying PSI-PMI courses because the GABECE is based on the regular math and science curriculum and PSI-PMI curriculum is slightly different. In consultation with the West African Examinations Council (WAEC), which administers the GABECE, it was decided that an alternate version of the GABECE was to be provided to PSI-PMI participating students so that they would not face any disadvantage. Thirty out of 40 questions in the assessment was drawn from the standard GABECE for science and math and the remaining 10 PMI midterm for Algebra I.
- Alignment of the PSI-PMI curriculum with the content coverage in the school leaving examination, WASSCE. The NJCTL examined the coverage of the WASSCE to determine if the PSI-PMI curriculum covered all the modules. They determined that PSI-PMI covers about 90 percent of it, but alerted the MoBSE on a few areas in WASSCE that are not in PSI-PMI so that the teachers can teach these areas to the PSI-PMI participating students in order to ensure they are adequately prepared for the WASSCE. Currently, under the Results for Education Achievement and Development (READ) project, financed by the WB and Global Partnership for Education (GPE), the NJCTL has been developing the modules of these areas not covered by the PSI-PMI model.

The Pilot Program focused on in-service training support. Given the importance of pre-service training in overall teacher effectiveness, the PSI-PMI approach should be integrated into pre-service training activities to promote sustainability and enhanced efficiency of the program. The training activities supported under this Pilot Program were limited to in-service training. The READ project has provided Technical Assistance (TA) to: (i) review the existing Primary Teachers Certificate (PTC) and Higher Teachers Certificate (HTC) programs[6] in the Gambia College (GC), and (ii) redesign the programs to focus more strongly on relevant subject content knowledge, pedagogical skills and relevant use of ICT. The NJCTL together with the consulting firm which has been providing TA have collaborated to include the PSI-PMI in both the PTC and HTC programs so that teacher trainees learn the PSI-PMI approach while they are attending pre-service training at the GC.

Differences in teaching hours in the US and The Gambia required a longer period for covering each subject in The Gambian context. As the modules were originally developed by NJCTL for use in the U.S., its implementation did not match the Gambian context which has a much lower number of contact hours. Contact hours for science and for math range between 120 and 160 minutes (180 minutes maximum) per week in The

[6] PTC and HTC are required to teach at Lower Basic Schools (LBS) and UBS respectively. They are pre-service programs at the Gambia College.

Gambia while New Jersey contact hours for math and physics are 200 minutes and 220 minutes per week respectively based on the US school curriculum. Therefore, PSI-PMI in The Gambia was able to cover about 60 to 70 percent of each course in a full year since these courses were designed by the NJCTL to be taught in 180 days with classes meeting for 200-220 minutes per week. Therefore, it takes longer to finish each course in The Gambia. In order to fully implement the PSI-PMI curriculum in the selected schools, the course was extended beyond one school year into the next. Moving forward, it has been suggested that these courses begin in an earlier grade (e.g. grade 7 instead of grade 9).

Lack of stable electricity: All 24 schools were connected to the grid, however, access to electricity was not stable during the implementation of the Pilot Program (in either the training or classes). Therefore, teachers and students were required to use hard copies when there was no electricity in the classroom – making it impossible at certain times to use the student responder technology and IWBs, which are essential to the PSI-PMI approach. The READ project will provide all 24 schools with solar panels to help address this issue.

Lack of technology and adequate facilities: For each class, the following technology and facilities were needed - electricity, a laptop, an interactive projector, Students Responders (one for each student). Since the available budget could not cover the cost of a full set of equipment for each school, it was necessary to determine the minimal quantity of each type of equipment that was needed in each school, and which items could be centrally located to be shared by the 12 schools. NJCTL advised on how to procure the necessary equipment within the available budget by providing model numbers and suggesting to buy directly through each specified supplier.

PART IV.
PSI-PMI effect on education performance in The Gambia

THE IMPLEMENTATION OF THE PILOT PROGRAM IN THE GAMBIA was considered successful and the results in terms of student learning outcomes have been very encouraging. An independent consulting firm was hired to measure the effects of the adapted PSI-PMI Pilot Program on student learning in The Gambia, using both quantitative and qualitative information. They undertook two evaluations of the Pilot Program – the first was carried out in 2013, about one year after the PSI-PMI approach was introduced for grades 9 and 10 students, and the second was undertaken in 2015 on grade 12 students[7]. The first assessment looked at performance of grade 9 students on the national examination as well as the progress of SSS students based on the PSI-PMI tests (NJCTL administered exams; using both pre-test and post-test results). The second assessment in 2015, assessed the performance of grade 12 students on the international examination, WASSCE.

The aim of these assessments was to look at the successful aspects of the program, and to determine, based on the findings, whether the program could be effectively expanded to more schools. These assessments also aimed to explore some of the issues faced during implementation and draw lessons learned from them that would be useful in any potential future expansion of the program. Background information on the evaluations and the main findings of these assessments and findings (also included in two separate reports) are presented below.

It should be noted that these evaluations are considered to show conservative and preliminary estimations of the effect of the PSI-PMI program primarily due to the fact that (i) the grade 9 students and SSS students evaluated in 2013 had only been exposed to PSI-PMI for half a year, due to delays in the start of the program, and (ii) the cohort of students that sat for the WASSCE (grade 12 examination) in 2015 were the same grade 10 students who received half a year of PSI-PMI instruction in 2013. As the program continues to be implemented in the 24 schools participating in the Pilot Program in The Gambia, it is expected that the effects will be much stronger and more robust. The students who took the WASSCE in 2016 are the first students to take the WASSCE having received more than one year of exposure to the program. The 2016 WASSCE results, not yet available, are expected to show improved learning outcomes in math and science. These two evaluations were essential monitoring and evaluation instruments for both the MoBSE and NJCTL to help support effective implementation of the PSI-PMI approach.

[7] Reports can be made available upon request

Effect on Upper Basic Students (Grade 9)

The effect of the PSI-PMI program on grade 9 students was assessed during the first program evaluation in 2013. An analysis compared test score performance of students participating in PSI-PMI to students not participating in PSI-PMI from the same schools on the GABECE (grade 9 examination which comprises four core components - English, Mathematics, Science and Social Studies). The exam was held in June 2013. The sample of students was taken from three UBS and included 177 student participants from the PSI-PMI program and over 1,330 students not participating in the PSI-PMI program from the same three schools[8].

Some of the key findings of this evaluation, included: (i) students participating in PMI outperformed non-PMI students in the same school by an average of 27 percentage points in Mathematics. The mean score of students participating in the PMI was 52.1 percent in Mathematics on the GABECE compared to an average of 25.1 percent among students not participating in PMI; and (ii) students participating in PSI outperformed students within the same schools who did not receive PSI instruction by an average of 12.4 percentage points in Science (Figure 3).

Figure 3: Summary of effect of PSI-PMI on Grade 9, Science

	N	MEAN	SE
TREATMENT			
Greater Banjul Upper Basic School	39	0.306	0.016
St. Therese's Upper Basic School	52	0.342	0.017
22nd July Academy	86	0.381	0.015
Overall	***177***	***0.353***	***0.027***
CONTROL			
Greater Banjul Upper Basic School	355	0.158	0.004
St. Therese's Upper Basic School	668	0.251	0.006
22nd July Academy	312	0.222	0.007
Overall	***1,335***	***0.219***	***0.009***
DIFFERENCE			
Greater Banjul Upper Basic School	394	0.148***	0.016
St. Therese's Upper Basic School	720	0.091***	0.018
22nd July Academy	398	0.159***	0.016
Overall	***1,512***	***0.124****	***0.029***

[8] The three schools included: Greater Banjul Upper Basic School, St. Therese's Upper Basic School and 22 July Academy

Figure 3: Summary of effect of PSI-PMI on Grade 9, Mathematics

	N	MEAN	SE
TREATMENT			
Greater Banjul Upper Basic School	39	0.394	0.028
St. Therese's Upper Basic School	52	0.519	0.025
22nd July Academy	86	0.581	0.023
Overall	***177***	***0.521***	***0.043***
CONTROL			
Greater Banjul Upper Basic School	354	0.155	0.004
St. Therese's Upper Basic School	668	0.304	0.008
22nd July Academy	315	0.247	0.010
Overall	***1,337***	***0.251***	***0.012***
DIFFERENCE			
Greater Banjul Upper Basic School	393	0.238***	0.029
St. Therese's Upper Basic School	720	0.215***	0.027
22nd July Academy	401	0.333***	0.025
Overall	***1,514***	***0.270****	***0.046***

Source: Hanover, 2013

Effect on Senior Secondary Students

The impact of the program on the performance of the first SSS cohort in 2013 was measured by (i) the evolution of the pre-test and post-test results on the PSI-PMI tests (NJCTL administered exams) for PSI-PMI students, and (ii) comparing the performance of PSI-PMI students and non-PSI-PMI students on these PSI-PMI tests.

Findings from the assessment on the impact of the PSI-PMI program on senior secondary students found that: (i) PMI students showed an average of 11.3 percentage point increase between the pre-test and post-test results on the PMI assessment, increasing from an average of 37.1 to 48.4 percent. The improvement varied across schools and also across the course units tested. Unsurprisingly, schools which covered more material and units, were inclined to perform better. The test results from the first unit content showed the greatest improvement across all schools, reflecting the fact that all students were exposed to this material; and (ii) PMI students also performed better than non-PMI students on the PMI test by an average of 8.8 percentage points. In addition, (iii) PSI students showed an average of 21 percentage point increase between the pre-test and post-test results on the PSI assessment, increasing from an average of 21.8 to 42.8 percent. Increases were recorded in all 6 science subjects (Kinematics, Dynamics, Uniform Circular Motion, Gravitation, Energy, and Momentum) although some variation is noted across schools (see Figure 4).

Figure 4: Summary of effect of PSI-PMI on SSS, Science by topic

	NO. OF OBS.	PRETEST	POSTTEST	DIFFERENCE
Kinematics	258	0.312	0.530	0.219***
Dynamics	258	0.259	0.476	0.217***
UCM	258	0.257	0.498	0.240***
Gravitation	258	0.141	0.479	0.338***
Energy	258	0.163	0.343	0.180***
Momentum	258	0.183	0.271	0.088***
PSI Score	***258***	***0.218***	***0.428***	***0.210****

*Note: *** p<0.01, ** p<0.05, * p<0.10. The number of observations in the pretest and posttest is 129. Statistical significance computed using a t-test.*

Longitudinal Student Learning Growth – PMI Students, by School in Mathematics

	NO. OF OBS.	PRETEST	POSTTEST	DIFFERENCE
22nd July Academy	38	0.323	0.446	0.124***
Gambia SSS	6	0.261	0.464	0.203***
Kotu SSS	38	0.382	0.542	0.160***
Muslim SSS	30	0.246	0.328	0.081***
Nusrat SSS	62	0.456	0.575	0.119***
Sifoe SSS	26	0.358	0.391	0.033
St. Joseph SSS	14	0.435	0.534	0.099**
Overall	***214***	***0.371***	***0.484***	***0.113****

*Note: *** p<0.01, ** p<0.05, * p<0.10. The number of observations in the pretest and posttest is symmetric across all schools and overall. Statistical significance computed using a t-test. Numbers representing the pretest, posttest, and difference are in percentages*

Source: Hanover, 2013

In the second evaluation in 2015, the assessment focused on the performance of grade 12 students on the WASSCE – an international exam taken at the end of the senior secondary cycle. The examination comprises several subjects although there are five core areas which all students must take in addition to three or four electives. The core subjects include: English Language, Mathematics, one science subject (Science, Chemistry, Physics or Biology), one of either English Literature, Geography or History, and either Agricultural Science or Vocational/Technical subjects. It is important to note that the assessment for this cohort is expected to yield relatively weaker results than could normally be expected since the PSI-PMI students from Cohort 1 who took the WASSCE in 2015 (Figure 6) were exposed to the program for only half a year at most. As such, the PSI-PMI program is expected to have stronger results on the Physics and Mathematics components (primary subjects), than on the Chemistry, Math and Science components (primary residual subjects). No impact would be expected on other subjects. Nonetheless, the analysis shows those students participating in PSI-PMI still performed better than their peers who did not participated in the PSI-PMI program. The analysis is based on data on WASSCE results from 74 schools over four years, where 16 of the schools participated in the PSI-PMI program (8 in 2012/2013 (Cohort 1) and 8 in 2013/2014 (Cohort 2)).

Some of the key findings of this assessment included: (i) PSI-PMI students showed considerable gains on the Physics exam, with 6 percent of students obtaining the highest score (a credit of 1) in 2015 as opposed to 1 percent in 2012. The gains in the control group were much lower, increasing from 1 percent to 2 percent. (ii) the number of WASSCE takers to have obtained a credit of 1 (highest score) in Further Mathematics, increased from 4 percent to 12 percent for Cohort 1 schools and from 0 to 10 percent for Cohort 2 schools. The percentage of those from the control group who obtained a credit of 1 in Further Mathematics increased by only 1 percentage point over the same period from 6 to 7 percent (see Figure 5). Additionally, (iii) performance on primary residual subjects also showed some strong results, especially for Cohort 1 students. For example, the percentage of students obtaining the highest score in Chemistry increased from 2 percent to 6 percent among Cohort 1 schools, from 1 to 2 percent among Cohort 2 schools and decreased in the non-PSI-PMI group.

The full effect of the program on grade 12 students is expected to be captured in 2016 when the WASSCE takers would have been exposed for at least a full year. Upcoming results are expected to be even stronger than those reported in 2015.

Figure 5: Summary of effect of PSI-PMI program on WASSCE Physics and Mathematics

	PHYSICS 512			FURTHER MATHEMATICS 401		
	COHORT 1	COHORT 2	CONTROL	COHORT 1	COHORT 2	CONTROL
2012	2%	1%	4%	16%	50%	19%
2013	0%	0%	1%	3%	25%	4%
2014	7%	5%	3%	9%	--	2%
2015	11%	15%	5%	24%	30%	17%
All Years	***5%***	***5%***	***3%***	***13%***	***35%***	***11%***
Total N	***1,376***	***331***	***1,552***	***531***	***16***	***391***

Source: Hanover, 2015

Student and Teacher Perceptions of the Program reported in the 2013 Evaluation

The perceived effectiveness of the PSI-PMI program among students and teachers is also a key metric of program success, as it captures, among other things, increased motivation and interest in the course material. To that end, a survey was conducted among Cohort 1 students and Cohort 1 and 2 teachers in PSI-PMI schools during the spring in 2014 to capture qualitative data related to the perceived effectiveness of the Pilot Program. Overall, both student and teacher feedback were very positive and indicate successful implementation, although there remains some room for improvement.

Some of the key findings of the qualitative analysis include the following observations:

- **Students enjoyed the new classroom dynamics - over 92 percent indicated that they enjoyed working with their peers in solving math and science problems, 94 percent felt that it had improved their learning and 92 percent reported feeling comfortable learning from mistakes in class.** In addition, 83 percent indicated that the student responders helped them in their learning, further supporting the need for embedded formative assessments in the class, and 82 percent thought this new way of teaching and learning was better than the previous methods. Eighty-two percent thought the IWB was helpful. The students also felt that they had learned more physics and mathematics and that they were more interested in pursuing sciences as a result of the program;
- **Teachers' responses indicated that they were comfortable in using the program and adapting their teaching methods accordingly.** Among Cohort 1 teachers for example, 100 percent recognized that students enjoyed learning in social groups and 94 percent believed that the program will lead to higher levels of students' achievement, and 87 percent of teachers believe that students learn more mathematics and science using the PSI-PMI curriculum. At the same time, 82 percent preferred teaching using the PSI-PMI curriculum. Ninety-three percent felt they had received enough training and 73 felt they had the necessary equipment to successfully implement the program. Eighty-eight percent felt that the curriculum was not too difficult for their students;
- **Although there were some variations in the frequency of adoption of PSI-PMI teaching methods, almost all teachers reported adopting all teaching techniques.** Among Cohort 1 teachers for example, all teachers encouraged the students to talk to each other and solve problems in groups at least some of the time (69 percent did so all of the time, 15 percent most of the time and 15 percent some of the time), and all teachers seated their students in collaborative learning groups (46 percent did so all the time). Ninety-two percent used embedded formative assessments and the SMART notebook presentations at least some of the time. All teachers made use, to some extent or another, of the results from the formative assessments in class to decide on whether to review, reteach the topics or to move on to the next topic or lesson. The only teaching method not as widely adopted was the use of the grading correlation table to report student grades, with only 58 percent of teachers using this method at least some of the time.
- **Cohort 2 teachers answered less positively in the survey.** This could be driven in some degree by the fact that Cohort 2 teachers, as noted earlier, were from regions 3-6 while Cohort 1 teachers were from regions 1 and 2, with perhaps less familiarity and exposure to the technology used. It could also be partly due to the fact that training of Cohort 2 teachers was done by the Ministry of Basic and Secondary Education, relying on some of Cohort 1 teachers. It also has to be noted that Cohort 2 teachers had not yet begun PSI-PMI instruction at the time of the survey. While this reinforces the sustainability of the program, it also implies that the first iterations will be subject to some shortcomings that can and will be improved upon with time.

PART V.
Going forward: Next steps following completion of the Pilot Program

THE FOLLOWING PROVIDES AN OVERVIEW OF COST OF THE PILOT PROGRAM and an overview of training still needed.

The total amount of the IDF grant was US$491,860. Of this amount, the contract with NJCTL was US$273,780, of which the cost of training amounted to US$157,500 and travel fees were US$116,280. This covered 5 training sessions in math and physics (face-to-face). For the first cohort (12 classrooms), 12 interactive projectors and 32 SMART Responders per classroom cost Euros 98,000. For the second cohort, SMART Technologies have agreed to a standard price set far below the first contract for the same quantity and products. The price of 12 interactive projectors and 32 student responders per classrooms was US$33,720 or US $40,548 including freight and taxes. The remaining budget of approximately US$40,000 was used to reinforce the security of 24 classrooms and also to purchase computers.

Remaining Trainings

The pilot program could not provide trainings for all the PSI-PMI courses (for UBS and SSS) due to limited funding. The training provided by NJCTL ended when the project funds were fully disbursed in April 2014. The list of remaining courses and length of time required (in order to fully train teachers who participated in the Pilot Program) is provided below.

Courses and length of training remaining for teachers in the pilot program

COURSES	ESTIMATED LENGTH OF TRAINING BY NJCTL
Advanced Physics	3 weeks
Chemistry	4 weeks
Biology and Advanced Biology	4 weeks
Algebra II	2 weeks
Trigonometry	4 weeks
Calculus	4 weeks

The READ project has reallocated about US$200,000 to fund at least half of the remaining courses. This includes funding of training of these teachers in Physics, Chemistry, Biology, Algebra II, Trigonometry, Pre-calculus and Calculus for SSS level.

Expansion and Scale up of the PSI-PMI Approach

The MoBSE has decided to expand the PSI-PMI program to all 150 public upper basic and senior secondary schools in the country. The ministry has been exploring financial resources to do that and it may be possible that they will receive financial support from the Islamic Development Bank (IDB), who has been discussing this plan with the MoBSE. Regarding the sustainability, trained teachers are expected to teach other teachers which has already been happening in Cohort 2 and 3. Once Cohort 1 teachers participate in training of all the courses, it will be sustainable as the MoBSE will be able to train teachers in their own system.

In The Gambia, grades 7 and 8 have not started the PSI-PMI program and teachers have not been trained. However this option may be explored in the future after the expansion of the program in grades 9-12. For grades 7 and 8, middle school science- basic science foundation and math (pre- algebra and geometry) will be taught. Starting the program even earlier in upper basic level would help reinforce the students' readiness in later classes and is expected to help further strengthen the learning outcomes.

It would cost approximately US$6 million to expand the PSI-PMI program to all 150 public UBS and SSS in the country (Table 2). For training on Science, the training would include a total of 700 teachers, consisting of 200 UBS Physics, 200 UBS Advanced Science, 100 SSS Physics, 25 SSS Advanced Physics, 75 SSS Chemistry, 25 SSS Advanced Chemistry, 50 SSS Biology, and 25 SSS Advanced Biology teachers. For training on Mathematics, it would include a total of 650 teachers, consisting of 200 UBS general mathematics, 200 UBS Algebra I Geometry I, 100 SSS Algebra I & Geometry I, 75 SSS Geometry II & Algebra II, 50 SSS Trigonometry & Pre-calculus, and 25 SSS Calculus teachers. The equipment and supplies would include 600 interactive projectors, 600 student polling device, 270,000 copies of materials for students, 150 science equipment and 600 laptops for teachers.

Table 2: Cost of training, equipment, and supplies to expand the program nationwide.

ITEM	PSI-PMI
Local Training	$ 527,730
NJCTL Cost of Training	$ 1,254,480
Interactive Projectors	$ 1,380,000
Student Polling Devices	$ 720,000
Student Copies	$ 912,162
Science Equipment	$ 652,500
Teacher Laptop	$ 480,000
Local Monitoring & Supervision	$ 60,000
NJCTL Monitoring & Supervision	$ 98,120
Total	$ 6,084,992

Annex

Figure 6: Implementation timeline for Cohort 1 and 2

TIMELINE	COHORT 1	COHORT 2
Spring 2012	**WASSCE administered.** Students in this Cohort have not received any PMI/PSI instruction.	WASSCE administered. Students in this Cohort have not received any PMI/PSI instruction.
August 2012	Two-week training for 24 9th and 10th grade teachers	
December 2012	Week-long training with 24 9th and 10th grade teachers	
February 2013	Partial PMI/PSI instruction begins	
Spring 2013	PMI/PSI instruction continues (and roll-out continues at more schools as additional schools receive technology)	
Spring 2013	**WASSCE administered.** Students who take the WASSCE would have been in 12th grade when PMI/PSI instruction began, and are thus not direct beneficiaries of PMI/PSI instruction.	WASSCE administered. Students in this Cohort have not received any PMI/PSI instruction.
Summer 2013	Teachers complete 10 additional days of PMI/PSI training	29 9th and 10th grade teachers begin PSI/PMI training
September 2013	Students return to school and continue PMI/PSI instruction	One school—St. Peters—begins instruction with PMI/PSI
November 2013	Students take benchmark exams	Students take baseline benchmark exams
January/February 2014		All Cohort 2 students begin receiving PMI/PSI instruction
Spring 2014	**WASSCE administered.** Students who take the WASSCE would have been in 11th grade when PMI/PSI instruction began, and are thus not direct beneficiaries of PMI/PSI instruction.	**WASSCE administered.** Students who take the WASSCE would have been in 12th grade when PMI/PSI instruction began, and are thus not direct beneficiaries of PMI/PSI instruction.
August 2014	9th and 10th grade teachers complete additional PMI/PSI training.	9th and 10th grade teachers complete additional PMI/PSI training.
Fall 2014	Students return to school and continue PMI/PSI instruction	Students return to school and continue PMI/PSI instruction
November 2014	Students take benchmark exams	Students take benchmark exams
Spring 2015	**WASSCE administered.** Students who take the WASSCE would have been in 10th grade when PMI/PSI instruction began, and have received approximately half a year of PMI/PSI instruction.	**WASSCE administered.** Students who take the WASSCE would have been in 11th grade when PMI/PSI instruction began, and are thus not direct beneficiaries of PMI/PSI instruction.

Source: Hanover, 2015

Table 3: Schools that have been implementing the PSI-PMI in The Gambia

REGIONS	SCHOOL NAME	TYPE OF SCHOOL
1	Charlesjaw (July 22nd)	UBS/SSS
1	Gambia	SSS
1	Greater Banjul	UBS
1	Kanifing East	UBS
1	Kotu	SSS
1	Latrikunda -LK	UBS
1	Muslim	SSS
1	Nusrat	SSS
1	Saint Joseph's	SSS
1	St Theresa's	UBS
2	Mayork	UBS/SSS
2	Sifoe	UBS/SSS
2	St. Peter's	UBS/SSS
2	St Edwards	UBS
3	Essau	SSS
3	Njaba Kunda	UBS/SSS
3	Sinchu Njabo	Basic Cycle Schools (BCS)
4	Tahir Ahmadiyya (Soma)	SSS
4	Kwinella	UBS
5	Bansang	UBS
5	Kaur	SSS
5	Niani	SSS
6	Fatoto	UBS/SSS
6	Diabugu	UBS/SSS

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