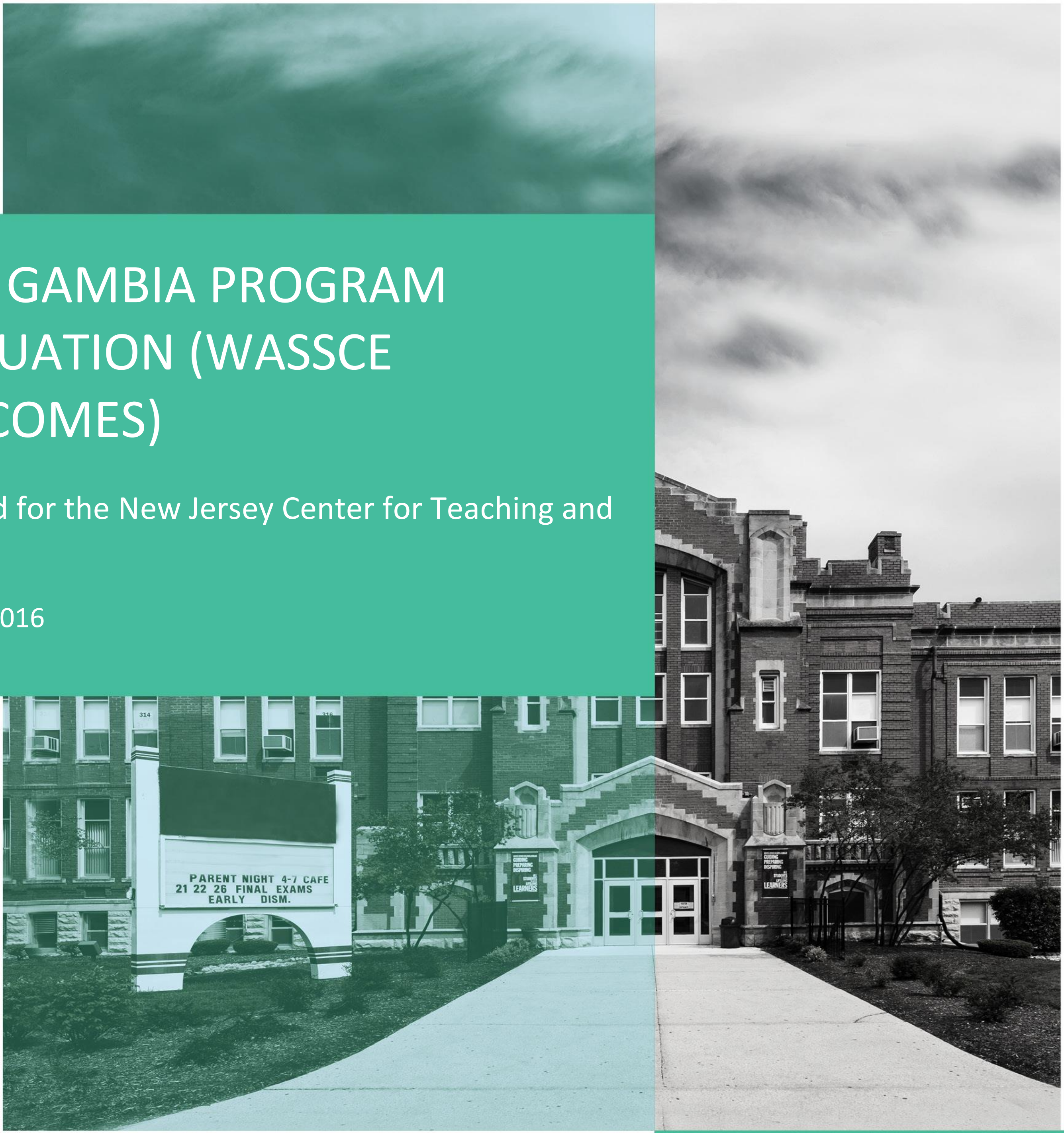
# 2015 GAMBIA PROGRAM EVALUATION (WASSCE OUTCOMES)

Prepared for the New Jersey Center for Teaching and Learning

January 2016




In this report, Hanover Research evaluates the impact of the implementation of progressive math and science initiatives in the Gambia by examining student math and science test scores. Specifically, the report analyzes assessment data from the West African Senior School Certificate Examination to identify program outcomes.

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## INTRODUCTION

This report uses student- and school-level data to examine the relationship between Progressive Science Initiative® (PSI®) or Progressive Mathematics Initiative® (PMI®) program participation and assessment outcomes for students at 16 senior secondary schools in The Gambia. In particular, our report uses assessment data from the West African Senior School Certificate Examination (WASSCE) to identify the effects of program participation on student outcomes. In our school-level descriptive analysis (Section III), we find that students in program schools have generally performed *better* than students in other schools on both initial and later assessments. We note that although the regression results account for differences in school of attendance and year effects, there are numerous factors that may be correlated with PSI or PMI participation and student test scores. Thus, the estimated program effects may not be viewed as causal or as definitive evidence of the program's efficacy or the lack thereof.

This report is organized as follows:

- **Section I: Data and Methodology** describes the data provided by the New Jersey Center for Teaching and Learning (CTL), the data processing conducted by Hanover Research, and the analytic methods employed in the subsequent sections. We also provide a descriptive analysis of the share of students by subject, cohort, and year who received credits or passed the course.
- **Section II: Program Participation and Outcomes, Descriptive Analysis** presents an analysis of the relationship between program participation and student assessment outcomes, with results for program schools and non-program schools depicted separately. Note that univariate analyses, by definition, include analyses without controlling for other observed factors.
- **Section III: Program Participation and Outcomes, Regression Analysis** models the probability of a student passing or receiving credit, as a function of program participation, while controlling for year and school fixed effects.

## KEY FINDINGS

- **The percentage of Cohort 1 students receiving the highest score of 1 on the physics, further mathematics, chemistry, math, and science WASSCE exams has grown substantially in the four years since program implementation and has outpaced the growth in positive outcomes among Control Group participants in each of these subject areas**. In the subjects areas that PMI and PSI are most designed to target, Cohort 1 experienced a 600% increase in the percentage of students receiving a 1 in physics and a 300% increase in the percentage of students scoring a 1 in further mathematics; this is compared to a 100% increase in physics and a 17% increase in further mathematics among Control Group students.
- **The percentage of Cohort 1 students receiving one of the *top three* scores on the subject area exams of physics, further mathematics, chemistry, and science has also grown at a faster pace than the percentage of Control Group students receiving the same scores.** The percentage of Cohort 1 students receiving one of the three top scores in physics increased over 500%, and the percentage of Cohort 1 students receiving one of the top three scores in further mathematics increased by 50% from 2012 to 2015. By contrast, the share of Control Group students receiving top scores increased by only 25% in physics and *decreased* by 11% in further mathematics during the same time period.
- **The percentage of Cohort 1 students receiving credit for their WASSCE scores (i.e., earning scores of 1-6) has increased for physics, further mathematics, chemistry and science and in all cases has outpaced the growth in the share of students receiving credit in the Control Group.** Notably, though the percentage of Control Group students receiving credit scores *declined* in physics and further mathematics, the percentage of Cohort 1 students receiving credit increased by five percentage points and 13 percentage points in these subjects, respectively.
- **The effects of program participation are somewhat less dramatic when examining effects through the lens of students receiving passing scores (i.e., scores of 1 to 9).** The percentage of students receiving passing scores in physics decreased among all student groups between 2012 and 2013, and while scores on the physics WASSCE have rebounded somewhat since then, they have still not attained their 2012 levels. However, although the percentage of Control Group students passing the further mathematics exam fell dramatically between 2012 and 2015, the percentage of Control Group students passing the exam increased by 5 percentage points.
- **All of the above findings from the descriptive analysis of results are confirmed by the regression models.** Further, many of the positive effects of program participation examined in these models are statistically significant at the highest confidence level. For instance, program participants are statistically significantly 2.5% more likely than Control Group participants to receive a score of 1 on the physics exam; given that, on average, students have a 1.99 percent probability of receiving a score of 1, this means that program participation more than doubles the possibility of a student scoring a 1 on this exam.

# PROGRAM INTRODUCTION

The New Jersey Center for Teaching and Learning (CTL) is a non-profit organization whose mission is to *empower teachers to lead change so that all children have access to a high quality education*. The hallmarks of CTL's programming are the Progressive Science Initiative® (PSI®) and the Progressive Mathematics Initiative® (PMI®). These programs were developed by CTL's current Executive Director, Robert Goodman, who joined CTL in 2009. Originally piloted in just one New Jersey school, the programs are now implemented in over 218 schools worldwide, including sites in New Jersey, Colorado, Rhode Island, Vermont, the Gambia, and Argentina. Over 1,500 teachers have been trained using CTL's progressive mathematics and science methods, and over 12,000 teachers have registered to use CTL's PMI and PSI assessment materials, strongly suggesting that these teachers are implementing CTL's programming independently.

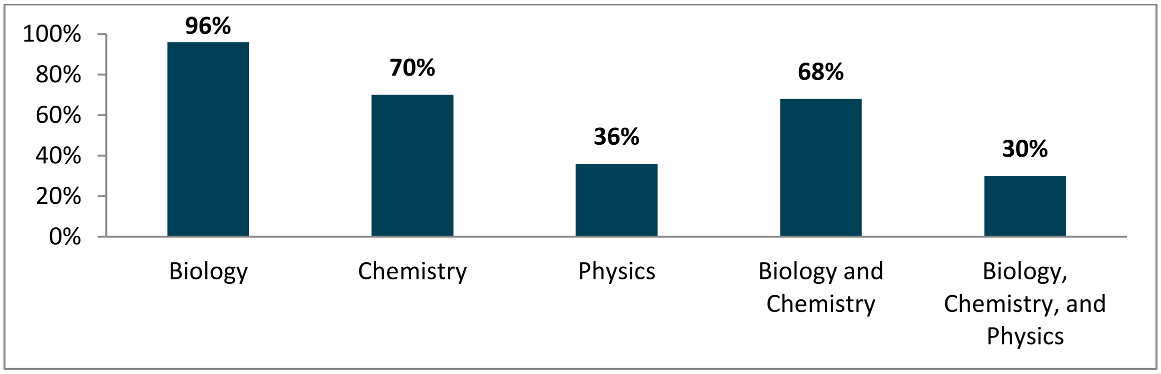
CTL receives financial support from the New Jersey Education Association and the National Education Association as well as from the Morgridge Family Foundation, Overdeck Family Foundation and Thompson Family Foundation.

## PROGRESSIVE EDUCATION IN MATHEMATICS AND SCIENCE

CTL's focus on PMI and PSI grew out of an understanding that the mathematical skills students gain during high school are necessary for college and career success. Specifically, CTL believes that all high school students should be required to pursue rigorous mathematics and science curricula characterized by proper course sequencing and at least one year of mathematically-rigorous physics. According to the National Center for Education Statistics, only 36 percent of 2009 high school graduates had taken physics during the most recent year for which data are available.[1] By contrast, 70 percent of graduating students had taken chemistry and 96 percent of graduating students had taken biology during the same year. Further, only 30 percent of students had taken biology, chemistry, and physics by the time they graduated from high school.

[1] "Fast Facts: Advanced Mathematics and Science Courses." The National Center for Education Statistics. http://nces.ed.gov/fastfacts/display.asp?id=97

**Figure I: Percentage of High School Graduates who Completed Selected Science Courses in High School, 2009**




Source: The National Center for Education Statistics

In order to address this critical gap in mathematics and science instruction in the United States, CTL developed PSI and PMI—both of which are designed to increase student access to and achievement in rigorous mathematics and science courses. These programs are characterized by free digital materials that teachers can download and use to support teaching in more than 30 mathematics and science courses. All course content includes instructional materials and assessments, and is aligned with either Advanced Placement (AP) science exams (in physics, chemistry, or biology) or the Common Core State Standards. Course content is available for all grade levels spanning pre-kindergarten through AP calculus in the mathematics sequence, and kindergarten through high school science in the science sequence. Course content is also available in Spanish.

PMI and PSI instruction is characterized by 5-10 minutes of direct instruction followed by a period of small group discussion and problem solving. This method of instruction is based on the theory that individuals construct knowledge through group interaction. In other words, the emphasis on group interaction during PMI and PSI instruction *speeds* and *enhances* learning in a way that direct instruction alone cannot.

Instruction is further characterized by the use of technology. CTL recommends that interactive whiteboards be used to deliver PSI and PMI content. The use of whiteboards allows content to be shared across classrooms, and allows for increased collaboration between students. PSI and PMI instruction also rely on whiteboards to allow for real-time formative assessment as content is delivered.

Finally, CTL also offers professional development for teachers designed to complement the PSI and PMI curricula. Currently, CTL offers two courses—one in which teachers can learn about CTL approaches to curriculum, pedagogy, technology, formative assessment, summative assessment, grading, and pacing (CTL Teaching Methods), and one in which teachers can learn content and teaching methods for Algebra-Based Physics (PSI Algebra-Based Physics for Teachers). CTL is an authorized professional development provider in the state of New Jersey.

In addition to providing professional development for existing mathematics and science teachers, CTL also trains and certifies science teachers in the areas of physics and chemistry through its Progressive Science Initiative Endorsement Program. CTL has graduated an average of 24 physics teachers in each year since the program started in 2010, and has certified a total of 175 physics and 35 chemistry teachers within the United States. Due to CTL's commitment to training science teachers, the organization is currently the #1 producer of physics teachers in the United States.

### PROGRAMMING IN THE GAMBIA

As CTL continues to expand its programming within the United States, the organization also seeks new opportunities to share its innovative and cost-effective approach to mathematics and science instruction with schools in countries worldwide. One such international initiative is CTL's work in the Gambia, where CTL has trained teachers to offer PSI and PMI instruction to students in the Gambia's Upper Basic and Senior Secondary schools.

In August of 2012, CTL, in partnership with the World Bank (WB) and the Gambia Ministry of Basic and Secondary Education (MOBSE), began piloting PMI and PSI in 12 upper basic (UBS) and senior secondary (SSS) schools in the Gambia. MOBSE selected the pilot schools based on their regional proximity to the CTL training site, favorable access to power supply, and relatively high numbers of physics teachers who could receive training as part of the project. The ultimate goal of CTL's work in the Gambia was to demonstrate a 25 percent increase in student learning in mathematics and physics. Implementation began when CTL staff members conducted a two-week PMI and PSI training session with 24 UBS and SSS teachers (Cohort 1). Four Peace Corps volunteers also participated in the training so that they could provide ongoing support to Gambian teachers as the project progressed. During this time, teachers were exposed to the interactive whiteboard technology that would be used to deliver PMI and PSI content, and were also exposed to the foundations of the PMI and PSI curricula. Training continued in December of 2012 with a week-long follow-up course.

In February of 2013, Cohort 1 students participating in the pilot began receiving PMI and/or PSI instruction from their CTL-trained teachers. Participating schools were provided with SMART responders, a SMART Board, and a computer with access to SMART notebook presentations in order to facilitate the delivery of the PMI and PSI curricula.[2] The WASSCE was administered to upper-secondary students in the spring of that year.

[2] Although MOBSE was originally planning to provide all necessary technological equipment by the beginning of the 2012 school year, purchasing issues necessitated a delayed start of the PMI and PSI programs to the winter of 2013. Educators estimate that students in Cohort 1 received instruction in approximately 25 percent of the total PMI and/or PSI curriculum as a result of these equipment delays.

Throughout the summer of 2013, Cohort 1 teachers completed 10 additional days of PMI or PSI training, while 29 Cohort 2 teachers met to begin training in PMI or PSI. These training sessions were facilitated by turnkey trainers in the Gambia with CTL oversight. In the fall, Cohort 1 students returned to school and continued to receive PMI and/or PSI instruction. Cohort 2 students then began receiving PSI-PMI instruction in January and February of 2014.

The same pattern continued throughout 2014, with all students in Cohort 1 and Cohort 2 taking the WASSCE in the spring, and all Cohort 1 and 2 teachers receiving additional training during the summer of 2014. Students then took the WASSCE again in 2015; these data are used as the final year for which data are available in our analysis.

The reader will note that, although Cohort 1 students have received instruction since the spring of 2013, students in this cohort were in Grade 9 or 10 during the spring 2013 WASSCE administration, and thus would not have taken the WASSCE. The same is true for the 2014 WASSCE administration, during which Cohort 1 students would have been in Grade 10 or 11 (and thus not have sat for the WASSCE). The first WASSCE exam in which Cohort 1 students could have participated is the 2015 administration; however, note that students taking the WASSCE in 2015 received, *at most* a half a year of PSI-PMI instruction. Thus, the 2015 WASSCE data represent the *preliminary effects* of PSI-PMI instruction, and we expect to see further evidence of PSI-PMI's effectiveness in subsequent years.

Note that the same holds true for Cohort 2 students: students in this cohort did not begin receiving PSI-PMI instruction until the spring semester of 2014, and thus will not sit for the WASSCE until 2016 at the earliest.

However, we note that although the teachers who received PSI-PMI training primarily teach the lower-secondary grades 9 and 10, they likely also teach upper-primary grade 11 and 12 students using many of the same instructional techniques and resources delivered through PSI-PMI training. Thus, we expect to see *ancillary effects* of PSI-PMI training in the 2013 and 2014 WASSCE data, based on the understanding that some students who took the WASSCE during these years were benefiting from PSI-PMI instructional techniques without having been enrolled in the program.

More information regarding the timeline for PSI-PMI implementation and WASSCE administration is provided in Figure II, below.

**Figure II: PSI-PMI Implementation Timeline, Cohorts 1 and 2**

| TIMELINE | COHORT 1 | COHORT 2 |
|---|---|---|
| Spring 2012 | **WASSCE administered**. Students in this Cohort have not received any PSI-PMI instruction. | **WASSCE administered**. Students in this Cohort have not received any PSI-PMI instruction. |
| August 2012 | Two-week training for twenty-four 9th and 10th grade teachers | -- |
| December 2012 | Week-long training with twenty-four 9th and 10th grade teachers | -- |
| February 2013 | Partial PSI-PMI instruction begins | -- |
| Spring 2013 | PSI-PMI 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 PSI-PMI instruction began, and are thus not direct beneficiaries of PSI-PMI instruction. | **WASSCE administered**. Students in this Cohort have not received any PSI-PMI instruction. |
| Summer 2013 | Teachers complete 10 additional days of PSI-PMI training | Twenty-nine 9th and 10th grade teachers begin PSI-PMI training |
| September 2013 | Students return to school and continue PSI-PMI instruction | One school—St. Peters—begins instruction with PSI-PMI |
| January/February 2014 | -- | All Cohort 2 students begin receiving PSI-PMI instruction |
| Spring 2014 | **WASSCE administered**. Students who take the WASSCE would have been in 11th grade when PSI-PMI instruction began, and are thus not direct beneficiaries of PSI-PMI instruction. | **WASSCE administered**. Students who take the WASSCE would have been in 12th grade when PSI-PMI instruction began, and are thus not direct beneficiaries of PSI-PMI instruction. |
| August 2014 | 9th and 10th grade teachers complete additional PSI-PMI training. | 9th and 10th grade teachers complete additional PSI-PMI training. |
| Fall 2014 | Students return to school and continue PSI-PMI instruction | Students return to school and continue PSI-PMI instruction |
| Spring 2015 | **WASSCE administered**. Students who take the WASSCE would have been in 10th grade when PSI-PMI instruction began, and have received approximately half a year of PSI-PMI instruction. | **WASSCE administered**. Students who take the WASSCE would have been in 11th grade when PSI-PMI instruction began, and are thus not direct beneficiaries of PSI-PMI instruction. |

# SECTION I: DATA AND METHODOLOGY

In this section, Hanover Research describes the data we analyze in this report and the methodologies used to conduct our analyses.

## DATA

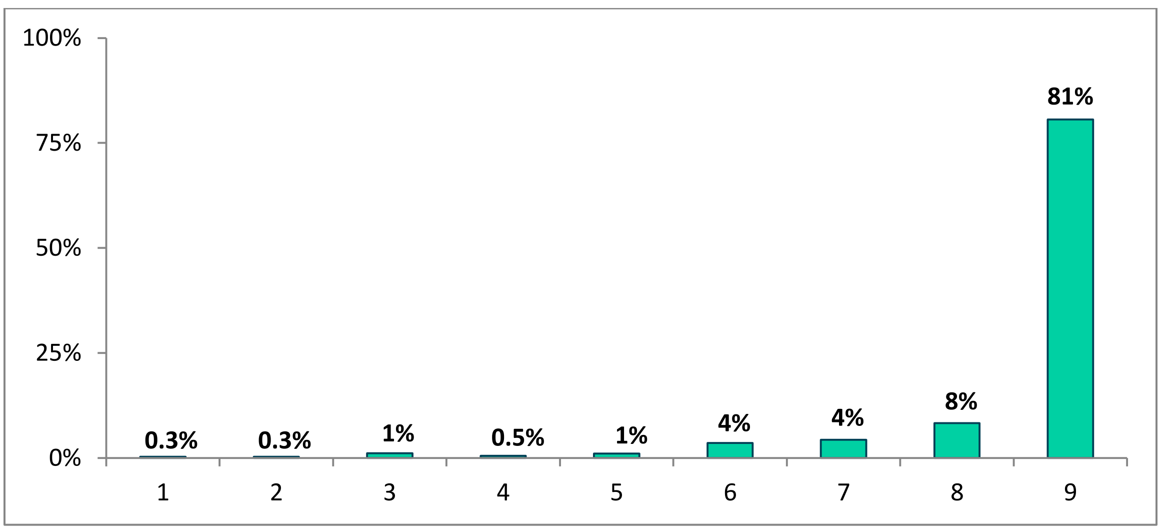
### DATASET

CTL provided Hanover with an Excel spreadsheet with raw assessment data from the WASSCE, which grade 12 students complete annually. These assessment data include each student's school and outcomes for a range of subjects tested by the exam. Most assessment outcomes range from one to nine, and Hanover excludes all outcomes with negative values, values of zero, symbol values (such as "#"), and values greater than nine. After processing this data, Hanover analyzed 35,190 WASSCE scores from 74 schools over four years.

### OUTCOME VARIABLES

The outcome variables in this report are assessment sub-scores from the WASSCE that were taken from 2012 to 2015. Specifically, the WASSCE contains sub-scores for math, further mathematics, science, chemistry, biology, agricultural science, and economics. Figure 1.1 describes the distribution of the mathematics outcomes for the WASSCE as an example of the skewness in these outcome variables. On nearly every assessment outcome we examine, more than 60 percent of students earn a score of nine, *meaning they failed*; this is the modal score in all cases.[3]

**Figure 1.1: WASSCE Math Score Distribution, 2012-2015**




N= 33,397

[3] Substantial skewness in the dependent variables means that the reported standard errors and associated p-values should be interpreted with caution.

## PROGRAM VARIABLES

As described in the program introduction, schools in the first program cohort began program implementation during the 2012-2013 academic year, meaning that the spring 2012 assessments were administered prior to implementation and the spring 2013 assessments were administered after implementation. The schools in the second program cohort began program implementation in the 2013-2014 academic year, meaning that the spring 2013 assessments were administered prior to implementation and the spring 2014 assessments were administered after implementation. The variable identifying program participation indicates whether the student was in the first program cohort (2012), the second program cohort (2013), or is a non-program student.

The data provided for this report do not distinguish between PMI and PSI programs, and throughout this report we will simply refer to both PMI and PSI programs as "the program." As can be seen in Figure 1.2, the non-program, or control, schools substantially outnumber the program schools, with WASSCE data from 16 program schools and 58 non-program schools. Figure 1.3 on the following page describes the program schools in more detail.

**Figure 1.2: Program and Non-program Schools**

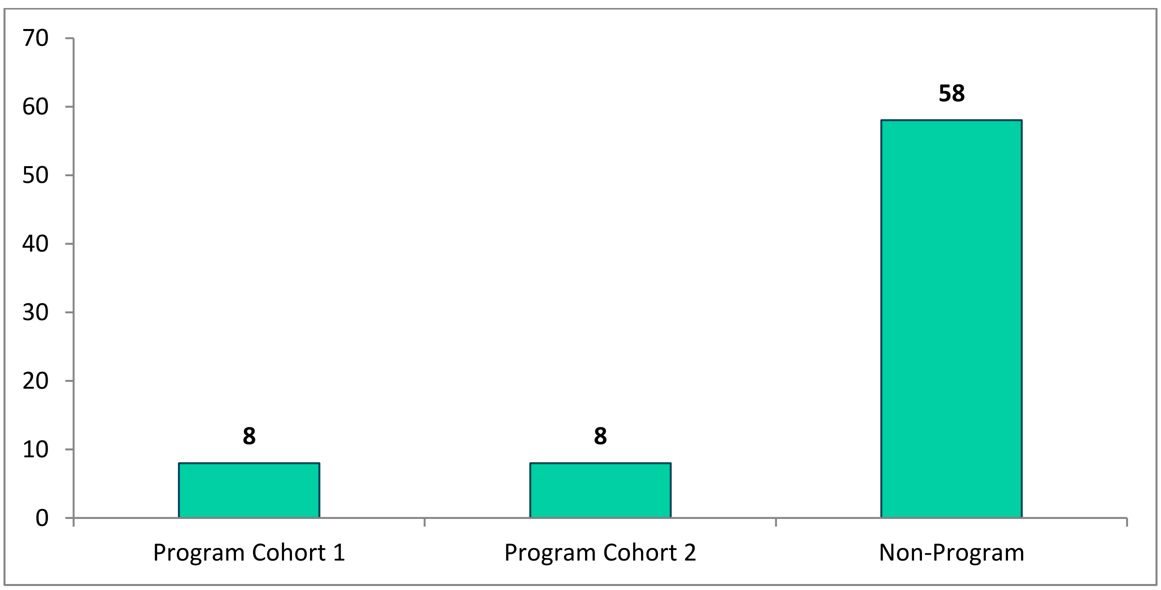


**Figure 1.3: Senior Secondary Program Schools**

| School Name | Beginning Program Year | Total Observations (2012 - 2015) |
|---|---|---|
| 22nd July Academy | 2013 | 543 |
| Diabugu Senior Secondary School | 2014 | 137 |
| Essau Senior Secondary School | 2014 | 433 |
| Fatoto Senior Secondary School | 2014 | 199 |
| Gambia Senior Secondary School | 2013 | 2,257 |
| Kaur Senior Secondary School | 2014 | 212 |
| Kotu Senior Secondary School | 2013 | 828 |
| Mayork Senior Secondary School | 2013 | 588 |
| Niani Senior Secondary School | 2014 | 153 |
| Njabakunda Senior Secondary School | 2014 | 71 |
| Nusrat Senior Secondary School, Bundung | 2013 | 2,085 |
| Siffoe Senior Secondary School | 2013 | 361 |
| St. Joseph's Senior Secondary School | 2013 | 565 |
| St. Peter's Technical Senior Secondary School | 2014 | 508 |
| Tahir Ahmadiyya Senior Secondary School | 2014 | 267 |
| The Gambia Muslim Senior Secondary School Annex | 2013 | 1,373 |

## METHODOLOGY

### Descriptive Analysis of Program Participation and Outcomes

In Section II, Hanover describes assessment score outcomes over time for program and non-program schools. Each figure presents mean scores by year, with vertical lines indicating the years of program implementation for Cohort 1 and Cohort 2 students. This analysis allows the reader to see changes before and after program implementation, comparing the program and non-program schools. The vertical line for each cohort is placed directly to the right of the most recent pre-program assessment in order to make clear what changes in outcomes over time may be attributable to the program.

### Regression Analysis of Program Participation and Outcomes

In Section III we analyze the relationship between program participation and positive student outcomes, while controlling for the average effect of the school and year. Specifically, in Section II, each regression model has a single dichotomous outcome variable and a set of predictor variables which include a program variable and fixed effects for each school and year. We estimate regression equations similar to (1) separately for each subject.

$$Y_i = \alpha + \beta_1 * \text{Prog}_i + \mu_s + \gamma_y + \epsilon_i \quad (1)$$

$Y_i$ denotes the outcome variable (i.e., pass or receive credit) for student *i.* $\text{Prog}_i$ is an indicator that represents whether the student is in a school that participated in the program in that year, zero otherwise. $\mu_s$ represents school-level fixed effects, accounting for differences in mean scores in different schools, and $\gamma_y$ indicates year-level fixed effects, accounting for differences in different years. Finally, $\epsilon_i$ is the idiosyncratic error term.

The parameter of interest to the evaluation is $\beta_1$ which indicates the difference in outcomes between students in the program and non-program students. This estimated effect is reported as the coefficient in the figures which report the results of ordinary least squares regression analyses. A positive and statistically significant estimate of $\beta_1$ indicates that the students in the program have a better outcome (higher score) than similar students who are not in the program. Again, we note that students are considered similar along their year and school information.

# SECTION II: PROGRAM PARTICIPATION AND OUTCOMES, DESCRIPTIVE ANALYSIS

In this section, Hanover describes changes in assessment scores over time for program and control students. In general, the program students have demonstrated *positive effects* of program participation, with Cohort 1 students demonstrating substantial growth on the WASSCE in the three and a half years since PSI-PMI implementation.

In the sections below, we examine both the percentage of students who achieve favorable outcomes (i.e., earning a score of 1; earning a score of 1-3; receiving credit with a score of 1-6; and passing with a score of 8 or better). Then, we provide graphs that chart mean WASSCE outcomes over time.

Please note that we have divided our discussion of WASSCE outcomes into three separate subject groups, as demonstrated in Figure 3.1. We expect to see the largest gains in the primary subject areas, with which PMI and PSI instruction are most highly correlated. We then expect to see *residual* effects of PSI-PMI instruction in the primary residual subject areas, as these subjects include content that is similar in some ways to the content covered in the primary subject areas. Finally, we expect to see null effects of PSI-PMI implementation in the secondary subject areas that do not align well with either the primary or primary residual subject areas.

**Figure 2.1: Subject Groupings**

| Grouping | Subject Areas Included |
|---|---|
| Primary Subjects | Physics 512 |
| | Further Mathematics 401 |
| Primary Residual Subjects | Chemistry 505 |
| | Math |
| | Science |
| Secondary Subjects | Biology 504 |
| | Agricultural Science 502 |
| | Economics 203 |

## PERCENTAGE OF STUDENTS WHO ACHIEVE FAVORABLE OUTCOMES

Figures 2.2a through 2.5c display the share of students who earned a favorable outcome (either a score of 1, a score of 1-3, a credit score, or a passing score) in each subject by year.

## RECEIVING A SCORE OF 1

### *PRIMARY SUBJECTS*

- Cohort 1 students made considerable gains on the WASSCE Physics exam, where the share of students in Cohort 1 receiving a score of '1' increased 600%, from 1% in 2012 to 6% in 2015. During this same time period, the percentage of students in Cohort 2 and in the Control group increased only 1% (from 1% to 2% in both groups) in 2015.
- Between 2012 and 2015, the percentage of Cohort 1 students receiving a score of '1' on the Further Mathematics WASSCE exam increased threefold, from 4% to 12%, and the share of students receiving a score of '1' from Cohort 2 increased from 0% to 10%. During this time, the share of students receiving the same score from the Control group increased only 1%, from 6% in 2012 to 7% in 2015.

### *PRIMARY RESIDUAL SUBJECTS*

- Students from Cohort 1 outperformed both Cohort 2 and Control students on the Chemistry WASSCE exam. Between 2012 and 2014, the share of Cohort 1 students receiving a score of '1' increased threefold, from 2% in 2012 to 6% in 2015. During that same time period, the share of Control students receiving a score of '1' doubled (from 1% to 2%), while the share of Cohort 2 students receiving a score of '1'decreased from 4% to 0%.
- Students from both Cohort 1 and Cohort 2 outperformed Control students on the Math WASSCE exam. The percentage of Cohort 1 students receiving a score of '1' increased threefold from 0.2% to 0.6% between 2012 and 2015, while the percentage of Cohort 2 students receiving a '1' remained steady at 0.5% during the same time period. Meanwhile, the percentage of Control students receiving the highest score on the exam *decreased* from 0.3% to 0.1% over the past four years.
- Cohort 1 and Cohort 2 students also outperformed Control students on the Science WASSCE exam. The percentage of Cohort 1 students receiving a '1' on the exam nearly doubled between 2012 and 2015, from 6% to 11%, while the percentage of Cohort 2 students receiving the highest score increased by 600% (1% to 6%) during the same time period. Meanwhile, the percentage of Control students receiving a score of '1' on the exam remained constant at 0.9%.

### *SECONDARY SUBJECTS*

- Across all three secondary subject areas, trends in the percentage of Cohort 1 and Cohort 2 students receiving the highest score closely mirrors trends in the percentage of Control students receiving the highest score from year to year. As we would expect to see no increase in achievement in these exams due to PSI-PMI instruction, these results further validate the positive findings for the primary and residual primary subject areas, since we observe those effects only in those subjects for which PSI-PMI instruction is *expected* to increase student achievement.

### OVERALL CONCLUSIONS

Even after receiving only ancillary PSI-PMI instruction, students in both Cohorts 1 and 2 generally outperform their Control Group peers in both the primary and residual primary subject areas of the WASSCE exam. Given the trajectory of the percentage of students receiving a score of '1' between 2012 and 2015, we would expect to see even greater increases in the percentage of students receiving the highest score on the 2016 WASSCE administration in these subjects in Cohort 1 students, who by this point will have received a full year of PSI-PMI instruction during their 10th grade year, as well as experienced the ancillary effects of PSI-PMI in grades 11 and 12. We further expect the positive effects of PSI-PMI instruction to continue for Cohort 2 students in 2016 as they continue to benefit from the ancillary effects of PSI-PMI teacher training.

**Figure 2.2a: Percentage of Students Receiving Scores of 1 (Primary Subjects)**

| | Physics 512 | | | Further Mathematics 401 | | |
|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 1% | 1% | 1% | 4% | 0.0% | 6% |
| 2013 | 0.0% | 0.0% | 0.3% | 0.7% | 0.0% | 2% |
| 2014 | 5% | 5% | 1% | 0.0% | -- | 0.0% |
| 2015 | 6% | 2% | 2% | 12% | 10% | 7% |
| **All Years** | **3%** | **2%** | **1%** | **4%** | **6%** | **4%** |
| **Total N** | **1,376** | **331** | **1,552** | **531** | **16** | **391** |

**Figure 2.2b: Percentage of Students Receiving Scores of 1 (Primary Residual Subjects)**

| | Chemistry 505 | | | Math | | | Science | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 2% | 4% | 1% | 0.2% | 0.5% | 0.3% | 6% | 1% | 0.9% |
| 2013 | 4% | 4% | 0.2% | 0.5% | 0.8% | 0.1% | 5% | 1% | 0.2% |
| 2014 | 6% | 8% | 0.7% | 1% | 0.2% | 0.2% | 5% | 2% | 0.3% |
| 2015 | 6% | 0.0% | 2% | 0.6% | 0.5% | 0.1% | 11% | 6% | 0.9% |
| **All Years** | **5%** | **4%** | **1%** | **0.6%** | **0.5%** | **0.2%** | **7%** | **3%** | **0.5%** |
| **Total N** | **1,471** | **188** | **1,725** | **8,368** | **1,925** | **23,104** | **6,683** | **1,315** | **19,199** |

**Figure 2.2c: Percentage of Students Receiving Scores of 1 (Secondary Subjects)**

| | Biology 504 | | | Agricultural Science 502 | | | Economics 203 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 0.0% | 0.0% | 0.1% | 1% | 2% | 0.2% | 3% | 0.0% | 0.2% |
| 2013 | 0.1% | 0.0% | 0.0% | 7% | 8% | 1% | 3% | 0.0% | 0.1% |
| 2014 | 1% | 0.0% | 0.0% | 2% | 4% | 0.4% | 3% | 0.0% | 0.0% |
| 2015 | 0.0% | 0.0% | 0.0% | 1% | 3% | 0.1% | 0.1% | 0.0% | 0.0% |
| **All Years** | **0.4%** | **0.0%** | **0.0%** | **3%** | **4%** | **0.5%** | **2%** | **0.0%** | **0.1%** |
| **Total N** | **2,868** | **667** | **5,645** | **6,814** | **1,815** | **19,075** | **4,135** | **815** | **14,244** |

## RECEIVING A SCORE OF 1-3

### *PRIMARY SUBJECTS*

- Cohort 1 made substantial gains in the percentage of students receiving the top scores of 1-3 between 2012 and 2015, with the percentage of students with these scores increasing more than five-fold over the time period studied. Cohort 2 students also experienced a 1500% increase in the percentage of students receiving the highest three scores, most of which occurred in 2014 and 2015. By contrast, the share of students receiving to top three scores among control students increased by only 25% over the same time period.
- The percentage of Cohort 1 students receiving the top three scores in further mathematics increased by 50% between 2012 and 2015. At the same time, the percentage of Cohort 2 and Control Group students receiving the same scores decreased by 40% for Cohort 2 and by 11% for the Control Group.

### *PRIMARY RESIDUAL SUBJECTS*

- The percentage of Cohort 1 students receiving the top 3 scores on the chemistry and science exams increased substantially from 2012 and 2015, by 8 percentage points for each subject area. By contrast, the share of Control Group students earning the top scores remained stagnant during this time.
- The percentage of students earning the top three scores in mathematics remained stagnant for all three student groups.

### *SECONDARY SUBJECTS*

- The percentage of students receiving the top three scores in the secondary subject areas remained relatively constant and comparable for all three groups across all four years. Students generally performed about the same from year to year on the biology and agricultural science assessments, and performed worse on the economics assessment from 2012 to 2015.

### *CONCLUSIONS*

Students in the treatment groups—even those who experience only ancillary effects of program implementation—have tended to make more substantial gains in the primary and residual primary subject areas across the period being studied. As students who have received PSI-PMI instruction continue to take the WASSCE in subsequent years, we will expect to see even more substantial gains in the share of these students receiving top marks in these target subject areas.

**Figure 2.3a: Percentage of Students Receiving Scores of 1-3 (Primary Subjects)**

| | 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** |

**Figure 2.3b: Percentage of Students Receiving Scores of 1-3 (Primary Residual Subjects)**

| | Chemistry 505 | | | Math | | | Science | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 13% | 9% | 7% | 3% | 2% | 1% | 17% | 4% | 5% |
| 2013 | 8% | 21% | 7% | 1% | 3% | 1% | 8% | 4% | 3% |
| 2014 | 23% | 16% | 5% | 4% | 2% | 1% | 20% | 6% | 5% |
| 2015 | 21% | 17% | 7% | 3% | 2% | 1% | 25% | 4% | 5% |
| **All Years** | **16%** | **16%** | **6%** | **3%** | **2%** | **1%** | **17%** | **5%** | **4%** |
| **Total N** | **1,471** | **188** | **1,725** | **8,368** | **1,925** | **23,104** | **6,683** | **1,315** | **19,199** |

**Figure 2.3c: Percentage of Students Receiving Scores of 1-3 (Secondary Subjects)**

| | Biology 504 | | | Agricultural Science 502 | | | Economics 203 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 6% | 5% | 2% | 18% | 15% | 5% | 14% | 0% | 3% |
| 2013 | 1% | 3% | 3% | 17% | 34% | 13% | 7% | 4% | 5% |
| 2014 | 15% | 6% | 3% | 22% | 21% | 5% | 15% | 0% | 3% |
| 2015 | 6% | 2% | 1% | 17% | 23% | 3% | 7% | 0% | 1% |
| **All Years** | **7%** | **4%** | **2%** | **18%** | **23%** | **6%** | **11%** | **1%** | **3%** |
| **Total N** | **2,868** | **667** | **5,645** | **6,814** | **1,815** | **19,075** | **4,135** | **815** | **14,244** |

## RECEIVING CREDIT

### *PRIMARY SUBJECTS*

- Both Cohort 1 and Cohort 2 students experienced substantial growth in the percentage of students receiving credit in physics between 2012 and 2015. During this time, the share of Cohort 1 students earning credit rose five percentage points (from 46% to 51%) while the share of Cohort 2 students receiving credit jumped eight percentage points (from 33% to 41%). Meanwhile, the share of students in the Control group receiving credit on the physics exam actually *declined* by nine percentage points, from 53% to 42%.
- The percentage of Cohort 1 students receiving credit in further mathematics also grew substantially over the past four years, from 31% in 2012 to 44% in 2015. During the same period, the share of Cohort 2 students receiving credit dropped 50%, and the share of Control Group students receiving credits dropped 10 percentage points, from 50% to 40%.

### *PRIMARY RESIDUAL SUBJECTS*

- Students across all cohorts tended to perform similarly and make similar gains in the percentage of credit scores across all three primary residual subject exams. For instance, each group saw a gain in the percentage of students receiving credit on the chemistry exam; however, gains for Cohort 1 (six percentage points) and Cohort 2 (11 percentage points) outpaced gains in the Control Group (one percentage point). Similarly Cohort 1 and Cohort 2 gains on the science exam (12 percentage points and 13 percentage points, respectively) outpaced Control Group gains (four percentage points).
- The only primary residual subject area in which Cohort 1 students experienced a decline was math, in which the share of students receiving credit dropped from 11% in 2012 to 10% in 2015. However, student achievement across all study groups was relatively low during this time period, with the percentage of students earning credit remaining stagnant for Cohort 2 students at 6%, and dropping for Control students from 5% to 2%.

### *SECONDARY SUBJECTS*

- As expected, Cohort 1 and Cohort 2 performance on the secondary subject WASSCE exams largely mirrored Control Group performance during the same time period. The share of students receiving credit in each of these subjects fell for all three cohorts between 2012 and 2015. Cohort 1 and Cohort 2 scores mostly dropped at a comparable rate to Control Group scores with the notable exception of biology, where Cohort 2 students' share of credit scores dropped 24 percentage points, compared to seven percentage points for Cohort 1 and four percentage points for the Control Group.

### CONCLUSIONS

Cohort 1 and Cohort 2 students tend to receive credit scores on the primary and residual primary WASSCE exams at a higher rate than their Control Group peers. Moreover, for the primary subject areas of physics and further mathematics, Cohort 1 students began 2012 with a lower percentage of students receiving credit scores than the Control Group; however, by 2015, Cohort 1 students exceeded the performance of Control Group students on both of these exams.

Given the trajectory of the percentage of students receiving credit on the WASSCE between 2012 and 2015, we would expect to see even greater increases in the percentage of students receiving credit on the 2016 WASSCE administration in these subjects in Cohort 1 students, who by this point will have received a full year of PSI-PMI instruction during their 10th grade year, as well as experienced the ancillary effects of PSI-PMI in grades 11 and 12. We further expect the positive effects of PSI-PMI instruction to continue for Cohort 2 students in 2016 as they continue to benefit from the ancillary effects of PSI-PMI teacher training.

**Figure 2.4a: Percentage of Students Receiving Credit (Scores of 1 through 6 – Primary Subjects)**

| | Physics 512 | | | Further Mathematics 401 | | |
|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 46% | 33% | 53% | 31% | 100% | 50% |
| 2013 | 32% | 23% | 23% | 23% | 100% | 25% |
| 2014 | 49% | 31% | 41% | 28% | -- | 22% |
| 2015 | 51% | 41% | 42% | 44% | 50% | 40% |
| **All Years** | **44%** | **33%** | **39%** | **31%** | **69%** | **36%** |
| **Total N** | **1,376** | **331** | **1,552** | **531** | **16** | **391** |

**Figure 2.4b: Percentage of Students Receiving Credit (Scores of 1 through 6 – Primary Residual Subjects)**

| | Chemistry 505 | | | Math | | | Science | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 37% | 30% | 19% | 11% | 6% | 5% | 34% | 8% | 15% |
| 2013 | 53% | 32% | 20% | 16% | 10% | 8% | 34% | 17% | 14% |
| 2014 | 45% | 28% | 26% | 12% | 7% | 4% | 45% | 13% | 19% |
| 2015 | 43% | 41% | 20% | 10% | 6% | 2% | 46% | 21% | 19% |
| **All Years** | **45%** | **34%** | **21%** | **12%** | **7%** | **5%** | **40%** | **15%** | **17%** |
| **Total N** | **1,471** | **188** | **1,725** | **8,368** | **1,925** | **23,104** | **6,683** | **1,315** | **19,199** |

**Figure 2.4c: Percentage of Students Receiving Credit (Scores of 1 through 6 – Secondary Subjects)**

| | Biology 504 | | | Agricultural Science 502 | | | Economics 203 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 32% | 34% | 14% | 50% | 40% | 20% | 32% | 8% | 13% |
| 2013 | 37% | 29% | 25% | 75% | 56% | 39% | 41% | 16% | 22% |
| 2014 | 40% | 31% | 19% | 53% | 42% | 22% | 35% | 5% | 14% |
| 2015 | 25% | 10% | 10% | 45% | 39% | 16% | 23% | 2% | 6% |
| **All Years** | **33%** | **24%** | **17%** | **55%** | **44%** | **24%** | **32%** | **8%** | **14%** |
| **Total N** | **2,868** | **667** | **5,645** | **6,814** | **1,815** | **19,075** | **4,135** | **815** | **14,244** |

## Passing

### *Primary Subjects*

- The percentage of students receiving passing scores in all cohorts and the Control Group declined between 2012 and 2015 on the physics WASSCE. Notably, the biggest declines were experienced between 2012 and 2013, when the percentage of students passing dropped 17 percentage points for Cohort 1, 26 percentage points for Cohort 2, and 32 percentage points for the Control Group. Since that time, passing scores have been trending positively for all three groups, with Cohort 1 experiencing an 11 percentage point increase in passing scores, Cohort 2 experiencing a 20 percentage point increase in passing scores, and the Control Group experiencing a 16 percentage point increase in passing scores.
- The percentage of Cohort 1 students passing the further mathematics exam increased 5 percentage points between 2012 and 2015; this is especially notable given that, as seen in the physics exam, the rate of passing scores dropped substantially between 2012 and 2013 for most groups. Between 2012 and 2015, the rate of passing scores remained constant for Cohort 2 and fell by 14 percentage points for the Control Group.

### *Primary Residual Subjects*

- The share of Cohort 1 students passing the chemistry and the mathematics exams dropped between 2012 and 2015 by seven percentage points and three percentage points respectively. During this same timeframe, Cohort 2 and Control Group passing rates *increased* in chemistry (10 percentage points and seven percentage points respectively), but decreased in mathematics (by two percentage points and seven percentage points respectively).
- Growth in the share of Cohort 1 and Cohort 2 students passing the science exam increased at a higher rate than growth in the score of Control Group students passing the same exam. Cohort 1 experienced an 11 percentage point increase in

the share of students passing the exam and Cohort 2 experienced an 18 percentage point increase in the share of students passing the exam; by contrast, Control Group students only experienced a four percentage point increase over the same time period.

### *Secondary Subjects*

- Once again, the share of students from all groups receiving passing scores dropped across all secondary subject areas from 2012 to 2015. The rate of decline was comparable between Cohort 1 and control group students across all three exams (as expected), but the rate of decline for Cohort 2 students often exceeded that of the other groups, with the exception of agricultural science.

### *Conclusions*

The findings for students passing each of the WASSCE exams examined for this report largely mirror the findings from previous sections examining high scores and credit scores, with students in Cohort 1 often outperforming Control Group students in primary and primary residual subject areas. However, we note that the dramatic effects of PSI-PMI implementation seen among students scoring higher on the exams tend to wane somewhat among lower-performing students.

This trend may be due to uneven implementation among lower-performing students at PSI-PMI schools. Unfortunately, current data supplied by the schools in The Gambia do not allow us to explore this question further at this time. However, this is an effect that we hope to investigate further with data from the 2016 WASSCE administration, which should differentiate between levels of implementation between student subgroups (e.g., lower-performing and higher-performing students).

**Figure 2.5a: Percentage of Students Passing (Scores of 1 through 8 – Primary Subjects)**

| | Physics 512 | | | Further Mathematics 401 | | |
|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 86% | 77% | 90% | 61% | 100% | 81% |
| 2013 | 61% | 51% | 58% | 55% | 100% | 69% |
| 2014 | 69% | 59% | 69% | 54% | -- | 67% |
| 2015 | 72% | 71% | 74% | 66% | 100% | 67% |
| **All Years** | **72%** | **66%** | **72%** | **59%** | **100%** | **71%** |
| **Total N** | **1,376** | **331** | **1,552** | **531** | **16** | **391** |

**Figure 2.5b: Percentage of Students Passing (Scores of 1 through 8 – Primary Residual Subjects)**

| | Chemistry 505 | | | Math | | | Science | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 69% | 43% | 37% | 26% | 16% | 17% | 59% | 30% | 42% |
| 2013 | 74% | 50% | 45% | 36% | 25% | 22% | 62% | 46% | 42% |
| 2014 | 65% | 38% | 49% | 29% | 18% | 17% | 71% | 40% | 42% |
| 2015 | 61% | 53% | 44% | 23% | 14% | 10% | 70% | 48% | 46% |
| **All Years** | **67%** | **46%** | **44%** | **28%** | **18%** | **16%** | **66%** | **41%** | **43%** |
| **Total N** | **1,471** | **188** | **1,725** | **8,368** | **1,925** | **23,104** | **6,683** | **1,315** | **19,199** |

**Figure 2.5c: Percentage of Students Passing (Scores of 1 through 8 – Secondary Subjects)**

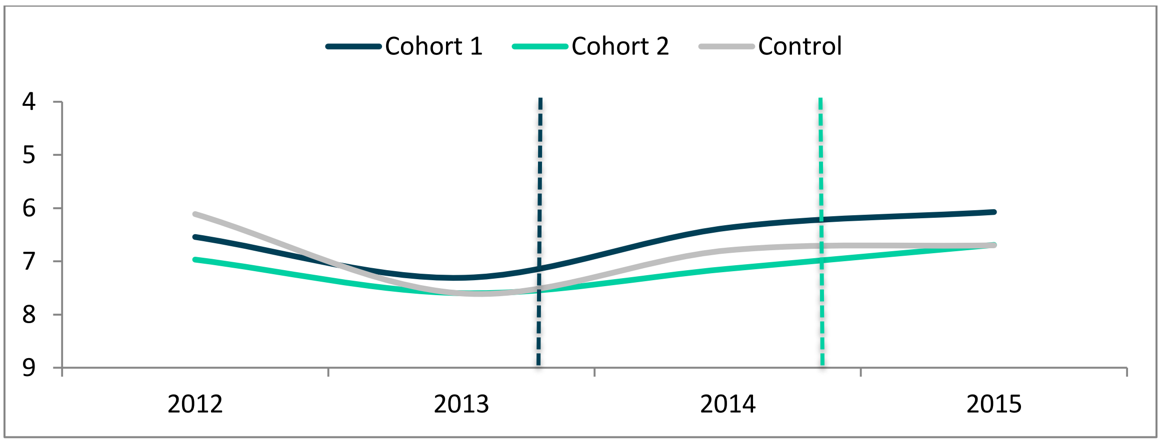
| | Biology 504 | | | Agricultural Science 502 | | | Economics 203 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control | Cohort 1 | Cohort 2 | Control |
| 2012 | 66% | 63% | 34% | 69% | 60% | 40% | 57% | 24% | 38% |
| 2013 | 67% | 55% | 47% | 85% | 71% | 58% | 61% | 37% | 43% |
| 2014 | 63% | 69% | 43% | 71% | 52% | 39% | 52% | 19% | 26% |
| 2015 | 43% | 28% | 25% | 64% | 54% | 37% | 37% | 9% | 15% |
| **All Years** | **60%** | **51%** | **37%** | **72%** | **59%** | **43%** | **51%** | **22%** | **30%** |
| **Total N** | **2,868** | **667** | **5,645** | **6,814** | **1,815** | **19,075** | **4,135** | **815** | **14,244** |

## WASSCE CHANGES OVER TIME

In this subsection, we chart mean WASSCE outcomes over time to demonstrate trends in student achievement. We note again that students participating in Cohort 1 did not take the WASSCE in 2012-2014, and only began to take the WASSCE in 2015 (though Cohort 1 students who took the WASSCE in 2015 would only have received—at most—a half-year of PSI-PMI instruction). Thus, we expect to see the true effects of program participation begin in 2015, and continue through the following academic year.

Figure 2.6 describes WASSCE physics scores over time. The scores for all three groups of students decline after Cohort 1 program implementation, and improve somewhat after Cohort 2 program implementation. By 2015, average performance is slightly higher for both Cohort 1 and Cohort 2 students compared to pre-program implementation, but *lower* for control students.

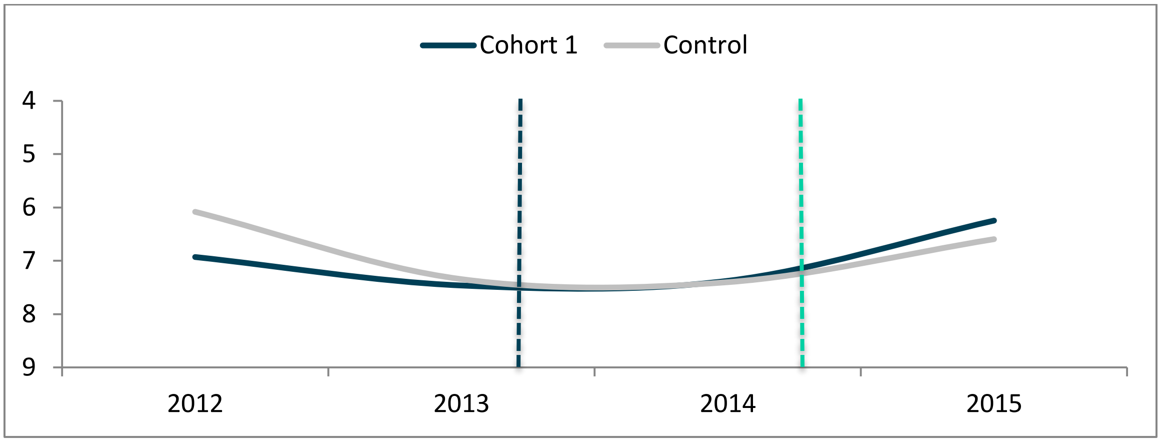
**Figure 2.6: WASSCE Physics Scores, 2012-2015**




N=3,259

Figure 2.7 describes WASSCE further mathematics scores over time. The scores for both Cohort 1 and the control group decline in the year after implementation, but improve in the final year. While the average is lower in 2015 than in the pre-program year for the control group, it is higher for Cohort 1 students, who also surpass the control group average.

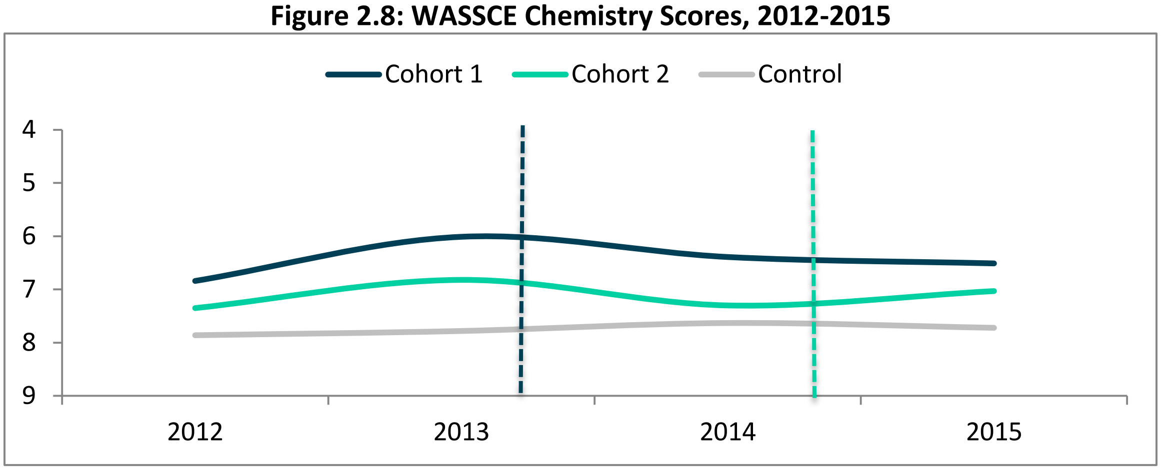
**Figure 2.7: WASSCE Further Mathematics Scores, 2012-2015**




N=938. The 16 students included in Cohort 2 are not pictured, as data were missing for 2014. The averages for Cohort 2 were 3.0 in 2012, 5.0 in 2013, and 5.3 in 2015.

Figure 2.8 describes WASSCE chemistry scores over time. Cohort 1 students' scores improve somewhat after program implementation, though performance declines in subsequent years. Nonetheless, average performance is never again as low as in the pre-program year. Cohort 2 students' performance declines somewhat after program implementation, but improves to approximately the mean of the four years in the final year of data.

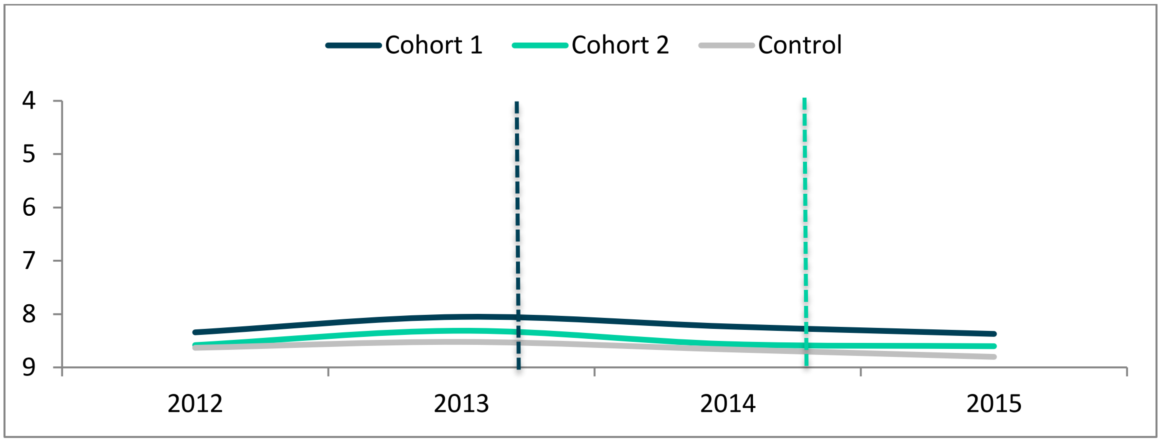
**Figure 2.8: WASSCE Chemistry Scores, 2012-2015**




N= 3,384

Figure 2.9 describes WASSCE mathematics scores over time. All groups have very high mean scores in all years, indicating *low performance*, with little change over time. Notably, however, the mean scores of both Cohort 1 and Cohort 2 slightly outperformed the mean score of the control group in each year examined. For example, the control group achieved a mean score of 8.8 in 2015 while Cohort 1 and Cohort 2 achieved mean scores of 8.4 and 8.6, respectively.

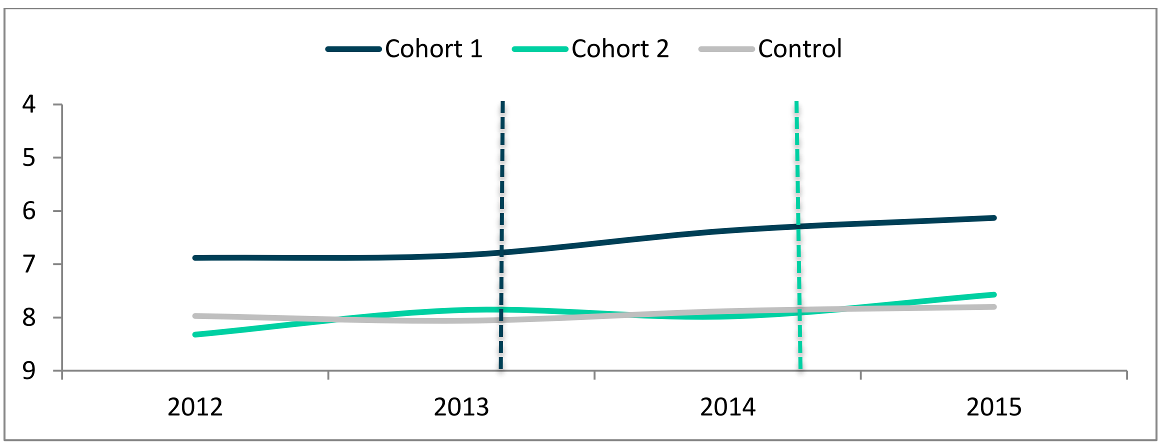
**Figure 2.9: WASSCE Math Scores, 2012-2015**




N= 33,397

Figure 2.10 describes WASSCE science scores over time. Notably, Cohort 1 students perform substantially better compared to Cohort 2 students and control students for all years. In the years following program implementation, Cohort 1 students' scores improve from a mean score of 6.1 in 2012 to a mean score of 6.9 in 2015. In the year following program implementation, Cohort 2 students' performance initially declines in 2014, then improves in the second year. Further, the control group achieved a mean score of 7.8 in 2015 while Cohort 1 and Cohort 2 achieved mean scores of 6.1 and 7.6, respectively.

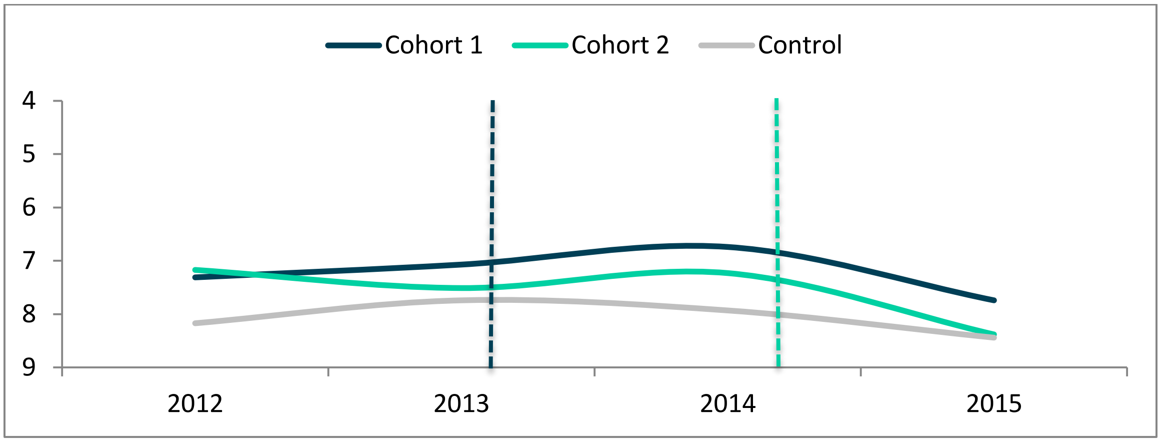
**Figure 2.10: WASSCE Science Scores, 2012-2015**




N= 27,197

Figure 2.11 describes WASSCE biology scores over time. Cohort 1 students' scores improve slowly in the two years following program implementation, but average performance declines to its lowest point in the final year. Cohort 2 students' scores improve slightly in the year after program implementation, but average performance declines to its lowest level in the final year of data.

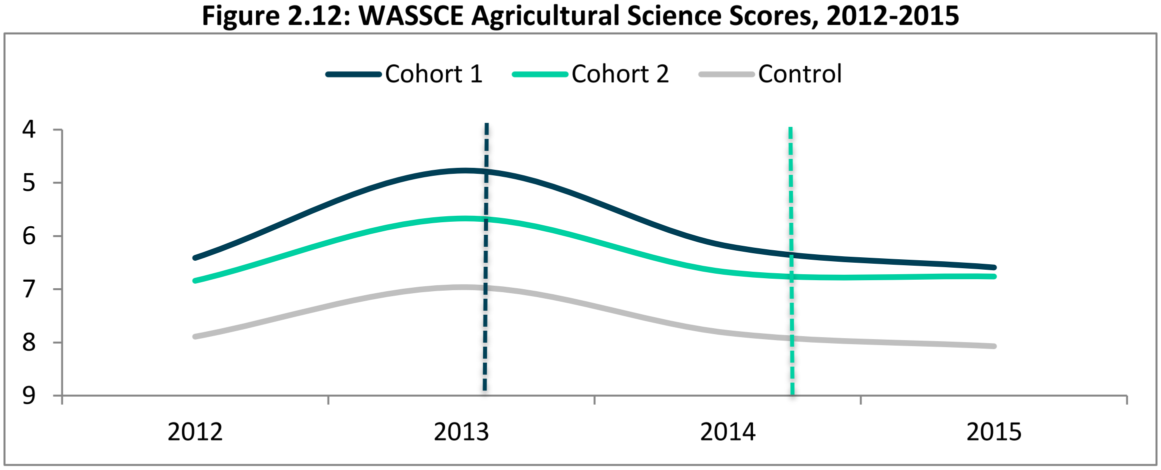
**Figure 2.11: WASSCE Biology Scores, 2012-2015**




N= 9,180

Figure 2.12 describes WASSCE agricultural science scores over time. All groups' scores, including those for Cohort 1, improve considerably in 2013, but decline in the following years. Although Cohort 1 scores improve in the year following program implementation, this is likely not a result of the program since the other students' scores also improve. Likewise, although Cohort 2 performance declines following program implementation, the control students' scores decline as well, indicating that the program may not be the cause of the drop in performance.

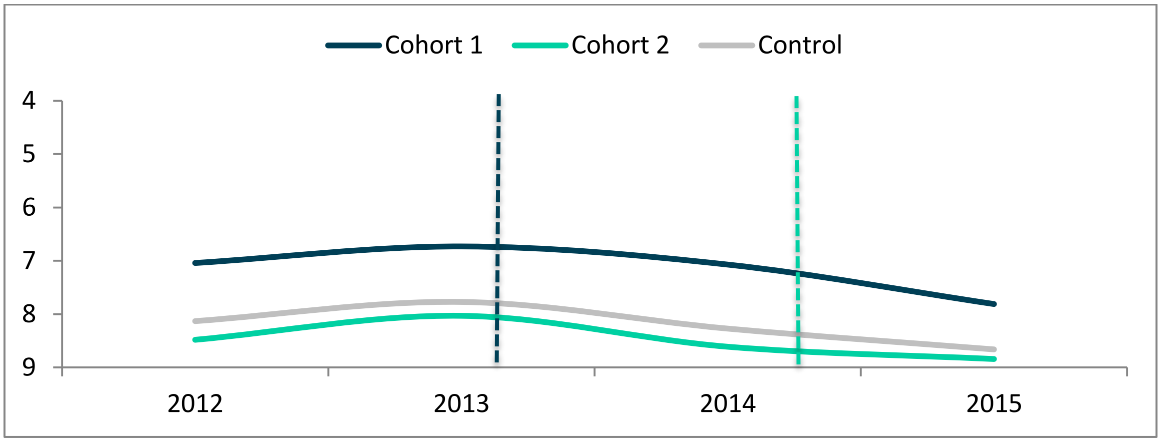
**Figure 2.12: WASSCE Agricultural Science Scores, 2012-2015**




N= 27,704

Figure 2.13 describes WASSCE economics scores over time. Although they improve somewhat in the year following program implementation, scores for students in Cohort 1 decline in the following years. Cohort 2 students' scores exhibit a similar trend, but the decline begins after the first year of program implementation. Since control students' scores also exhibit this pattern of improving in 2013 and declining in the following years, it is likely that the changes are not attributable to the program in either case.

**Figure 2.13: WASSCE Economics Scores, 2012-2015**




N= 19,194

# SECTION III: PROGRAM PARTICIPATION AND OUTCOMES, REGRESSION ANALYSIS

In this section, Hanover presents the results of ordinary least squares (OLS) regression analyses in order to supplement the discussion of descriptive statistics in Section II. The coefficient should be interpreted as the change in the probability that the student will achieve a particular outcome in the given subject if they participate in the program. Thus, for example, from Figure 3.1, we see that program participation increased the probability of a student achieving a score of 1 in chemistry by 3.1 percentage points. In general, we observe that the program has mostly positive effects on WASSCE outcomes, especially for the higher scores.

It is important to note that the 3.1 percentage point increase in chemistry, which was mentioned in the previous paragraph, is over an average of 2.75 percent of students who receive a score of 1 in this subject. Therefore, although the effect may at first appear small, when taken in context, it is actually much larger, since a program participant essentially has a 5.85 percent chance of scoring a 1, which is a **46 percent increase in the probability of scoring a 1** over Control Group participants. We provide these comparisons in each of the outcome tables below.

## WASSCE OUTCOMES

Figures 3.1 through 3.3 describe program effects for the WASSCE assessment outcomes. We measure the effect of the program on three specific outcomes: the probability that a student will receive the higher score of 1 (Figure 3.1), the probability that a student will receive credit (Figure 3.2), and the probability that a student will pass (Figure 3.3).

We see that most of the positive effects are seen with the high performance outcomes. Specifically, being in the program improves the probability that a student will receive a score of 1 in mathematics by 0.5 percentage points, in physics by 2.5 percentage points, in chemistry by 3.1 percentage points, and in biology by 0.6 percentage points. Similarly, being in the program improves the probability that a student will receive credit in physics by 13 percentage points and in chemistry by 8.4 percentage points. All of these results are statistically significant at the 99 percent level of confidence indicating that the relationship is unlikely due to chance.

Furthermore, these results are not just statistically significant but also substantial. For example, the reader will note that the probability of scoring a 1 in Physics 512 improves by 2.5 percentage points after program participation (Figure 3.1). Since, on average, only 1.99 percent of students receive a 1, participation in the program more than doubles the probability of a student receiving a 1. Although not statistically significant, we also estimate that a student's probability of receiving a 1 increases by 4.3 percentage points for program participants, which is also about double the sample average of 3.94 percent of students who receive one's in Further Mathematics 401.

As Figure 3.2 describes, we continue to find very substantial positive effects of the program on the probability of students receiving credit in Physics 512. Specifically, although 40.84 percent of the students in the sample received credit for Physics 512, we find that the probability of receiving credit increases by 13 percentage points if the student participates in the program.

**Figure 3.1: Program Effect on WASSCE Outcomes (Score of 1)**

| Subject | Program Effect | N | R-Squared | Percent of Students Receiving 1's | Estimated Probability of Student Receiving a 1 after the program |
|---|---|---|---|---|---|
| Physics 512 | **0.025*** ** | 3,259 | 0.06 | 1.99% | 4.5% |
| Further Mathematics 401 | 0.043 | 938 | 0.06 | 3.94% | 8.2% |
| Chemistry 505 | **0.031*** ** | 3,384 | 0.09 | 2.75% | 5.9% |
| Math | **0.005*** ** | 33,397 | 0.03 | 0.28% | 0.8% |
| Science | -0.001 | 27,197 | 0.17 | 2.18% | 2.1% |
| Biology 504 | **0.006*** ** | 9,180 | 0.02 | 0.13% | 0.7% |
| Agricultural Science 502 | 0.007 | 27,704 | 0.07 | 1.29% | 2.0% |
| Economics 203 | -0.012** | 19,194 | 0.06 | 0.54% | -0.7% |

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1. Coefficients are estimated using ordinary least squares (OLS) regression, and all regression models include fixed effects for both year and school.

**Figure 3.2: Program Effect on WASSCE Outcomes (Receive Credit)**

| Subject | Program Effect | N | R-Squared | Percent of Students Receiving Credit | Estimated Probability of Student Receiving Credit after the program |
|---|---|---|---|---|---|
| Physics 512 | **0.130*** ** | 3,259 | 0.25 | 40.84% | 53.8% |
| Further Mathematics 401 | 0.152** | 938 | 0.14 | 33.80% | 49.0% |
| Chemistry 505 | **0.084*** ** | 3,384 | 0.36 | 32.27% | 40.7% |
| Math | 0.014** | 33,397 | 0.22 | 6.76% | 8.2% |
| Science | -0.011 | 27,197 | 0.41 | 22.52% | 21.4% |
| Biology 504 | 0.032* | 9,180 | 0.30 | 22.55% | 25.8% |
| Agricultural Science 502 | -0.007 | 27,704 | 0.40 | 33.20% | 32.5% |
| Economics 203 | -0.007 | 19,194 | 0.36 | 17.42% | 16.7% |

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1. Coefficients are estimated using ordinary least squares (OLS) regression, and all regression models include fixed effects for both year and school.

**Figure 3.3: Program Effect on WASSCE Outcomes (Passing Score)**

| Subject | Program Effect | N | R-Squared | Percent of Students Passing | Estimated Probability of Student Passing after the program |
|---|---|---|---|---|---|
| Physics 512 | 0.052* | 3,259 | 0.26 | 71.37% | 76.6% |
| Further Mathematics 401 | 0.099 | 938 | 0.18 | 64.82% | 74.7% |
| Chemistry 505 | -0.063* | 3,384 | 0.34 | 54.11% | 47.8% |
| Math | 0.007 | 33,397 | 0.32 | 19.42% | 20.1% |
| Science | 0.027** | 27,197 | 0.36 | 48.71% | 51.4% |
| Biology 504 | -0.035* | 9,180 | 0.34 | 45.24% | 41.7% |
| Agricultural Science 502 | -0.032*** | 27,704 | 0.41 | 51.33% | 48.% |
| Economics 203 | 0.016 | 19,194 | 0.36 | 34.13% | 35.7% |

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1. Coefficients are estimated using ordinary least squares (OLS) regression, and all regression models include fixed effects for both year and school.

# PROJECT EVALUATION FORM

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# CAVEAT



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