A Final Evaluation of Houghton Mifflin Harcourt's Holt McDougal Biology Program

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Executive Summary

Today's high school science educators are challenged with preparing students for future studies in science, as well as with helping them become scientifically literate adults. Houghton Mifflin Harcourt developed Holt McDougal Biology to help educators meet these challenges. Holt McDougal Biology is a state-of-the-art program that encompasses the most current biological research and gives teachers flexible, timesaving tools to help students connect to the living world of biology. With this program, students are able to master biology standards through a variety of multimedia tools, classroom materials, and leveled content.

Houghton Mifflin Harcourt recognizes that educators need research evidence to help inform their decisions about biology curricula. Thus, they contracted with Magnolia Consulting, LLC, an independent evaluation consulting firm, to conduct an efficacy study of Holt McDougal Biology. Magnolia Consulting conducted this study in eight schools with 24 teachers and 1,415 students during the 2011/12 school year. This final report describes the study design and methods, program implementation and teacher perceptions of the Holt McDougal Biology program, and findings regarding student learning and interest in biology.

Study Design & Methods

The primary purpose of this study was to evaluate the efficacy of Holt McDougal Biology in increasing high school students' learning in biology. This study also assessed the degree to which Holt McDougal Biology contributed to student interest in biology. Finally, this study examined teachers' implementation of the Holt McDougal Biology program, as well their perceptions regarding its quality and usefulness.

Evaluators used a randomized controlled trial (RCT) design in the conduct of this study. Specifically, teachers were randomly assigned to implement either the Holt McDougal Biology program or their regular biology program with their students. This study's student measures included the Stanford Achievement Test, Tenth Edition (SAT-10), the Partnership for the Assessment of Standards-Based Science (PASS) Biology assessment, and a student interest survey. Teacher measures included monthly online implementation logs, classroom observations, and teacher interviews.

Program Implementation

KEY QUESTION:

How did teachers implement the Holt McDougal Biology program?

Using data from the monthly logs and classroom observations, evaluators calculated an implementation fidelity score for each treatment teacher who participated in the Holt McDougal Biology study. Overall, treatment teachers met implementation fidelity requirements based on findings from logs and observations, with an average implementation score across teachers of 84.32%. Some teachers experienced implementation challenges because of school-required sequencing, limited availability of classroom computers, a lack of understanding of how to use the online components, and the unavailability of some of the online resources, particularly at the beginning of the study period. Although most treatment teachers reported using Holt McDougal Biology as their primary instructional program, most teachers also indicated that they supplemented the program with other resources.

Student Learning and Interest Results

KEY QUESTION:

Did students who participated in the Holt McDougal Biology program demonstrate learning gains in biology over the study period?

Multilevel modeling analyses examining learning gains among treatment students indicated that on average, students who participated in the Holt McDougal Biology program demonstrated statistically significant gains on the SAT-10 Science and PASS Biology assessments from pretest to posttest. The average treatment student SAT-10 Science scale score gain, which reflected several science domains, corresponded to a small effect size of 0.28. The average treatment student PASS Biology scale score gain, which specifically reflected biology, corresponded to a large effect size of 0.78. Therefore, participating in Holt McDougal Biology during the 2011/12 school year was associated with statistically significant learning gains for students in this study. Figure 1 displays Holt McDougal Biology participants' unadjusted mean pretest and posttest SAT-10 Science scale scores, and Figure 2 displays their unadjusted mean pretest and posttest PASS Biology scale scores.

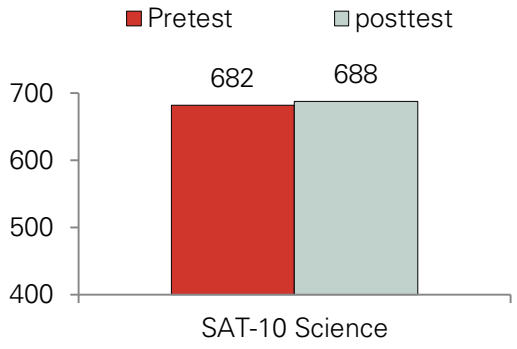

Figure 1. Holt McDougal Biology participants' unadjusted mean pretest and posttest SAT-10 Science scale scores.

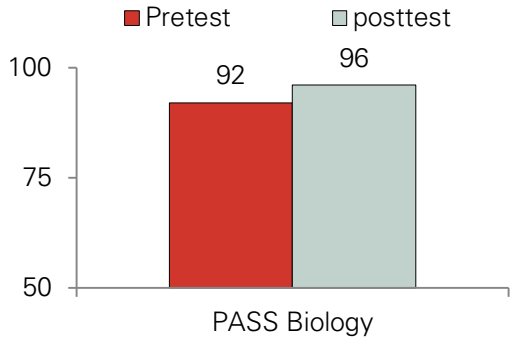

Figure 2. Holt McDougal Biology participants' unadjusted mean pretest and posttest PASS Biology scale scores.

Exploratory analyses examining whether or not student and teacher characteristics were related to learning gains revealed statistically significant relationships for student pretest performance (with students scoring relatively lower at pretest gaining relatively more) and student grade (with students in ninth grade gaining relatively more than students in other grades).

KEY QUESTION:

Did students who participated in the Holt McDougal Biology program demonstrate gains in their interest in biology during the study?

Multilevel modeling analyses comparing treatment students' pretest and posttest scores reflecting their self-reported interest in biology found no statistically significant changes from pretest to posttest. Thus, among students who participated in Holt McDougal Biology during the study, biology interest remained relatively constant throughout the study period.

KEY QUESTION:

How did the biology learning of students who participated in the Holt McDougal Biology program compare to that of students who participated in comparison programs?

Multilevel modeling analyses comparing the SAT-10 Science and PASS Biology scale scores among treatment and comparison group students showed that on average, Holt McDougal Biology participants' adjusted posttest SAT-10 Science and PASS Biology scale scores were higher than those of comparison group students, but the differences were not statistically significant. The findings for both assessments corresponded to small effect sizes. However, the findings for the PASS Biology assessment, which specifically assessed biology content rather than multiple science domains, corresponded to a notable effect size (0.12). Thus, it is possible that if the study's sample size had been larger, the finding regarding the impact on biology achievement would have been statistically significant. Together, findings from both assessments suggest that the treatment and comparison students demonstrated similar achievement on the measures used for this study.

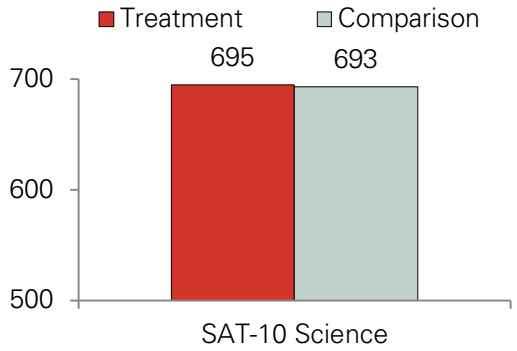

Figure 3. Impact of Holt McDougal Biology on SAT-10 Science achievement.

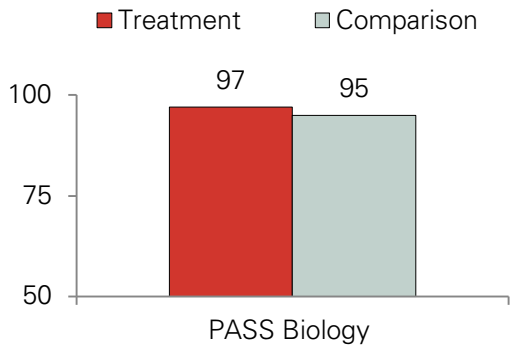

Figure 4. Impact of Holt McDougal Biology on PASS Biology achievement.

KEY QUESTION:

How did the biology interest of students who participated in the Holt McDougal Biology program compare to that of students who participated in comparison programs?

Multilevel modeling analyses comparing treatment and comparison students' biology interest demonstrated that treatment and comparison students self-reported similar levels of biology interest. Thus, across study conditions, student interest in biology was comparable.

Program Perceptions

KEY QUESTION:

What were teachers' perceptions of the quality and utility of the Holt McDougal Biology program?

Teachers who implemented the Holt McDougal Biology program components most often reported that the program required *just the right amount of time*. Additionally, treatment teachers most frequently reported that Holt McDougal Biology program components were *reasonably paced* and allowed them to somewhat meet or meet their students' needs. Treatment teachers shared their perceptions about the amount of material

offered by Holt McDougal Biology and the majority of teachers either reported that the program provided the right amount of materials or too much to cover.

Teachers most often indicated that students showed high engagement or average engagement with the Holt McDougal Biology program. Students especially seemed to appreciate the online review capabilities, graphics, and videos. Treatment teachers reported that the varied resources, including interactive readers, allowed them to meet the needs of below-level and advanced-level students.

In addition to sharing positive feedback, treatment teachers also offered suggestions for improvement. Specifically, treatment teachers were frustrated with the delayed launch of the online materials and would have preferred to have the materials at the very beginning of the school year. Additionally, many teachers wished they had additional training to better use the many available resources. Some treatment teachers also suggested improving the PowerNotes alignment to the text, the Exam View, and the PowerPoint presentations.

In general, treatment teachers conveyed greater satisfaction with the Holt McDougal Biology program than comparison teachers conveyed about their schools' regular core biology programs. Treatment teachers also reported having more program-developed complementary materials than comparison teachers. Treatment teachers felt better able to meet diverse student needs, in contrast to comparison teachers who often reported being unable to fully meet needs of below-level or advanced-level students because they had insufficient resources or support. Additionally, on average, treatment teachers rated the Holt McDougal Biology program higher than comparison teachers rated their programs at effectively increasing most of the skill areas assessed.

Finally, compared to teachers in the comparison group, treatment teachers were happier with the student text and appreciated its more up-to-date content, whereas comparison teachers often reported using older, outdated materials.

Conclusions

Students who participated in the Holt McDougal Biology program demonstrated statistically significant learning gains. Treatment students' learning achievement was comparable to that of students using other high-quality biology programs. However, the positive, notable effect sizes for the PASS Biology assessment and for some of the subgroup analyses suggest that if the sample size had been larger, the study might have had enough statistical power to detect meaningful impacts on student biology achievement. Although teachers generally implemented the program with moderate to high fidelity, they also noted several challenges that negatively affected their program implementation. It is possible that if these challenges had not existed, program implementation would have been higher, which might have positively contributed to impacts on student learning and interest.

Treatment teachers who used Holt McDougal Biology appreciated many aspects of the program. In addition, as a group, treatment teachers were more satisfied with the program than comparison teachers were with their programs, and they generally perceived Holt McDougal Biology as more effective than comparison teachers perceived their programs. Thus, not only did students who used the Holt McDougal Biology program show statistically significant learning gains that were comparable to learning gains of students using other high-quality programs, but treatment teachers generally rated the program more positively than comparison teachers rated their programs.

Acknowledgements

Magnolia Consulting was honored to conduct this efficacy study of Holt McDougal Biology on behalf of Houghton Mifflin Harcourt. The study represents a collective endeavor among Magnolia Consulting, Houghton Mifflin Harcourt, and study participants from eight schools. Magnolia Consulting evaluators appreciate the time and efforts of the many people who made this study possible. We are especially grateful to the school administrators, teachers, and students who participated in the study during the 2011/12 school year. Additionally, Magnolia Consulting appreciates the staff at Houghton Mifflin Harcourt for their commitment to demonstrating and improving the efficacy off their programs through independent research. Finally, we want to express our gratitude to the members of the Magnolia Consulting team for their support of the data collection, management, and analysis efforts for this study.

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Introduction

In an ever-changing technological world the demand for quality science education continues to grow. Unfortunately, in the last decade the United States has shown a shortage of high-level scientific workers and innovators (National Research Council, 2006). In 2005, the National Research Council estimated that 59% of Chinese students and 66% of Japanese students majored in science, technology, engineering, and math (STEM) disciplines at universities compared to under 30% of U.S. students. Researchers have consistently shown that the U.S. is ranked behind many nations in terms of science achievement (Forgione, 1998; Gonzales et. al, 2008; Snyder & Dillow, 2010).

Due to the decline of U.S. science education, a broad coalition of industry and educators was formed in 2006 to advocate for improved STEM education so that the U.S. could better compete in global markets. The STEM Education Coalition has worked to improve funding, coordination, training, and access to STEM programs for teachers and students nationwide. Despite such efforts, analyses from the Program for International Student Assessment (PISA) by Hanushek, Peterson, and Woessmann (2010) and Fleischman, Hopstock, Pelczar, and Shelley, (2010) show that the U.S. continues to fall behind other nations in producing strong advanced-level adolescent science students. Recent studies by the National Science Foundation (NSF) call for better preparation for student science achievement and STEM education by improving curriculum, access, and accountability (NSB, 2010).

The STEM Education Coalition challenges high school science educators to more effectively prepare students not only for future studies in the sciences, but also to become scientifically literate adults. Researchers of curriculum materials advocate that high school science materials are an important aspect of science instruction and should therefore be a target of reform and improvement efforts (Ball & Cohen, 1996).

In response to the need for higher quality high school biology materials, Houghton Mifflin Harcourt developed the Holt McDougal Biology program. The program, created by Duke University Professor Stephen Nowicki, encompasses the most current biological research and gives teachers effective, flexible, and timesaving tools to help students connect to the living world of biology.

The Holt McDougal Biology program offers a variety of multimedia tools, classroom materials, and leveled content to help students master biology standards. The student text uses a clear, approachable writing style, engaging visuals, and short sections designed to support student learning and comprehension. It also includes a media gallery through which teachers can access thousands of graphics, videos, and animation to create slide shows that bring classroom biology presentations to life. Holt McDougal Biology provides teachers with customized assessments and tools to differentiate instruction and includes an online interactive component involving virtual labs, games, quizzes, and animated activities that help students build knowledge, stay engaged, and meet testing standards. In addition, the program provides access to BioZine, an online magazine that connects students directly to the latest biology news and allows students to explore cutting-edge issues, technology, and careers in biology.

Houghton Mifflin Harcourt contracted with Magnolia Consulting, LLC, an external, independent consulting firm specializing in educational research and evaluation, to evaluate the efficacy of the Holt McDougal Biology program for high school students. This evaluation report includes an overview of the evaluation design and methods, a description of the Holt McDougal Biology program, and a discussion of study findings. Magnolia Consulting conducted this study on behalf of Houghton Mifflin Harcourt throughout the 2011/12 school year.

Research Design

The main purpose of this study was to evaluate the efficacy of the Holt McDougal Biology program in increasing student learning of biology content as measured by the study's assessments. This study also examined the degree to which the Holt McDougal Biology program affected student interest in biology. Finally, this study examined teachers' implementation of the program, as well as their perceptions regarding Holt McDougal Biology's quality and usefulness.

Magnolia Consulting used a randomized controlled trial design (RCT) to conduct this study in eight high schools during the 2011/12 school year. The evaluation study addressed the following central evaluation questions:

1. How did teachers implement the Holt McDougal Biology program during the study?
2. What factors influenced how teachers implemented the program in their particular classroom setting?
3. What were teachers' perceptions regarding the quality and utility of the Holt McDougal program?
4. Did students who participated in the Holt McDougal Biology program demonstrate learning gains in biology during the study? Were various student and teacher characteristics associated with learning gains?
5. Did students who participated in the Holt McDougal Biology program demonstrate gains in their interest in biology during the study?
6. How did biology learning of students who participated in the Holt McDougal Biology program compare to that of students who participated in comparison programs?
7. How did biology interest of students who participated in the Holt McDougal Biology program compare to that of students who participated in comparison programs?

Methodological Approach

For this study, evaluators used a RCT design and randomly assigned teachers within participating schools to either the treatment group or the comparison group. Treatment teachers implemented the Holt McDougal Biology program as their primary instructional materials, and comparison teachers used their existing programs. Therefore, within the same school, some teachers used the Holt McDougal Biology program and others used only their existing biology curriculum. This design enabled evaluators to estimate the impact of Holt McDougal Biology on student learning and interest and to determine if there were statistically significant differences in learning and interest by study condition (Raudenbush, Spybrook, Liu, & Congdon, 2005). To strengthen the validity of the study in making causal inferences, evaluators used multiple student outcome measures at different time periods during the study.

In this study, students were nested in teachers' classrooms, which created a hierarchical data structure. Specifically, students with the same teacher were exposed to the same teacher-level influences, and these shared influences might have affected the way they responded to educational materials (Borman et al., 2005). In educational studies with this type of nested data structure, it is important to account for the varied potential influences on student

outcomes, such as characteristics of students themselves, in addition to characteristics of the teachers who instruct them. Thus, for this study, evaluators used multilevel modeling to address the key evaluation outcomes related to student learning and interest in biology. Evaluators conducted additional analyses as well, including calculation of descriptive statistics, parametric statistics, and non-parametric statistics. Finally, when appropriate, evaluators calculated standardized effect sizes to characterize the magnitude of program effects when appropriate (Borenstein, Hedges, Higgins, & Rothstein, 2009).

Measures

Evaluators collected descriptive, outcome, and implementation data using multiple teacher and student measures throughout the study period. Evaluators used these measures to strengthen the validity of the study and to gain a full understanding of how teachers implemented the Holt McDougal Biology program.

Teacher Measures

To assess study teachers' implementation and perceptions of their programs, evaluators collected monthly online implementation logs completed by all treatment and comparison teachers throughout the 2011/12 school year. In addition, evaluators conducted classroom observations and teacher interviews with all study teachers. Using multiple teacher measures increased the validity of the qualitative findings by facilitating data triangulation. The data yielded information about teacher's use of the Holt McDougal Biology program, the effectiveness of the program in improving students' biology knowledge, and changes in student interest towards biology during the study period.

Teacher Implementation Logs

Evaluators created monthly online implementation logs to gauge the breadth and depth of teachers' use of Holt McDougal Biology or their usual biology programs. Treatment and comparison teachers spent approximately 10–15 minutes completing logs during each program administration. The logs addressed the following components:

a) the frequency and extent to which teachers implemented specific biology components and materials,
b) how often teachers used their programs' additional resources, and
c) teachers' perceptions about their biology programs.

Using the logs, teachers also reported interruptions in their biology instruction periods (e.g., fire drill, testing, field trips, etc.), as well as student attrition. The treatment and comparison logs were designed similarly to allow for program comparison. Evaluators aggregated data from the logs, and findings are presented in the program implementation section.

Classroom Observation Protocols

Evaluators conducted 40-minute classroom observations for all treatment classrooms and a sample of comparison classrooms in the spring. Evaluators developed observation protocols to guide observations of treatment and comparison classrooms. The treatment observation protocol differed slightly from the comparison observation protocol because it included items specific to the Holt McDougal Biology program.

Treatment protocols included the following constructs:

a) teacher-student interactions,
b) equipment and technology,
c) instructional strategies,
d) Holt McDougal Biology lesson implementation, and
e) student engagement.

Each treatment observation construct was subdivided into multiple items. Specifically, the teacher-student interactions construct included items on teacher language, teaching points, and encouragement. The equipment and technology construct included items about presentation tools, text books, and computer equipment. Instructional strategies addressed teacher routines, teaching practices, teaching techniques, and individualized routines. Procedures associated with Holt McDougal Biology Lesson Implementation included program sequences, routines, pace of the lesson, vocabulary, concepts, activities, practice, and assessments. Finally, student engagement covered student transition, focus, and interest in the materials.

The comparison observation protocol focused on teacher's existing biology programs instead of the Holt McDougal Biology program. Comparison classroom observation protocols addressed the following four constructs:

a) teacher-student interactions,
b) instructional strategies,
c) lesson components, and
d) student engagement.

Each comparison observation construct included multiple items. The teacher-student interactions construct included items on teacher language, teaching points, and encouragement. The instructional strategies construct included teacher routines, teaching practices, teaching techniques, and individualized routines. The construct on lesson components included items about the materials, the pace, vocabulary, concepts, activities, practice, and assessments. Finally, student engagement covered student transition, focus, and interest in the materials.

For each observed item, evaluators assigned a rating based on a scale from 0 to 3 (0 = *Not at All—does not meet this indicator*; 1 = *Partially—apparent but on a somewhat inconsistent basis*; 2 = *Mostly—apparent but not fully consistent*; and 3 = *Fully—fully meets indicator*).

Interview Protocols

Evaluators also conducted 15–20 minute interviews with all treatment teachers and a sample of comparison teachers during the spring site visits. The interviews focused on implementation fidelity and teacher perceptions of the treatment and comparison programs, as well as teachers' perceptions regarding the effects of the programs on student learning and interest in biology. Evaluators structured the interview protocols into five categories:

- About the classroom lesson
- About the students
- Use and general perceptions of the Holt McDougal Biology program (for treatment teachers) or comparison programs (for comparison teachers)

- Assessments and student impacts
- General feedback

Student Measures

Evaluators assessed student learning in biology with two student measures, the science subscale of the Stanford Achievement Test, Tenth Edition (SAT-10) a norm-referenced, general science assessment, and the Partnership for the Assessment of Standards-Based Science (PASS) Biology Content Assessment, a biology-specific assessment. Evaluators also measured changes in students' biology interest during the study using a student interest survey.

Stanford Achievement Test, Tenth Edition (SAT-10)

The SAT-10 is a group-administered assessment that gauges a number of content areas, including science, reading, and mathematics. The assessment uses a multiple choice format and is appropriate for administration in the fall and spring. This study used the SAT-10 TASK 2 Science test, which is appropriate for grades 10.0–10.9 and addresses a variety of science domains. The science test consists of 40 test items and should take approximately 25 minutes to complete. Although the assessment gives general time guidelines, the assessment allows flexible testing times.

Teachers administrated the SAT-10 to all treatment and comparison groups at the beginning and the end of the 2011/12 school year. Teachers returned the completed tests to Pearson Scoring Services after the completion of each administration. Pearson Scoring Services provided multiple scores including scaled scores, national and local percentile ranks and stanines, grade equivalents, and normal curve equivalents. For this study, evaluators used vertically scaled scores for the student achievement analyses.

Partnership for the Assessment of Standards-based Science (PASS)

The PASS Biology Content Assessment is a customized assessment based on the National Science Education Standards for biology. PASS developers at WestEd developed two forms of a 30 multiple-choice item biology assessment for this study. Teachers administered the assessment at the beginning and the end of the study. The assessment took 30 minutes to administer. Assessment development included a rigorous validation process so that it was backed by solid validity and reliability data. WestEd provided assessment scoring services which yielded students' total scale scores.

Student Interest Survey

Evaluators developed a 20-item survey to measure students' interest in biology at pretest and posttest. The survey included items related to student interest in biology, overall interest in studying biology, and students' self-efficacy in biology and science in general. The assessment required students to choose a response that best describes their feelings regarding each of the 20 items. Response options were on a five-point Likert scale and included the following options: *really agree, agree, not sure, disagree,* and *really disagree*.

Study Procedures

Magnolia Consulting implemented specific study procedures to ensure that the evaluation study was implemented as planned. This portion of the report provides an overview

of procedures used to select study sites, and to randomly assign teachers to treatment and comparison groups.

Site Selection and Group Assignment

Houghton Mifflin Harcourt and Magnolia Consulting worked together to select sites to participate in this study. Specifically, Houghton Mifflin Harcourt provided Magnolia Consulting with information about selection criteria, which included priority states based on Houghton Mifflin Harcourt's preferences, as well as schools with at least two biology teachers who were not current users of recent editions of the program. To reach potential sites, Houghton Mifflin Harcourt contracted with the policy research group MDRC to send an email blast in April 2011 to all district and school biology coordinators, department chairs, and curriculum directors in suburban and urban schools in targeted open territory states. In addition, Magnolia Consulting pulled from its database of district contacts in curriculum and instruction and identified and contacted those who might be interested in participating in the study. Magnolia Consulting evaluators also queried National Center for Education Statistics (NCES) databases based on site selection criteria. Finally, Magnolia Consulting contacted schools referred to them by Houghton Mifflin Harcourt sales representatives. Interested sites completed study applications, which evaluators reviewed. If sites met the selection criteria and were comfortable with study requirements, they were accepted into the study.

Once sites were selected into the study, Magnolia Consulting evaluators randomly assigned teachers to participate in either the treatment group or the comparison group. Treatment teachers implemented the Holt McDougal Biology program during the study period, and comparison teachers used their current biology programs but did not use Holt McDougal Biology program materials.

Study Timeframe

This study took place during the 2011/12 school year. Site recruitment began in the spring of 2011 and was completed in the summer of 2011. Once eligible sites agreed to participate, Magnolia Consulting randomly assigned teachers to treatment and comparison groups in the summer of 2011. In September, Houghton Mifflin Harcourt conducted the Holt McDougal Biology training for all treatment teachers, and Magnolia Consulting conducted the study orientation. More detail about the trainings and orientations is provided in the implementation fidelity section. Implementation of Holt McDougal Biology in treatment classrooms and comparison programs in comparison classrooms began in the fall, soon after the study orientation. During the fall and spring of the 2011/12 school year Magnolia Consulting oversaw the administration of all student measures. Magnolia Consulting administered teacher implementation logs for treatment and comparison teachers monthly throughout the school year. Finally, Magnolia Consulting analyzed data during the summer of 2012. Table 1 presents an overview of the study timeframe.

Table 1. Timeline of Holt McDougal Biology study activities

Task and Activity	2011					2012						
	May - August	September	October	November	December	January	February	March	April	May	June - August	September
Study recruitment and protocol development	◆											
Training, study orientation, study begins		◆										
Administration of student assessments (SAT-10, PASS Biology Content Assessment, and Student Interest)		→	→						→	→		
Implementation of Holt McDougal Biology in treatment classrooms and comparison programs in comparison classrooms		◆	◆	◆	◆	◆	◆	◆	◆	◆		
Administration of monthly teacher implementation logs (treatment and comparison)		◆	◆	◆	◆	◆	◆	◆	◆	◆		
Teacher observations and interviews (treatment and comparison)								→	→			
Data analyses											◆	
End study												◆

Implementation Fidelity

Magnolia Consulting and Houghton Mifflin Harcourt conducted orientations and trainings, and communicated with teachers throughout the school year to ensure that treatment teachers implemented Holt McDougal Biology with fidelity. At the beginning of the study, Magnolia Consulting conducted a study orientation for all participating teachers and provided them with folders containing a study schedule, instructions, and an informed consent form. During the orientation, evaluators discussed participation requirements, including the procedures for all data collection activities. After the study orientation, Houghton Mifflin Harcourt provided training for all treatment teachers regarding key program features and how to implement the Holt McDougal Biology program with their students. During this training, Magnolia Consulting also provided all treatment teachers with guidelines outlining program implementation requirements for the study (see Appendix A). The training was designed to ensure implementation fidelity by orienting teachers to required program components. Magnolia Consulting evaluated implementation via multiple methods, including the classroom observations and interview protocols, as well as the monthly implementation logs described previously.

Settings

Eight high schools in seven districts participated in this study. According to the U.S. Department of Education, National Center for Education Statistics, (2012a, 2012b), three of the seven districts are classified as "Suburb: Large," two districts were classified as "City: Large," one district was classified as "City: Midsize," and one as "Rural: Fringe." Four districts were from the East North Central region of the United States, two were from the West North Central, and one was from the Middle Atlantic region. Overall, the average number of schools in each district ranged from 3 to 276. The average student enrollment was 36,335 students per district (range 3,488–165,694). Across districts the average student/teacher ratio was 16.20.

Table 2. Characteristics of participating districts

	District 1	District 2	District 3	District 4	District 5	District 6	District 7
Geographic location and city description	West North Central Rural: Fringe	East North Central City: Midsize	East North Central Suburb: Large	East North Central Suburb: Large	East North Central Suburb: Large	West North Central City: Large	Middle Atlantic City: Large
Total number of schools	10	33	58	3	9	66	276
Student/Teacher ratio	15.72	16.00	17.81	19.46	17.17	12.33	14.92
Total student enrollment	4,904	16,646	41,446	3,513	3,488	18,839	165,694
Ethnic breakdown							
Caucasian	93.8%	68.1%	33.3%	16.9%	92.6%	8.9%	32.4%
African American	0.8%	12.6%	6.7%	57.1%	1.3%	62.6%	52.7%
Asian/Pacific Islander	1.4%	10.9%	8.0%	0.3%	0.9%	3.0%	4.3%
Hispanic	2.5%	4.0%	49.0%	21.5%	4.6%	25.3%	12.7%
American Indian/ Alaskan Native	0.6%	0.3%	0.5%	0.4%	0.8%	0.2%	0.3%
Multiracial/Other	2.4%	6.6%	2.5%	3.8%	2.9%	-	3.1%
English language learners	1.92%	5.61%	22.68%	1.54%	5.79%	16.48%	7.35%

Sources: U.S. Census Bureau (geographic regions) and National Center for Educational Statistics (city descriptions).
Note. District 3, District 4 & District 6 ethnic data is sourced from district sites. District 2 & District 6 are private schools located within the listed school district.

Participants

This section presents the demographic information of teachers and students included in the analysis sample, the attrition analyses of the overall sample, and the equivalence between treatment and comparison groups.

Teacher Participants

The study's final sample included 24 teachers. Eleven of these teachers served as treatment-group teachers and 13 served as comparison-group teachers. These teachers reported their highest earned degree, with 79.16% of teachers having a master's degree

(70.83% have a master's of arts and 8.33% have a master's of science), and 20.83% have a bachelor's degree. The average number of years teaching was 14.83 and ranged greatly, from 0 to 38 years, while the number of years at their current school averaged 8.88 (range 0–28 years). The number of students per teacher ranged from 14 to 143 students, with an average number of 61.71 students.

Researchers conducted *t*-tests to determine if there were statistically significant differences in teacher characteristics by study condition. These analysis revealed that the treatment and comparison groups were comparable with regard to the number of students per teacher, $t(22) = -1.15$, $p = 0.26$, the total number of years teachers had been teaching, $t(22) = 0.12$, $p = 0.92$, and the number of years teachers had been teaching at their current school, $t(22) = 1.38$, $p = 0.18$.

Student Participants

Sample Attrition

Because high attrition rates can affect the validity of a randomized control trial's findings, evaluators examined the study's overall sample attrition rate by comparing the number of student participants at the beginning and end of the study. The initial study sample consisted of 752 treatment students and 663 students in the comparison classrooms, for a total sample of 1,415 students enrolled in the fall. The final sample included 1,301 students enrolled in the spring, with 694 participants in the treatment group and 607 students in the comparison group. The difference between the initial sample and the final sample yielded an overall sample attrition rate of 8.06%. Evaluators removed students from the study sample if they moved out of the school during the study period. The total number of students who were removed from the original study sample totaled 114. The number of students per school who were removed from the original study sample ranged from 3 to 39 students.

In addition to overall study attrition, the validity of a randomized control trial depends partly on whether or not there is differential attrition by study condition. Evaluators examined whether or not there was differential attrition by calculating and comparing attrition rates for each condition. The treatment group had an attrition rate of 7.71%, and the comparison group had an attrition rate of 8.45%. Thus, the differential attrition rate was 0.74%. A chi-square test of independence showed that this difference was not statistically significant [$\chi^2(1, n = 1{,}415) = .17$, $p = .68$]. Because the overall attrition rate was less than 10% and the differential attrition rate was less than 6%, the attrition rates for this study fell within acceptable levels based on the What Works Clearinghouse guidelines (U.S. Department of Education, 2011).

Analysis Sample

The final analysis sample consisted of 1,255 students (671 treatment students and 584 comparison students). Students were included in the analysis sample if they were enrolled at both pretest and posttest and did not change conditions during the study period. The CONSORT (see Appendix D) presents the flow of students throughout the study, showing how many students were included at pretest and posttest,completed each assessment, and were included in the analysis sample.

Evaluators examined various demographic characteristics for students in the analysis sample, including gender, ethnicity, limited English proficiency (LEP), special education status

(SPED), free and reduced-priced lunch (FRL), and Section 504[1]. This information is presented in Table 3. Based on available demographic data, slightly over half of the students were female (53.63%) and nearly half of the students were male (46.37%). The majority of students were either in the ninth grade (67.25%) or 10th grade (31.95%), while less than 1% were in the 11th or 12th grade. Across grades and treatment conditions, 67.81% of students were Caucasian, 15.38% were Hispanic, 8.76% were African American, 4.22% were Asian or Pacific Islander, and 3.82% were categorized as either American Indian, multiracial, or other. Additional demographic data indicated that 40.30% of students qualified for free or reduced-priced lunch, 7.50% were special education students, 4.55% of the students were considered limited English proficient, and 3.03% of students were classified as Section 504.

Table 3. Student demographics by group

	Comparison Students (*n* = 584)		Treatment Students (*n* = 671)		Total Students (*N* = 1,255)		Chi-square Results	
Characteristics	Percent	*n*	Percent	*n*	Percent	*n*	Value	Sig. (alpha = 0.05)
Grade[a]								
Ninth	62.50%	365	71.39	479	67.25%	844	-	-
10th	36.64%	214	27.87	187	31.95%	401		
11th	0.51%	3	0.75	5	0.64%	8		
12th	0.34%	2	0.00%	0	0.16%	2		
Gender								
Male	44.01%	257	48.44%	325	46.37%	582	2.29	.13
Female	55.99%	327	51.56%	346	53.63%	673		
Ethnicity								
African-American	9.08%	53	8.49%	57	8.76%	110	23.14	.00
Hispanic	10.62%	62	19.52%	131	15.38%	193		
Asian/Pacific Islander	3.25%	19	5.07%	34	4.22%	53		
Caucasian	72.95%	426	63.34%	425	67.81%	851		
Other	4.11%	24	3.58%	24	3.82%	48		
Free/Reduced Lunch[b]								
FRL	34.18%	175	45.84%	259	40.30%	434	14.70	.00
Non-FRL	65.82%	337	54.16%	306	59.70%	643		
English Proficiency								
LEP	3.78%	22	5.22%	35	4.55%	57	1.17	.28
Non-LEP	96.22%	560	61.4%	636	95.45%	1,196		
Special Education								
Special Ed	10.48%	61	4.92%	33	7.50%	94	13.11	.00
Non-Special Ed.	89.52%	521	95.08%	638	92.50%	1,159		
Section 504								
Section 504	2.92%	17	3.13%	21	3.03%	38	.002	.96

[1] A student with a Section 504 classification has a diagnosed impairment, which may include long-term illness, disability or various disorder (e.g., ADHD, diabetes, epilepsy, allergies), that significantly impairs their ability to access learning in the educational setting. Students classified as Section 504 can receive test accommodations and modifications. Physical and mental impairments are not a disability under Section 504.

Characteristics	Comparison Students (*n* = 584) Percent	*n*	Treatment Students (*n* = 671) Percent	*n*	Total Students (*N* = 1,255) Percent	*n*	Chi-square Results Value	Sig. (alpha = 0.05)
Non-Section 504	97.08%	556	96.87%	650	96.97%	1,215		

a. Chi-square results are not provided for grade due to a small sample size in that category.
b. Student-level FRL was not available for students in school B.

Group Equivalence

Using chi-square tests with the final analysis sample, researchers examined student demographic characteristics to determine the equivalence of students between conditions. As seen in Table 3, the chi-square tests indicated that in this study, treatment and comparison groups were comparable in gender, English proficiency, and Section 504 status. There were statistically significant differences between conditions in ethnicity, free or reduced-price lunch, and special education. Specifically, the treatment group had a greater percentage of students eligible for free or reduced-price lunch than the comparison group, and the comparison group had a greater percentage of special education students than the treatment group. Additionally, as shown in Table 4, evaluators conducted hierarchical linear modeling (HLM) analyses to assess the equivalence between treatment and comparison groups in the final analysis sample by examining differences in student pretest performance. These analyses revealed no statistically significant differences between groups on mean student pretest achievement.

Table 4. Group equivalence at pretest

Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. *df*	*p*-value
Pretest SAT-10 Science scale Score	-1.93	7.44	-0.26	22	.808
Pretest PASS Biology scale score	-0.64	1.40	-0.46	22	.65
Pretest student interest score	-0.01	0.09	-0.16	22	.88

Program Description

Houghton Mifflin Harcourt's Holt McDougal Biology is a high school biology program that encompasses the most current biological research and gives teachers flexible, timesaving tools to help students connect to the living world of biology. A textbook and supporting materials assist teachers in creating engaging lessons that help students better understand biological concepts. Holt McDougal Biology is designed for classroom implementation over the course of one school year. Teachers who participated in the treatment group were required to use the program as their primary material for at least 80% of their biology instruction.

The Holt McDougal Biology program includes a range of text, online, and multimedia resources designed to hold student interest in an increasingly technological world. Specific components are described below.

Textbook and Print Resources

The Holt McDougal Biology student text, written by Duke University Professor of Biology Stephen Nowicki, uses a clear, approachable writing style, engaging visuals, and short sections designed to support student learning and comprehension. Textbook chapters include Real World Connections to prompt class discussions or projects, and end-of-chapter review problems and practice worksheets. Other print materials include, open inquiry labs, hands-on STEM labs, active reading techniques, and worksheets help reinforce student learning.

The program is designed to meet the needs of students with a wide range of ability levels and includes many ways to differentiate instruction. Throughout the book there are multiple opportunities for review. Reading Tool boxes provide helpful hints for students about key concepts throughout the chapters. Graphs and data presentation help to reinforce concepts and analyses of data. Vocabulary and reading support are available in each chapter.

Each lesson also includes differentiated instructional strategies to help support below-, at, and above-level learners. Leveled study guides are available for students who need additional help. Interactive readers accompany the program and include text written two levels below grade-level. These booklets are designed to be consumable to help strengthen student understanding of biological concepts. The student edition and assessments are also available in Spanish and well as many other languages.

The teachers' edition includes differentiated learning strategies for teachers to help support advanced students as well as English language learners. Teachers can also assign various levels of student guides, assessments and remediation, and worksheets.

Multimedia Resources

In addition to the textbook, the Holt McDougal Biology program offers teachers multimedia resources to help engage students and further reinforce the text. The multimedia instructional resources offer high-quality graphics, engaging videos, and interactive games.

Instructional resources include That's Amazing! Video-Based Inquiry and short videos designed to engage students. Animated Biology is an online simulation and animation of biological concepts. Video Demonstration Labs are professionally produced online videos that show students how to do a lab or demonstrate what to do during a lab. The program also provides access to BioZine, an online magazine that connects students directly to the latest biology news, and allows students to explore cutting edge issues, technology, and careers in biology. Weblinks offer students examples of physics in action with multiple online resources.

The program also includes an online interactive component made of virtual labs, games, quizzes, and animated activities that help students build knowledge, stay engaged, and meet learning standards. Students can use self-checks online, which include assessments that are immediately graded, and remediation activities if needed. Interactive Review games are included to help motivate students and increase their enjoyment of biology. The Smart Grapher, Lab Generator, Virtual Dissections, and Concepts Maps reinforce biological concepts while engaging students in active learning. The program also provides online Real World Connection activities for classroom projects or community connection. Data analyses tools help students explore examples of data analyses skills such as entering data and graphing.

Teachers have access to the online Media Gallery, which has thousands of professional images and video animations that can be used for developing PowerPoint presentations, Interactive whiteboards, and other visual aids that help bring biology lessons to life.

Holt McDougal Biology also provides teachers with customized online assessments and tools to differentiate instruction, measure student knowledge, and provide remediation. Exam view is an additional bank of questions teachers can use to customize their assessments and provide practice for their students.

Program Implementation

This section of the report describes teachers' implementation of the Holt McDougal Biology program (treatment) and various comparison biology programs (comparison). Evaluators gauged program implementation fidelity with programs, through monthly logs, a one-time comparison teacher survey, observations, and interviews. As a group, the 11 treatment teachers completed a total of 87 monthly logs, for an overall response rate of 100%. The average number of teacher log responses within each study site ranged from 7 to 8, depending on length of program implementation. All treatment and comparison teachers participated in the spring observations and interviews.

KEY QUESTION:

How did teachers implement the Holt McDougal Biology program during the study?

Implementation of Holt McDougal Biology in Treatment Classrooms

Treatment teachers were asked to follow the implementation guidelines for the Holt McDougal Biology program (see Appendix A). Guidelines included using the program five days a week, following the program scope and sequence, using key program components, and implementing the program as the primary method of instruction. Evaluators calculated an implementation fidelity score for each treatment teacher who participated in the Holt McDougal Biology program by examining data from the monthly logs and observations. Evaluators converted each indicator into a percentage score based on the requirements set forth in the implementation guidelines (see Appendix A). The logs and observations were given equal weight when calculating the overall implementation fidelity score for each teacher.

Overall, treatment teachers met the implementation fidelity requirements for this study, with an average implementation fidelity score of 84.32%. The majority of treatment teachers in the study (54.55%) implemented the program with high fidelity, while 45.45% of teachers implemented the program with moderate fidelity (see Table 5). As a group, treatment teachers excelled in their observation implementation fidelity scores with an average rating of 93.27%. Treatment teachers scored well across all observation categories, with the exception of student accessibility to computers in the classroom (22.24%). Treatment teachers' average log implementation fidelity scores (75.38%), calculated from the monthly surveys, were lower than their average observation implementation fidelity scores.

Table 5. Holt McDougal Biology program implementation levels

Implementation Fidelity Score	Number of Teachers
High (85–100%)	6
Moderate (70%–84%)	5

On the monthly logs, teachers indicated the degree to which they implemented the following program components each month: Building Study Skills, Plan and Prepare, Focus and Motivate, Teach, Additional Support and Intervention, and Review and Assess. For each of these components, teachers' implementation ranged from 11.90% to 91.67%. The logs revealed that teachers had implementation difficulties in several areas, including the number of chapters completed (53.55%) and the use of the teacher toolkit (43.09%). See Appendix C for a detailed table of teachers' average ratings for all Holt McDougal Biology implementation indicators.

Program Use

Teachers in the treatment group reported that they implemented Holt McDougal Biology as their primary instructional program on 96.55% of the logs (see Figure 3). On the majority of logs (71.43%), teachers reported using the program for 80–100% of their biology curriculum each day. On 23.81% of logs, treatment teachers reported using the program for 60–80% of their daily biology curriculum, and on 4.76% of logs, teachers reported using the program for 40–60% of their daily biology curriculum. On average, teachers reported that they used the Holt McDougal Biology program for 4.67 days per week.

On the monthly logs, treatment teachers indicated the extent to which they supplemented the Holt McDougal Biology curriculum. Across logs, most treatment teachers' responses (84.52%) indicated that they supplemented the Holt McDougal Biology curriculum with additional materials. Teachers reported using the following supplementary materials (percentages represent instances of log reports, and do not total 100% because teachers could report more than one supplementary material per log):

- worksheets and handouts (26.76%)
- resources from previous years (23.94%)
- labs (23.94%)
- activities (18.31%)
- videos (12.68%)
- quizzes (11.27%)
- other Holt McDougal materials (11.27%)
- Internet resources (8.45%)
- PowerPoints (7.04%)
- review materials (5.63%)

The implementation guidelines indicated that teachers should implement the program chapters in order. Most log responses (93.27%) revealed that teachers were implementing the chapters in order.

The Holt McDougal Biology program required hands-on student lab work. On the monthly logs, teachers indicated how they acquired resources for these labs (the percentages of times each was reported do not total 100% because teachers often provided more than one response):

- curriculum/text (66.67%)
- supplemental materials (59.77%)
- Teacher-created (45.98 %)
- other (19.54%)

Of those teachers who reported *other*, teachers most frequently mentioned the Internet as their resource for finding lab activities.

The Holt McDougal Biology program includes an array of resources, including online materials, PowerPoint presentations, and a teacher toolkit. On the majority of logs (78.57%), teachers reported that they used the online resources for their biology instruction, and then in a follow-up question, these teachers specified the online resources they used. The most common resources were videos, online curriculum resources, and virtual labs. Across all logs throughout the year, teachers indicated that they used PowerPoint regularly when teaching biology (84.52%). Also, teachers reported using the teacher toolkit on 43.37% of the logs. On average, teachers spent 161.85 minutes each week planning and preparing for their Holt McDougal Biology lessons.

KEY QUESTION:

What factors influenced how teachers implemented the Holt McDougal Biology program in their particular classroom setting?

Factors Affecting Implementation

Teachers, reporting that they had difficulties implementing Holt McDougal Biology on 44.05% of the logs, further explained their difficulties in the qualitative portion of the survey.

Most of the difficulties reported (66.67%) related to technical aspects of the program, especially with accessing the online resources. At the beginning of the year teachers were frustrated with the slow start to the program and that materials were not available right away. Once all online materials were available, teachers' use of the program's online components increased.

In many cases, treatment teachers' implementation fidelity was also negatively affected by the limited availability of in-class computers. Several teachers indicated that they did not have access to in-class computers, limiting their students' ability to use the online components. When classrooms did not have in-class student computers, teachers used a single classroom computer to project online activities or took the students to the computer lab.

Other reported difficulties related to specific program components, including ExamView and its test bank of questions, and the compatibility of PowerPoint and PowerNotes. Some teachers also reported that there was too much to cover, or that the program was not always in line with school requirements.

In two of the study sites, treatment teacher implementation fidelity was affected by school requirements that biology lessons be taught in a predetermined sequence. This did not allow some teachers to follow the Holt McDougal Biology program sequencing suggested by

the implementation guidelines. Additionally, some school administrators asked teachers to vary the program's sequence because it was important for all teachers at the school to cover the same material for school-level testing. These school-level requirements affected the treatment teachers' ability to follow the Holt McDougal Biology sequencing and pacing requirements.

Some treatment teachers felt they were unprepared for the program and did not understand how to use the online components very well. These teachers said they became more adept towards the end of the year, but noted they would have benefited from a longer, more in-depth training, or a second training held later in the year. All treatment teachers said their implementation of the online components was greatly limited by the availability of the materials, which were significantly delayed from the start of the study period.

Varied student ability levels also affected teachers' implementation of the program components. Teachers with more advanced students were able to stay on pace with the program more easily, and said that the advanced students were very engaged. However, those with below-level students struggled to complete all of the components offered by the program, which affected their implementation of the program as prescribed by the study implementation guidelines. Teachers with mixed ability levels were challenged to adapt the program as needed.

Implementation of Core Biology Programs in Comparison Classrooms

Evaluators interviewed and observed all comparison teachers in the spring of 2012 and collected their monthly logs in order to assess teacher implementation of comparison biology programs. All 13 comparison teachers completed 100% of the monthly logs.

The comparison teachers observed during this study used a variety of instructional methods including whole group instruction, small groups, and lab work. Most comparison teachers were organized and used a combination of core program materials and supplemental materials. Table F1 provides a summary of these comparison core biology programs.

On average, comparison teachers reported using their core science program materials 3.83 days a week (range 1–5) and supplementing their program an average of 3.04 days a week (range 1–5). Comparison teachers' monthly logs revealed that they used a variety of core materials. They specified the core materials they used as follows (the percentages of times each was reported do not total 100% because teachers often reported more than one material in each response):

- student textbooks or books (68.27%)
- other curriculum materials (41.35)
- Internet resources(16.35%)
- labs (13.46%)
- teacher-designed materials (13.46%)
- handouts or workbooks (11.54%)
- journal articles (2.88%)

Like the treatment logs, the comparison-teacher logs also asked teachers to indicate how they acquired resources for their labs. Comparison teachers shared the following (the percentages of times each was reported do not total 100% because teachers often provided more than one response):

- supplemental materials (71.15%)
- teacher-created (67.31%)
- curriculum/text (66.35%)
- other (17.31%)

Similar to treatment teachers, of the comparison teachers who reported *other*, most responses indicated that they found their lab resources mainly from the Internet, and some mentioned using other curriculum materials.

Evaluators asked comparison teachers about their use of textbooks during spring interviews. Two teachers said they do not use the biology textbooks at all. One teacher cited only owning 22 texts and had not opened them in about four years because the information in them was so outdated. Another teacher only used the books about once a week, and used it more as a reference for students. One teacher said:

> **TEACHER QUOTE:**
>
> I don't use a text very often. We use it a reference for certain things. Sometimes it is not accurate, or it is at too high of reading level, so it is not useful. I tend to have a more organic approach to finding and creating reading materials for them. Everything they need to know is in the notes outline, or on an assignment that I give to them. They can check out a book, but we don't have enough copies to give to every student.

Comparison teachers reported using supplemental materials in 91.35% of the logs. Out of these logs, they specified the following materials they used to supplement their program (the total does not equal 100% because teachers were allowed to report more than one material in each response):

- labs (30.00%)
- teacher-designed materials (22.22%)
- Internet (21.11%)
- textbooks, journals or articles (14.44%)
- other curriculum materials (12.22%)
- activities or games (10%)
- videos (8.88%)
- worksheets or handouts (8.88%)

On the comparison logs, 77.88% of responses indicated that comparison teachers were using online resources. Out of these responses, teachers then specified that they most commonly used educational websites, online curriculum resources, videos, PowerPoints or SmartBoards, online textbooks, information, links or articles, labs, worksheets or handouts, Google searches, and activities or games.

Comparison teachers were most concerned with making the biology information usable and interesting for students. One comparison teacher said the textbook was too difficult for students, too fact-heavy and outdated. Some teachers said that they taught using a more "common sense" approach to make it more applicable for the students. During observations of

comparison classrooms, most teachers were very organized, while two of the teachers were less organized and their students were very unfocused.

Comparison teachers spent on average 162.70 minutes per week (range 2–600) preparing for their biology lessons. On 10.68% of logs, comparison teachers reported having challenges or difficulties with their biology materials. On these logs, teachers then shared reasons for their difficulties. Some of the most noted challenges were:

- lacking materials (36.36%)
- insufficient time (27.27%)
- inadequate textbooks or information (27.27%)

Across monthly logs, comparison teachers reported assessing students daily (38.46%), weekly (50.96%), or monthly (9.61%) using several measurements of student knowledge, including tests or quizzes (81.55%), activities, projects or labs (27.18%), reports (20.39%), homework assignments (16.50%), worksheets (15.53%), questions or discussions (12.62%), student presentations (9.71%), and journaling (2.91%). Teachers also categorized their assessments as state, district, or school designed assessments (11.65% of responses), formative (8.74% of responses) or summative (3.88% of responses) assessments, curriculum-based assessments (6.80% of responses), or teacher-designed assessments (6.80% of responses).

Student Performance Results

Evaluators conducted various analyses to address the evaluation study questions regarding student learning and interest in biology. Specifically, evaluators calculated descriptive statistics, used multilevel modeling, and calculated effect sizes when appropriate. Evaluators considered findings statistically significant using an alpha level of .05. For this study, data were missing for some of the student outcome variables (see Appendix E for a description of missing data rates). In order for evaluators to use all available data and maximize the study's power, evaluators used multiple imputation procedures to impute missing data. Multiple imputation procedures yielded five complete datasets, and estimates for imputed datasets were pooled using SPSS and HLM 7.0, as appropriate. The results in this report reflect the findings from the pooled estimates. However, evaluators also conducted sensitivity analyses using only cases with complete data. There were no differences regarding the statistical significance of any findings, regardless of the method uses to address missing data.

KEY QUESTION:

Did students who participated in the Holt McDougal Biology program demonstrate learning gains in biology during the study?

Learning Gains among Students who Participated in Holt McDougal Biology

To examine learning gains among students who participated in Holt McDougal Biology, evaluators examined treatment-group students' pretest and posttest SAT-10 Science scale scores and PASS Biology assessment scale scores.

Descriptive Analyses Regarding the SAT-10 and PASS Biology Assessment

As indicated previously, students participating in this study took the SAT-10 Science assessment as a pretest and posttest. Figure 5 displays treatment students' grade equivalent scores corresponding to their unadjusted mean pretest and posttest scale scores. As a group, students using the Holt McDougal Biology program demonstrated pretest SAT-10 achievement levels corresponding to an average grade equivalent of 11.8. By the end of the study, treatment students' mean SAT-10 Science achievement levels had increased to a post-high school level. These findings suggest that on average, students participating in the Holt McDougal Biology program demonstrated gains in science achievement that corresponded to more than one grade level over the 2011/12 school year.

In addition to the SAT-10, evaluators assessed participating students' learning gains using the PASS Biology assessment at pretest and posttest. Because this assessment did not yield grade equivalent score, descriptive analyses focused on scale scores. Figure 6 displays treatment students' pretest and posttest unadjusted mean PASS Biology assessment scale

scores. These unadjusted means suggest that on average, students using the Holt McDougal Biology program demonstrated increased scale scores from pretest to posttest.

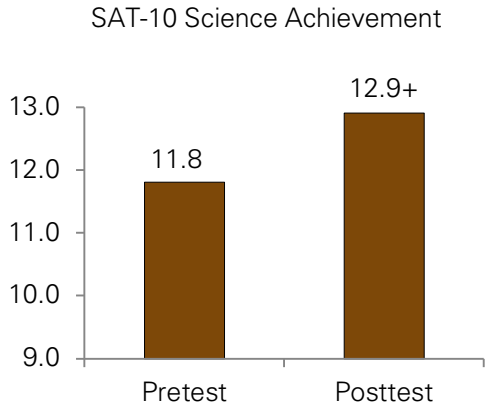

Figure 5. Pretest and posttest SAT-10 Science grade equivalent scores for students participating in the study's treatment group.

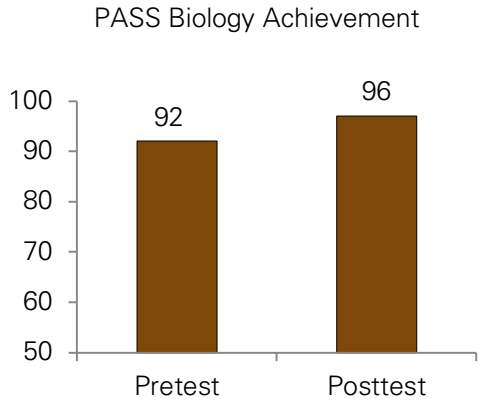

Figure 6. Pretest and posttest PASS Biology scale scores for students participating in the study's treatment group

Multilevel Modeling Analyses Examining Treatment Student Learning Gains

This study incorporated a nested design, in which students were nested in classrooms of teachers randomly assigned to study conditions. To account for the nested data structure, evaluators used multilevel modeling analyses to examine whether treatment students' learning gains were statistically significant. Researchers ran one model to examine whether or not learning gains evidenced by the SAT-10 Science assessment were statistically significant, and one model to examine whether or not learning gains evidenced by the PASS Biology assessment were statistically significant. Because the purpose of these analyses was to examine whether or not gains were statistically significant rather than to explain gains, the models did not include covariates. After running these models, evaluators calculated standardized effect sizes by dividing the adjusted pretest-to-posttest gain by the standard deviation corresponding to the pretest.

Table 6 shows that on average, students who participated in the Holt McDougal Biology program during the 2011/12 school year demonstrated statistically significant gains on the SAT-10 Science test and the PASS Biology assessment. Treatment students gained an average of 8.07 scale score points on the SAT-10 Science assessment, which corresponded to a small effect size (0.28). On the Pass Biology assessment, treatment students gained an average of 4.76 scale score points, which corresponded to a large effect size (0.78).

Table 6. Pretest-to-posttest learning gains among students participating in Holt McDougal Biology

SAT-10 Gains						
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value	Effect Size
SAT-10 Biology Scale Score Gain	8.08	3.10	2.60	10	0.03	.28
PASS Biology Gains						
Outcome Measure	Coefficient	Standard Error	t-value	Approx. df	p-value	Effect Size
PASS Biology Scale Score Gain	4.76	1.31	3.64	10	0.01	.78

KEY QUESTION:

Were various student and teacher characteristics associated with learning gains among treatment students?

Analyses Exploring Relationships Between Learning Gains and Student and Teacher Characteristics

This study included diverse student and teacher participants. Therefore, evaluators conducted exploratory analyses to examine the degree to which various student and teacher characteristics were related to learning gains on the SAT-10 Science and PASS Biology assessments. Student-level characteristics examined in the analyses included pretest performance, gender, grade (Grade 9 or other), and ethnicity (Caucasian or other). Eligibility for free- or reduced-price lunch was included as a teacher-level characteristic (i.e., the percentage of students in a classroom eligible for free- or reduced-price lunch), because not all teachers were able to provide these data at the student level. Other teacher-level characteristics included the degree to which teachers implemented the program with fidelity, teaching experience, teacher degree (bachelor's degree versus advanced degree), and length of the biology instructional period. Because these exploratory analyses subdivide the sample into relatively smaller groups than the sample used in the study's main analyses, the analyses have limited statistical power. Therefore, readers should use caution when interpreting findings.

Analyses examining the relationship between pretest performance and pretest-to-posttest learning gains revealed a statistically significant negative relationship for the SAT-10 Science and PASS Biology assessments. Specifically, students who performed relatively higher at pretest tended to have lower pretest-to-posttest learning gains compared to students who scored relatively lower at pretest. Additionally, there was a statistically significant relationship between grade level and pretest-to-posttest SAT-10 Science and PASS Biology assessment gains. On both assessments, students who were in ninth grade tended to score relatively higher compared to students who were in 10th, 11th, or 12th grades. The relationships between the other student and teacher-level characteristics and learning gains were not statistically significant. However, because these analyses had limited statistical power, it is possible that some of the findings would have been statistically significant if the teacher

sample size had been larger. The full results from these analyses are displayed in Tables E2 and E3 in Appendix E.

KEY QUESTION:

Did students who participated in the Holt McDougal Biology program demonstrate gains in their interest in biology during the study?

Biology Interest among Students who Participated in Holt McDougal Biology

Evaluators examined students' pretest and posttest interest in biology (as evidenced by the interest survey) to determine whether or not students who participated in Holt McDougal Biology program demonstrated changes in their interest in biology over the study period.

Descriptive Analyses Regarding Biology Interest

Evaluators assessed participating students' biology interest using the student interest survey at pretest and posttest. Figure 7 displays treatment students' pretest and posttest interest survey scores. Unadjusted means suggest that on average, students using the Holt McDougal Biology program demonstrated decreases in their interest in biology from the beginning to end of the study, but their interest remained above the mid-range of the scale (3.0) throughout the study period.

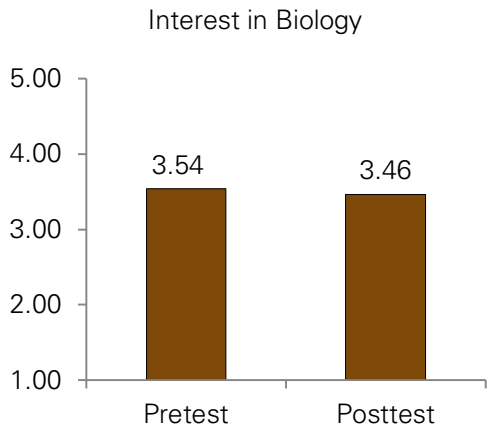

Figure 7. Pretest and posttest student interest survey scores for students participating in the Holt McDougal Biology program.

Multilevel Modeling Analyses Examining Treatment Students' Changes in Biology Interest

Evaluators used multilevel modeling analyses to examine whether or not treatment students demonstrated statistically significant changes in their interest in biology over the study period. This analysis sought to examine whether or not changes were statistically significant

rather than to explain any changes. Therefore, the model did not include covariates. In addition to running the multilevel model, evaluators calculated a standardized effect size by dividing the adjusted pretest to posttest gain by the pretest.

As illustrated in Table 7, the average student participating in the Holt McDougal program during the 2011/12 school year had end-of-year biology interest, as evidenced by the student interest survey, that was 0.06 points lower than their beginning-of-year biology interest. However, the difference from beginning to end-of-year scores was not statistically significant and corresponded to a small but notable effect size (-0.10). Thus, on average, student interest in biology was similar at pretest and posttest for treatment students.

Table 7. Pretest-to-posttest interest in biology among students participating in Holt McDougal Biology

Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value	Effect Size
Interest in Biology Gain	-0.06	0.04	-1.54	10	.16	-0.10

KEY QUESTION:

How did science and biology learning of students who participated in the Holt McDougal Biology program compare to that of students who participated in comparison programs?

Comparisons of Student Achievement by Study Condition

Evaluators conducted descriptive analyses, as well as multilevel modeling analyses, to compare the learning achievement of students who participated in Holt McDougal Biology and students who used their regular classroom biology programs.

Descriptive Analyses Comparing Student Achievement by Study Condition

Figures 8 and 9 display treatment and comparison students' unadjusted mean SAT-10 Science and PASS Biology scale scores, respectively, by study condition. The unadjusted means do not account for the clustered nature of the data, or for pretest differences among study participants, but can be useful for visually examining patterns of change from pretest to posttest. These unadjusted means suggest that across treatment and comparison groups, the pattern of change from pretest to posttest was similar.

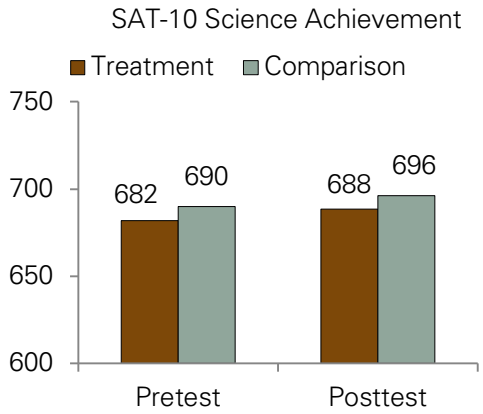

Figure 8. SAT-10 Science pretest and posttest unabjected mean scales scores by study condition.

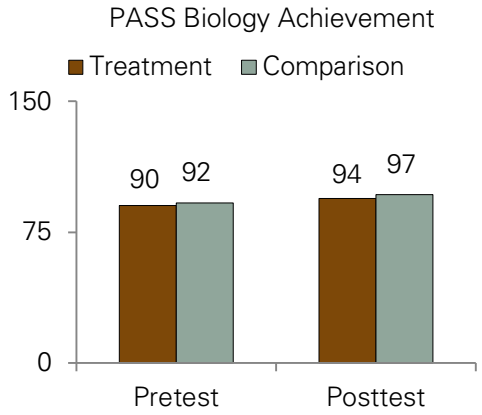

Figure 9. PASS Biology pretest and posttest unadjusted mean scale scores by study condition.

Multilevel Modeling Analyses Comparing Student Achievement by Study Condition

As indicated previously, it was important for this study to account for the nested data structure resulting from students nested in classrooms of teachers randomly assigned to study conditions. Therefore, evaluators used multilevel modeling analyses to estimate the impact of the Holt McDougal Biology program on student learning. Evaluators ran one model for each outcome of interest: posttest SAT-10 Science achievement and posttest PASS Biology achievement. Each model included a dummy-coded variable at the teacher level to indicate random assignment to study condition (treatment or comparison group). Additionally, each model included student-level pretest achievement as a level-1 covariate and classroom-level pretest achievement as a level-2 covariate to increase the precision of the impact estimate and account for any preexisting differences between the treatment and comparison groups (Bloom, Richburg-Hayes, & Black, 2007; Hedges & Hedberg, 2007). Finally, because random assignment occurred within schools, these models included dummy-coded school indicator

variables as level-2 covariates. After running these models, evaluators calculated standardized effect sizes by dividing the adjusted difference between treatment and comparison groups by the standard deviation of the comparison group.

Table 8 shows that on average, Holt McDougal Biology participants demonstrated adjusted mean posttest SAT-10 Science achievement scale scores that were 2.32 points higher than those of students who participated in comparison programs during the study. However, this difference was not statistically significant and corresponded to a small effect size (0.06). On the posttest PASS Biology assessment, Holt McDougal Biology participants scored an average of 1.21 scale score points higher than comparison-group participants. Although this difference was not statistically significant, the effect size was notable (0.12). Evaluators also conducted sensitivity analyses using models that included additional covariates. The findings from the sensitivity analyses were consistent with findings reported here.

Table 8. Impact of Holt McDougal Biology on student achievement in science and biology

SAT-10 Science Achievement						
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value	Effect Size
SAT-10 Science achievement	2.32	3.24	0.72	14	.49	0.06
PASS Biology Achievement						
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value	Effect Size
PASS Biology achievement	1.21	0.98	1.24	14	.23	0.12

Figure 10 and Figure 11 display the adjusted posttest SAT-10 Science scale scores and PASS Biology assessment scale scores, respectively, by study condition. The differences in these scores reflect the impact of Holt McDougal Biology, when accounting for the nested structure of the data, as well as the covariates included in each model.

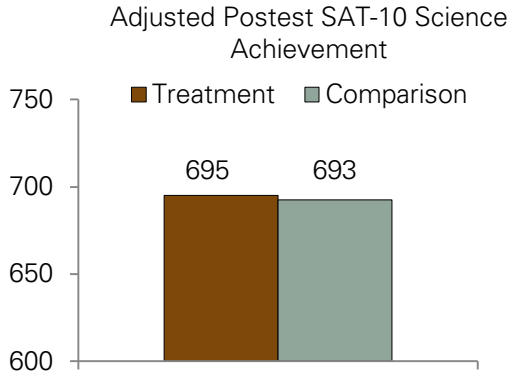

Figure 10. Impact of Holt McDougal Biology on SAT-10 Science achievement.

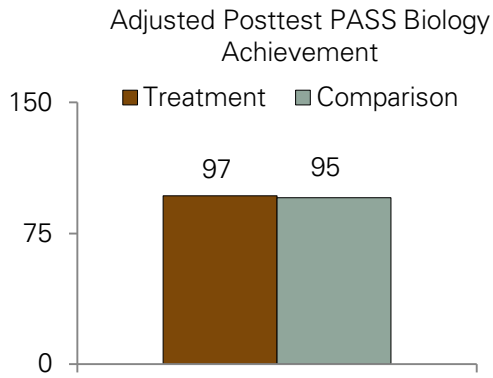

Figure 11. Impact of Holt McDougal Biology on PASS Biology Achievement.

Impact of Holt McDougal Biology for Various Subgroups

In addition to the main impact analyses, evaluators also conducted exploratory analyses to look at the impact of the Holt McDougal Biology program on various subgroups of students. These analyses were conducted for the following subgroups, each of which had a sample size of at least 150 students: females, males, Caucasian, non-Caucasian, eligible to receive free- or reduced-price lunch, not eligible to receive free- or reduced-price lunch, students in ninth grade, and students in another grade. The analytic models for these subgroup analyses were based on the model for the main impact analyses, but examined the impact only for the targeted group of students. These exploratory analyses divided the study sample into relatively small subgroups, which reduced the statistical power of the analyses to detect statistically significant effects. Therefore, readers should use caution when interpreting findings.

There were no statistically significant impacts of the Holt McDougal Biology program on SAT-10 Science achievement or PASS Biology achievement within the subgroups examined. Thus, within each of these subgroups, students in the treatment and comparison group performed comparably. Table E4, in Appendix E, displays the results of these findings, and Table 9, below, displays the effect sizes corresponding to the impact analyses. Although all effect sizes are small, they are all positive, favoring Holt McDougal participants. Furthermore, many of the effect sizes were notable, including the effect size corresponding to the impact of Holt McDougal Biology on SAT-10 Science achievement for students classified as eligible for free- or reduced-price lunch, as well as the effect sizes corresponding to the impact of the program on PASS Biology achievement for students in Grades 10, 11, and 12, as well as students identified as female, Caucasian, non-Caucasian, and ineligible for free-or reduced-price lunch.

Table 9. Effect sizes for analyses examining Holt McDougal Biology impact for subgroups

SAT-10 Science Achievement	
Student Subgroup	Effect Size
Ninth graders	0.08
10th, 11th, or 12th graders	0.05
Female	0.04
Male	0.07
Caucasian	0.04
Not Caucasian	0.03
Eligible for free- or reduced-price lunch	0.12
Not eligible for free- or reduced-price lunch	0.02
PASS Biology Achievement	
Student Subgroup	Effect Size
Ninth graders	0.08
10th, 11th, or 12th graders	0.16
Female	0.11
Male	0.07
Caucasian	0.10
Not Caucasian	0.19
Eligible for free- or reduced-price lunch	0.09
Not eligible for free- or reduced-price lunch	0.13

KEY QUESTION:

How did biology interest of students who participated in the Holt McDougal Biology program compare to that of students who participated in comparison programs?

Comparisons of Student Interest in Biology by Study Condition

Evaluators conducted descriptive analyses and multilevel modeling analyses to compare the biology interest of students who participated in Holt McDougal Biology and students who used their regular classroom biology programs.

Descriptive Analyses Comparing Student Biology Interest by Study Condition

Figure 12 displays treatment and comparison students' unadjusted mean biology interest pretest and posttest scores. As mentioned previously, the unadjusted means do not account for the clustered nature of the data, or for pretest differences among study participants, but they can be useful for visually examining patterns of change from pretest to posttest. These descriptive statistics suggest that across treatment and comparison groups, student interest in biology decreased slightly over the study period.

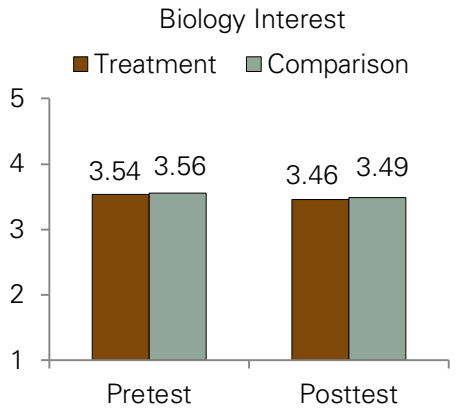

Figure 12. Unadjusted mean pretest and posttest student biology interest by study condition.

Multilevel Modeling Analyses Comparing Student Biology Interest by Study Condition

To account for the nested data structure resulting from students nested in classrooms of teachers randomly assigned to study conditions, evaluators used multilevel modeling analyses to compare students' posttest biology interest across study conditions as measured by the student interest survey. To indicate random assignment to study condition (treatment or comparison group), the model included a dummy-coded variable at the teacher level (coded 1 for treatment group and 0 for comparison group). The model included student-level pretest biology interest as a level-1 covariate and classroom-level biology interest as a level-2 covariate to increase the precision of the impact estimate and account for any preexisting differences between the treatment and comparison groups (Bloom, Richburg-Hayes, & Black, 2007; Hedges & Hedberg, 2007). Finally, the model included dummy-coded school indicator variables as level-2 covariates. After estimating the group difference in posttest student interest, evaluators calculated a standardized effect size by dividing the adjusted difference between treatment and comparison groups by the standard deviation of the comparison group.

Table 10 shows that on average, Holt McDougal Biology participants demonstrated adjusted mean posttest biology interest that was 0.01 point lower than that of comparison students. This difference was not statistically significant and translated to a small effect size (-0.01). Evaluators also conducted a sensitivity analysis with additional covariates. Results were consistent across models.

Table 10. Impact of Holt McDougal Biology on student interest in biology

Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value	Effect Size
Interest in Biology	-0.01	0.06	-0.24	14	.81	-0.01

Figure 13 shows the adjusted posttest student biology interest scores by study condition. The difference in these scores corresponds to the impact of Holt McDougal Biology on student biology interest, when accounting for the nested data structure and covariates included in each model.

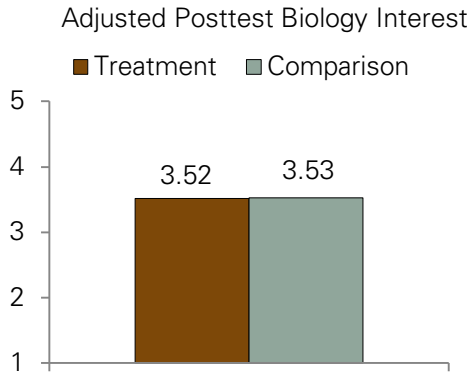

Figure 13. Impact of Holt McDougal Biology on student biology interest.

Program Perceptions

This part of the report describes teachers' perceptions of the Holt McDougal Biology program (treatment) and various comparison biology programs (comparison). Evaluators gauged teachers' program perceptions through monthly logs, a one-time comparison teacher survey, observations, and interviews.

KEY QUESTION:

What were teachers' perceptions regarding the quality and utility of the Holt McDougal Biology program?

Treatment Teachers' Perceptions of Holt McDougal Biology

In addition to collecting data regarding implementation of the program, evaluators also collected data regarding treatment teachers' perceptions of the Holt McDougal Biology program.

Time Requirements, Pacing, and Sequencing

On their monthly logs, treatment teachers commented on the time required to implement the Holt McDougal Biology program, as well as its pacing and sequencing. Most often, teachers reported that the program required *just the right amount of time* to implement (93.90%), and sometimes (6.10%) teachers reported that the program *does not require enough time*. Across all logs, teachers most frequently reported that Holt McDougal Biology program components were *reasonably paced* (65.06%), while 33.73% of the log responses indicated that teachers perceived the program as *fast paced* and 1.20% of responses indicated that teachers perceived it as *slow paced*. Teachers most often reported that the amount of material in the program was either *just right* (47.62%) or had *too much to cover* (46.43%). In some instances, teachers said the program did not have enough material to cover (5.95%). Teachers most often reported that the pace of the biology program allowed them to *somewhat meet* (50.00%) or *meet* (39.29%) the needs of students in their class, while in 10.71% of the logs they reported that the pace did not allow adequate time to address the needs of all students.

Treatment teachers also shared perceptions of the program's pacing and sequencing during interviews. Specifically, during interviews, the majority of teachers (82%) reported that the program was too fast paced. One teacher said, "you have too much to cover, it is unbelievably fast. It is a mile wide and an inch deep." Others said they "had to rush to complete everything," "had to skip stuff," or ended up doing a "quick version" of the program because there was not enough time. One teacher said, "there is no way you can cover everything." One teacher suggested the program could be improved by including a pacing guide for the year. Interviews suggested that teachers had mixed reviews of the program's

sequencing. A few teachers particularly appreciated the sequence approach from "small to big" concepts. Others disagreed, saying they "preferred to start with ecology and then to cells; I feel like when you get kids engaged in the big pictures and then do cells it is better." Despite teachers' perceptions of the sequence, and their attempts to follow the suggested schedule, two teachers had to follow their school requirements for sequencing.

Student Engagement and Interest

In their monthly logs, teachers shared their perceptions regarding student engagement in Holt McDougal Biology program, reporting the percentages of students exhibiting high, average, and low engagement levels in the program. On average, teachers indicated that the largest group of students exhibited *high engagement* (52.93%) followed by *average engagement* (36.21%), and *low engagement* (10.74%). Figure 14 displays these findings.

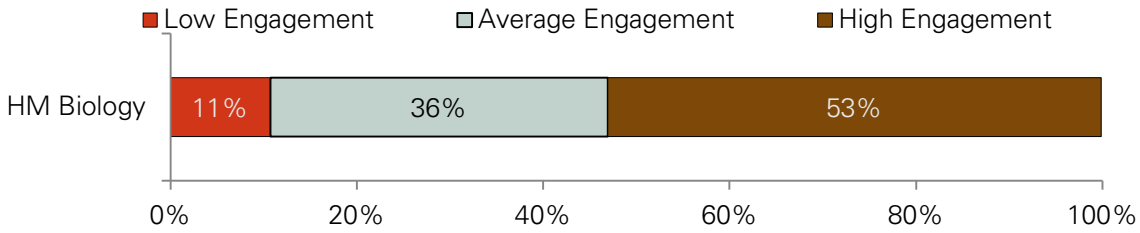

Figure 14. Student engagement in Holt McDougal Biology as reported by teachers in their monthly logs.

In interviews, teachers also reported average or high student engagement in the Holt McDougal Biology program. Teachers appreciated the variety of activities offered by the program, which they reported helped to increase student interest. One teacher said, "they [the students] really like it and love having the online resources!" Other teachers said students liked the book, going to the computer lab to use the online activities, the graphics, the videos, and using the online/Internet review. Specifically, teachers appreciated the online resources available for the students and said that students would comment on the activities in class. One teacher reported:

> **TEACHER QUOTE:**
> They love it! They love the book, and are very engaged in the program. They love the online features they can do at home and the concept mapping. They like the online videos especially because they can view something that they may not have understood in class, they can look at it again. They also really like the interactive review games, and like to get worksheets on their own.

Some teachers enjoyed the program's ability to relate to real-life concepts through video, graphics, and activities. One teacher said:

TEACHER QUOTE:

I think it is a more practical application of the material. They are seeing a more direct correlation to real life biology. Because they bring up more examples of how it is the world around them. They are seeing it in the community around them. It is more common sense for them rather than just facts. They understand it more than just knowing it. This class is very smart, so they would be able to just memorize facts, but this is so much more engaging and meaningful for them.

Student Learning Needs and Achievement

Each month, teachers reported the degree to which the Holt McDougal Biology program met the needs of below-level, on-level, advanced-level, and ELL students. Across logs, treatment teachers most often reported (79% of the time) that the program was at least *adequate* or *very adequate* in meeting the needs of on-level students, below-level students, and advanced students (see Table 11).

Table 11. Percentage of treatment teacher logs dentifying student needs met, by achievement level

Student Needs	Below-level	On-level	Advanced	ELL
Very Inadequate	1.39%	1.23%	1.22%	0.00%
Inadequate	2.78%	0.00%	8.54%	0.00%
Neither Inadequate or Adequate	15.28%	0.00%	2.44%	21.62%
Adequate	50.00%	34.57%	41.46%	59.46%
Very Adequate	30.56%	64.20%	46.34%	18.92%

Teachers who had below-level students in their biology classrooms felt very supported by the additional materials offered by the Holt McDougal Biology program. All teachers who used the interactive readers praised their ability to help below-level and ELL students with understanding key concepts. Teachers said they gave the interactive readers to ELL students, students with disabilities, and low-level students, all of whom benefited from the slower pace and lower reading level. Teachers with advanced students thought the program was very appropriate for their classes, noting that these students enjoyed the many activities that accompanied the program. Most teachers with advanced students did not use the interactive reader, but one teacher reported using the interactive reader with advanced students as a review guide. As reported previously, teachers reported supplementing some of the text to meet the needs of the advanced-level students.

Addressing Key Skills

On monthly logs, teachers rated on a scale of 1 to 5, (1 = *very ineffective*, 2 = *ineffective,* 3 = *somewhat effective*, 4 = *effective*, 5 = *very effective*), the degree to which they perceived the Holt McDougal Biology program was effective at increasing students' skills in specific areas. On average teachers reported that the program was effective in increasing academic vocabulary (mean rating was 4.39), understanding key biology concepts (mean rating

was 4.35), note taking (mean rating was 4.16), academic reading (mean rating was 4.15), and data analysis (mean rating was 4.06) (see Figure 15).

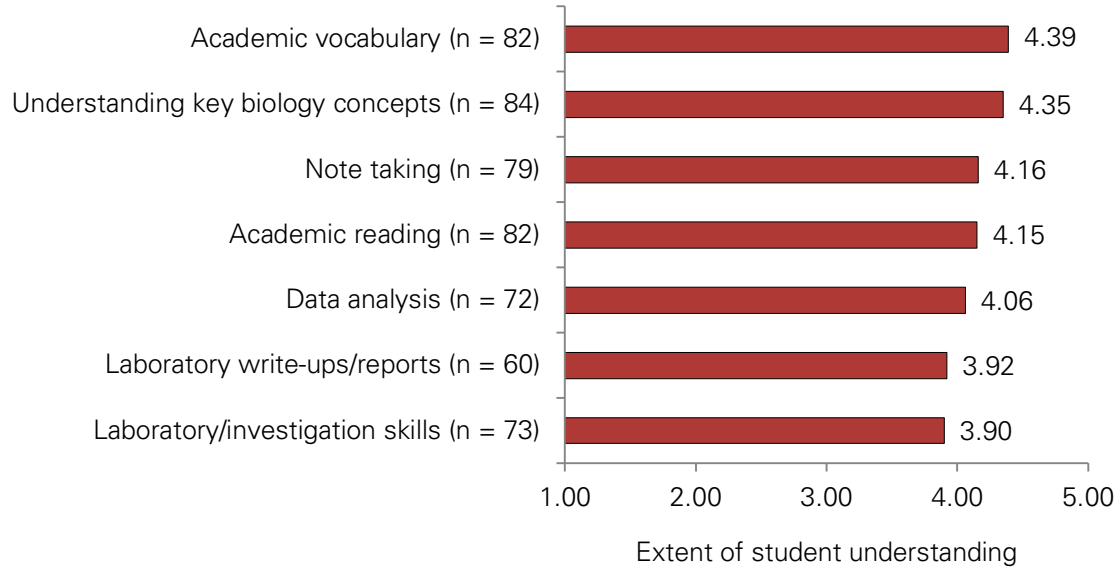

Figure 15. Teachers' perceptions of program effectiveness in key skill areas
Note: Ns represent the number of responses across all logs for each skill area. Teachers did not always provide a response for every skill area.

All teachers reported that their students were learning throughout the year and progressing with their biology knowledge. A few teachers said their students were exceeding the performances of students from previous years. One teacher said, "We just had state assessments. Forty percent of the students were in the exemplary range, I was pleased with that. I think they are learning. I will ask some questions and sometimes I am surprised at what they remember." Multiple teachers said that even though every year is different, they felt that this year students understood the concepts better.

Overall Strengths of the Holt McDougal Biology Program

Through the qualitative section in the logs, teachers were able to provide feedback about what they particularly liked about the program. Teachers shared this type of feedback on 64.28% of the completed monthly logs. Teachers most often shared positive feedback about the following components (percentages represent numbers of times each component was favorably reported, and do not total 100% because teachers could provide more than one response):

- PowerPoints (26.09%)
- PowerNotes (26.09%)
- labs (23.91%)
- videos and animations (21.74%)
- program books (17.39%
- online review and review games (13.04%)
- presentations (10.87%), and
- program activities (8.70%)

Treatment teachers also appreciated the variety of materials available. As described below, teachers echoed these perceptions of the program during the teacher interviews.

PowerPoints

The majority of treatment teachers said the PowerPoints were helpful. Teachers liked the variety of graphics, links, and videos available in the slides. Teachers said they often used the PowerPoints as a "starting point" for their slides and would make adjustments as needed. Overall, teachers said they liked not having to search for resources and liked having all the materials available for use. One teacher said she "shows the pages of the textbook on the screen, especially for illustrations and when we do some of the labs." Finally, teachers thought the PowerPoints and videos were entertaining for the kids and helped hold their interest during the lesson.

PowerNotes

Some teachers were very positive about the PowerNotes and were very enthusiastic about their usefulness in the classrooms. One teacher said they fit really well into a 45-minute period. Another teacher liked the PowerNotes because it combined concept mapping with note taking for the students. One teacher reported:

> **TEACHER QUOTE:**
>
> Main thing I think Holt McDougal Biology does is the PowerNotes, which are really helpful because it helps students to structure the way that they think. That is the highlight of the program for me. It sets up the categories so your brain thinks the right way.

Textbook

Across study sites, treatment teachers said the student textbook was an excellent addition to their classrooms. Teachers appreciated the extra instructional resources offered throughout the text, in addition to the many supporting materials. One teacher said, "It is relevant and it is comprehensive. It has lots of additional resources right there. Excellent comprehensive book that we need." Multiple teachers said that they liked how words were highlighted in the text and how the book was visually stimulating for students.

Online activities

During interviews, teachers also praised the online components offered by the Holt McDougal Biology program. One teacher said, "I love the website." Teachers liked the higher-level thinking activities, the pre-AP activities, the handouts, and the video clips, and said they had never seen something with so many graphics and activities. One teacher said, "the students are enthralled by the video clips." Overall, teachers appreciated having everything online. Teachers said that students are now visual learners and are stimulated by online graphics, videos, and games. Teachers made use of the online labs and said that students were very engaged by them, that the labs "gave them more of an experience." One teacher said the online review was very useful for students, and once they found the review games online, the students used them frequently. One teacher reported:

TEACHER QUOTE:

I really like the online resources. Those are great. I have never seen anything that has that much there [online]. That is really nice. I like that because the kids think that way. The kids' brains function that way now. They glean information that way. It feels natural and intuitive to get information online. It is something they are able to do. So I really like the online parts.

Interactive reader

During the teacher interviews, most treatment teachers said they used the interactive readers for their below-level students, while a few teachers gave an interactive reader to every student in their class. Teachers said that the interactive reader was easier for below-level students to read and more appropriate for their level of reading. One teacher said, "it helps them a lot." The teachers who used readers for their advanced level students said that students used them as a helpful study guide for test preparation. Another teacher used them for make-up work for students who were frequently absent, to help get them caught up again. Overall, teachers were very happy with the interactive reader and liked having it as a resource.

Areas for Potential Improvement

In the qualitative section of the monthly logs, treatment teachers also had the opportunity to provide feedback about what they did not like about the program. Teachers shared this type of feedback on 23.81% of the monthly logs. One of the most frequently noted categories was that teachers found some of the program resources to be lacking (45.00% of these responses). For example, on several logs, teachers reported that they disliked the ExamView (30.00% of responses) because the question bank did not have enough questions available. On a few logs, teachers also noted that they disliked the PowerPoints and PowerNotes (25.00% of responses), mostly because they are unable to change or edit the PowerPoints. Teachers also noted the difficulties they had in accessing program resources (25.00% of responses).

During treatment teachers' spring interviews, evaluators confirmed the difficulties reported in the logs. Specifically, teachers suggested improvements for the PowerPoints, PowerNotes, ExamView, and training. Although some teachers appreciated the availability of the PowerPoint slides, some teachers found shortcomings in their usability. One teacher, who has a Promethean Board, said she could not use the interactive whiteboard materials and ended up having to build her own PowerPoints and insert her own video clips. Many teachers said they had to modify the slides significantly. One teacher said:

TEACHER QUOTE:

They [the PowerPoints] are not designed well. Not user friendly. Each bullet might be in its own text box. They might use bullets, instead of 1, 2, 3. So, I have to work with them quite a bit to make them user friendly. Pictures are great, but the supporting text has to be supplemented.

Teachers also shared challenges with the PowerNotes. A few teachers said the PowerNotes and PowerPoints do not go together, so they had difficulty correlating slides to the PowerNotes. Teachers said they often needed to add a lot of information to the notes, and said it would be nice if they were more closely correlated. One teacher said the students do not like the layout, because it is difficult for them to see the flow and the organization. One teacher suggested the program would be improved by offering a copy of the notes already completed, so the teachers do not have to do it on their own before the lesson.

The majority of teachers were very disappointed with ExamView. Overall, teachers said there were not enough questions in the test bank. Teachers said that even though there are two versions available, they include the same questions, just worded differently. Others said that the questions did not go in depth enough, so they had to be supplemented by the teachers.

Treatment teachers reported a few additional challenges during interviews. One teacher reported having difficulties early in the year with the program timing out during lab activities. Some teachers said that students thought the book was too heavy and did not like having to bring it to and from school. Lastly, teachers were frustrated that the materials were not up and running earlier in the year. Many teachers liked using the program once it was available, but had to wait for several months before it was fully available.

Some treatment teachers had additional suggestions for improving the program. One teacher said it would be nice to have an online tutorial for how to set up the online textbook and use the online materials. Another suggested using screen shots to show how to set up a class or having YouTube videos online for teachers. One teacher reported:

> **TEACHER QUOTE:**
>
> It would have been nice to have a more in-depth training about everything the program can do. There are so many different resources but it's hard to have time to go and explore resources. It would have been nice to have a full day to go on the computer and really look at everything. I would have liked a more hands-on training where we could look at things and walk through it more with on your own. I would have used more of it if I had known all that was available.

Comparison Teachers' Perceptions of their Core Biology Programs

Similar to treatment teachers, comparison teachers also shared their perceptions of their biology programs on the online logs and during interviews.

Time Requirements, Pacing, and Sequencing

On the monthly logs, comparison teachers rated their perceptions about the amount of time it takes to implement their biology program. Teachers reported on 75.25% of the logs that it required *just the right amount of time*. On 24.75% of the logs they indicated it required *too much time*. Comparison teachers also described the pacing of their biology programs. Teachers

most often reported that their programs were *reasonably paced* (80.58%), while 17.48% of logs indicated that teachers perceived the program as *fast paced* and 1.94% of logs showed that teachers perceived their program as *slow paced*.

Researchers also asked teachers about their perceptions of the amount of material offered by their programs. Teachers most often reported that the amount of material was *just right* (69.23%) or *too much to cover* (28.85%), with a few reporting the amount of material as *not enough to cover* (1.92%). Across all logs, most teachers reported that the pace of the biology program allowed them to *meet* (44.23%) or *somewhat meet* (36.54%) the needs of students in their class, while in 19.23% of logs teachers reported that the pace of instruction did not allow them to adequately address the needs of students. Many of the comparison teachers agreed that they did not really like the current sequence of their biology materials, but they understood the importance of following current school or district guidelines.

Student Engagement

On the monthly logs, comparison teachers described student engagement in the biology programs they used. Teachers rated student engagement based on their observations by indicating the percentage of students they would place in each of three categories—*high engagement*, *average engagement*, and *low engagement*. Overall, comparison teachers indicated their the largest group of their students (47.41%) were highly engaged, followed by average engagement (40.64%), and low engagement (12.85%) (see Figure 16).

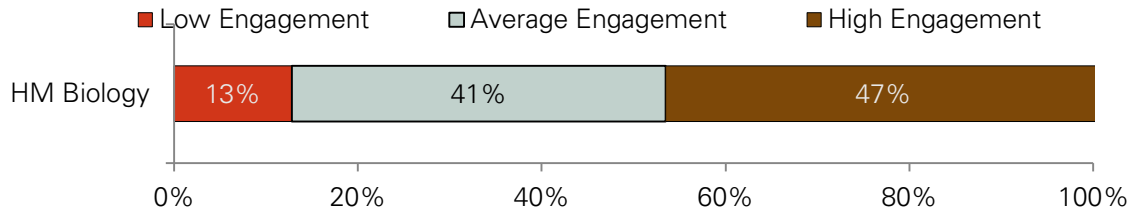

Figure 16. Student engagement in comparison-group core biology programs.
Note: For each log, student engagement level assignments could only add to 100%, but due to the rounding of calculations over the monthly logs (on average), the percentages do not add to 100.

Comparison teachers did not attribute high levels of student engagement to their textbook or district-assigned materials. However, teachers did report that their supplemental materials and their own teacher-created materials had a positive effect on students, and helped to get them excited about biology. Teachers said they tried to use as many different ways to engage students as possible, including audio, visual, technology, natural, hands-on, and other techniques.

Student Learning Needs and Achievement

On the monthly logs, comparison teachers reported the degree to which their programs met the needs of various students. Table 12 summarizes these findings. Comparison programs seemed most adequate at meeting the needs of on-level students.

Table 12. Percentage of comparison teachers identifying student needs met, by achievement level

Student Needs	Below-level	On-level	Advanced	ELL
Very Inadequate	8.25%	0.98%	0.96%	9.72%
Inadequate	35.05%	5.88%	12.50%	41.67%
Neither Inadequate or Adequate	10.31%	6.86%	8.65%	19.44%
Adequate	44.33%	54.90%	62.50%	26.39%
Very Adequate	2.06%	31.37%	15.38%	2.78%

During interviews, some comparison teachers said they addressed the needs of below-level students by supplying them with review sheets, additional vocabulary, or additional attention. However, the majority of comparison teachers said they did not do anything to address the needs of the below-level students. For advanced readers, most teachers said they did not have a lot to offer those students, but one teacher did provide some "high-end questions" and additional discussions to help them "think outside the box."

Key Skills

Evaluators also asked comparison teachers to rate how effective their core biology program was at increasing a variety of students' skills using a scale of 1 to 5, (1 = *very ineffective*, 2 = *ineffective,* 3 = *somewhat effective*, 4 = *effective*, 5 = *very effective*). On average teachers reported that their program was effective in increasing students' understanding of key biology concepts (mean rating was 4.13), and academic vocabulary (4.11) (see Figure 17). Treatment and comparison teachers' responses for these items are compared in Table 13.

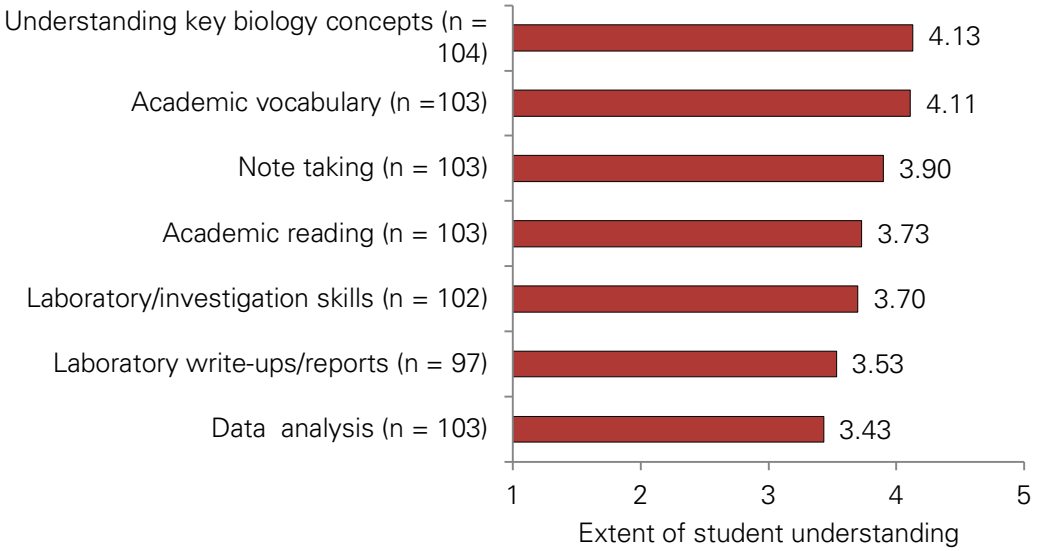

Figure 17. Comparison teachers' perceptions of core biology program impacts on student skills
Note: Ns represent the number of responses across all logs for each skill area. Teachers did not always provide a response for every skill area.

Comparison teachers reported observing increases in student understanding throughout the year during class and on assessments. However, comparison teachers also noted that keeping 9th graders engaged and interested in the material was a challenge. One teacher said

students memorized information needed for the tests, but did not actually master the biology concepts.

Overall Perceptions Regarding Comparison Programs

In their monthly logs, comparison teachers reported what they liked and disliked about their programs. Across all logs, 55.77% of teachers reported that they *liked* or *somewhat liked* aspects of their biology program. Out of these responses, teachers particularly liked the following components (the percentages of times each was reported do not total 100% because teachers often provided more than one response):

- labs or projects (44.44%),
- the materials (22.22%)
- the specific topic being taught (16.67%)
- the videos used (5.56%).

Comparison teachers also reported positively on the organization of materials and the variety of materials and activities available in their programs. Teachers liked these aspects of their programs because they thought they were interesting or engaging to students and helped them understand concepts.

Comparison teachers reported that they *disliked* or *somewhat disliked* something about their program on 21.35% of the logs. Most often, they reported disliking their program because they did not have enough time to cover the material (36.36% of responses). They also disliked their available materials (textbooks, resources, etc.) or said that they lacked needed materials (31.81% of responses). These teachers also noted that they did not like the available labs and activities or that there were not enough activities to choose from (18.18% of responses).

During spring interviews, comparison teachers said they liked their labs, supplemental materials, and teacher-created materials. However, the majority of comparison teachers said they disliked their textbooks and did not use them very often. Teachers were frustrated by district or school-led sequencing and wanted to have more autonomy in the classroom. Teachers also said they wished they had more support through online activities, technology, or lab equipment to better support their students. Teachers also reported not being able to meet the needs of students with different learning abilities because their classes were too large, and there was too much material to cover.

One comparison teacher reported wanting new materials with updated content and opportunities for students to go farther with the material. Another with many students classified as special education students indicated that the current materials were too dense and shared a desire for something simpler. Most comparison teachers said they used an organic approach to teaching and used many different materials from multiple sources to supplement their textbooks.

Comparison of Biology Programs in Treatment and Comparison Classrooms

Overall, teachers participating in the Holt McDougal Biology program expressed more satisfaction with their program than comparison teachers. Treatment teachers had more

program-created supplemental materials to offer students, such as online activities, review sheets, note pages, etc. Treatment teachers were also very happy with the textbook, because it had vocabulary and comprehension strategies for the students, and the text was up-to-date, while the majority of comparison teachers were using textbooks over 10 years old. Treatment teachers were better able to meet the needs of students with different ability levels, because of the availability of interactive readers, review sheets, supplemental activities, and leveled assessments. Comparison teachers did not feel like they could meet the needs of below-level or advanced- level students very well because they did not have the available resources or support.

As mentioned previously, the monthly logs asked treatment and comparison teachers to rate the extent to which they thought the programs they were using were effective at increasing student skills in specific areas. Evaluators conducted independent samples *t* tests to determine if there were statistically significant differences in program effectiveness ratings by study condition. Table 13 displays these findings, and shows that on average, treatment teachers rated the Holt McDougal Biology program higher than comparison teachers rated their programs in the following areas:

- effectiveness at increasing skills for understanding key biology concepts
- effectiveness at increasing academic vocabulary skills
- effectiveness at increasing note taking skills
- effectiveness at increasing academic reading skills
- effectiveness at increasing data analysis skills
- effectiveness at increasing laboratory write-ups/reports skills

Table 13. Teacher ratings by study condition regarding the effectivness of their biology programs at increasing skills in specific areas

Outcome Measure	Treatment Mean (*SD*)	Comparison Mean (*SD*)	*t*-value	Approx. df	*p*-value
Understanding key biology concepts	4.35 (0.77)	4.13 (0.63)	2.11	160	.04
Academic vocabulary	4.39 (0.75)	4.11 (0.61)	2.77	155	.01
Note taking	4.16 (0.84)	3.90 (0.66)	2.28	145	.02
Academic reading	4.15 (0.80)	3.73 (0.88)	3.34	183	.001
Data analysis	4.06 (0.85)	3.43 (1.00)	4.47	166	<.000
Laboratory write-ups/reports	3.92 (0.89)	3.53 (1.00)	2.48	155	.01
Laboratory/investigation skills	3.90 (0.92)	3.70 (0.95)	1.45	173	.15

These findings indicate that as a group, treatment teachers found the Holt McDougal program more effective than comparison teachers found their programs at increasing the skills gauged.

Both treatment and comparison teachers reported potential areas for improvement. Treatment teachers did not think the PowerNotes were well aligned to the text, the PowerPoints could be improved, and the ExamView had limited use. Comparison teachers were unhappy with their texts, and had to seek out supplemental materials from the Internet, their colleagues, and create their own. Treatment teachers would have liked to have had additional training opportunities, and felt that they were not able to take advantage of all of the program activities. Treatment teachers were also frustrated that all of the program components were not available at the start of the year, which made it difficult to use the program to its full extent. Comparison teachers were using programs they had used previously and, although the material was outdated, they were comfortable with the content.

Summary and Discussion

This randomized controlled trial evaluated the efficacy of Houghton Mifflin Harcourt's Holt McDougal Biology program in increasing high school students' learning, as measured by the SAT-10 Science assessment and PASS Biology content assessment. It also assessed the degree to which Holt McDougal Biology contributed to student interest in biology. Finally, this study used monthly online implementation logs, classroom observations, and teacher interviews to examine teachers' implementation of the Holt McDougal Biology program as well as their perceptions regarding its quality and usefulness.

Overall, treatment teachers met implementation fidelity requirements outlined in the study's implementation guidelines. However, in some cases, teachers' implementation fidelity was negatively affected by school-required sequencing, limited availability of classroom computers, a lack of understanding of how to implement the online components, and the lack of availability of online resources. Treatment teachers generally found the program's time requirements and amount of materials appropriate. They felt the up-to-date materials, graphics, and videos contributed to student engagement in the program, and they appreciated the variety of resources to meet diverse student needs.

Findings regarding student learning revealed that students participating in the Holt McDougal Biology program during the study period demonstrated statistically significant gains on the SAT-10 Science and PASS Biology assessments. The average gain on the SAT-10 Science assessment, which measures various domains of science achievement, corresponded to a small effect size of 0.28. The average gain on the PASS Biology assessment, which measures biology achievement more specifically, corresponded to a large effect size of 0.78. Thus, participating in Holt McDougal Biology during the 2011/12 school year was associated with statistically significant learning gains for students in this study. Although researchers conducted exploratory analyses to examine whether or not student and teacher characteristics were related to learning gains, the analyses had limited statistical power because they divided the sample into smaller subgroups, and the only statistically significant findings that emerged were for student pretest performance (with students who scored relatively lower at pretest gaining relatively more) and student grade (with students in ninth grade gaining relatively more than students in other grades).

The study revealed no statistically significant pretest-posttest differences in the level of interest in biology among treatment students. On average, students using the Holt McDougal biology program reported biology interest that was above the mid-range of the scale at both time points assessed. Thus, it appears that student interest in biology remained relatively stable over the study period for students in the treatment group.

To examine the impact of Holt McDougal Biology on student learning, evaluators used multilevel modeling to compare SAT-10 Science and PASS Biology scale scores among treatment and comparison group students. On average, these analyses revealed that Holt McDougal Biology participants' adjusted posttest SAT-10 Science and PASS Biology scale scores were higher than those of comparison group students, but the findings were not statistically significant. The finding regarding SAT-10 Science achievement corresponded to a

small effect size of 0.06. Although the finding regarding PASS Biology achievement also corresponded to a small effect size, the effect size was notable (0.12). Therefore, findings suggest that treatment and comparison students demonstrated similar achievement on measures used for this study, but it is possible that if the sample size had been larger, statistically significant group differences might have emerged regarding biology achievement.

Exploratory analyses examining the impact of Holt McDougal Biology on learning within subgroups of students revealed positive effect sizes favoring treatment students for all subgroups examined. The analyses divided the sample into relatively small subgroups, which limited the statistical power, and none of the findings were statistically significant. However, there were several notable effect sizes. Thus, it is possible that Holt McDougal Biology is more effective than comparison programs for specific subgroups of students. Future research examining the impact on these subgroups with larger samples sizes would yield more insight into this possibility.

Regarding student interest in biology, findings from the student interest survey showed that treatment and comparison students demonstrated similar levels of interest in biology. Across study conditions, student biology interest was comparable and remained relatively stable across time periods.

As a group, treatment teachers expressed more satisfaction with the Holt McDougal Biology program than comparison teachers expressed regarding their regular core biology programs. Compared to teachers in the comparison group, treatment teachers reported having more program-created supplemental materials to offer students, such as online activities, review sheets, note pages, etc. Treatment teachers were also very satisfied with the textbook, the vocabulary and comprehension strategies, and the up-to-date content; while the majority of comparison teachers were less satisfied and were using textbooks that were over 10 years old. Additionally, more treatment than comparison teachers were able to meet the needs of students with different ability levels, using the program's interactive readers, review sheets, supplemental activities, and leveled assessments. Comparison teachers often did not feel like they could fully meet the needs of below-level or advanced level students because they did not have the available resources or support. As a group, treatment teachers rated the Holt McDougal Biology program higher than comparison teachers rated their programs at effectively increasing most of the skill areas assessed.

In conclusion, treatment teachers appreciated many components of the Holt McDougal Biology program, and students who participated in the program demonstrated statistically significant learning gains. Although their learning achievement was comparable to that of students using other high-quality biology programs, the positive, notable effect size for the PASS Biology assessment, as well as the positive, notable effect sizes for some of the subgroup analyses, suggest that future research using a larger study sample would facilitate a more thorough understanding of the efficacy of the program, especially with various subgroups of students. Additionally, although teachers generally implemented the program with moderate to high fidelity, they also noted several barriers to implementation: school-required sequencing, limited access to classroom computers, limited understanding of how to implement online resources, and lack of availability of online resources. Therefore, if these barriers had not been in place, it is possible that treatment teachers' implementation would have been higher, which might have positively contributed to impacts on student learning and interest. Overall, this

study found that not only did students who used the Holt McDougal Biology program show statistically significant learning gains that were comparable to learning gains of students using other high-quality programs, but treatment teachers generally rated the program more positively than comparison teachers rated their programs.

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Appendix A

Houghton Mifflin Harcourt *Holt McDougal Biology* Program
General Implementation Guidelines

Teachers should implement *Holt McDougal Biology* as their primary method of instruction for the 2011 - 2012 school year. Teachers should be able to meet the following general implementation requirements:

1. Follow the scope and sequence of the program to match your school's schedule.
2. Have computer access in your classroom with the ability to display from the computer (i.e. whiteboard or projector).
3. Have access to an internet connection in your classroom.
4. Have a minimum of three computers for student use in your classroom.
5. Use hands-on labs.
6. Follow the chapters in sequence.
7. Complete a minimum of 8 units during the 2011-2012 school year.
8. Implement *Holt McDougal Biology* as the primary method of instruction, for a minimum of 80% of class instruction.

Specific Implementation Guidelines

Build Student Study Skills

1. At the beginning of the school year, take the time to strengthen student's reading skills in preparation for using the textbook. This can be done by teaching students various reading techniques found in the Teacher Toolkit. Assist students in development and mastering various Reading and Notetaking Skills and Vocabulary Strategies.

Plan and Prepare

Pre-Test

1. Begin each chapter with a **Diagnostic Test** to gain insight into students' level of readiness and prior knowledge of concepts taught in this chapter. This information can influence the time and activity spent on the concepts of the chapter.
    a. Diagnostic tests are available online as printable .pdf files or ExamView question banks.

Reading

2. Read the **Textbook**
    a. Assign students to read the chapter or sections of the textbook before covering the material is in class
        i. Students should be asked to apply at least one **Reading** or **Notetaking Skill** (i.e. Before Reading, Graphic Organizers) and one **Vocabulary**

Strategy from the Teacher Toolkit while reading the assigned pages of the textbook

ii. Encourage students to perform the activities suggested in the **Reading Toolboxes** as they come across them on the textbook pages.
iii. Encourage students to review the material at the top of each textbook section (i.e. **Vocabulary, Key Concepts, and Main Ideas**) before reading the section.
iv. Students should be assigned to answer the "**reading check**" and **Formative Assessment** questions as they come across them in their reading. Discussing the answers to these questions in class or in a small group is suggested (see **Interactive Learning** techniques in the Teacher Toolkit). Alternatively, Web 2.0 technologies could also be employed.
v. If available, students should reference that online media resource links (**Virtual Investigations, Animated Biology, Biology Video Clips**) as they come across those links in their reading. A complete list of online media resources is available online. Internet access is required.
vi. Lastly, students may check their reading comprehension by going online to the **Interactive Review** and taking the **Section Self-Check**. Internet access is required.

Focus and Motivate (In Class)

Class Discussion

1. Show the **image** from the chapter opener by accessing it via the **Media Gallery** or the first slide of the associated **PowerPresentation**.
2. Ask students the question from the image on the chapter opener.
3. Conduct a **class discussion** of the question using the supporting information on the chapter opener in the Student Edition and supporting discussion material in the Teacher Edition.

Activate Prior Knowledge

1. Employ the **Activate Prior Knowledge** from the chapter opener Teacher's Edition as well as the Section level Activate Prior Knowledge.
2. Preview the chapter vocabulary by employing the **Preview Vocabulary** in the Teacher's Edition.
3. Conduct the **Student Activity** or Teacher Demo at the beginning of the chapter in the Teacher's Edition.

Teach

Present and Discuss

1. Present and discuss chapter material using P**owerPresentation** files or create your own using the **Media Gallery**.
    a. Students may take notes using the associated **PowerNotes** or employ a **Note Taking** technique offered in the Teaching Toolkit.
2. Randomly test student comprehension with Formative Assessment spot questions and if necessary, reteach material according to recommendations found in Teacher's Edition under **Assess and Reteach**

3. Include suggested **Vocabulary** from the Teacher's Edition as appropriate and try to include the additional Teacher Edition material into the class discussion (i.e. **History of Science, Science Trivia, Take it Further, The Inside Story, Integrating "*science topic*", Addressing Misconceptions**)
4. When available, utilize the online media to strengthen and remediate student understanding. Examples include **Visual Concepts, Biology Animations, Interactive Whiteboard Resources and Video Clips, Teaching Visuals**, **and WebLinks**.
5. If you use the **Teaching Visuals** in addition to the PowerPresentation, refer to the "**Teach from Visuals**" material found in the Teacher's Edition.
6. If a **QuickLab** is available, use it to strengthen student understanding.
7. If hands-on **laboratory experiments** are part of your curriculum, try to incorporate at least one lab experiment per chapter (virtual and video are also an option).

Additional Support and Intervention (use as needed)

1. **Graphic Organizers** can be employed to assist students in organizing their thinking either before or after the core instruction.
2. Apply **Differentiated Instruction** material from the Teacher's Edition as needed.
    a. Categories include: **English Learners, Below-Level, Pre-AP, Teach with Technology, Hands-on Activity, Inclusion**)
3. In addition, use the **Interactive Reader** to assist students who are Below-Level.
4. To strengthen student's **data analysis skills**, a number of resources can be used.
    a. In-text Data Analysis Activities
    b. That's Amazing video-based inquiry
    c. Data Analysis Practice worksheets
    d. Online SmartGrapher Activities
5. Biology **enrichment** and **extension** is offered by
    a. BioZine, online biology magazine
    b. Unit Projects
    c. WebQuests
6. English Language Learners are offered additional support by **chapter audio readings** in English and Spanish. In addition, the **Multilanguage Glossary** and Spanish Glossary contained within the Student Edition are available.
7. Additional reading comprehension practice is offered by **Active Reading worksheets**

Review and Assess

1. Assign at least one **Study Guide** to help students review and reinforce the key concepts.
    a. Options include: **Study Guide A, Study Guide B, Vocabulary Practice, Reinforcement, Pre-AP activity**. These are also available in Spanish
2. Students may wish to review the chapter material using the **Chapter Review** page of the Student Edition.
3. Have students strengthen their review of the chapter material by playing the online **Review Games**.
4. Lastly, **assess and reteach** if needed using one or more of the following assessment instruments (available as a printable .pdf or ExamView test bank).

    a. **Chapter Test A, Chapter Test B, Alternative Assessment, Extended Response, or Section Quizzes**. These are also available in Spanish
5. For more **extensive assessment and remediation**, select students can be assigned one or more of these same assessments in Holt McDougal's Online Assessment and Remediation tool. This tool will automatically assess and reteach and re-assess for concept mastery.

Foundation Skills Support

If students require additional skills in the **scientific method, analyzing data**, or **writing in Biology**, please refer to the Teacher Toolkit for presentations, activities and information about these subjects.

Thank you for your help with Holt McDougal Biology implementation! Please contact Dr. Grant or Dr. Shannon with any study-related questions or concerns:

- Billie-Jo Grant (805.550.9132 or bgrant@magnoliaconsulting.org)
- Lisa Shannon (919.367.9433 or Lisa@magnoliaconsulting.org)

Appendix B. School-Level Characteristics

	District 1						District 2		
	School A			School B			School C		
	Treatment	Comparison	Total	Treatment	Comparison	Total	Treatment	Comparison	Total
Number of Students									
Ninth grade	12	72	84	56	42	98	21	23	44
10th grade	19	59	78	50	27	77	0	0	0
11th grade	3	0	3	0	0	0	0	0	0
12th grade	0	2	2	0	0	0	0	0	0
School Totals									
Classrooms	1	2	3	2	1	3	1	1	2
Number of students	34	133	167	106	69	175	21	23	44
Gender Among Participants									
Female	41.18%	56.39%	53.29%	47.17%	44.93%	46.29%	42.86%	52.17%	47.73%
Male	58.82%	43.61%	46.71%	52.83%	55.07%	53.71%	57.14%	47.83%	52.27%
Ethnicity Among Participants									
Caucasian	91.18%	88.72%	89.22%	89.62%	92.75%	90.86%	90.48%	91.30%	90.91%
African American	2.94%	2.26%	2.40%	0.94%	2.90%	1.71%	4.76%	4.35%	4.55%
Asian/Pacific Islander	0.00%	2.26%	1.80%	4.72%	0.00%	2.86%	4.76%	4.35%	4.55%
Hispanic	0.00%	0.00%	0.00%	1.89%	1.45%	1.71%	0.00%	0.00%	0.00%
Other	5.88%	6.77%	6.59%	2.83%	2.90%	2.86%	0.00%	0.00%	0.00%
Limited English Proficiency Among Participants									
LEP	0.00%	1.50%	1.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Non-LEP	100.00%	98.50%	98.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Special Education Among Participants									
Special Education	14.71%	6.02%	7.78%	11.32%	11.59%	11.43%	0.00%	0.00%	0.00%
Non-Special Education	85.29%	93.98%	92.22%	88.68%	88.41%	88.57%	100.00%	100.00%	100.00%
Free/Reduced Price Lunch Among Participants									
Free/Reduced Lunch	8.82%	12.03%	11.38%	8.50%	5.80%	7.43%	0.00%	0.00%	0.00%
Non-Free/Reduced Lunch	91.18%	87.97%	88.62%	91.50%	94.20%	92.57%	100.00%	100.00%	100.00%
Section 504 Among Participants									
Section 504	14.71%	6.77%	8.38%	4.72%	1.45%	3.43%	0.00%	4.35%	2.27%
Non-Section 504	85.29%	93.23%	91.62%	95.28%	98.55%	96.57%	100.00%	95.65%	97.73%

	District 3 School D			District 4 School E			District 5 School F		
	Treatment	Comparison	Total	Treatment	Comparison	Total	Treatment	Comparison	Total
Number of Students									
Ninth grade	181	72	253	41	16	57	123	126	249
10th grade	0	1	1	1	0	1	7	4	11
11th grade	0	0	0	0	1	1	0	1	1
12th grade	0	0	0	0	0	0	0	0	0
School Totals									
Classrooms	2	1	3	1	1	2	1	2	3
Number of students	181	73	254	42	17	59	130	131	261
Gender Among Participants									
Female	47.51%	53.42%	49.21%	57.14%	82.35%	64.41%	49.23%	55.73%	52.49%
Male	52.49%	46.58%	50.79%	42.86%	17.65%	35.59%	50.77%	44.27%	47.51%
Ethnicity Among Participants									
Caucasian	26.52%	28.77%	27.17%	26.19%	17.65%	23.73%	98.46%	93.13%	95.79%
African American	6.63%	10.96%	7.87%	52.38%	76.47%	59.32%	0.77%	2.29%	1.53%
Asian/Pacific Islander	7.18%	8.22%	7.48%	4.76%	0.00%	3.39%	0.00%	0.76%	0.38%
Hispanic	56.35%	46.58%	53.54%	14.29%	5.88%	11.86%	0.77%	3.05%	1.92%
Other	3.31%	5.48%	3.94%	2.38%	0.00%	1.69%	0.00%	0.76%	0.38%
Limited English Proficiency Among Participants									
LEP	16.02%	1.39%	11.86%	0.00%	0.00%	0.00%	2.31%	3.05%	2.68%
Non-LEP	83.98%	98.61%	88.14%	100.00%	100.00%	100.00%	97.69%	96.95%	97.32%
Special Education Among Participants									
Special Education	2.76%	15.28%	6.32%	0.00%	5.88%	1.69%	3.08%	6.87%	4.98%
Non-Special Education	97.24%	84.72%	93.68%	100.00%	94.12%	98.31%	96.92%	93.13%	95.02%
Free/Reduced Price Lunch Among Participants									
Free/Reduced Lunch	67.96%	52.78%	63.64%	78.57%	76.47%	77.97%	37.69%	40.46%	39.08%
Non-Free/Reduced Lunch	32.04%	47.22%	36.36%	21.43%	23.53%	22.03%	62.31%	59.54%	60.92%
Section 504 Among Participants									
Section 504	2.76%	1.39%	2.37%	4.76%	0.00%	3.39%	1.54%	3.82%	2.68%
Non-Section 504	97.24%	98.61%	97.63%	95.24%	100.00%	96.61%	98.46%	96.18%	97.32%

	District 6 School G			District 7 School H			Study Totals		
	Treatment	Comparison	Total	Treatment	Comparison	Total	Treatment	Comparison	Total
Number of Students									
Ninth grade	6	9	15	39	5	44	479	365	844
10th grade	26	39	65	84	84	168	187	214	401
11th grade	0	0	0	2	1	3	5	3	8
12th grade	0	0	0	0	0	0	0	2	2
School Totals									
Classrooms	1	2	3	2	3	5	11	13	24
Number of students	32	48	80	125	90	215	671	584	1255
Gender Among Participants									
Female	100%	100%	100%	53.60%	38.89%	47.44%	51.56%	55.99%	53.63%
Male	0.00%	0.00%	0.00%	46.40%	61.11%	52.56%	48.44%	44.01%	46.37%
Ethnicity Among Participants									
Caucasian	84.38%	83.33%	83.75%	52.80%	41.11%	47.91%	63.34%	72.95%	67.81%
African American	0.00%	0.00%	0.00%	15.20%	25.56%	19.53%	8.49%	9.08%	8.76%
Asian/Pacific Islander	0.00%	0.00%	0.00%	10.40%	8.89%	9.77%	5.07%	3.25%	4.22%
Hispanic	15.63%	12.50%	13.75%	12.00%	17.78%	14.42%	19.52%	10.62%	15.38%
Other	0.00%	4.17%	2.50%	9.60%	6.67%	8.37%	3.58%	4.11%	3.82%
Limited English Proficiency Among Participants									
LEP	0.00%	25.00%	15.00%	2.40%	3.37%	2.80%	5.22%	3.78%	4.55%
Non-LEP	100.00%	75.00%	85.00%	97.60%	96.63%	97.20%	94.78%	96.22%	95.45%
Special Education Among Participants									
Special Education	0.00%	0.00%	0.00%	5.60%	26.97%	14.49%	4.92%	10.48%	7.50%
Non-Special Education	100.00%	100.00%	100.00%	94.40%	73.03%	85.51%	95.08%	89.52%	92.50%
Free/Reduced Price Lunch Among Participants									
Free/Reduced Lunch	0.00%	0.00%	0.00%	40.80%	62.50%	49.77%	45.84%	34.18%	40.30%
Non-Free/Reduced Lunch	100.00%	100.00%	100.00%	59.20%	37.50%	50.23%	54.16%	65.82%	59.70%
Section 504 Among Participants									
Section 504	0.00%	0.00%	0.00%	1.60%	0.00%	0.93%	3.13%	2.92%	3.03%
Non-Section 504	100.00%	100.00%	100.00%	98.40%	100.00%	99.07%	96.87%	97.08%	96.97%

Note. School B provided classroom-level percentages that were aggregated up to the school level. Study totals for Free/Reduced Price Lunch does not include Schools B.

Appendix C

Table C1. Implementation tasks

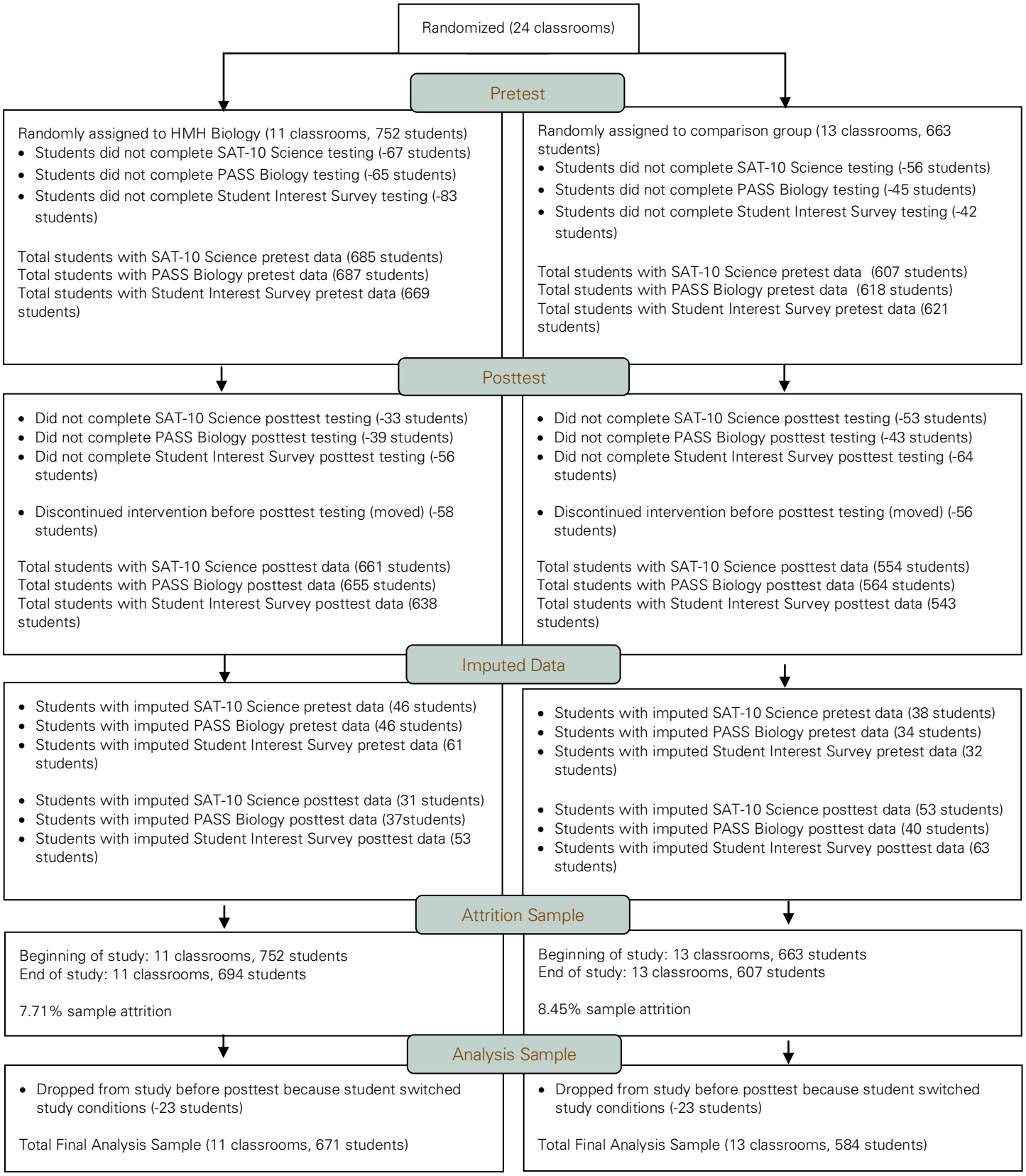
Did you implement the following tasks this month?	Yes	No	Partially	N/A
Build Study Skills				
Did you take time to strengthen students' reading using the reading techniques found in the teacher toolkit?	33.33%	30.95%	33.33%	2.38%
Did you assist students in developing Reading and Note taking Skills and Vocabulary Strategies?	63.86%	16.87%	16.87%	2.41%
Plan and Prepare				
Did you begin each chapter with a diagnostic test?	14.29%	71.43%	13.10%	1.19%
Did you assign chapters for students to read from the book?	67.86%	15.48%	16.67%	0.00%
Did you encourage students to use the vocabulary strategies in the book?	91.67%	3.57%	4.76%	0.00%
Did you encourage students to use the reading toolboxes and reading checks in the book?	82.14%	5.95%	11.90%	0.00%
Did students have an opportunity to access the online media resources (virtual investigations, animated biology, biology video clips, lab investigations, quick labs)?	51.19%	25%	23.81%	0.00%
Did students use the interactive review?	57.83%	14.46%	27.71%	0.00%
Focus and Motivate (in Class)				
Do you facilitate class discussions with each chapter opener?	57.14%	22.62%	20.24%	0.00%
Did you Activate Prior Knowledge from the chapter opener?	53.57%	22.62%	23.81%	0.00%
Did you Preview Vocabulary?	67.47%	16.87%	15.66%	0.00%
Teach				
Did you use power presentations for your biology instruction?	83.33%	10.71%	5.95%	0.00%
Did you use the media gallery for class	38.10%	42.86%	19.05%	0.00%

Did you implement the following tasks this month?	Yes	No	Partially	N/A
presentations?				
Did you use any multimedia (animations, videos, virtual labs, weblinks, Biology Animation) to present material?	77.38%	8.33%	14.29%	0.00%
Did you use any differentiated learning materials from the Teacher's Edition?	32.14%	40.48%	22.62%	4.76%
Did you assign a study guide for the chapter?	66.27%	21.69%	12.05%	0.00%
Did you use the review games for your chapter review?	52.38%	35.71%	9.52%	2.38%
Did you use the Interactive Whiteboard resource?	11.90%	64.29%	4.76%	19.05%
Did you encourage students to access BioZine?	52.38%	32.14%	11.90%	3.57%
Additional Support and Intervention				
Did you use the Concept Maps to assist student organization?	50.00%	30.49%	17.07%	2.44%
Did you use the lesson plans?	20.48%	46.99%	31.33%	1.20%
Did students use the interactive reader?	51.22%	18.29%	29.27%	1.22%
Did you use BioZine, Pre-AP activity or WebQuests to facilitate biology enrichment and extension?	34.94%	46.99%	16.87%	1.20%
Did you offer ELL students chapter audio recordings or the Multilanguage Glossary?	10.84%	27.71%	8.43%	53.01%
Review and Assess				
Did you assign a Study Guide?	-	-	-	-
Did you have students use the Chapter review?	74.70%	9.64%	13.25%	2.41%
Did students use the online Review Games?	46.99%	31.33%	18.07%	3.61%
Did you use any online assessment and remediation tools?	20.48%	63.86%	10.84%	4.82%
Did students use Section Self-Checks?	54.76%	16.67%	27.38%	1.19%
Did you use ExamView?	68.67%	26.51%	3.61%	1.20%

Table C2. Comparison of teacher perceptions of program effectiveness in key skill areas

	Very Ineffective		Ineffective		Neither Ineffective or Effective		Effective		Very Effective		N/A	
	T	C	T	C	T	C	T	C	T	C	T	C
Understanding key biology concepts	2.38%	0.00%	0.00%	3.85%	3.57%	2.88%	48.81%	70.19%	45.24%	23.08%	0.00%	0.00%
Academic vocabulary	2.38%	0.00%	0.00%	3.88%	1.19%	1.94%	47.62%	73.79%	46.43%	20.39%	2.38%	0.00%
Academic reading	2.38%	0.97%	0.00%	11.65%	10.71%	14.56%	52.38%	59.22%	32.14%	13.59%	2.38%	0.00%
Note taking	1.20%	0.00%	2.41%	3.88%	12.05%	15.53%	43.37%	66.99%	36.14%	13.59%	4.82%	0.00%
Laboratory/investigation skills	1.19%	0.00%	1.19%	18.27%	29.76%	8.65%	27.38%	55.77%	27.38%	15.38%	13.10%	1.92%
Data Analysis	1.20%	0.96%	1.20%	23.08%	18.07%	18.27%	37.35%	46.15%	28.92%	10.58%	13.25%	0.96%
Laboratory write-ups/reports	0.00%	0.97%	1.20%	18.45%	27.71%	18.45%	19.28%	42.72%	24.10%	13.59%	27.71%	5.83%

Appendix D. CONSORT Flow Diagram



Appendix E

Tables to Support Student Learning and Interest Findings

This appendix includes tables to support the findings regarding student achievement and interest.

Missing Data Rates

Table E1. Missing data rates by variable and time point

	Percent Missing
SAT-10 Science	
Pretest	7.2%
Posttest	7.1%
PASS Biology	
Pretest	6.6%
Posttest	6.1%
Student Interest	
Pretest	8.2%
Posttest	9.2%

Unadjusted Pretest and Posttest Means by Study Condition

Table E2. Unadjusted SAT-10 Science means, PASS Biology achievement means, and student interest survey means by study condition, across all five imputed datasets

	Treatment			Comparison		
	N	Mean	*SD*	*N*	Mean	*SD*
SAT-10 Science						
Pretest	3355	681.86	28.13	2920	689.93	28.71
Posttest	3355	688.43	35.07	2920	696.26	35.64
PASS Biology						
Pretest	3355	90.29	6.02	2920	91.96	5.90
Posttest	3355	94.26	10.46	2920	96.60	9.69
Student Interest						
Pretest	3355	3.54	0.57	2920	3.56	0.63
Posttest	3355	3.46	0.65	2920	3.49	0.76

Table E3. Relationship between student and teacher characteristics and treatment students' SAT-10 Science gains

Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
Intercept	153.11	66.20	2.31	5	.07
Implementation fidelity	29.08	81.65	0.36	5	.74
Years teaching	0.17	0.34	0.50	5	.64
Teacher degree	7.38	7.47	0.99	5	.37
Length of instructional period	0.06	0.10	0.61	5	.57
Percent of students in class eligible for free- or reduced-price lunch	-36.30	16.92	-2.15	5	.09
Grade 9 (versus 10, 11, or 12)	8.85	2.25	3.93	656	<.001
Female (versus male)	-2.74	1.55	-1.77	656	.08
Caucasian (versus non-Caucasian)	0.55	2.00	0.27	656	.79
Pretest achievement	-0.26	0.03	-7.80	656	<.001

Table E4. Relationship between student and teacher characteristics and treatment students' PASS Biology assessment gains

Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
Intercept	34.66	25.40	1.36	5	.23
Implementation fidelity	-0.26	32.64	-0.01	5	.99
Years teaching	-0.09	0.14	-0.69	5	.52
Teacher degree	3.90	2.99	1.30	5	.25
Length of instructional period	0.02	0.04	0.45	5	.67
Percent of students in class eligible for free- or reduced-price lunch	-13.00	6.75	-1.93	5	0.11
Grade 9 (versus 10, 11, or 12)	2.93	0.88	3.32	656	<.001
Female (versus male)	-0.37	0.62	-0.59	656	.56
Caucasian (versus non-Caucasian)	0.19	0.78	0.24	656	.81
Pretest achievement	-0.34	0.06	-5.81	656	<.001

Table E5. Impact of Holt McDougal on student achievement within subgroups

Females					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	1.44	3.30	0.447	21	.67
PASS Biology Achievement	1.15	1.40	0.82	21	.42
Males					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	2.92	4.48	0.65	18	.52
PASS Biology Achievement	0.51	1.78	0.29	18	.78
Caucasian					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	1.47	3.62	0.41	14	.69
PASS Biology Achievement	1.09	0.91	1.19	14	.25
Non-Caucasian					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	1.11	4.57	0.24	14	.81
PASS Biology Achievement	1.84	1.40	1.31	14	.21
Eligible for Free- or Reduced-Price Lunch					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	3.65	6.18	0.59	13	.58
PASS Biology Achievement	0.67	1.60	0.42	13	.68
Not Eligible for Free- or Reduced-Price Lunch					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	0.66	4.01	0.17	18	.87
PASS Biology Achievement	1.37	1.72	0.80	18	.43
Grade 9					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value
SAT-10 Science Achievement	3.11	4.58	0.68	13	.51
PASS Biology Achievement	0.89	1.03	0.87	13	.40
Grade 10, 11, 12					
Outcome Measure	Coefficient	Standard Error	*t*-value	Approx. df	*p*-value

SAT-10 Science Achievement	1.52	2.86	0.53	17	.60
PASS Biology Achievement	1.36	1.23	1.11	17	.28

Appendix F

Summary of Comparison Programs

This appendix provides a summary of programs used by teachers in the comparison group.

Table F1
Comparison Program Information Chart

Comparison Programs	Description
Program A	Program A offers a comprehensive phylogenetic approach to biology and presents key concepts within a historical framework to ensure students understand that scientific theories are developed over time and are dynamic. Lab components are designed to support an understanding of scientific inquiry, concepts and experimentation, and provide comprehensive skills practice for students. Audio-visual components seek to keep students actively engaged in their learning.
Program B	Program B is designed to help all students succeed with its organization around major themes of biology and its strong support for reading comprehension. This program's comprehensive content is made relevant to students through engaging real-world contexts. A wide variety of lab experiences are designed to build strong inquiry skills. The abundance of differentiated instructional strategies seeks to help teachers reach all learners. Seamlessly integrated technology allows teachers to save time and increase productivity.
Program C	Program C is designed to strengthen and emphasize vocabulary, reading, real-world connections, data analysis, and online resources. A robust selection of new animations, simulations, interactive whiteboard resources, review games, web resources, and videos have been added to the already exciting technology offerings.
Program D	Program D is a comprehensive high school biology program designed to address the range of diverse learners. The complete instructional package has many types of hands-on experiences to delve deeper into many aspects of biology.

Note. Descriptions are from publishers' website and are for the most recent editions. Each describes the curriculum as a whole, and comparison programs often only used the accompanying textbooks.