The Effects of iBooks Biology on Student Science Achievement and Motivation

Prepared by:
Marcy Baughman, M.A.  Pearson
Mary Ehmann, M.A.  Pearson
Ann Vilcheck, M.A.  Pearson

October, 2013
Table of Contents

Background and Context ........................................................................................................... 3
Research Questions .................................................................................................................... 3
Methodology ............................................................................................................................... 4
  Research Design ......................................................................................................................... 4
  Measures ................................................................................................................................... 4
School Selection .......................................................................................................................... 6
Sample ....................................................................................................................................... 7
Teacher and Control Implementation ......................................................................................... 11
Results ....................................................................................................................................... 12
Summary and Discussion ............................................................................................................ 25
References .................................................................................................................................. 27

Figures and Tables

Figure 1: Technology Problems Prohibiting iBooks Biology Usage ........................................... 11
Figure 2: Student Posttest Performance on SAT 10 for Print and iBooks Conditions .................. 13
Figure 3: ESL and non-ESL Student Posttest Performance on SAT10 for Print and iBooks Conditions ......................................................................................................................... 14
Figure 4: Frequency of iBooks Biology General Features Usage .............................................. 15
Figure 5: Frequency of iBooks Biology Content Features Usage ............................................... 16
Figure 6: Student Post-Implementation Motivation for Print and iBooks Conditions ................... 17
Figure 7: Student BMQ-II for iBooks and Print Conditions by Days Missed ............................ 18
Figure 8: Teacher Perceptions of Amount of Material Offered by iBooks Biology .................... 21
Figure 9: Teacher Perceptions of iBooks Biology Pacing ........................................................... 21
Figure 10: Teacher Perceptions of Ease of iBooks Biology Implementation ............................... 22
Figure 11: Teacher Perceptions of Student Engagement with iBooks Biology ............................ 22
Figure 12: Teacher Perceptions of Student Understanding with iBooks Biology ...................... 23
Figure 13: Teacher Perceptions of Value of iBooks Biology as Instructional Tool ..................... 23
Figure 14: Teacher Perceptions of Value of iBooks Biology General Features .......................... 24
Figure 15: Teacher Perceptions of Value of iBooks Biology Content Features .......................... 24
Figure 16: Teacher Perceptions of Value of iBooks Biology Chapter Level Features .................. 24

Table 1: District-Level Characteristics of Participating Schools ................................................. 7
Table 2: Demographics of Study Sample ..................................................................................... 9
Table 3: Teacher Participant Demographics .............................................................................. 10
Table 4: Final Analytic Sample .................................................................................................. 10
Table 5: SAT-10 Normal Curve Equivalent (NCE) Means (standard deviations) ..................... 12
Table 6: Study Sample for Biology Motivation Questionnaire .................................................... 16
Table 7: Biology Motivation Questionnaire Means (standard deviations) ................................ 16
Table 8: Student Responses on Specific Motivation Questionnaire (MQ) Items ....................... 18
Table 9: Motivation Questionnaire (MQ) and SAT-10 Correlation Table ................................. 19
I. BACKGROUND AND CONTEXT

iBooks is an application from Apple that allows a user to download and read books on either an iPad or iPhone. iBooks has many features that enable users to customize their reading experience through functions such as highlighting, searching, note-taking, and bookmarking.

In an effort to take advantage of the iBooks digital interface for use with educational instructional content, Pearson partnered with Apple in 2012 to develop textbooks on the iBooks platform. The Miller and Levine Biology program was one program that was transferred from a print medium to the digital iBooks interface. The purpose of creating the iBooks textbooks was to transform the instructional content so that students could enjoy a more interactive experience with their textbook content. For example, a standard biology textbook could be 1000 pages. In the iBooks format, the core instructional content is maintained but is not constrained by the physical pages of a book. A picture becomes interactive, allowing students to zoom into features and/or touch parts of the picture to get additional explanation about what they are seeing. Videos are used to give students more verbal explanations of concepts and to provide context.

Since the iBooks are relatively new, little research had been conducted on the efficacy of iBooks textbooks as compared to print textbooks. This research study attempts to investigate the impact of the iBooks on student biology learning, and to document implementation practices associated with iBooks in the classroom.

II. RESEARCH QUESTIONS

Pearson Program Measurement used a quasi-experimental non-equivalent groups design to conduct this study during the 2012-13 school year. The purpose of the study was to: Examine the impact of the iBooks Biology program on student learning; compare the science performance of students using iBooks Biology to those that used a print Biology program; explore implementation practices; examine student engagement and teacher motivation; and gather feedback on student and teacher perceptions of the program. The following research questions were explored:

1. Does the presentation style of iBooks Biology have an impact on student achievement when compared to a print Biology program?
2. Does the impact of iBooks Biology on student achievement differ by subpopulations of students?
3. How are teachers implementing iBooks Biology? To what extent are teachers utilizing the various features/functions of the program?
4. How is student motivation impacted by usage of iBooks Biology?
5. How and why do teachers integrate print components with iBooks Biology usage?
6. What challenges and/or barriers do teachers confront when using iBooks Biology? How do they address or overcome these barriers?
7. What are teacher perceptions of iBooks Biology? Do perceptions change with exposure or time?
8. What are student perceptions of iBooks Biology? Do perceptions change with exposure or time?
III. METHODOLOGY

Research Design
A quasi-experimental non-equivalent groups design was used to conduct this study. Biology teachers were asked to assign half of their Biology sections to use the iBooks Biology program (treatment condition), while the other half continued using the current district Biology program (comparison condition). The teachers were asked to select sections with similar student ability levels and demographics for each study condition.

Measures
A combination of qualitative and quantitative data were collected and analyzed. Data collection methods included teacher monthly online implementation logs, teacher interviews, classroom observations, student Biology assessment, and teacher and student attitude surveys.

Teacher Measures
Evaluators used monthly online implementation logs, interviews, classroom observations, and surveys to gather information about teachers’ perceptions of the iBooks Biology program, its impact on their motivation, and their preferred implementation practices.

Monthly Online Implementation Log
Teachers provided information about their usage and perceptions of the iBooks Biology program via the implementation log. A link was sent to each teacher monthly, and they completed the implementation log independently. The log inquired about pacing, amount of material offered, adequacy of program in meeting needs of all learners, ease of implementation, teacher perceptions of student engagement and learning, usage of iBooks Biology content and features as well as perceptions of these items, and open-ended questions that allowed teachers to comment on anything related to the study or the iBooks Biology program. The study had a 100% response rate for log-implementation across all teachers. Teachers submitted a total of 18 logs across the study period. Data from the logs was aggregated to provide feedback about program implementation.

Classroom Observations
An observation protocol was developed to include ideal classroom instructional practices and implementation recommendations based on the guidelines presented by the Pearson Educational Consultant who trained the iBooks Biology teachers. Examples of rubrics related to instructional practices are classroom control, teacher/student rapport, differentiated instruction, and technology integration. Examples of rubrics related to implementation of the iBooks Biology program are usage of iBooks content, general and chapter-level features and iBooks navigation. Evaluators observed each teacher once in December 2012 and again in April/May 2013 for at least one entire iBooks Biology class period and one print Biology (comparison) period.

Teacher Interviews
Interview protocols were developed by the evaluators to enhance information learned from the implementation logs and classroom observations. Teachers participated in the interviews before or after the
evaluators observed their classrooms. The interview protocols inquired about teacher perceptions of iBooks Biology usage and general perceptions of the program, pacing and navigation comfort, student response to the program, and teacher perception of students’ learning and engagement. Teachers were interviewed at both observation periods, and the average interview lasted 30 minutes.

**Teacher Attitude Surveys**
Teachers were given a battery of surveys at the beginning and end of the study period. This battery included: The System Usability Scale (SUS), the Technology Acceptance Model (TAM), and The Teacher Motivation and Job Satisfaction Survey.

The System Usability Scale, developed as part of the usability engineering programme in integrated office systems development at Digital Equipment Company (United Kingdom), is a 10-item survey that provides a simple rating of system usability from a global viewpoint. The survey is administered after teachers have exposure to the new system, and should be completed without consultation with other teachers or professionals for an unbiased rating. The survey provides a score on a scale of 1 – 100 that provides information on teacher’s perception of ease of use and navigation of the system.

The Technology Acceptance Model (TAM) Questionnaire, developed by Fred Davis in 1986 as part of a doctoral dissertation for the Massachusetts Institute of Technology (MIT), posits the assumption that perceived usefulness and perceived ease of use determine an individual’s intent to use a system. Furthermore, the TAM assumes that perceived usefulness is directly impacted by perceived ease of use.

The Teacher Motivation and Job Satisfaction Survey, developed by Dr. Craig Mertler, measures the extent to which teachers are motivated to teach and are satisfied with their jobs. A research study by Mertler (2002) found differential effects in job satisfaction and motivation when examining gender, teacher experience, age, and school setting.

**Student Measures**
Evaluators used the Stanford Achievement Test – Version 10 (SAT10) to measure student achievement gains over the study period. A motivation survey, the Biology Motivation Questionnaire II (BMQ-II) developed by Shawn M. Glenn in 2011, was also administered at the beginning and end of the study period. Finally, a student feedback survey was administered at the end of the study to collect data on students’ perceptions of their Biology programs.

**Stanford Achievement Test – Version 10 (SAT10)**
The Stanford Achievement Test Version 10 (SAT10) Task 2 Science subtest, comprised of 40 items, was administered in October 2012 and May 2013. The SAT10 is a standardized, multiple-choice assessment that helps to identify student strengths and needs, leading to effective placement and instructional planning. Each item is designed to measure up to four achievement parameters: content cluster, process cluster, cognitive level and instructional standard. The Science subtest assesses students’ understanding of the life, physical, and earth sciences, and the nature of science with questions that elicit problem solving and inquiry using a basic understanding of science. Students must use reasoning skills throughout the subtest to reach answers. These skills include estimating, making simple calculations, seeking patterns, making observations, recognizing cause and
effect, reading standard instruments, and drawing conclusions. Students are challenged to apply foundation concepts and skills as they think through questions.

**Biology Motivation Questionnaire II (BMQ-II)**
The Biology Motivation Questionnaire II (BMQ-II), comprised of 25 items, was also administered in October 2012 and May 2013. The BMQ-II assesses five components of students’ motivation to learn Biology in college or high school courses, including intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation. The items on the survey are described by the authors as randomly ordered, strongly worded, unambiguous declarative statements in the form of short, simple sentences without jargon. Students respond to the statements on a rating scale of 0 – 4, with 0 indicating never, 1 rarely, 2 sometimes, 3 often, and 4 always. The sum of student responses provides an indicator of student motivation to learn Biology.

**Student Survey**
The student survey was administered at the conclusion of the year to collect feedback on students’ opinions of their Biology program. The questions focused on student’s perception of their program, how they would describe their program, favorite and least favorite features, and areas for change or improvement.

**School Selection**
Schools were selected based on several criteria: (1) schools had an adequate number of iPads and the technology infrastructure so that half of their Biology sections could utilize the iBooks Biology program, (2) schools had at least 1 Biology teacher with multiple sections of Biology classes, and (3) willingness of the schools’ administration and teachers to implement the iBooks Biology program with half of their sections and to continue using the current district Biology curriculum with the other half of the sections.

The Pearson Sales team assisted with recruitment by providing leads to schools that were interested in the research study. Schools were required to submit a research application to the Pearson Research team. The research application helped Pearson Research to learn more about the schools current Biology implementation, their technology infrastructure, and their student population. After two schools were identified for participation in the study, Pearson Research submitted research review applications to the districts of each school and was approved to conduct research. Pearson Research followed district and school policies regarding data collection procedures for the duration of the study.

**Sample**
The study included participants from two high schools in two districts. One school is designated as a small city charter school located in SC, while the other is a large suburban public school in NJ. The SC district is larger, with 96 schools, while the NJ district is smaller with 7 schools. The demographics of each district are presented in Table 1.
Table 1. District-Level Characteristics of Participating Schools

<table>
<thead>
<tr>
<th></th>
<th>NJ District</th>
<th>SC District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of schools</td>
<td>7</td>
<td>96</td>
</tr>
<tr>
<td>Student/Teacher ratio</td>
<td>12.2</td>
<td>17.3</td>
</tr>
<tr>
<td>Total student enrollment</td>
<td>5,540</td>
<td>71,930</td>
</tr>
</tbody>
</table>

**Ethnic Breakdown**

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>NJ District</th>
<th>SC District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>79.9%</td>
<td>68.6%</td>
</tr>
<tr>
<td>African-American</td>
<td>7.6%</td>
<td>22.4%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.3%</td>
<td>4.1%</td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>0.1%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Asian</td>
<td>3.4%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Hawaiian or other Pacific Islander</td>
<td>0.3%</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>Other/Multiracial</td>
<td>3.4%</td>
<td>3.5%</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>0.8%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Students with IEP’s</td>
<td>17.9%</td>
<td>14.0%</td>
</tr>
</tbody>
</table>

**NJ School**

The NJ school is designated a large public suburban school by the National Center for Education Statistics, and has a student population of 1,655. The school serves grades 9 – 12, and has a moderate amount of ethnic diversity. Two Biology teachers participated in the study. The teachers were asked to select two sections of students with similar ability levels, and assign one section to use iBooks Biology and assign the other section to continue to use their current print Biology program. The Biology classes are taught in an A/B block schedule with 90 minutes of instruction occurring every other day. Students complete lab activities every two weeks. The iBooks Biology program was the primary source of instructional material, however the district also has a series of resources that are utilized to ensure compliance with the state curriculum. The teachers used the iBooks Biology program for 80% of their instructional time, and the district resources for 20% of the time.

Data collection officially began on November 1st, which allowed parents adequate time to learn about the study and gave them the opportunity to opt their children out of the study per School Board requirements. The school was also closed for over one week due to Hurricane Sandy.

**SC School**

The SC school is designated a small charter city school, and has 420 students. The school serves grades 9 – 12, and has a moderate amount of ethnic diversity. One Biology teacher participated in the study. She selected her A block sections of students (3 sections) to use iBooks Biology, and her B block sections of students (2 sections) to use their current print Biology program. The Biology classes are taught on an A/B schedule with 85 minutes of instruction occurring every other day. Students complete lab activities one time per week. The iBooks Biology program was the primary source of instructional material, with little supplementation. In order for students to have access to the iPads, their parents had to pay an iPad usage fee. If the fee was not paid, the student was transferred to another section. Only one student had to be transferred to the B section due to non-payment of the fee.
Data collection began on November 1st, which allowed parents adequate time to learn about the study and opt their child out, if desired.

### Table 2. Demographics of Study Sample

<table>
<thead>
<tr>
<th></th>
<th>iBooks Biology</th>
<th>Print Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>53%</td>
<td>17.3</td>
</tr>
<tr>
<td>Female</td>
<td>46%</td>
<td>71,930</td>
</tr>
<tr>
<td>N/A</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>69%</td>
<td>71%</td>
</tr>
<tr>
<td>African-American</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Asian</td>
<td>1%</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>N/A</td>
<td>7%</td>
<td>1%</td>
</tr>
<tr>
<td><strong>English Language Learners</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>No</td>
<td>86%</td>
<td>91%</td>
</tr>
<tr>
<td>N/A</td>
<td>7%</td>
<td>3*</td>
</tr>
<tr>
<td><strong>Students with IEP’s</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>No</td>
<td>88%</td>
<td>95%</td>
</tr>
<tr>
<td>N/A</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Eligible for free/reduced lunch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15%</td>
<td>8%</td>
</tr>
<tr>
<td>No</td>
<td>78%</td>
<td>88%</td>
</tr>
<tr>
<td>N/A</td>
<td>7%</td>
<td>3%</td>
</tr>
</tbody>
</table>

| Days missed (mean [SD])** | 8.1 (5.5) | 6.9 (5.6) |

* District records
N/A = Data Not Available
**Only the NJ school had data on this variable

### Teacher Participants

Three teachers participated in the study from 2 schools across 2 districts. The teachers varied in experience and degrees completed; see Table 3 for teacher demographics. The classroom size varied from 12 students to 23 students. On average, the class size in the SC school was 15 students, while the class sizes in the NJ schools were 21 students. As incentive for participation in the study, teachers were provided the iBooks Biology program free of charge for the duration of the 2012/13 school year. Teachers also received a stipend of $700 for completing all data collection requirements for the study.
Table 3. Teacher Participant Demographics

<table>
<thead>
<tr>
<th></th>
<th>SC Teacher</th>
<th>NJ Teacher</th>
<th>NJ Teacher B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years teaching</td>
<td>12</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Years teaching Biology</td>
<td>5</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Years teaching at current school</td>
<td>9</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Highest Degree Completed</td>
<td>M.A./M.S.</td>
<td>B.A./B.S.</td>
<td>B.A./B.S.</td>
</tr>
<tr>
<td>Receive instructional support in classroom</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Student pulled out for instructional support</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Attrition

Attrition was calculated by subtracting the number of students at the conclusion of the study from the number of students at the beginning of the study. The initial study sample was 184 students, and the final analytic sample was 178 students. Table 4 shows the number of students in the final analytic sample by condition and teacher, along with an explanation of why 6 students were not included in the final analytic sample.

Table 4. Final Analytic Sample

<table>
<thead>
<tr>
<th></th>
<th>iBooks Biology</th>
<th>Print</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC Teacher</td>
<td>42</td>
<td>56*</td>
<td>98</td>
</tr>
<tr>
<td>NJ Teacher A</td>
<td>21**</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>NJ Teacher B</td>
<td>20</td>
<td>18***</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>95</td>
<td>178†</td>
</tr>
</tbody>
</table>

† Final Survey Sample = 164; 76 iBooks Biology, 88 Print
SAT-10 six students removed for analytic sample:
*One switched conditions; Two no pretest
**One refused consent; One no pretest
***One outlier NCE loss.

Two types of attrition analyses were calculated: overall sample attrition and differential attrition. Overall sample attrition was determined by examining the number of students who began and completed the study. The overall sample attrition rate was 3.3%.

Differential attrition was measured by calculating attrition rates for iBooks and Print conditions and then conducting chi-square analyses to determine if these rates statistically significantly differed from each other. The attrition rate for the iBooks sample was 2.4%, and the attrition rate for the Print sample was 4.0%. The differential attrition rate was 1.6%. Chi-square analyses (i.e., Fisher’s Exact Test [FET] due to small cell sizes) revealed that there was not a statistically significant difference in attrition rates by
condition (FET, n = 184, p = .69). Because overall attrition was less than 10% and the differential attrition rate was less than 6%, the attrition for this study falls within acceptable levels based on What Works Clearinghouse (WWC) standards (What Works Clearinghouse, 2011).

Treatment and Control Implementation

**iBooks Biology Implementation**

Implementation of the iBooks Biology program was examined through monthly implementation logs, classroom observations, and teacher interviews. Pearson provided implementation guidelines meant to guide teacher usage of the iBooks Biology program as used for daily instruction. Both schools utilized an A/B schedule, with students receiving 85 – 90 minutes of Biology instruction every other day.

Teachers were required to use the Pearson iBooks Biology program for each Biology class. Teachers reported when implementation was disrupted, including natural events like Hurricane Sandy and technology problems. Technology problems rarely prohibited usage of the iBooks Biology program (see Figure 1). One teacher reported that her implementation was disrupted once and another teacher reported her implementation was disrupted twice over the study period due to technology problems. The third teacher did not experience a disruption of implementation.

![Figure 1. Technology Problems Prohibiting iBooks Biology Usage](image-url)
Data from the monthly implementation logs was also used to gather information on the value and frequency of usage for main components and features of the iBooks Biology program. That data will be presented in the Results section.

**Comparison Implementation (Print Biology Programs)**
The NJ teachers use a print biology textbook from a major publisher as a core source of instructional material, along with supplemental material and information from videos and wiki sites found online to meet their state curriculum. The students in the comparison section do have access to iPads, but the iPads are primarily used to view videos and to access the wiki sites set up by their teachers.

The SC teacher also uses a print biology textbook from a major publisher as a core source of instructional material, but she also has access to the textbook’s online ancillary resources which includes graphic organizers, simulations, and labs. She uses websites that she discovers to supplement her instruction, along with the SMART curriculum. The students in her comparison classes do not have regular access to iPads.

**IV. RESULTS**

Does the presentation style of iBooks Biology have an impact on student achievement when compared to a print Biology program?

As seen in Table 5, the Print group had a statistically significant decrease on SAT-10 NCE scores from pre to post, whereas the iBooks group showed an educationally meaningful increase (i.e., defined as .05 < p < .10) on NCE scores from pre to post.

**Table 5. SAT-10 Normal Curve Equivalent (NCE) Means (standard deviations)**

<table>
<thead>
<tr>
<th>Condition</th>
<th>NJ Teacher</th>
<th>NJ Teacher B</th>
<th>Gain Score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>iBooks</td>
<td>57.1 (14.3)</td>
<td>59.1 (14.0)</td>
<td>2.0 (10.6)</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Print</td>
<td>58.6 (16.6)</td>
<td>56.3 (17.9)</td>
<td>-2.3 (10.5)</td>
<td>.04</td>
</tr>
</tbody>
</table>

†Effect Size for difference in Condition Gain Scores.

Furthermore, ANCOVA analyses indicate that students using the iBooks Biology program had significantly higher posttest scores on the SAT10 after controlling for pretest scores. The iBooks and Print NCE posttest scores translate to Percentile Rank scores of 68 and 61, respectively. (See Figure 2)
Does the impact of iBooks Biology on student achievement differ by subpopulations of students?

Evaluators looked at subgroup differences in SAT-10 scores by condition where sample sizes were large enough and found that there were no differences in gender, ethnicity, and lunch status. That is, males and females, whites and non-whites, and free/reduced lunch students and paid lunch students performed equally on the SAT10 across both the iBooks and Print conditions. Sample sizes were too small to examine differences between Special Education (SPED) and Non-SPED students. Further, there was not a correlation between number of days missed and SAT-10 scores. However, there was a significant finding when disaggregating by the English as a Second Language (ESL) subgroup (ESL by Condition interaction (p < .02)). Specifically, ESL students using iBooks Biology significantly outgained their ESL peers using the print Biology program (Figure 3). Furthermore, ESL students using iBooks Biology also outgained their non-ESL peers using both the print and iBooks Biology programs. This finding should be interpreted with caution due to the small ESL sample size (n=12: 6 print and 6 iBooks).
The iBooks and Print NCE posttest scores for both Non-ESL and ESL students translate to the following Percentile Rank Scores:
- iBooks ESL = 74
- iBooks Non-ESL = 67
- Print ESL = 40
- Print Non-ESL = 61

How are teachers implementing iBooks Biology? And to what extent are teachers utilizing the various features/functions of the program?

The study teachers used the iBooks Biology program daily as their primary source of science instruction. The two teachers in NJ implemented the program 90 minutes every other day, while the one teacher in SC implemented 85 minutes every other day.

The NJ teachers supplemented with some lessons from their district curriculum that were tailored to specific NJ and district science standards. They estimated that they supplemented approximately 20% of their usage time with the district curriculum. The SC teacher rarely had to supplement, but did so when she had a favorite lesson or activity that she wanted to incorporate.

When teachers did supplement, they most frequently reported using worksheets from the internet, video clips with related articles, quizzes from either other published materials or the internet, and graphic organizers. The teachers reported that these supplements helped increase student understanding and
engagement by teaching similar content in a different manner, allowed teachers to test students for knowledge and understanding, and helped to ensure district and state science standards were being met. During observations, all teachers walked around the classroom with their iPads with the iBooks Biology program open. The students were generally following along with the lesson on their own iPads, but the teachers did project certain features like videos, graphics, and/or questions from the chapter. During these portions of class, students could either look at the board to follow along with teacher projections or they could follow their own iPads.

The observations occurred twice over the school year, so evaluators primarily relied on feedback from the monthly implementation logs to determine how often teachers were utilizing certain features of the iBooks Biology program.

Figure 4 indicates the frequency of usage for the general features associated with the iBooks. General features include taking notes, highlighting, bookmarks, the glossary, and the search feature. The majority of the general features were used an average of 11 – 15 days per month, which indicates that they were used at least weekly although not daily. The highlighting and glossary features were consistently used each month by every teacher, while the other features had some months were they were not used at all by at least one of the teachers.

Figure 4. Frequency of iBooks Biology General Features Usage

Evaluators also examined usage of iBooks Biology content features (Figure 5), which included taking notes, interactive elements, tutor time, in your notes, lesson assessments, multiple choice questions in the lesson, vocabulary, mystery clues, analyzing data, and key questions. None of the features were consistently used every month. The mystery clues tended to be popular during observations and interviews, and the usage data shows it has the highest percentage of teachers who indicated during some months...
they used the clues more than 16 days. Many of the features were used an average of 6 – 15 days per month, although features like vocabulary, taking notes, analyzing data and in your notes had higher percentages of teachers who indicated they did not use that feature at all during certain months.

Figure 5.
Frequency of iBooks Biology General Features Usage

<table>
<thead>
<tr>
<th>Frequency of iBooks Biology General Features Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 Days</td>
</tr>
<tr>
<td>Notes</td>
</tr>
<tr>
<td>Highlights</td>
</tr>
<tr>
<td>Bookmarks</td>
</tr>
<tr>
<td>Definitions/ Glossary Support</td>
</tr>
<tr>
<td>Search</td>
</tr>
</tbody>
</table>

How is student motivation impacted by usage of iBooks Biology?

Table 6 shows the Biology Motivation Questionnaire sample sizes for the iBooks and Print groups by study teacher. As seen in Table 7, students in the Print group experienced a significant decrease on the Biology Motivation Questionnaire (BMQ) from beginning to end of year, while the iBooks Biology students had statistically equivalent means from beginning to end of year.

Table 6. Study Sample for Biology Motivation Questionnaire

<table>
<thead>
<tr>
<th>SC Teacher</th>
<th>NJ Teacher A</th>
<th>NJ Teacher B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>iBooks Biology</td>
<td>36</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>Print</td>
<td>53</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>89</td>
<td>44</td>
<td>31</td>
</tr>
</tbody>
</table>

Table 7. Biology Motivation Questionnaire Means (standard deviations)

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Gain Score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>iBooks</td>
<td>67.1 (13.3)</td>
<td>65.1 (17.7)</td>
<td>-2.0</td>
<td>n.s.*</td>
</tr>
<tr>
<td>Print</td>
<td>62.9 (14.5)</td>
<td>58.2 (17.0)</td>
<td>-4.7</td>
<td>.002</td>
</tr>
</tbody>
</table>

*n.s. = not significant
When evaluating the scores at posttest only, the iBooks Biology group had an educationally significant (p < .10) greater posttest score than the Print group on the Biology Motivation Questionnaire after controlling for pretest scores (Figure 6).

Figure 6. Student Post-Implementation Motivation for iBooks and Print Conditions

![Bar Chart](chart)

ANCOVA-adjusted SAT-10 Biology Motivation Questionnaire Posttest scores estimated at Pretest = 64.9. Mean difference between Print and iBooks posttest is educationally significant at p < .10.

Evaluators also examined subgroup differences in questionnaire scores by condition where sample sizes were large enough and found that there were no differences in gender, ethnicity, ESL status, and lunch status. That is, males and females, whites and non-whites, ESL and non-ESL students, and free/reduced lunch students and paid lunch students performed equally on the Biology Motivation Questionnaire across both the iBooks and Print conditions. Sample sizes were too small to examine differences between SPED and non-SPED students.

However, there was a significant finding when examining the number of days missed by students. (Note that only the NJ school was able to provide attendance data). For the Print condition, there was a significant negative correlation (r = -.50, p < .01) between number of days missed and total posttest questionnaire score. That is, as the number of days missed increased, the students’ biology attitude as reported on the questionnaire decreased. Interestingly, this finding was not seen for the iBooks group. Furthermore, there was no significant difference between the iBooks and Print groups for days missed (7.3 days vs. 7.1 days, respectively) nor for pretest attitude score (67.0 vs. 67.4, respectively). (See Figure 7.)
Although in aggregate, there was a decrease in score from pre to post on the BMQ for both iBooks and Print groups, there were increases in a few individual questions within the iPad group as well as statistically significant between-group gain differences when disaggregating the survey by teacher as shown in Table 8.

Table 8. Student Responses on Specific Motivation Questionnaire (MQ) Items
Evaluators also ran correlations between the BMQ and SAT-10 NCE scores to see if there was a relationship between student motivation and student achievement (Table 9). Some noteworthy correlations are highlighted that indicate the relationship between the BMQ and SAT-10 at pretest and posttest. There was no correlation between the SAT-10 and BMQ at pretest and a small correlation between these two assessments at posttest (Cohen, 1988).

Table 9: Motivation Questionnaire (MQ) and SAT-10 Correlation Table

<table>
<thead>
<tr>
<th></th>
<th>Pre-test MQ</th>
<th>Post-test MQ</th>
<th>Gain MQ</th>
<th>Pre-test SAT-10</th>
<th>Post-test SAT-10</th>
<th>Gain SAT-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test MQ</td>
<td></td>
<td>-0.24**</td>
<td>-0.02</td>
<td>-0.05</td>
<td>-0.04</td>
<td></td>
</tr>
<tr>
<td>Post-test MQ</td>
<td>0.61**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain MQ</td>
<td>0.20*</td>
<td>0.14</td>
<td>0.17*</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test SAT-10</td>
<td></td>
<td></td>
<td></td>
<td>0.77**</td>
<td>-0.28**</td>
<td></td>
</tr>
<tr>
<td>Post-test SAT-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.39**</td>
</tr>
<tr>
<td>Gain SAT-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p-value < .05; ** p-value < .01

How and why do teachers integrate print components with iBooks Biology usage?

Teachers did opt to supplement with print materials each month for a variety of reasons. The most popular items used to supplement were print lab manuals and workbooks. Teachers also reported supplementing with teacher-created worksheets. The teachers were able to use favorite worksheets from previous years and/or to create new ones if they felt it was necessary. Some teachers used the worksheets as reinforcement for lessons or skills taught with the iBooks; others used them to give students additional practice or to prep students for district or state testing.

Assessments and graphic organizers were also used as supplements, although they were not cited as frequently as the workbooks, lab manuals, and worksheets. Some teachers created assessments to ensure their students were getting ready for state or district testing, while others had assessments they had used in past years to monitor student progress.

What challenges and/or barriers do teachers confront when using iBooks Biology? How do they address or overcome these barriers?

Teachers were able to share challenges and/or barriers that they faced through their monthly implementation logs and by communicating via email with the evaluators. The teachers reported very few technology problems, with only 3 of the 18 logs indicating that classes had been disrupted due to technology problems. On those 3 logs, the disruptions were limited to less than 5 days in the month.
A valuable lesson learned during this study came directly from the administration at each school. Both administrations were committed to integrating the iPads into their science (and some other) classrooms. As such, they dedicated the appropriate resources to ensuring the technology would work consistently and function at its highest capacity. Both schools had their bandwidth evaluated so that it could support the number of students that would be accessing the internet at the same time. The schools also had dedicated technology specialists to program the equipment, maintain it, and support the teachers.

The teachers reported that they were able to avoid challenges by establishing classroom protocols and routines regarding the equipment. Students were prohibited from using other programs during instruction time, and the devices were also locked so that students could not download programs onto their devices. Each student had his or her own dedicated device and was responsible for putting it back into its charging dock at the conclusion of each class. The devices were kept in locked storage facilities in each room, and the teacher had a master copy of devices assigned to students so that they could be tracked.

However, teachers did experience some problems throughout the year. One of the most frequent problems reported was student complaints that they could not open their iBooks application. The teachers learned that shutting down the iPad and then rebooting it often solved the problem. Teachers also instructed their students to completely close down all applications after each class, and this seemed to resolve some of the issues with opening applications. One teacher had trouble projecting her iPad. She found that having the LCD projector, document camera, and Apple TV working simultaneously were causing problems. This required assistance from their technical support staff to synch the devices, and the teacher did not report problems thereafter.

Establishing a good infrastructure at each school, developing a support network, and creating classroom routines and expectations helped to avoid the pitfalls that many teachers experience when incorporating technology into their classrooms.

What are teacher perceptions of iBooks Biology? Do perceptions change with exposure or time?

The study teachers shared an abundance of feedback regarding their perceptions of the iBooks Biology program. The study teachers received the Miller and Levine iBooks Biology program which covered standards associated with one year of biology instruction. Across the 18 logs, teachers reported 56% of the time that they had just the right amount of material to implement their lessons successfully. On 33% of the logs, they indicated they had too much material to cover, and on 11% of the logs they did not have enough material. (See Figure 8.)
The majority of the time, teachers felt that the program offered a reasonable pace for them to follow (Figure 9). Only 17% of the logs indicated the program pacing was too fast, while 11% of logs indicated it was too slow.

The iBooks Biology program was new to all study teachers, and so it was important to understand whether it was easy for them to implement. Figure 10 shows that in 61% of the logs, teachers indicated implementation was easy to very easy. In the remaining 39% of the logs, they reported implementation was somewhat easy. No teachers indicated that the program was difficult to implement during the entire study period.
In half of the logs, teachers felt that student engagement improved with the use of the iBooks Biology program (Figure 11). They also felt that student understanding of Biology improved in almost half of their log entries (Figure 12). This feedback from teachers is encouraging given that the iBooks are presenting the same science content in a different and more interactive manner.
Teachers also reported that the iBooks Biology program was a valuable or very valuable instructional tool on the vast majority of the logs (Figure 13).

The evaluators also wanted to understand the value of iBooks Biology features. Figures 14 – 16 show teacher ratings of various iBooks features. When asked about iBooks general features, teachers particularly valued the search and glossary features. Teachers also really enjoyed the lesson assessments, multiple choice questions in the chapters, and the build vocabulary from the iBooks Content features.
Figure 14.
Teacher Perception of Value of iBooks Biology General Features

- Notes
- Highlights
- Bookmarks
- Definitions/Glossary Support
- Search

Figure 15.
Teacher Perception of Value of iBooks Biology General Features

- Notes
- Highlights
- Bookmarks
- Definitions/Glossary Support
- Search

Figure 16.
Teacher Perception of Value of iBooks Biology Chapter Level Features

- Chapter Study Guide
- Chapter Assessment: Multiple Choice Questions
- Chapter Assessment: Understand Key Concepts
- Chapter Assessment: Think Critically
- Chapter Assessment: Connecting Concepts
- Chapter Assessment: Write About Science
- Chapter Assessment: Analyzing Data
- Standardized Test Prep
- Standardized Test Prep: Self-Check
- Multiple Choice

iBooks Biology Chapter Level Features
What are student perceptions of iBooks Biology? Do perceptions change with exposure or time?

Students were asked to share their perceptions of the iBooks Biology program via a survey completed at the end of the school year. Overall, 78% of the student responses were positive in nature. Students were asked to name their favorite iBooks feature, and their responses were then content-coded for major themes. Thirty-eight percent of students indicated an iBooks feature was their favorite, such as highlighting or note-taking. Twenty-seven percent of the students chose a Pearson feature, with the most popular responses being the pictures, videos, or animations in the book. The remainder of responses were related to iBooks being more fun to use than print books, easier or lighter to carry, and other general comments.

Students were also asked whether they preferred learning with an iBooks or a print book, and the overwhelming majority indicated they preferred the iBooks. Twenty-eight percent of the students cited iBooks features such as the ability to search and easily navigate the book as their reason for preferring the iBooks. Twenty-four percent said the iBooks were easier to carry and/or lighter and had everything in one place. The remainder of the students said the iBooks was more interactive, easier to use, or they indicated a specific Pearson feature they really liked, such as videos.

Summary and Discussion

Pearson partnered with Apple in 2012 to develop textbooks on the iBooks platform. The Miller and Levine Biology program was transferred from a print medium to the digital iBooks interface. The purpose of creating the iBooks textbooks was to transform the instructional content so that students could enjoy a more interactive experience with their textbook content. Since the iBooks were relatively new, little research had been conducted on the efficacy of iBooks textbooks as compared to print textbooks. The research study was conducted during the 2012-13 school year in 2 schools with 3 teachers and 178 students and investigated the impact of the iBooks on student biology learning, and documented implementation practices associated with iBooks in the classroom.

Evaluators collected student data through the Stanford Achievement Test – Version 10 (SAT10), Biology Motivation Questionnaire II (BMQII), and student survey. Teacher data was collected by monthly online implementation logs, classroom observations, interviews and attitude surveys.

Results from the study indicate that students using iBooks Biology had significantly higher posttest scores on the SAT10 when compared to their peers using Print biology books. Furthermore, the student using Print biology books saw a significant decrease in achievement over the course of the year while iBooks Biology students experienced gains in achievement. Analyses of subpopulations found that ESL students using iBooks Biology significantly outgained their ESL peers using Print biology programs. The ESL iBooks students also outgained their non-ESL peers using both Print and iBooks Biology programs.

Students using the Print biology programs also experienced a decrease in motivation scores over the course of the year, while iBooks Biology students’ motivation remained the same. When analyzing posttest scores adjusted for pretest, iBooks Biology students had higher motivation scores than Print
biology students. Evaluators also found that as the number of days missed increased, the Print biology students’ motivation as reported on the questionnaire decreased. Interestingly, this finding was not seen for the iBooks Biology group.

Teachers reported using the iBooks Biology program as their core biology instructional resource, although each teacher did supplement when needed to meet district or state requirements. Lab manuals, workbooks, and teacher-created workbooks were the most frequently cited supplements to iBooks Biology instruction. The most frequently used iBooks features were the highlighting and glossary elements. The iBooks content features were used an average of 6 – 15 days per month, with vocabulary, taking notes, analyze data, and in your notes being used the most frequently.

The teachers were asked to rate their perception of the iBooks Biology program each month, and their responses were tabulated over the course of the study. The majority of responses indicated that teachers thought the amount of material and pacing of the program were just right, that the program was easy to implement, student engagement and student understanding improved using the iBooks Biology program, and that the iBooks Biology program was a valuable instructional resource.

Evaluators are interested in further exploring the results of the ESL population with a larger sample of students, and would also like to replicate the study with different schools to determine if the results are consistent. As educational instruction becomes more prevalent on digital platforms, the outcomes of these studies will be increasingly important in helping educators make informed decisions about their instructional tools and practices.

REFERENCES


