Effects of E-Books and Online Homework on Learning in Calculus I

AMATYC
November 20, 2015

Sallie Paschal, PhD
Professor of Mathematics
Georgia Perimeter College, Newton Campus
Abstract

Now that publishers are providing platforms that include electronic books and online homework, quizzes and tests, are students performing better in their collegiate mathematics classes? To explore, this presentation will compare student performance in traditional Calculus 1 classes and technology-enhanced Calculus I classes using e-books and online assessments.
BACKGROUND

Technology in the classroom has come a long way.
Traditional Instructor

1. Come to class

2. Do your homework
How do you get students to do their homework?

These are the methods I have used in the past:

**Beg**
Take it up and grade it every day
Take it up and spot grade examples
Collect hw notebook on test day
Give hw quizzes once a week
Give quizzes based on hw several times
Advantages to counting homework more than a token, using a fixed deadline:

1. Students do it
2. They can’t wait until the last minute to do hw problems immediately before a test
3. They stay current with the new material
4. They perform better on tests
Disadvantages to counting homework more than a token

I have to grade it in a timely manner
• **Publishers**
  - Have been providing ancillary materials for years
  - Test Banks
  - Solutions Manuals
  - Videos

• ...and then the landscape began
• to change
• Web Based Platforms

“Online Instructional Systems”

MyMathLab
WebAssign
Aleks
WebWork

Every mainline calculus text has digital resources.
Digital Resources Include:

E-book
section videos
homework platform with helps
Interactive figures
Applets
...more
The CODE
### Online GPC Bookstore Pricing

<table>
<thead>
<tr>
<th>Option</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy New with code</td>
<td>$337.25</td>
</tr>
<tr>
<td>Buy Used, no code</td>
<td>253.00</td>
</tr>
<tr>
<td>Rent new, no code</td>
<td>232.70</td>
</tr>
<tr>
<td>Rent used, no code</td>
<td>165.25</td>
</tr>
<tr>
<td>Rent ebook only</td>
<td>89.49</td>
</tr>
</tbody>
</table>
From the Publisher’s Website

(No paper book is included)

- Multi-term (Lifetime) use $110
- Single-term use $75
- High School Code $50.00
- HW only $21.50

14 day grace period is given to students before purchase is required.
Students are reacting to high cost of books

- A study detailed in the “Wired Campus” newsletter of the Chronicle of Higher Education reported that students are arriving in classes with
  
  1. illegally scanned books
  
  2. pirated digital copies of books
  
  3. out of print editions of currently required book
• **Bottom Line**

  • Low of $75 for single use code only

  • High of $337.25 for code and new book

  • The tuition at GPC for Calculus I is $354.68

  • At Georgia Perimeter College we allow students to purchase any of the options mentioned. Most do not buy the physical textbook. Purchase of the code is **required** in my classes.
In my calculus classes,

Weekly Homework is due in WebAssign.

Homework grade counts 25% of the semester grade.

HOLY COW!!!  25%  ???????

They’ll cheat! They’ll use Wolfram Alpha!
Welcome to WebAssign!

Use the username, institution, and password provided by your instructor or account representative.

Username: sarah.paschal
Institution: gpc
Password: ********

Forgot your username?
What's this?
Forgot your password?

Students: If your instructor gave you a Class Key, add yourself to that class here.
I have a class key

Trouble Logging In?
Differentiate.

\[ f(x) = 2x^7 - 5 \cos x \]

\[ f'(x) = 14x^6 + 5 \sin(x) \]
“Watch It” gives the walk through of a similar problem

\[
f'(x) = \frac{d}{dx} \left[ 3x^2 - 2\cos(x) \right]
\]

\[
= \frac{d}{dx} [3x^2] - \frac{d}{dx} [2\cos(x)]
\]

\[
= 3 \frac{d}{dx} [x^2] - 2 \frac{d}{dx} [\cos(x)]
\]

\[
= 3(2x) - 2(-\sin(x))
\]

\[
= 6x + 2\sin(x)
\]
Student benefits of Using WebAssign for Homework

• ** They get instant feedback
• They can see a quick video of a similar problem
• They are allowed 3 tries before it is marked wrong, then another randomized question is available with 3 more tries.
• (This is completely customizable by the instructor)
• Students get instant feedback. They don’t have to wait until “next Tuesday” to ask you in class

• They can view a well-made “watch it” video from their computer at home that you can trust to be correct

• Grade goes into a Gradebook that keeps their average up to date each time they complete an assignment

• No more midterm or “pre-exam” Progress Reports printed
Electronic Gradebook in WebAssign

<table>
<thead>
<tr>
<th>Assignment Category [M = Manual] Grade</th>
<th>Final</th>
<th>Homework</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight Toward Final Grade [dropped]</td>
<td>100</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Class Average (mean) less...</td>
<td>82.45</td>
<td>94.31</td>
<td>76.52</td>
</tr>
<tr>
<td>median</td>
<td>82.00</td>
<td>100.00</td>
<td>82.00</td>
</tr>
<tr>
<td>standard deviation</td>
<td>12.95</td>
<td>10.78</td>
<td>17.47</td>
</tr>
<tr>
<td>min/max</td>
<td>61.00/98.00</td>
<td>68.05/100.00</td>
<td>50.00/97.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Final</th>
<th>Homework</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>98.00</td>
<td>100.00</td>
<td>97.00</td>
</tr>
<tr>
<td>A</td>
<td>93.33</td>
<td>100.00</td>
<td>87.00</td>
</tr>
<tr>
<td>A</td>
<td>91.33</td>
<td>100.00</td>
<td>96.00</td>
</tr>
<tr>
<td>A</td>
<td>97.33</td>
<td>100.00</td>
<td>96.00</td>
</tr>
<tr>
<td>D</td>
<td>61.61</td>
<td>84.82</td>
<td>50.00</td>
</tr>
<tr>
<td>A</td>
<td>98.00</td>
<td>100.00</td>
<td>97.00</td>
</tr>
<tr>
<td>C</td>
<td>76.88</td>
<td>86.65</td>
<td>82.00</td>
</tr>
<tr>
<td>A</td>
<td>93.51</td>
<td>96.53</td>
<td>92.00</td>
</tr>
<tr>
<td>B</td>
<td>82.00</td>
<td>100.00</td>
<td>73.00</td>
</tr>
<tr>
<td>A</td>
<td>96.00</td>
<td>100.00</td>
<td>94.00</td>
</tr>
<tr>
<td>D</td>
<td>66.90</td>
<td>66.71</td>
<td>67.00</td>
</tr>
<tr>
<td>D</td>
<td>67.65</td>
<td>92.94</td>
<td>55.00</td>
</tr>
<tr>
<td>D</td>
<td>66.47</td>
<td>100.00</td>
<td>60.00</td>
</tr>
<tr>
<td>D</td>
<td>65.53</td>
<td>96.60</td>
<td>60.00</td>
</tr>
<tr>
<td>C</td>
<td>77.72</td>
<td>99.15</td>
<td>67.00</td>
</tr>
<tr>
<td>C</td>
<td>77.33</td>
<td>100.00</td>
<td>66.00</td>
</tr>
<tr>
<td>B</td>
<td>88.00</td>
<td>100.00</td>
<td>82.00</td>
</tr>
</tbody>
</table>

Names have been omitted.
The Experiment

- I have gradebook/attendance data on classes taught using paper book and regular homework

- I have gradebook/attendance data on classes taught using ebook and online homework.

- They took the same 25 question Multiple Choice exam.

- I also teach statistics.
Two Sample t-test comparing Final Exam Scores
$\mu = \text{mean of final exam scores}$

- $H_0: \mu_1 = \mu_2$  
- $H_1: \mu_1 \neq \mu_2$

- $H_0: \mu_1 = \mu_2$
- $H_1: \mu_1 > \mu_2$

- $H_0: \mu_1 = \mu_2$
- $H_1: \mu_1 < \mu_2$
<table>
<thead>
<tr>
<th>Class</th>
<th>( \bar{x} )</th>
<th>s</th>
<th>n</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Class</td>
<td>70.3</td>
<td>15</td>
<td>51</td>
<td>-</td>
</tr>
<tr>
<td>1 Section Fall 2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Section Summer 2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Section Spring 2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-book and Online HW Class</td>
<td>70.2</td>
<td>18</td>
<td>61</td>
<td>-</td>
</tr>
<tr>
<td>2 sections Fall 2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 section Spring 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total/Results</td>
<td>t = -.04</td>
<td>p = .48</td>
<td>112</td>
<td>110</td>
</tr>
</tbody>
</table>

**Using all 3 alternative hypotheses, there was no difference in performance on the final exam between the two calculus classes.**
• There is no difference in the final exam score for students who used electronic books and online homework vs. those who had a paper text and traditional pencil/paper homework.

• Hmmmm.....
• Are these surprising or disappointing results?

• Let’s look at some Qualitative Data
Qualitative Data
How treatment students felt about buying/not buying the text.

Book Purchase

- Bought a book and used it a lot: 4
- Bought a book and hardly used it: 12
- Didn't buy a book and I'm glad I didn't: 32
- Didn't buy a book but I wish I had: 7
How treatment students liked HW in WebAssign

- I liked having HW in WebAssign: 53
- I didn’t like having HW in WebAssign: 5
## Success Rates

<table>
<thead>
<tr>
<th>Category</th>
<th>A/B/C</th>
<th>D</th>
<th>F/W/WF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Students (65)</td>
<td>52</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>(Used ebook and online HW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Students (61)</td>
<td>36</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Traditional</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In the final analysis:

1. They spend far less money
2. They must do scheduled homework
3. I feel much better about it
Thank You