Effect of Electronic Homework on Small College Physics Courses

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Background

- Homework is important to student learning\(^2\)
- Other studies have look at the effect of online homework in Physics and Chemistry\(^5\) courses
  - Cheng shows that on-line homework improves scores on the Force Concept Inventory\(^1\)
  - Dufresne shows improved test scores from on-line homework\(^4\)
- Additional studies show online homework also is beneficial in other subjects such as business classes.\(^3\)

\(^1\) Cheng, 2004  \(^2\) Cooper, 2006  \(^3\) Dillard-Eggers, 2008  \(^4\) Dufresne, 2002  \(^5\) Fynewever, 2008
Classes involved in study

- Both introductory calculus based and algebra based classes.
- 2009 – 2014
- Subjects
  - Fall Semester - Mechanics (kinematics, forces, momentum, energy, waves)
  - Spring Semester – EM/Light (electricity, magnetism, optics, diffraction, modern)
- Class size : 14 to 50
- Same instructor for all courses
Homework Description

Paper Homework

- Assigned from text\textsuperscript{15,16} for each chapter
- Students turned problems in worked on paper
- Papers were graded by either instructor or grader.

Online Homework

- Assignments were based on those from text\textsuperscript{15,16}
- Problems were programmed into Moodle\textsuperscript{9,11} course management system
- Students were given unlimited attempts at each problem with a 10% penalty for each incorrect submission

\textsuperscript{9}Martín-Blas,2009 \hspace{1cm} \textsuperscript{11}Moodle v2.3 \hspace{1cm} \textsuperscript{15}Serway (College Physics) \hspace{1cm} \textsuperscript{16}Serway (Physics for Scientists & Engineers)
SECTION 17.4 RESISTANCE, RESISTIVITY, AND OHMS LAW

17.13: Nichrome wire of cross-sectional radius 0.722 mm is to be used in winding a heating coil. If the coil must carry a current of 6.00 A when a voltage of 120 V is applied across its ends, find (a) the required resistance of the coil.

Answer: 20 Ω

Feedback:
Correct. Use Ohm's Law $R = \frac{\Delta V}{I} = \frac{120 V}{6.00 A}$. The correct answer is: 20 Ω. Marks for this submission: 3.00/3.00. Accounting for previous tries, this gives 2.70/3.00.
Student Scores – Algebra Based Mechanics

Scores are not significantly different for online based homework.
Student Scores – Calculus Based Mechanics

<table>
<thead>
<tr>
<th></th>
<th>Homework</th>
<th>Exams</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>online</td>
<td>77.5 ± 20.6</td>
<td>79.3 ± 13.4</td>
<td>80.1 ± 12.3</td>
</tr>
<tr>
<td>paper</td>
<td>78.9 ± 21.6</td>
<td>84.5 ± 17.2</td>
<td>79.3 ± 26.0</td>
</tr>
<tr>
<td>p (t-test)</td>
<td>0.85</td>
<td>0.22</td>
<td>0.90</td>
</tr>
</tbody>
</table>

- Scores are not significantly different for online based homework.
- p statistic is comparison of paper vs online class.
Student Scores – Algebra Based EM/Light

Scores are not significantly different for online based homework.

<table>
<thead>
<tr>
<th></th>
<th>Homework</th>
<th>Exams</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>online (n = 43)</td>
<td>92.4 ± 11.6</td>
<td>89.5 ± 14.7</td>
<td>87.6 ± 14.6</td>
</tr>
<tr>
<td>paper (n = 14)</td>
<td>87.7 ± 13.1</td>
<td>89.4 ± 9.1</td>
<td>89.5 ± 7.4</td>
</tr>
</tbody>
</table>

p (t-test) | 0.24 | 0.33 | 0.55

p statistic is comparison of paper vs online class.

Scores are not significantly different for online based homework.
Student Perception

Students Generally Prefer the Online Format

Likes
- INSTANT FEEDBACK
- Hints for simple mistakes
- Full explanation after correct submission
- Multi-step problems shows logic of problem solving
- Can rework problem

Dislikes
- Computer is too picky
- Lack of hints
- Penalties for incorrect submissions
- Easy to get stuck on multi-step problems

Comments from formal and informal surveys and in person discussions

5 Fyneweyer, 2008
13 Richards-Babb, 2011
Games for Learning

People learn while playing games\textsuperscript{6,10}

Why do people like to play games?

What about arcade games (Pack man, Tetris, etc.)?

\textsuperscript{6}Green, 2010 \quad \textsuperscript{10}Mayo, 2007
Homework = Game?

Key to motivation: Low stakes (10% penalty per try) and a reward (instant feedback)

Video games activate reward centers in the brain.²

Student Comments:
- Get excited when the “green” bar pops up
- Keep working until answer is correct.

²Keopp, 1998
Concerns Regarding On-line Homework

Students will not be as careful and thoughtful in working problems (some do not write their solutions down at all, but work in calculator alone)

Poor students will not try at all
Pascarella divides students into four types\textsuperscript{12}

<table>
<thead>
<tr>
<th></th>
<th>Thinkers</th>
<th>Guessers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work problem logically</td>
<td>Check solution logically - Rework</td>
<td>Use examples to try to find equation</td>
</tr>
<tr>
<td>Traditional</td>
<td>Traditional</td>
<td>Traditional</td>
</tr>
<tr>
<td>CAPA</td>
<td>Check solution against computer</td>
<td>No checking of answer - Stop</td>
</tr>
</tbody>
</table>

\textbf{(Computer Assisted Personalized Approach)}

Some in the “Thinkers” category for paper turn in to Guessers for online homework
Some in the “Guessers” category for paper turn into Thinkers for online homework

One way to possibly discourage students from becoming guesses is to invoke a small penalty for each attempt or eliminate multiple attempts\textsuperscript{14}
Advantages

- Students can work with each other, but direct coping is not possible since each student receives different values.

- Elimination of homework grading time\(^5\)
  - Initial set-up takes about the same amount of time as grading paper homework (depending on class size) [Moodle, WebCT = free]
  - Many publishers also offer online homework tools [~$30/student]

- Focus students during office hours
  - Generally don’t discuss a problem until student has tried it
  - Work only on areas student is having trouble

- Can “spy” on students\(^8\)
  - Monitor progress through assignment
  - Review previously entered values
  - See when each student first starts and submits assignment
  - Identify early in the course students who are struggling
## Monitor Student Progress

### Moodle Instructor View of an Assignment

<table>
<thead>
<tr>
<th>Time taken</th>
<th>Grade/100.00</th>
<th>Q. 1 /3.00</th>
<th>Q. 2 /1.00</th>
<th>Q. 3 /1.00</th>
<th>Q. 4 /1.00</th>
<th>Q. 5 /2.00</th>
<th>Q. 6 /3.00</th>
<th>Q. 7 /5.00</th>
<th>Q. 8 /5.00</th>
<th>Q. 9 /5.00</th>
<th>Q. 10 /5.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 days 2 hours</td>
<td>98.90</td>
<td>3.00 ✓</td>
<td>1.00 ✓</td>
<td>1.00 ✓</td>
<td>1.00 ✓</td>
<td>2.00 ✓</td>
<td>3.00 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
</tr>
<tr>
<td>7 days 4 hours</td>
<td>96.40</td>
<td>2.70 ✓</td>
<td>1.00 ✓</td>
<td>1.00 ✓</td>
<td>1.00 ✓</td>
<td>2.00 ✓</td>
<td>3.00 ✓</td>
<td>4.00 ✓</td>
<td>5.00 ✓</td>
<td>4.50 ✓</td>
<td>5.00 ✓</td>
</tr>
<tr>
<td>8 days 3 hours</td>
<td>73.35</td>
<td>2.70 ✓</td>
<td>1.00 ✓</td>
<td>0.75 ✓</td>
<td>1.00 ✓</td>
<td>2.00 ✓</td>
<td>2.40 ✓</td>
<td>4.50 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
</tr>
<tr>
<td>8 days</td>
<td>76.56</td>
<td>3.00 ✓</td>
<td>1.00 ✓</td>
<td>0.25 ✓</td>
<td>1.00 ✓</td>
<td>1.60 ✓</td>
<td>2.40 ✓</td>
<td>4.00 ✓</td>
<td>5.00 ✓</td>
<td>0.00 ✗</td>
<td>0.00 ✗</td>
</tr>
<tr>
<td>6 days 3 hours</td>
<td>94.30</td>
<td>3.00 ✓</td>
<td>1.00 ✓</td>
<td>0.50 ✓</td>
<td>1.00 ✓</td>
<td>1.60 ✓</td>
<td>3.00 ✓</td>
<td>4.00 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
</tr>
<tr>
<td>7 days</td>
<td>87.95</td>
<td>2.70 ✓</td>
<td>1.00 ✓</td>
<td>0.25 ✓</td>
<td>1.00 ✓</td>
<td>2.00 ✓</td>
<td>2.70 ✓</td>
<td>1.50 ✓</td>
<td>4.50 ✓</td>
<td>5.00 ✓</td>
<td>5.00 ✓</td>
</tr>
</tbody>
</table>
Conclusion

- Recommend implementing online homework where possible
- Students prefer the instant feedback
- Reduction in work load for instructors
References


11. Moodle version 2.3 skinned as “Loras eLearn”


Questions?

- Acknowledgements
  - Loras College
  - Students in Introductory courses