



Effect of Electronic Homework on Small College Physics Courses

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Background



- Homework is important to student learning²
- Other studies have look at the effect of online homework in Physics and Chemistry⁵ courses
 - Cheng shows that on-line homework improves scores on the Force Concept Inventory¹
 - Dufresne shows improved test scores from on-line homework⁴
- Additional studies show online homework also is beneficial in other subjects such as business classes. ³

¹ Cheng, 2004

²Cooper, 2006

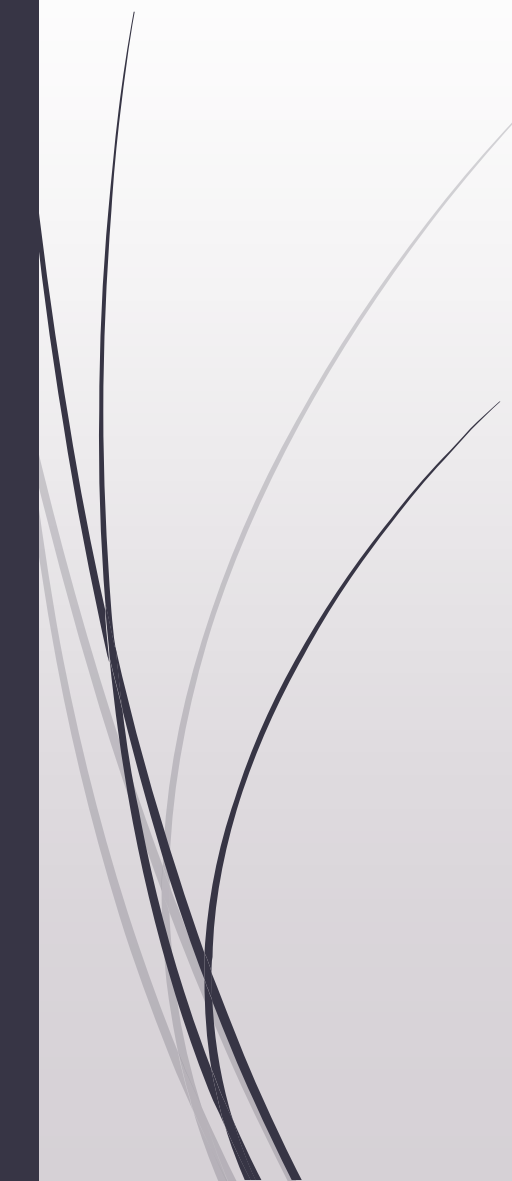
³ Dillard-Eggers, 2008

⁴Dufresne, 2002

⁵Fynewever, 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
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Homework Description

Paper Homework

- ▶ Assigned from text^{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^{15,16}
- ▶ Problems were programmed into Moodle^{9,11} course management system
- ▶ Students were given unlimited attempts at each problem with a 10% penalty for each incorrect submission

Online Question Example

Question 3

Correct

Mark 2.70 out of 3.00



Edit question

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:

Check

Multi-part problem

Problem Statement

Correct. Use Ohm's Law $R = \frac{\Delta V}{I} = \frac{120V}{6.0A}$

Explanation

The correct answer is: 20 Ω

Feedback

Correct

Marks for this submission: 3.00/3.00. Accounting for previous tries, this gives 2.70/3.00.

Make comment or override mark

Response history

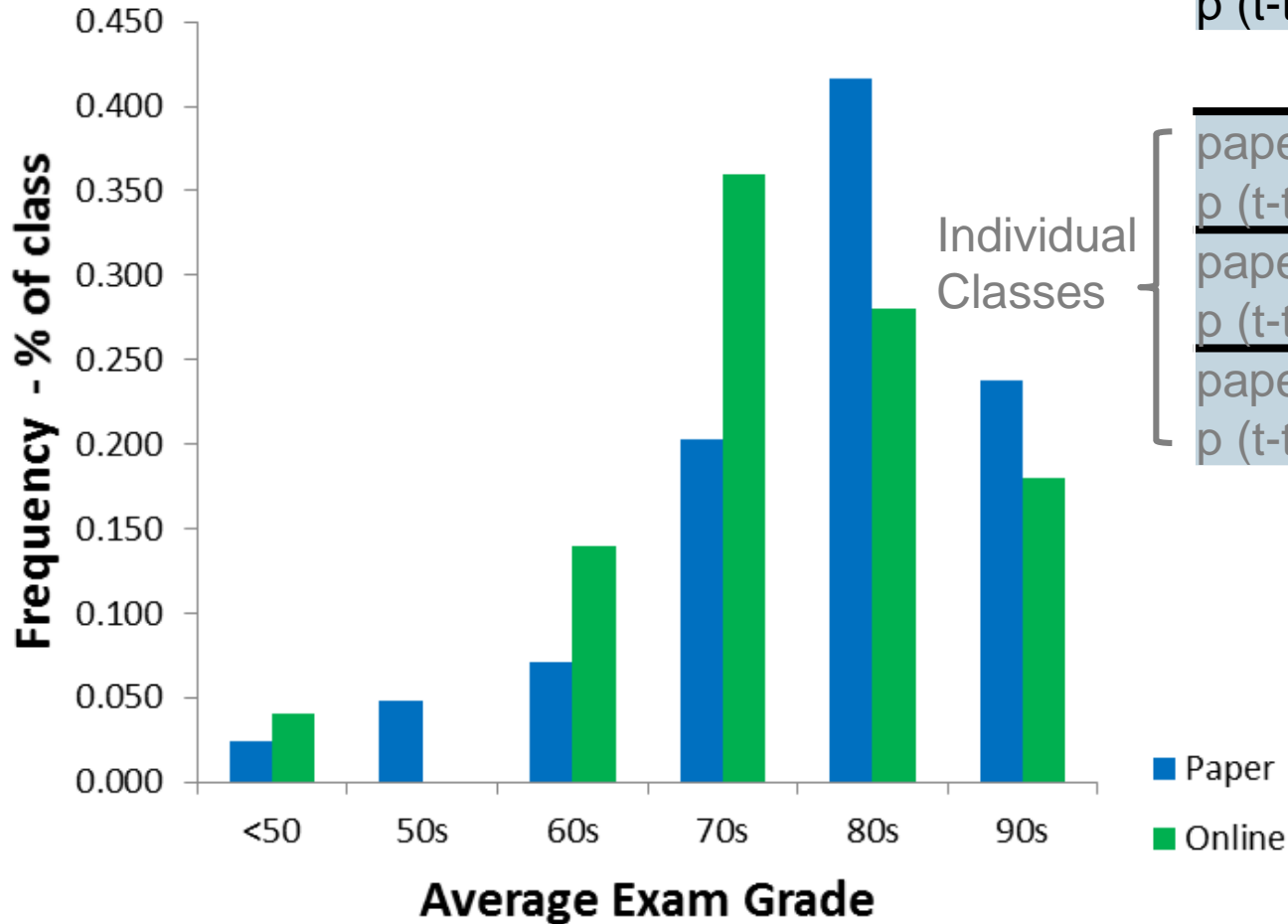
Step	Time	Action	State	Marks
1	24/02/14, 19:39	Started	Not complete	
2	24/02/14, 20:53	Submit: 60 Ω	Incorrect	0.00
3	24/02/14, 20:53	Submit: 20 Ω	Correct	2.70
4	26/02/14, 13:34	Attempt finished	Correct	2.70

Multiple Attempt History

Student Scores – Algebra Based Mechanics

Statistics for the three paper based classes →

	Homework	Exams	Final
online (n = 50)	80.6 ± 22.5	79.2 ± 11.9	81.4 ± 11.3
paper (n = 84)	86.1 ± 10.0	81.8 ± 12.3	83.6 ± 7.8
p (t-test)	0.11	0.29	0.24



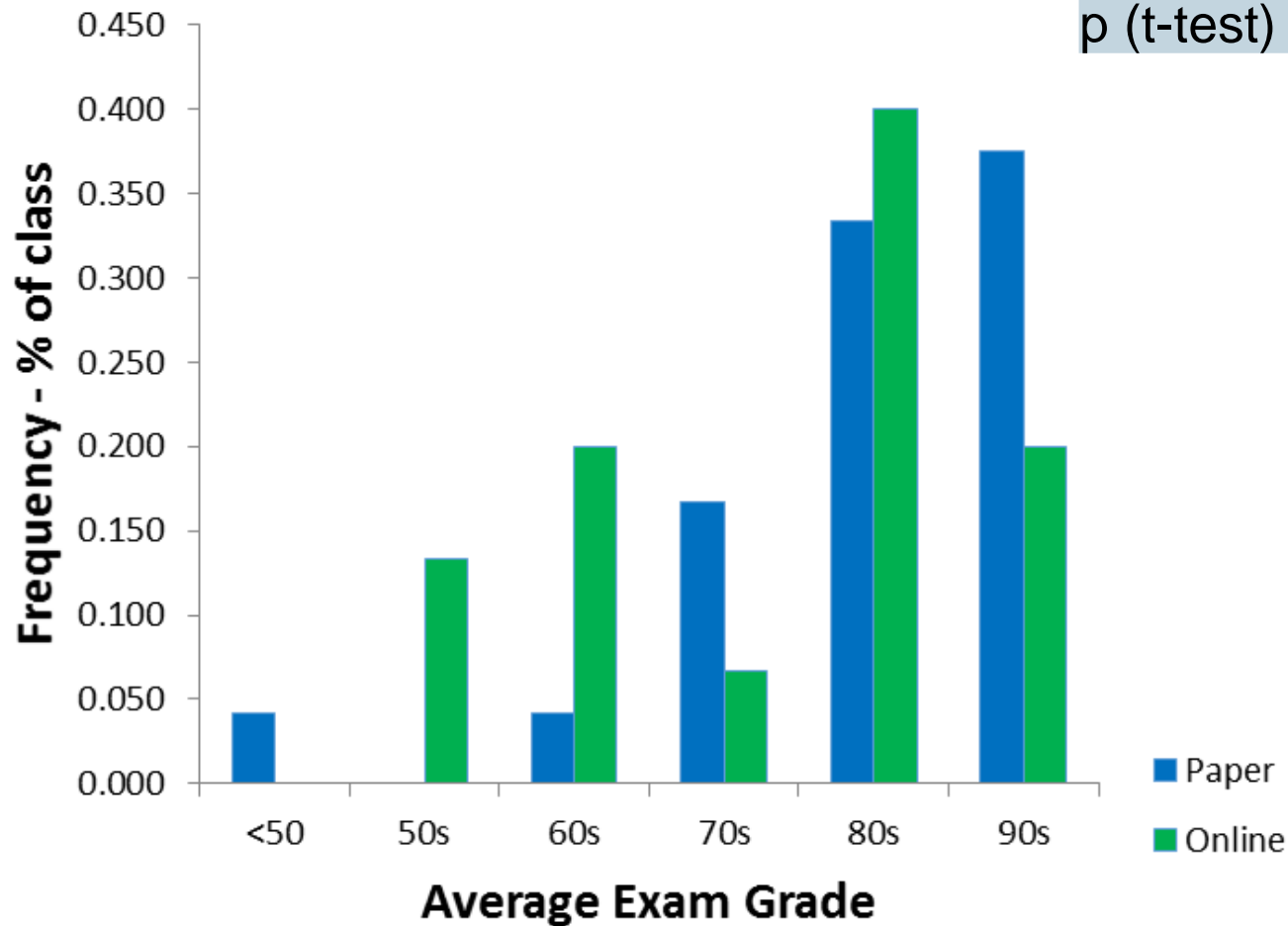
paper (n = 22)	84.4 ± 9.4	85.9 ± 13.2	84.2 ± 7.8
p (t-test)	0.30	0.006	0.16
paper (n = 31)	86.9 ± 10.2	80.5 ± 15.9	84.3 ± 9.4
p (t-test)	0.09	0.69	0.22
paper (n = 31)	86.5 ± 10.3	79.4 ± 9.4	82.4 ± 7.3
p (t-test)	0.11	0.93	0.64

p statistic is comparison of paper vs online class

Scores are not significantly different for online based homework

Student Scores – Calculus Based Mechanics

	Homework	Exams	Final
online (n = 15)	77.5 ± 20.6	79.3 ± 13.4	80.1 ± 12.3
paper (n = 24)	78.9 ± 21.6	84.5 ± 17.2	79.3 ± 26.0
p (t-test)	0.85	0.22	0.90

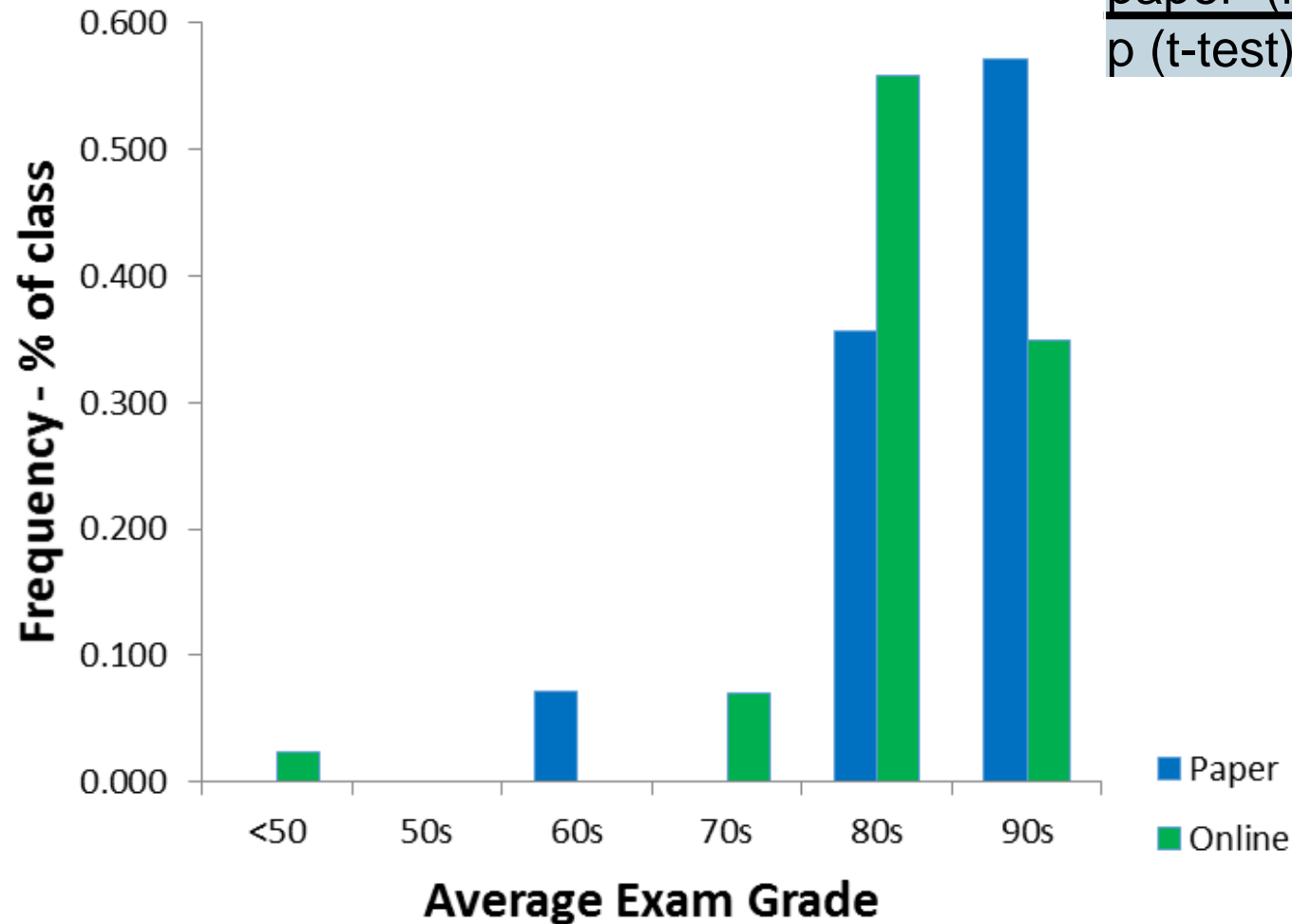


p statistic is comparison of paper vs online class

Scores are not significantly different for online based homework

Student Scores – Algebra Based EM/Light

	Homework	Exams	Final
online (n = 43)	92.4 ± 11.6	89.5 ± 14.7	87.6 ± 14.6
paper (n = 14)	87.7 ± 13.1	89.4 ± 9.1	89.5 ± 7.4
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 Format¹³

Likes

- INSTANT FEEDBACK⁵
- Hints for simple mistakes
- Full explanation after correct submission
- Multi-step problems shows logic of problem solving
- Can rework problem⁵

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

⁵Fynewever , 2008

¹³ Richards-Babb, 2011

Games for Learning



People learn while playing games^{6,10}

Why do people like to play games?

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

⁶Green, 2010

¹⁰Mayo, 2007

Homework = Game?

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

Video games activate reward centers in the brain⁷

Student Comments:

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

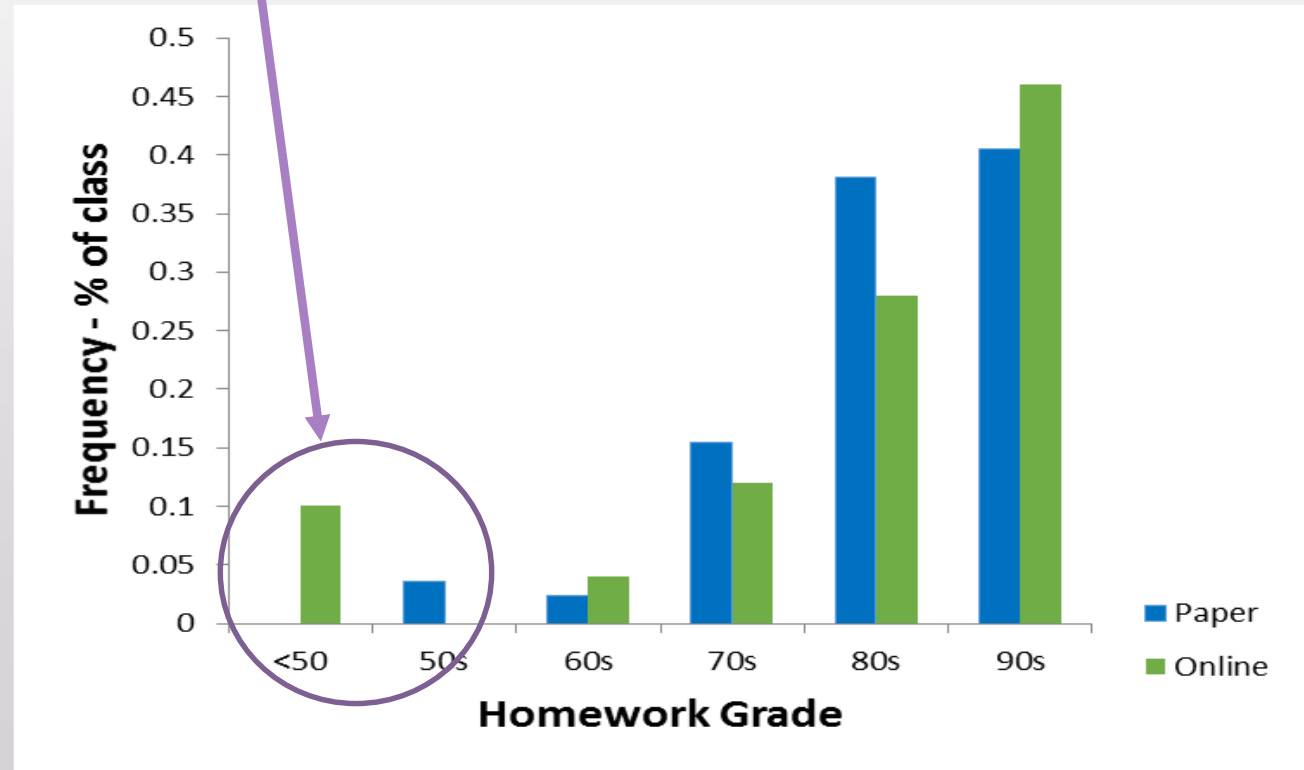
⁷Keopp, 1998

The screenshot shows a homework question interface. On the left, a sidebar indicates 'Question 3' is 'Correct' with a score of 'Mark 2.70 out of 3.00'. The main area displays the question: 'SECTION 17.4 RESISTANCE, RESISTIVITY, AND OHMS LAW' and '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.' The user has entered '20' in a text box, which is highlighted in green and marked with a checkmark. A dropdown menu shows the unit 'Ω'. A 'Check' button is visible. Below the input, a yellow feedback box states: 'Correct. Use Ohm's Law $R = \frac{\Delta V}{I} = \frac{120V}{6.0A}$. The correct answer is: 20 Ω'. A green bar at the bottom of the feedback box says 'Correct'. At the very bottom, it says 'Marks for this submission: 3.00/3.00. Accounting for previous tries, this gives 2.70/3.00.'

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



Student Problem Approach

Pascarella divides students into four types¹²

Thinkers		Guessers	
Work problem logically		Use examples to try to find equation	
Traditional	CAPA	Traditional	CAPA
Check solution logically - Rework	Check solution against computer	No checking of answer - Stop	Check solution against computer

(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 attempts¹⁴

Advantages

- ▶ Students can work with each other, but direct coping is not possible since each student receives different values.
- ▶ Elimination of homework grading time⁵
 - 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 students⁸
 - 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

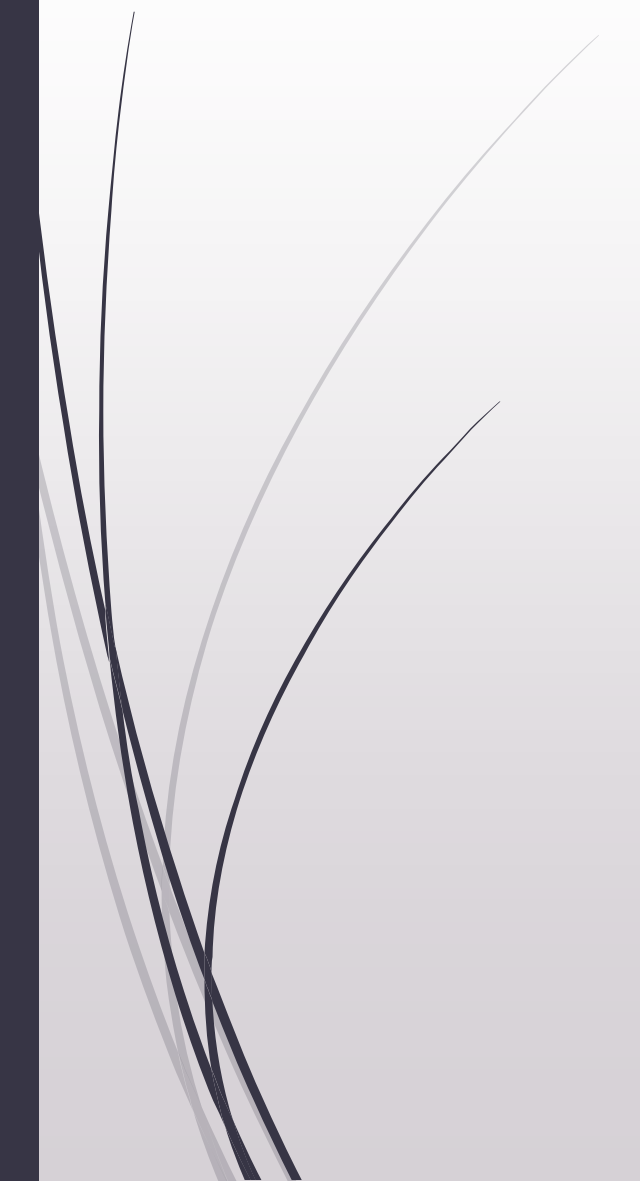
Monitor Student Progress

Moodle Instructor View of an Assignment

Time taken	Grade/100.00	Q. 1 /3.00	Q. 2 /1.00	Q. 3 /1.00	Q. 4 /1.00	Q. 5 /2.00	Q. 6 /3.00	Q. 7 /5.00	Q. 8 /5.00	Q. 9 /5.00	Q. 10 /5.00	Q. 11 /5.00
7 days 2 hours	98.90	3.00 ✓	1.00 ✓	1.00 ✓	1.00 ✓	2.00 ✓	3.00 ✓	5.00 ✓	5.00 ✓	5.00 ✓	5.00 ✓	5.00 ✓
7 days 4 hours	96.40	2.70 ✓	1.00 ✓	1.00 ✓	1.00 ✓	2.00 ✓	3.00 ✓	4.00 ✓	5.00 ✓	4.50 ✓	5.00 ✓	5.00 ✓
8 days 3 hours	73.35	2.70 ✓	1.00 ✓	0.75 ✓	1.00 ✓	2.00 ✓	2.40 ✓	4.50 ✓	5.00 ✓	5.00 ✓	5.00 ✓	5.00 ✓
8 days	76.55	3.00 ✓	1.00 ✓	0.25 ✓	1.00 ✓	1.60 ✓	2.40 ✓	4.00 ✓	5.00 ✓	0.00 ✗	0.00 ✗	5.00 ✓
6 days 3 hours	94.30	3.00 ✓	1.00 ✓	0.50 ✓	1.00 ✓	1.60 ✓	3.00 ✓	4.00 ✓	5.00 ✓	5.00 ✓	5.00 ✓	5.00 ✓
7 days	87.95	2.70 ✓	1.00 ✓	0.25 ✓	1.00 ✓	2.00 ✓	2.70 ✓	1.50 ✓	4.50 ✓	5.00 ✓	5.00 ✓	5.00 ✓



Conclusion

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

- Acknowledgements
 - Loras College
 - Students in Introductory courses