



Students – Ask Them to Eat Their Vegetables!

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Abstract

As entry level mechanics class sizes in engineering programs continue to grow, some classes swell to several hundreds of students per class [1], many faculty are turning to online homework based systems (Pearson's Mastering, Wiley Plus and/or McGraw Hill's Connect). These systems provide content, grading and assessment of student work, and feedback to the students while solving problems. One of the things that is missing from all of these tools is the capability to assess the student's communication of their thought process as they progress through a problem. Most problems in these systems provide step-by-step guidance where students are asked to "fill-in-the-blanks" with their answers. They do not allow for independent thought for the students to analyze and solve a problem in a manner that might make sense to themselves. In addition, they do not allow for analysis of that thought process by the faculty. Finally, there is no capability to assess technical communication through drawings and presentation of the solution.

There is still debate as to whether these homework systems are the best mode of education for students. This paper illustrates the want from, and benefits to, students for both hand written and online homework. Teaching students how to solve a problem and present their work allows students to perform better on exams and instills a formal/orderly documentation process that may be used in future technical communication [2], [3]. Students appreciate the instant feedback from online homework systems [3]. Maybe there is a middle ground? This paper attempts to identify if students believe that handwritten and online homework are both helpful to their learning. Student evaluations of coursework indicate there is a desire for better online homework systems and/or a desire to return to hand written homework due to issues with online homework systems.

Introduction

There has been a lot of work assessing and analyzing the correlation between student performance on online homework assignments and exams [4]–[7]. A longitudinal study shows online homework leads to better student performance [8]. Others suggest there is no difference between using online homework systems and traditional pencil and paper homework [9]. Some indicate that there are very tangled correlations between online homework performance and the metrics used to quantify difference [10]. Those authors also showed that 31% of students actually preferred "traditional" (hand graded) homework assignments [10]. Another study analyzed five other works and found that hand graded homework had a significant positive impact on student learning. Finally, a study in Economics correlated attitudes toward online homework systems with factors such as motivation, GPA and intended major. They demonstrated that course specific motivation was strongly correlated with a student's attitude toward online homework [11].

Wherever you go, there is support for both cases – using online homework in your classes or using traditional (hand written) homework in your classes [3], [12]. So what is the answer? Maybe it is both. Only a few studies have investigated if the mixture of online and hand written homework affects student performance on graded events [5], [13]. Davis and McDonald showed that between three modes of homework (Online Only, Hand Written only and Hybrid) students performed best when a hybrid style of (both online and hand written) homework was assigned

[5], [14]. Students illustrate here that they understand handwritten work will be beneficial to them in the future. Therefore, we suggest that asking students to eat their ice cream (Online homework) along with their vegetables (Hand written homework) may be a good way of students learning material and practicing problem solving. Similar hybrid approaches have proven to be successful in other disciplines as well [14].

Methods

Engineering students at the University of Southern Indiana have experience with online homework in some of their Math/Calculus (WebWork) classes, and most of their Physics classes (Mastering Engineering & Wiley Plus). In Engineering, there are a variety of options; faculty can decide on textbooks and choose whether or not to use the online homework systems.

Here, we surveyed over 60 engineering students in Statics, Strength of Materials and/or Dynamics classes (all of whom had been exposed to an online homework system) to help understand the desire for or against using online homework systems in class. Our goal is to *begin* to better understand students' attitude toward online and traditional (hand written – the “vegetables”) homework to best determine how to use it to students (and our) advantage. As a preliminary study, students were asked:

1. Which types of problems (Multiple Choice, Fill in the Blank or Handwritten) are best for which area of study (Math, Physics, and Engineering)?
2. To what degree did you find online homework helpful?
3. Which types of problems will help in your career?

Results

Results (Fig. 1 below) indicate that students overwhelmingly feel hand written homework is best suited for the Engineering discipline (over 90%). Furthermore, 57-60% of these same students indicate that this type of solution is appropriate in the Math and Physics disciplines, so most students do see value in traditional homework methods. So why are faculty using online homework problems in these classes? One reason may be student retention. A consistent focus of universities is student retention; and it is approached in different ways[15]–[17]. With larger class sizes negatively correlated with student performance [18], online homework systems are becoming necessary to retain students while providing assessment in a timely manner. Students obviously like and find online homework systems helpful (See Fig. 2 below).

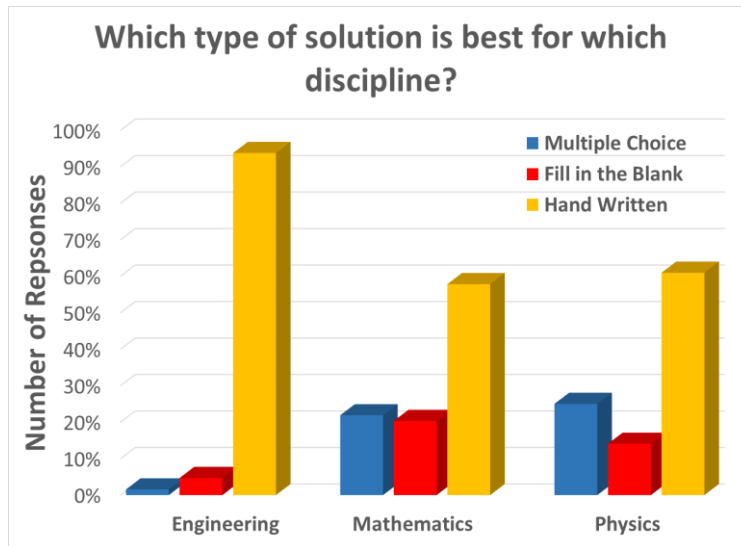


Figure 1. Survey Results for Which Question Type is Best for Which Discipline

Over 90% of the responses of these engineering students indicate that they think hand written homework solutions are best for the engineering discipline. Fewer percentages of students feel that Physics and Math classes are suited for hand written problems, but it still does garner over 60% of the problem type for each discipline.

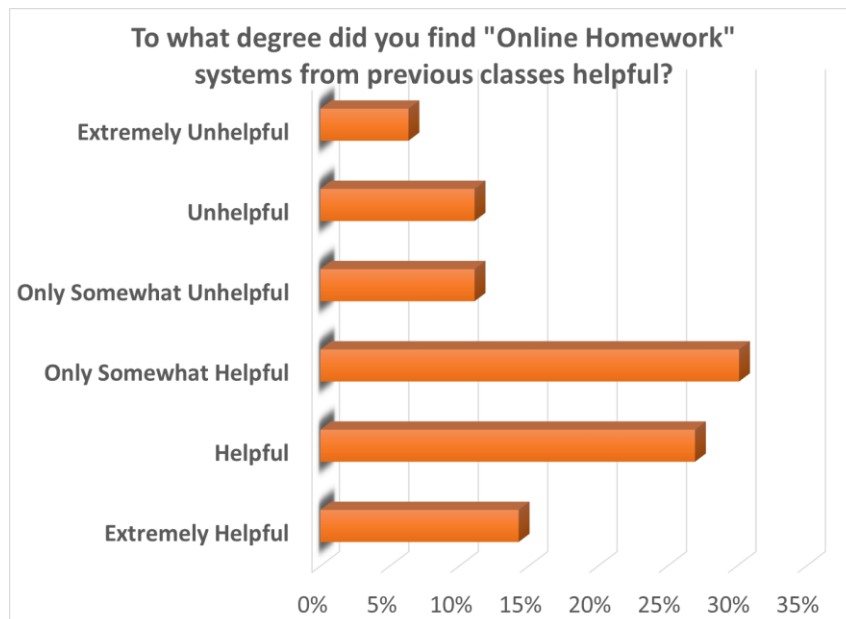


Figure 2. Students do feel that Online Homework is helpful in their classes

Over 75% of students described online homework as helpful (responses of Only Somewhat Helpful – Extremely Helpful) in their classes. So, there is utility in asking students to work problems using an online homework system. It seems that the students appreciate the practice and the instantaneous feedback and solutions.

They provide instantaneous answers for students to check their solutions. They also provide hints along the way should students need a little push to check a concept. In this vein, online homework systems are one mechanism to cater to student's likes to keep them engaged in the course. Students do indicate that they like the software and find it helpful (see Fig. 3 below).

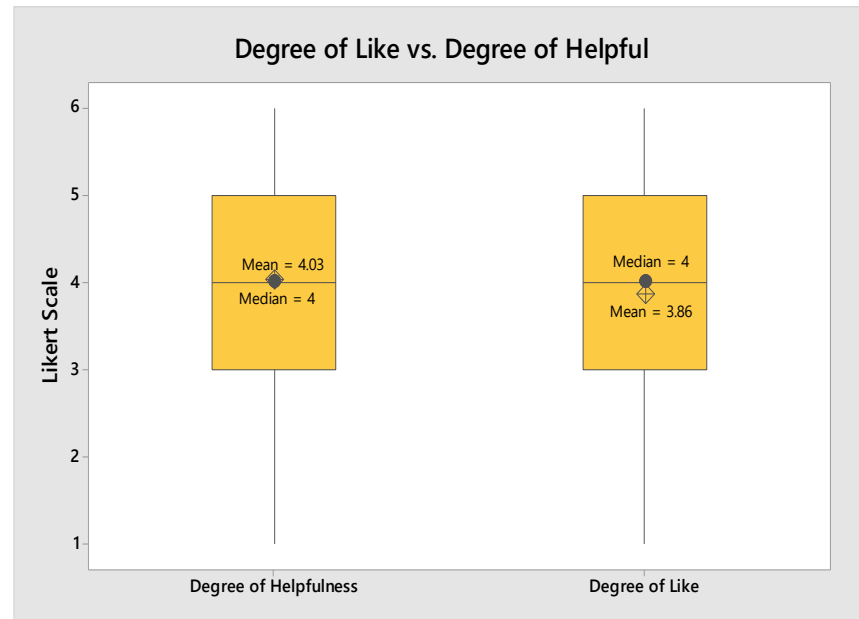


Figure 3. Students Find Online Homework Systems Helpful and Like it

Overall, students do find Online homework helpful and like it. These plots show on Likert scales from 1 to 6 that students find the Online Homework Systems somewhat helpful.

Likert Scale: 1 = Strongly Dislike to 6 = Strongly Like and

Likert Scale: 1 = Extremely Unhelpful to 6 = Extremely Helpful

Even more interesting, however, is that of those students who registered that they *did not* like online homework, many still indicated that they found it helpful (see Fig. 4 – below). So there is value in assigning online homework. There needs to be a good way of using it to the faculty's and to the student's advantage.

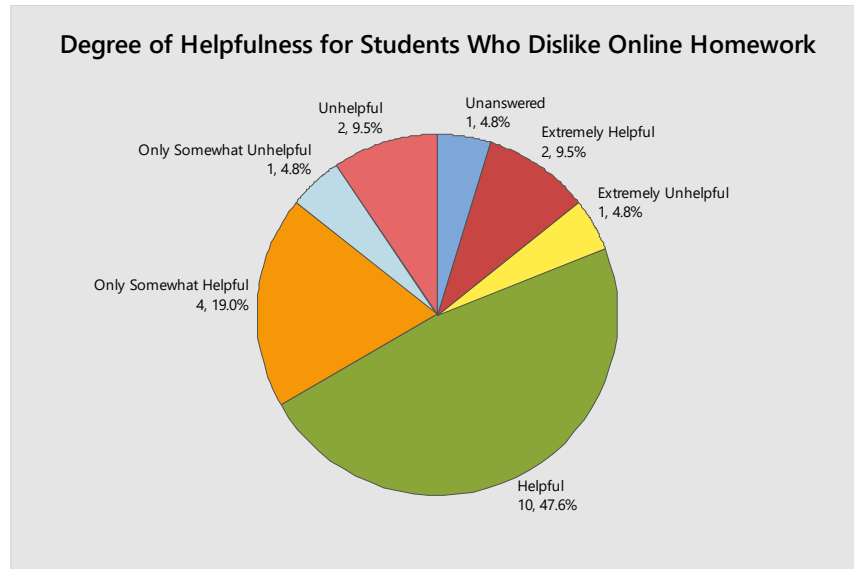


Figure 4. Students who dislike Online Homework still find it Helpful

From all the students who indicated a dislike for online homework, there is still an indication that it is helpful – and even “Somewhat helpful”

Most interesting in this preliminary study is the following result: over 71 percent of student responses identify hand written work as being the most beneficial in their future career. Some identified that they will need all three skills (Multiple Choice, Fill in the Blank and Hand Written). Overwhelmingly, engineering students are telling us that they think it is important to learn how to hand write their solutions; how to communicate their solution using a pencil and paper.

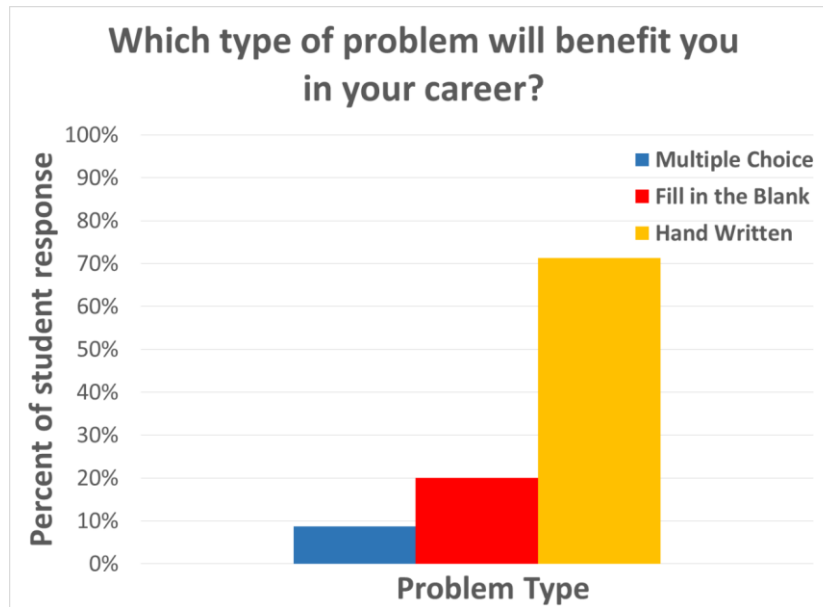


Figure 5. Which type of problem is best for your career

Over 70% of the responses indicate that students feel that a hand written solution will benefit them in their career. (Note that some students selected multiple types of problems.)

Discussion

While there are positives and negatives to using online homework systems in a course, it seems obvious that the trick is to find the balance between both styles for *your* course. Using online systems can provide students feedback and practice that can positively affect their attitude toward the class. It also allows for students to perform a self-assessment of different topics within the course. Though access to solutions manuals may be a method of circumventing this, randomization of given numbers in Online homework systems could be a benefit in asking students to at least practice solving problems. However, if this is the only method of formative assessment, it may be a disservice to the students' education.

Online homework systems do not yet provide students feedback towards the problem-solving-methodology and technical communication of their method. This is where the hand grading must step in. Though large class sizes make hand grading large homework sets in detail an almost unfeasible task for faculty and teaching assistants, a reduced load can be achieved by selecting one or two problems to grade. This may be the best way to assess the problem-solving-methods and technical communication. This could be a method of formative assessment that can scaffold onto the online homework assessment and student's self-assessment.

From previous courses in which online homework systems were used in conjunction with hand written homework [6], those authors found that student performance on homework was enhanced significantly. Online homework systems can still improve the technical communication portion and illustration/formatting of problem solution portion of their systems before relying solely on online homework systems as the ONLY method for low stake assessment of learning. However, it seems as if every year publishers are making advances in online homework technology. So, in

the meantime, maybe the middle ground is to lessen the grading load on faculty and teaching assistants, while still providing an opportunity for students to practice the problem solving with online homework.

Future work will apply similar hybrid homework assignment methods to mechanics courses to evaluate best practices in how to utilize both methods of homework. Our thoughts are to ask them to eat their vegetables – practicing and refining their solutions with hand written homework where they can clearly communicate their solution, before they get their ice cream – the instant gratification of the knowing if they are right or wrong from online homework.

Conclusions

With many schools turning towards online homework systems as a method for assigning homework and assessing students, it is worth asking the students if they value it, and if they value it with respect to how it is being used. Certainly, there is literature backing both sides of the coin; for and against, online systems and traditional homework methods [3], [4], [7]–[9], [11]. Students however, are clearly asking for both, and indicate that both will probably be helpful. Similar hybrid approaches have proven to be successful in other disciplines [14]. Maybe we should ask them to eat their vegetables alongside their ice cream!

References

- [1] M. F. Schar, A. M. Harris, R. J. Witt, R. Rice, and S. D. Sheppard, “Connecting for Success; The Impact of Student-to-Other Closeness on Performance in Large-Scale Engineering Classes,” p. 23, 2016.
- [2] J. L. Davis and T. McDonald, “Can Enforcing an Organized Solution Lead to Better Grades ? Can enforcing an organized solution lead to better grades ?,” *2016 ASEE Annu. Conf. Expo.*, 2016.
- [3] J. Penner, E. Kreuze, S. Langsam, and J. Kreuze, “Online Homework versus Pen and Pencil Homework: Do the benefits outweigh the costs?,” 2010.
- [4] R. O’Neill, A. Badir, L. D. Nguyen, and D. J. Lura, “Homework methods in engineering mechanics, part two,” *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2016–June, 2016.
- [5] J. L. Davis and T. N. McDonald, “Online, Handwritten or Hybrid Homework: What’s best for our students in the long run?,” *J. Online Eng. Educ.*, vol. 6, no. 2, pp. 4–7, 2016.
- [6] J. L. Davis and T. N. McDonald, “Online Homework: Does it Help or Hurt in the Long Run?,” in *Proceedings of the 2014 ASEE Conference*, 2014.
- [7] H. G. Cooke, “Impact of Mastering Engineering on Student Learning and Perceptions in a Strength of Materials Course,” no. June, 2017.
- [8] M. L. Arora, Y. J. Rho, and C. Masson, “Longitudinal Study of Online Statics Homework as a Method to Improve Learning,” *J. STEM Educ. Innov. Res.*, vol. 14, no. 1, pp. 36–44, 2013.
- [9] V. Berardi, “The Impact of Using Randomized Homework Values on Student Learning,” vol. 11, no. 2, pp. 4–17, 2011.
- [10] J. Dillard-Eggers, “Evidence On The Effectiveness Of On-Line Homework,” *Coll. Teach. Methods Styles J.*, vol. 4, no. 5, 2008.
- [11] D. J. Doorn, S. Janssen, and M. O’Brien, “Student Attitudes and Approaches to Online Homework,” *Int. J. Scholarsh. Teach. Learn.*, vol. 4, no. 1, 2010.
- [12] H. J. Walberg, R. A. Paschal, and T. Weinstein, “Homework’ s powerful effects on

- learning,” *Educ. Leadersh.*, no. april, pp. 76–79, 1985.
- [13] E. A. Howard, “Purdue e-Pubs How do Millennial Engineering and Technology Students Experience Learning Through Traditional Teaching Methods Employed in the University Setting?,” 2011.
- [14] D. B. Smithrud and A. R. Pinhas, “Pencil-Paper Learning Should Be Combined with Online Homework Software,” *J. Chem. Educ.*, vol. 92, no. 12, pp. 1965–1970, 2015.
- [15] E. Hoover, “Spotlight on Retention,” *The Chronicle of Higher Education*, 09-Mar-2015.
- [16] D. Glenn, “In Student Retention, Attitude Seems to Matter Most,” *The Chronicle of Higher Education*, 02-Jun-2010.
- [17] L. Biemiller, “Can a Signature Program Save Your College?,” *The Chronicle of Higher Education*, 11-Mar-201AD.
- [18] J. Monks and R. M. Schmidt, “The Impact of Class Size on Outcomes in Higher Education,” *B. E. J. Econom. Anal. Policy*, vol. 11, no. 1, pp. 1–27, 2011.