



Investigating Students' Performance for Textbook and in-House Homework Assignments

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ABSTRACT

Homework assignments have always been an integral part of learning in all majors and disciplines. These assignments are usually selected from the textbook as these provide a variety of problems related to the topic at hand. Before the advent of internet, the solution manuals to these problems were confidential as they were in most cases hard copies mailed directly to the professor. Nowadays almost any problem in a textbook can have its solution available over the web, and many students are believed to have access. Since homework are sometimes used to assess the student learning outcomes, it is important to make sure the work presented by the students is descriptive of their understanding.

The objective of this paper was to compare and analyze the grades on homework assigned directly from the textbook and those created and assigned for the first time by the instructor. In the latter case, the solutions were impossible to find by the students. The aim was to investigate the differences in performance between the different cases. To this end, a number of instructors in several courses in the Mechanical Engineering Department were alternating homework assignments between those never seen before and the ones from the assigned textbook. The average class grades on these assignments were considered as the performance indicator examined to determine if there is a particular trend. The result of this study shows that the average for the in-house homework was less than that of textbook and the standard deviation for the in-house homework was higher than that of the textbook assigned. It indicates that in-house homework can be used to assess the student learning outcomes. In addition, this study also shows that the difference was higher for Dynamics than the Statics and Strength of Materials. It suggests that for more challenging courses, the differences are more pronounced.

INTRODUCTION

Assigning homework to students that is graded is very useful in helping students learn engineering topics. A study conducted at Cal-Poly [1] showed that students who didn't have access to solution manuals performed better than those who did when it comes to taking exams. A paper [2] entitled, "*Development of a Comprehensive Assessment Technique to Invigorate Students' Problem-Solving Skills and Deter Cheating*," also mentions that independent study on homework assignments enables students to develop greater cognitive level problem solving skills.

Homework is a very valuable tool in learning engineering. Therefore, we are concerned with our students whether they are copying the homework solutions available in internet and/or other sources. This has become especially evident when a student gets a perfect or near perfect overall score for their homework grade, yet their test scores are very low. A study by Wichita State University [3] mentions that approximately 70% of students in the U.S. were involved directly or indirectly in cheating during exams, homework, term projects, reports, papers and presentations using different techniques. According to a paper [4] entitled, "The Theory of Planned Behavior as a Model of Academic Dishonesty in Engineering and Humanities Undergraduates," plagiarism is one of the biggest problems related to cheating. While copying the home work answers from

solution manuals found on the internet may not be directly considered to be called plagiarism, it could still be construed to be the same thing.

Another obvious indication of cheating on homework became apparent when one of the authors of this paper used a textbook homework problem where the solution manual had solved it wrong. After grading the homework, it was found that several of the students solved it wrong in exactly the same manner that was done in the textbook solution. A paper entitled, “*Student Use of Textbook Solution Manuals: Student and Faculty Perspectives in a Large Mechanical Engineering Department*” indicated that 90% of engineering students have used the solution manual, and up to 75% of these students use the solutions on a regular basis [5]. Consequently, the main objective of this paper is to examine from our data how prevalent it is that the students at our institution are using the solution manual or other sources to solve their homework problems.

To accomplish this task, one of the techniques used at our institution was to compare and analyze the grades on homework problems assigned directly from the textbook and those created by the instructor. The fact that students do not have access to a detailed solution of the problems can be an indicator of the frequency in which the students used the solution manual to copy the answers.

METHOD

Data from three different courses in the Mechanical Engineering curriculum were collected for this study: MENG 240 (Statics), MENG 241 (Strength of Materials) and MENG 242 (Dynamics). We are in quarter system at our institution, and the entire course outlines are delivered to students within 10-weeks-time frame. While Statics and Strength of Materials are 4 hours of lecture per week, Dynamics meets 5 hours a week. Students are required to face extensive amount of 10 Homework Assignments, 3 exams and a final. All problems associated with HW and tests are required to be solved using a simple scientific calculator. One instructor taught all of these courses, wrote and graded all the assignments. This should reduce the inconsistencies in grading. Grading is done based on the approach and analysis of the problem and not so much on the final numerical results. Partial credit is given when a sound method is used. The descriptions of the courses are stated below.

- MENG 240 (Statics) objective is to understand the fundamentals of applied mechanics, equivalent force systems, equations of equilibrium, structures, three dimensional force systems and friction.
- MENG 241 (Strength of Materials) is a study of the internal stresses, internal deformations and deflections of materials. Topics may include: shear and moment diagrams for beams, combined loading on beams, temperature stresses and torsional loading.
- MENG 242 (Dynamics) objective is to understand the kinematics and kinetics of particles and rigid bodies using vector analysis; force mass acceleration, work and energy, impulse and momentum, translating and rotating coordinate system.

The two types of homework problems (in-house and textbook) were similar in difficulty and did not cover the same topic in every course. For example, if in one quarter, Newton’s Second Law is covered by in house assignment, it may not be the case for the next time around. This is to

ensure that the data does not reflect the difficulty of the topic. In addition, some in house problems were assigned more than once, without given any kind of solution to the students.

For MENG 242 (Dynamics) class, we are using the textbook, Dynamics (R. C. Hibbeler, 12th edition, Pearson). Sample examples of the textbook and in-house problems are shown below. In order to solve those example problems, students must be able to formulate the equations from rigid bodies undergoing translation, rotation about a fixed axis, and general plane motion. Textbook problem solutions can be found easily on internet search engine such as Google and Bing. However, the in-house homework problems can't be found that way.

Textbook Problems

The bar has a mass m and length l . If it is released from rest from the position $\theta = 30^\circ$, determine its angular acceleration and determine the horizontal component of reaction at the pin O.

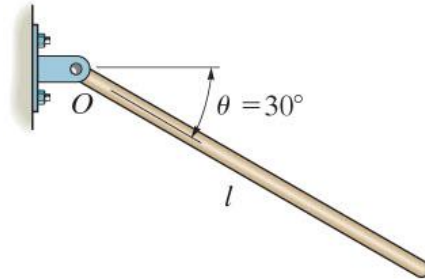


Figure 1: A typical textbook homework problem relating to Kinetics: Rotation about a fixed axis.

The slender rod of length L and mass m is released from rest when $\theta = 0^\circ$. Determine as a function of θ the normal and the frictional forces which are exerted by the ledge on the rod at A as it falls downward. At what angle θ does the rod begin to slip if the coefficient of static friction at A is μ ?

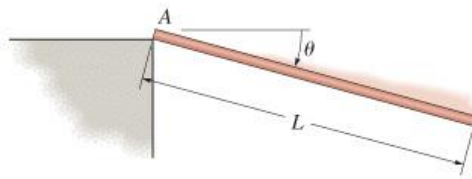


Figure 2: A typical textbook homework problem relating to Kinetics: General plane motion.

In-house problem

The bar is released from rest. Find the reactions at A at that moment if

- A is a pin
- A is a roller
- Find the minimum μ_s for it is not to slide.

Take $m_{bar} = 10$ kg, Length of bar, $L = 2$ m and $I_{bar} = \frac{1}{3}m_{bar}L^3$. Assume the bar is uniform.

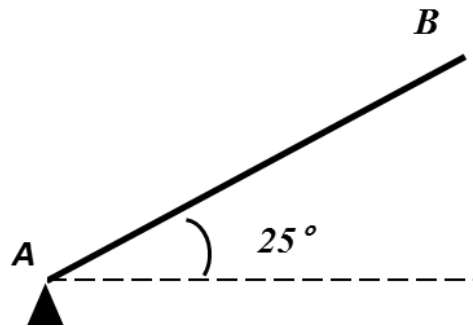


Figure 3: A typical in-house homework problem relating to Kinetics: Rotation about a fixed axis and general plane motion.

RESULTS AND DISCUSSIONS

The two types of homework problems (In-house and Textbook) were similar in difficulty and did not cover the same topic in every course. The total number of In-House HW assignments sets is 989 while the total number of Textbook HW assignments sets is 1583. Each set consists on average of 4 to 5 individual problems. The number of in-house assignments is lower due to the fact that they are extremely time consuming to write, and the authors felt that any kind of adjustment to include the same numbers in both cases might skew the results. On average there is about 7 to 9 assignments per course per quarter.

Table 1 lists average score and standard deviations for both types of homework. The average scores on in-house and textbook HW assignment were found to be 83.54% and 90.77%, respectively. Thus, the results show an increase of 7.22% in the grades for the textbook homework compared with the In-House homework assignments. What is interesting is the difference in the standard deviations. For textbook assigned type, the standard deviation is 2.02 while for the in-house assignments it is 7.16.

This difference can be seen in the histograms of Figure 4 and 5, there is a wider distribution of grades for the in-house type. This wider distribution is mainly towards the lower values of the scale. The authors suspect the difference between the standard deviation of the averages is the result of some students not being able to access the detailed solution.

Table 1: Class averages and standard deviations.

TERM and Course	Averages In-House	Averages Textbook
FALL 2011 STATICS	90.41	90.92
FALL 2012 STATICS	88.20	92.37
WINTER 2013 STRENGTH	91.27	92.15
SPRING 2013 DYNAMICS	98.48	94.75
FALL 2014 DYNAMICS	78.19	88.50
FALL 2014 STATICS	75.40	90.28
SPRING 2015 DYNAMICS	81.20	89.55
SPRING 2015 DYNAMICS	82.37	90.69
FALL 2017 DYNAMICS	81.22	n/a
FALL 2016 DYNAMICS	78.78	n/a
FALL 2016 STATICS	72.01	n/a
Fall 2017 STATICS	85.01	87.67
AVERAGES	83.54%	90.77%
STANDARD DEVIATIONS	7.17	2.02

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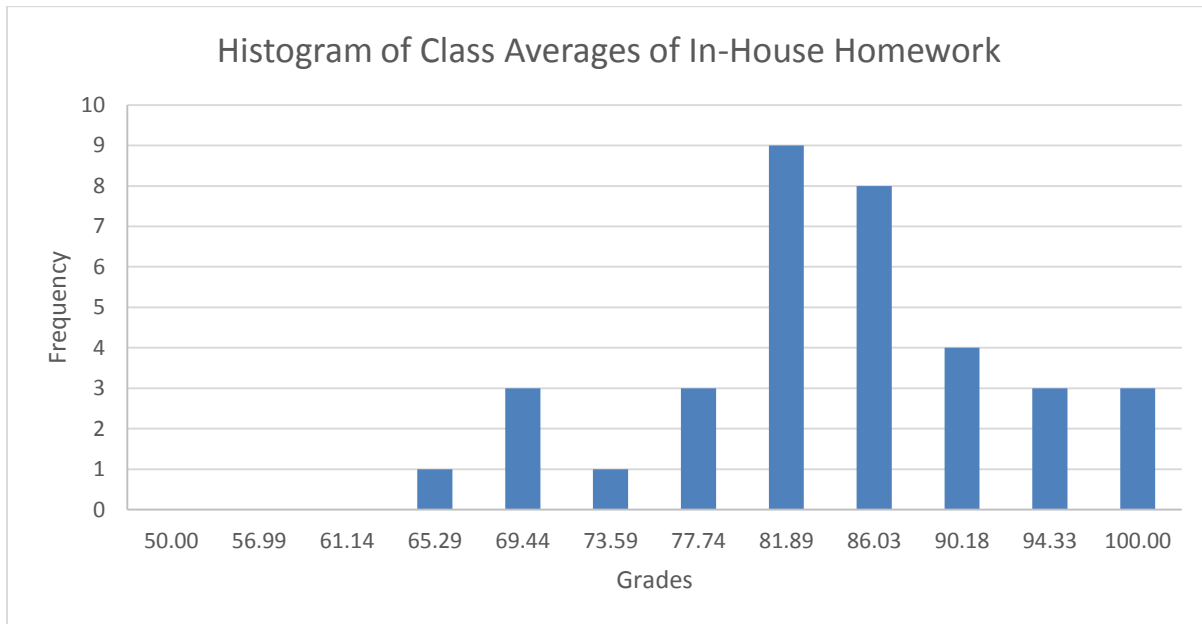


Figure 4: Histogram of the class averages of in-house assignments.

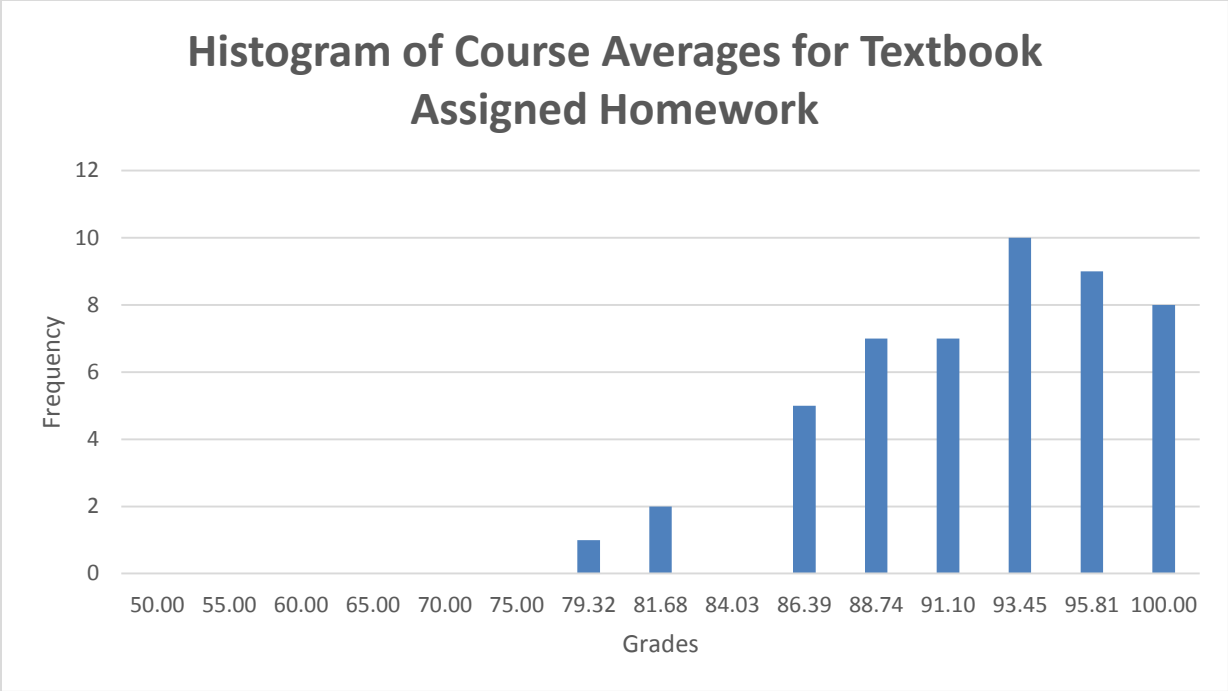


Figure 5. Histogram of the class averages for textbook assigned homework.

Table 2 lists the averages and standard deviations of the entire set of homework, i.e. all in-house and textbook assignments grades are lumped together in two groups. Here again, the results show the standard deviation to be higher for the in-house assignments than for the textbook assigned. This is shown in the histograms shown in figure 6. The spread in the data is clear for the in house assignments when comparing to the textbook assigned. It is important to note that while table 2 shows the standard deviations of the entire homework assignments lumped together (all in house of all courses together and all textbook assigned of all courses together) table 1 shows the standard deviations of the class averages for the two cases (in house and textbook assigned).

Table 2: Averages and standard deviations for all in house and textbook assignments (all courses combined together)

Average of all in-house assignments	Averages of all textbook assignments	Standard deviation of all in-house assignments	Standard deviation of all textbook assignments
83.54	90.77	15.63	11.92

Table 3 lists the results for the Dynamics, Statics and Strength of Materials courses taken together. This is because Dynamics is usually a more involved course and a more challenging one for the students due to the complexity of the topic. The idea is to see if the topic difficulty has an influence on the standard deviations. In this case also, the standard deviations are higher for the in-house assignments. The difference for the Dynamics course is about 5.93 while that for the Statics and Strength is 2.00. This difference might suggest that for harder courses not having access

to the solution manual has a more drastic effect. The difference in averages is also greater for the case of Dynamics than that of Statics and Strength of Materials.

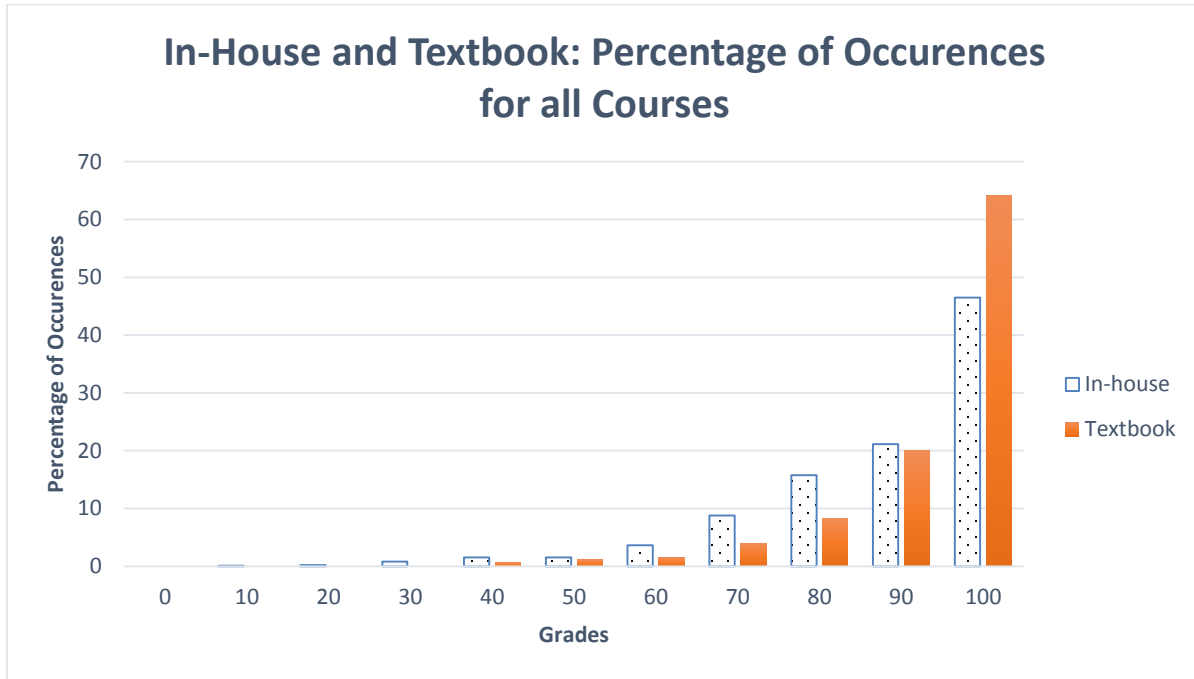


Figure 6: Histogram of all in-house and textbook assignments for all courses combined.

Table3: Standard Deviations and averages of homework assignments for Dynamics and Statics and Strength courses.

COURSE	Standard deviation In-house assigned	Standard deviation textbook assigned	Average in-house assignment	Average textbook assignment	Difference in Averages	Difference in Standard deviations
DYNAMICS	17.95	12.02	83.37%	91.37%	8.00%	5.93
STRENGTH & STATICS	15.02	13.20	83.72%	90.68%	6.96%	1.82

CONCLUSION

Homework problems were assigned in two different ways for three Mechanical Engineering courses. In one case, the problems are chosen from a textbook. In other case, the problems were created in-house. The main difference being that contrary to the textbook selected homework, the in-house problems have no solutions online. The data showed the following:

- 1) The average score of all in-house assignments was 7.22 percentage points lower than the average for the textbook assigned ones.
- 2) The standard deviation of all in-house assignments is 15.63 and the one for the textbook assigned one is 11.92.

- 3) The standard deviations of the of class averages also showed a value of 7.17 for in-house as opposed to textbook assigned at 2.00.
- 4) The standard deviations for the Dynamics course taken separately are 17.95 and 15.02 for in-house and textbook assigned, respectively.
- 5) The standard deviations for the Statics and Strength of Materials courses combined are 12.02 and 13.20 for in-house and textbook assigned, respectively.
- 6) The averages of the in-house and textbook homework for the Dynamics course taken separately are and 83.37% for in-house and 91.37% for the textbook assigned, respectively.
- 7) The averages for the Statics and Strength of Materials courses combined are 83.72% and 90.68% for in-house and textbook assigned, respectively.
- 8) The difference in averages between the two types of homework is 1% larger for the Dynamics course than the Statics and Strength of Materials courses combined.
- 9) The standard deviations difference for in house and textbook type is 5.93 for Dynamics and 1.82 for the Statics and Strength of Materials courses combined.

The data shows the averages for the in-house homework were consistently lower than those of the textbook assigned while their standard deviations were higher. Furthermore the differences in both the averages and standard deviations between in-house and textbook assigned are higher for the Dynamics than the Statics and Strength of Materials courses. This suggests that for more challenging courses the use of the solution manual becomes more prevalent. When considering the average differences for every course taken separately, except for one instance, all the averages were higher for the textbook assigned homework than the in-house. For that unique case, the in-house assignment given was only one assignment, the rest were textbook assigned.

Since a trend was detected for these specific courses and a specific instructor, the authors plan to study the data from other courses taught by other instructors in order to determine if this trend exists on a larger scale within the department, as well as investigating the relationship between homework and test scores.

REFERENCES

- [1] Widmann J., Shollenberger K. and Kennedy J. "Student use of author's textbook solution manuals: Effect on student learning of mechanics fundamentals." In: Proceedings of the 2007 American society for engineering education annual conference & exposition, Honolulu, Hawaii, 2007, pp.12.1319.1–12.1319.9. Washington, DC: ASEE.
- [2] Alemayehu F., Logan M., Barhorst A. "Development of a comprehensive assessment technique to invigorate students' problem-solving skills and deter cheating." International Journal of Mechanical Engineering Education, 2015, Vol. 43(4) 265-285.
- [3] Srikanth M., Asmatulu R. "Modern cheating techniques, their adverse effects on engineering education and preventions." International Journal of Mechanical Engineering Education, 2014, Vol. 42(2) 130-140.
- [4] T. S. Harding, M. J. Mayhew, C. J. Finelli and D. D. Carpenter, 'The Theory of Planned Behavior as a Model of Academic Dishonesty in Engineering and Humanities Undergraduates', *Ethics & Behavior*, 17(3) (2007), pp. 255–279.
- [5] Widmann J. and Shollenberger K. "Student use of textbook solution manuals: Student and faculty perspectives in a large mechanical engineering department." In: Proceedings

of the 2006 American society for engineering education annual conference & exposition, Chicago, Illinois, 2006, pp.11.1168.1–11.1168.9. Washington, DC: ASEE.