

2006-756: STUDENT USE OF TEXTBOOK SOLUTION MANUALS: STUDENT AND FACULTY PERSPECTIVES IN A LARGE MECHANICAL ENGINEERING DEPARTMENT

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Student use of Textbook Solution Manuals: Student and Faculty Perspectives in a Large Mechanical Engineering Department

Abstract

Anecdotal evidence indicates that Mechanical Engineering students have unprecedented access to textbook solutions manuals, and possibly a large percentage of students regularly refer to these manuals when working graded homework assignments. Many faculty voice concerns regarding the ethics of this behavior and its affect on student learning; however, the prevalence of the solutions manual usage and its effects on learning are not well documented. To better understand how students use solutions manuals, a survey was submitted to undergraduate students and faculty of the Mechanical Engineering Department at California Polytechnic State University, San Luis Obispo, as part of a larger study on the effects of solution manual access on student learning. The methodology emulates earlier studies at M.I.T.¹ and Georgia Tech² that addressed student perceptions of cheating. This survey was administered in a number of required courses, with multiple sections that are typically offered every quarter at Cal Poly. The goal of this survey was to determine the incidence rate of solution manual use and student perceptions on the ethics and educational value of using the solution manuals when working homework assignments. Faculty perceptions were also tabulated using a similar survey. Quantitative results are presented along with an assessment of interactions between student perceptions and their use of the solution manuals.

Introduction

California Polytechnic State University (Cal Poly), San Luis Obispo's College of Engineering has approximately 4600 undergraduate students, with about 1000 students enrolled in the Mechanical Engineering (ME) Department. The ME Department has 34 full-time faculty including tenure-track professors and lecturers and offers approximately 30 different courses each quarter, many with multiple sections. A defining feature of the Cal Poly approach to engineering education is giving the students many laboratory intensive, "hands-on" experiences coupled with small lecture class sizes (usually less than 36 students). These small lecture classes are to encourage close interactions between instructors and students. A typical junior or senior level class consists of three 50-minute lectures and one three-hour lab experience per week. An introductory class such as Statics, Dynamics, or first courses in Fluid Mechanics and Thermodynamics consist of only the lecture portion. The introductory classes are often required courses for students in other departments. Due to the large number of students and small class sizes, it is not unusual for the ME department to offer five to eight sections of Statics or Dynamics with two to four different instructors each quarter. The major objectives of these introductory courses are to impart an understanding of the theoretical basics of applied physics and instill in the students a formalized problem solving process. For the majority of the introductory courses, assigned homework is the prime mechanism of problem solving practice. This method of assigned and collected homework persists throughout the curriculum into the higher level classes that have the laboratory component. The usual source of the homework problems is the assigned textbook for the course. This is the most expedient method of

generating problems and providing correct solutions for student review after the homework is turned in. Typically the instructor is supplied a textbook solution manual with homework solutions for reference by the publisher of the class text. These textbook solution manuals have traditionally come in bound form, but are now more often found in electronic form on a CD or can be accessed by the instructor through a website provided by the publisher.

Background

Anecdotal evidence supplied by faculty in the ME department suggests that many students have access to a variety of non-instructor supplied resources to assist in working their homework assignments or writing laboratory reports. For many years the existence of compiled homework solutions and graded laboratory reports by organizations such as clubs, fraternities and engineering societies has been assumed. It is likely that these sets of compiled homework solutions and lab reports are employed by students to either assist in working homework assignments or simply for copying. Some faculty consider this type of resource at worst a severe form of academic dishonesty (“cheating” or plagiarism) or at least an unfair advantage for the student with access to these files. A more recent trend noted by the faculty of the ME department is student submitted homework assignments that contain solutions that are direct copies from the textbook solution manual. In some instances students have come to faculty members during office hours with text book solution manual pages seeking explanations of the author’s approach. Informal discussion with the ME faculty indicate that some feel this is a form of cheating and should likely be discouraged and/or punished although little consensus seems to exist on strict guidelines concerning the student use of textbook solution manuals. This situation is not unique to the ME department at Cal Poly. A faculty member in another engineering department indicated that he has taught a course where he specifically forbid the students from using the textbook solution manual; meanwhile, a colleague teaching the same course in the same quarter put the textbook solution manual on reserve in the library and encouraged his students to use it as a resource for working homework problems.

The apparent availability of solution files and textbook solution manuals to students raises several questions that have not been adequately answered. Questions include the rate of usage and in what manner are the students are using the manuals? For example, do the students use the manuals as an aid to homework solutions, directly copying, and/or as study guides for exams? Also unknown is the student’s perception as to whether the use of these sources is a form of academic dishonesty or simply an aid to learning. It is also clear that the faculty in the ME department have varied perceptions of how often and in what capacity the students are using the manuals and whether it is a form of “cheating”. Research concerning academic dishonesty among engineering students is reviewed thoroughly by Harding³. His survey shows that 72% of engineering students would consider the direct copying of homework solutions as cheating. This study was based on surveys of 65 engineering students. Harding along with Ozment, et al², discuss the causes of this cheating as well. An earlier study at M.I.T.¹ in 1993 indicated that the most widespread form of cheating at that institution was on homework problem sets. A more recent cheating scandal at the University of Virginia that was nationally publicized involved published answer keys to textbook problems⁴. As for the usefulness of homework solutions to the students, Eschenbach⁵ describes results of a study in which students were asked to check their solutions using provided examples of “Beautiful Homework” solutions written by other

students prior to handing in the assignments. The students in that study indicated that this would be a useful aid to learning in all four of the introductory course listed previously. Finally, defining what constitutes cheating at Cal Poly is largely at the discretion of the instructor as long as it is clearly articulated to the students⁶.

Survey Design

Two separate surveys were written for students and faculty. The direct survey question (DSQ) approach was chosen for this study because of its simplicity. To encourage honesty the student surveys were anonymous. Surveys were administered during class time, to ensure a high response rate, in the last two weeks of the fall 2005 quarter after completion of the majority of homework assignments. A total of 20 and 17 multiple choice questions were asked on the student and faculty surveys, respectively. The initial survey questions were used to establish background information such as gender, age, year in school, and department. The remaining survey questions were used to determine the following: (1) if students and faculty regarded assigned homework and problem solutions as useful, (2) if the use of solution manuals has been forbidden, (3) if using a textbook solution manual to solve assigned homework problems is cheating, and (4) how many students use textbook solution manuals and how they are used. These questions were typically asked first in general and then specifically for the class during which the survey was completed. Response choices ranged from strongly agreeing to strongly disagreeing on a scale of one to five or from always to never on a scale of one to four.

Survey Results and Discussion

The surveys were completed by 674 engineering students (67.4% mechanical, 15.6% civil and environmental, 6.2% aerospace, and 10.2% other engineering) and 13 mechanical engineering faculty. There are approximately 4,600 engineering students enrolled at Cal Poly, thus the survey was completed by about 14.6% of this population. For mechanical engineering alone, there are approximately 1000 students and 34 full-time faculty, thus this represents 45% of the students and 38% of the faculty. This sample is a reasonable representation of mechanical engineering student population at Cal Poly and, to a lesser degree, the engineering student population at Cal Poly in general. Classes surveyed included sophomore (200 level, 59.1%), junior (300 level, 30.5%), and senior (400 level, 10.4%) classes as shown in Table 1. Multiple sections and faculty were surveyed for many of the classes.

Table 1. Courses, sections, faculty, and number of students surveyed.

Course	Number of Sections	Faculty Position	Number of Students
ME 211, Statics	5	1 lecturer	142 (21.1%)
ME 212, Dynamics	5	1 lecturer, 2 professors	174 (25.8%)
ME 236, Measurement Uncertainty	3	1 professor	82 (12.2%)
ME 303, Thermodynamics II	3	1 retired professor	94 (13.9%)
ME 329, Intermediate Design	2	1 professor	64 (9.5%)
ME 347, Fluid Mechanics II	2	1 professor	48 (7.1%)
ME 422, Mechanical Controls Systems	2	1 professor	46 (6.8%)
ME 423, Robotics	1	1 professor	24 (3.6%)

For the students surveyed, 19.4% are under 20, 75.0 % are between 20 and 24, 3.6% are between 25 and 30, and 2.0% are above 30 years of age. This is consistent with the “traditional age” student body at Cal Poly. The sample consisted of 0.2% freshmen, 20.5% sophomore, 33.1% junior, 28.3% senior, and 17.9% five years or more. Again, this is consistent with the level of classes surveyed and the typical graduation rate of five years. Most of the students (76.3%) were admitted as freshmen. For the classes surveyed, all but two of the classes, ME 236 and ME 423, had a solution manual in electronic form available to the students.

Assigned Homework Problems and Problem Solutions Useful

Three survey questions were asked to determine if students and faculty regarded assigned homework and problem solutions as useful. Most of the students agree (44% strongly agree, 31% somewhat agree, and 14% agree) that “turning in assigned homework problems contributes significantly” to their “understanding of a subject” while 7% somewhat disagree and 4% strongly disagree. One student commented that they strongly agreed that doing homework problems is useful, “but they don’t have to be assigned and graded.” Another student stated that their usefulness “depends on the course; some people need to have homework graded/turned in to get them motivated to do their homework.” When we consider the 200 level classes versus the 300 level classes the number of students who strongly agree that assigned homework is useful shifts from 41% to 49%, respectively. This is offset by a shift of students who somewhat agree from 35% to 25% for 200 and 300 level classes, respectively. This suggests that older students value assigned homework more. The faculty surveyed are more certain that assigned homework contributes significantly to the students’ understanding of a subject with 85% strongly agreeing and 15% somewhat agreeing.

The second question asked students if “any solutions to textbook problems (other than the example problems included in the text) are a useful study guide.” Again most students agree, but this time more strongly (67% strongly agree, 19% somewhat agree, and 11% agree) and still only a few disagree (2.5% somewhat disagree and 0.5% strongly disagree). In contrast, the faculty no longer agree as strongly (25% strongly agree, 33% somewhat agree, and 17% agree) and 25% now somewhat disagree. This suggests that students rely heavily on using problem solutions to learn course material and that faculty are less certain about the effectiveness of this method of learning. The third question asked with respect to the course being surveyed was “do you generally find the textbook solution manual a useful study guide?” Of the students who used the textbook solution manual, 51% stated it was always useful, 24% occasionally useful, and 16% rarely useful. By contrast, faculty were asked if “textbook solution manuals are a useful study guide for students?” This time most faculty disagreed (8% strongly agreed, 15% somewhat agreed, 15% agreed, 31% somewhat disagree and 31% strongly disagreed). Again, students are much more convinced that reviewing solved problems is an effective way to learn a subject.

Forbidden Use of Solution Manuals

We then asked if the use of “textbook solution manuals as an aid to solving assigned homework problems” has been forbidden for any course at Cal Poly or for the course being surveyed in particular. Note that Cal Poly’s official policy on cheating does not specifically mention assigned homework problems in any way. About half of the students (43%) indicated that they have been

in courses at Cal Poly where they have been forbidden. This is consistent with 46% of the faculty stating they have at some time forbidden their use. One student commented that instructors have “forbid us from copying, but not using for help.” Another student stated “she just said don’t plagiarize (i.e. copy) although she made it very clear she didn’t approve.” When asked specifically for the course being surveyed, the answers shifted significantly. In particular, only 26% of the students and 31% of the faculty now indicated that the use of textbook solution manuals is forbidden. This suggests that faculty have forbidden their use more often in previous years. In order to check the correlation between the faculty’s and students’ perception for each class, Table 2 shows the responses to this question for each faculty member. For the four cases where the faculty felt they had forbidden the use of the textbook solution manual, only one of the sections had a large number of students (84%) acknowledging that it had been forbidden. For the six cases where the faculty felt they had not forbidden the use of the textbook solution manual, the students perception ranged widely (1% to 39% thinking it had been forbidden).

Table 2. Comparison of faculty and student responses for whether the textbook solution manual has been forbidden for each course surveyed.

Course	Faculty Response	Student Response (Yes)
ME 211	no	13%
ME 212, 3 sections	yes	84%
ME 212, 1 section	no	39%
ME 212, 1 section	yes	21%
ME 236	yes	22%
ME 303	no	1%
ME 329	no	5%
ME 347	no	35%
ME 422	no	7%
ME 423	yes	13%

Cheating

Both students and faculty were asked if “the use of a textbook solution manual, not distributed by the professor, as an aid to solve assigned homework problems is cheating” for any course at Cal Poly or for the course being surveyed in particular. For any course at Cal Poly, the majority of students (84%) did not believe this is cheating (2% strongly agree, 6% somewhat agree, 8% agree, 44% somewhat disagree, and 40% strongly disagree). These percentages were approximately the same when directed towards the course being surveyed (2% strongly agree, 7% somewhat agree, 7% agree, 41% somewhat disagree, and 43% strongly disagree). Several student comments agreed with the statement that “it’s ok to use as an aid as long as you tried the problem without it first and you still don’t understand. But, it’s not ok to copy.” Another student who agreed with this comment continued that “it can be extremely frustrating not being able to get an answer. Tests prove how well people know the material, homework is practice.” By contrast, one student said “I feel cheated by not having one, as so many others do.”

For any course at Cal Poly the majority of the faculty (77%) do agree this is cheating (8% strongly agree, 8% somewhat agree, 61% agree, and 23% somewhat disagree). These

percentages shifted towards stronger agreement when directed towards the specific course being surveyed (23% strongly agree, 54% agree, and 23% somewhat disagree). **There is significant difference between faculty's and students' perceptions concerning the use of textbook solution manuals. The majority of students only regard this as cheating if it can be considered plagiarism.** Again, to compare faculty's and students' perceptions, the results for each section are broken down for this question and presented in Table 3. As shown, even in sections where the faculty strongly agree that it is cheating and the use of the textbook solution manual has been forbidden (see Table 2), the students' belief that it is not cheating does not change significantly. Also note that faculty who indicated in Table 2 that they did not forbid the use of the textbook solution manual often still consider their use cheating which may be confusing for the students. The most noticeable trend in Table 3 is that as students move towards the higher level classes there is an approximately 20% shift from somewhat disagreeing to strongly disagreeing with the statement that the use of a textbook solution manual is cheating.

Table 3. Comparison of faculty and student responses for textbook solution manual cheating where SA for strongly agree, A for agree, and SD for strongly disagree.

Course	Faculty Response	Student Response				
		SA		A		SD
ME 211	somewhat disagree	0%	7%	8%	39%	46%
ME 212, 3 sections	strongly agree	8%	9%	8%	49%	27%
ME 212, 1 section	strongly agree	0%	8%	4%	53%	35%
ME 212, 1 section	agree	3%	3%	7%	45%	41%
ME 236	strongly agree	1%	9%	13%	40%	37%
ME 303	agree	1%	5%	4%	35%	54%
ME 329	agree	0%	6%	5%	38%	52%
ME 347	somewhat disagree	0%	4%	10%	42%	44%
ME 422	agree	0%	7%	9%	40%	44%
ME 423	agree	13%	8%	0%	29%	50%

Student Use of Textbook Solution Manuals

The majority of students either always (16%) or occasionally (61%) use “textbook solution manuals not distributed by the professor for courses at Cal Poly to either help with assigned homework or as a study aid.” **Only 10% of the students have never used textbook solution manuals.** However, the faculty overwhelmingly believe that students either always (62%) or occasionally (38%) use textbook solution manuals. This suggests that while the use of textbook solution manuals is widespread, that faculty somewhat overestimate their use and there is a fraction of the student population that does not use them.

For eight of the courses surveyed the textbook solution manual was published in electronic form. For these courses 73% of the students had access to the textbook solution manual in electronic form, 1% of the students had bound manuals, and 1% of the students had copies of individual problems from previous students. The manuals were obtained from other students (91%), internet purchases (4%), store purchases (3%), or from other faculty (3%). One of the courses surveyed (ME 236) does not use a textbook and homework problems are written by the faculty at Cal Poly. Many of these problems are used repeatedly each quarter and 13% of the students surveyed

reported having copies of old solutions. Finally, one of the courses surveyed (ME 423) only has the solution manual available in bound form and 9% of the students surveyed reported having copies of old solutions that were distributed by faculty during previous quarters. Thus, access to solution manuals is widespread in courses where it is published in electronic form. Although solutions are much less available in courses where there is no solution manual or it is only published in bound form, a significant number of the students do gain access.

Finally, two survey questions were used to determine how students make use of textbook solution manuals. The first question asked students how often they “used the solution manual as an aid to solving assigned homework problems.” Of the students who have solution manuals, 14% always, 33% occasionally, and 35% rarely use them. The second question asked students how often they “used the solution manual as a study guide in preparation for a quiz or exam.” This time the students reported higher usage with 38% always, 34% occasionally, and 13% rarely using them. The faculty was also asked these questions to determine how they perceive students use textbook solution manuals. The majority of the faculty felt that the students use them often for assigned homework (23% always, 69% occasionally, and 8% rarely) and as a study guide (31% always, 54% occasionally, and 15% rarely). **The reported student usage on assigned homework is much less than that perceived by the faculty.**

Conclusions and Future Research

Several conclusions can be drawn from the results of this pilot study on the usage of textbook solution manuals by students in a large public engineering school. First, both students (to a higher extent) and faculty (to a lesser extent) agree that working assigned homework problems is useful and contributes to the student’s understanding of the course material. It is likely that instructors will continue to assign homework and students will continue to seek the textbook solution manual as a resource. Second, only about 1/3 of the mechanical engineering faculty at Cal Poly specifically forbid the use of textbook solution manuals for their classes and for those who do forbid the usage, their students are often unaware of this fact. Faculty must more clearly convey their expectations to the student in regards to the usage of textbook solution manuals. Third, most faculty (77%) consider the use of textbook solution manuals as a form of “cheating” while the majority of students (84%) disagree even when explicitly forbidden from using the manuals. This indicates that clearer guidelines and policies with regards to the use of textbook solution manuals must be established within the department and brought to the student’s attention. Lastly, the overall rate of textbook solution manual use among students is high (90% of students have used them at least once); however, students do not use them as often as assumed by the faculty. Future work by the authors will focus on determining whether student use of textbook solution manuals contributes to or hinders learning.

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