A Chegg® Era Model for HW

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Background

Why assign Homework? Does it assess student learning? Is it a tool for developing mastery? Is it an outdated model? In his recent paper *Homework Is So 20th Century!,* Brunnhoeffer observes, "For most student[s]…the homework assignment becomes a game of getting it in with the least effort possible. It is a short term strategy to minimize the effort (time spent solving problems) and to maximize the reward (grade awarded for completing the assignment)" [1]. Chegg® seems to agree. A user's twitter post featured on the front page of their textbook solutions page promoting the service states "Shoutout to Chegg Study for allowing me to knockout [sic] my homework in 30 min" [2]. If Homework is simply an obstacle I need to jump through to my desired credential (a degree in engineering), I will certainly find the quickest and easiest way through or around that obstacle. It is our job as engineering educators to ensure that Homework is not the goal, but a means to the end of mastering the skills required for the practice of engineering. Access to Chegg® is not good or bad, but it is real. Faculty can hold onto our old models and fight access to these resources under rules of ethics or other means, or they can accept the existence of the new tools and build better educational models for the 21st century. Chegg® may have broken the old way of homework, but it could end up pushing faculty toward a better system.

Problem

The following analysis is based on 2011, 2012, and 2016 engineering dynamics course offerings. In 2011/12, labeled the Pre-Chegg® Era, a strong correlation between homework grades and exam scores was observed ($R^2 = 0.74$ and 0.98, respectively, as shown in Figure 1). In 2016, students in this course self-reported extensive use of web-based solutions to textbook problems (i.e., Chegg®). In this Post-Chegg® Era, the correlation between HW and exams broke down ($R^2 = 0.08$, also shown in Figure 1). Students with a final grade below 60% were not included (2 students across the 3 data sets). These outliers often did not turn in HW assignments, and numerous 0 grades distorted the correlations with very low HW grades (below 30%). Another recent paper indicated similarly poor correlation between HW and exams (R^2 ranging between 0.03 and 0.47: 6 exams/2 courses) [3].

In the pre-Chegg® sections, the average test score was 85%, compared to 80% post-Chegg®. The percentage of students scoring below 80% on the exams nearly doubled. At the same time, HW scores rose from 87% to 90%. Anecdotally, fewer office hour visits to get help on HW had been observed. Students no longer came to office hours to get help with material they were struggling with on HW but instead turned to Chegg® for off-the-shelf solutions.

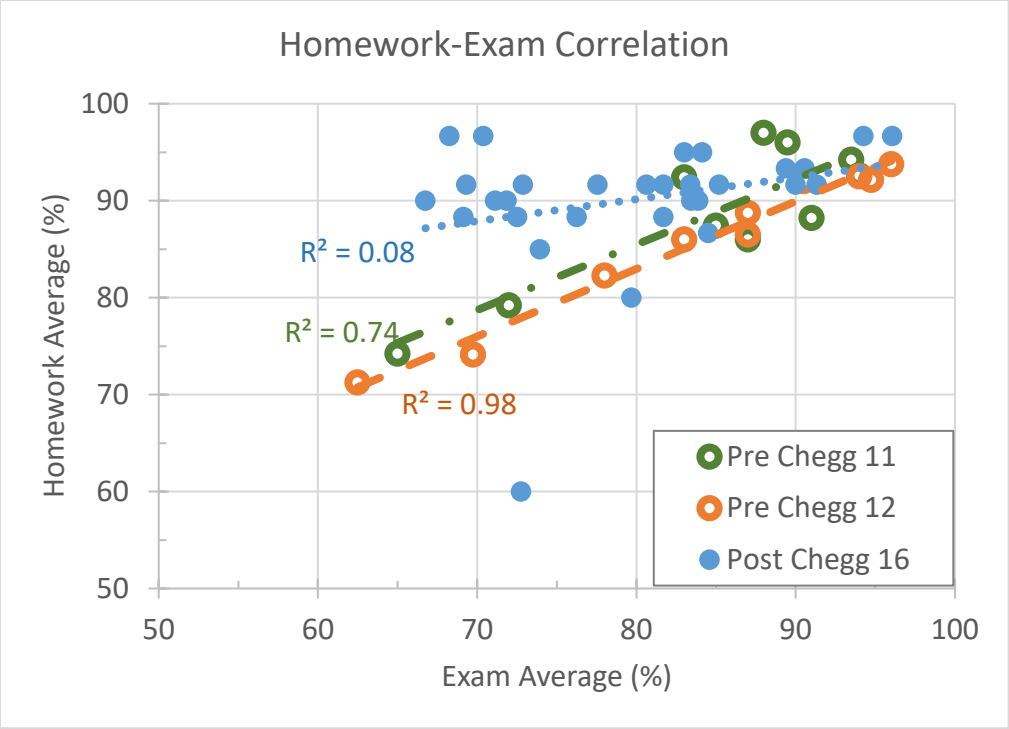

Figure 1: Correlation between homework average and exam average for student groups with low use of Chegg®-type resources and those reporting heavy use of these resources. All in a third-year engineering dynamics course.

Students were no longer using HW effectively for developing their analytical skills. A system of assessment based primarily on correctness led to high HW scores without improving test performance. Does the broad availability of solutions to HW problems demand a new model for HW? How could HW be redesigned to prioritize interactive student learning over assessment?

Solutions/Literature Review

Numerous new approaches to Homework have been adopted in recent years. Many of these directly address this changing landscape. Karimi and Manteufel looked at several methods: These efforts included creating novel homework problems, using more quizzes and exams, having students engage in class with response clickers, project assignments, flipping the classroom, and requiring attendance at recitation sessions. They found that creating new custom HW problems was effective at increasing exam grades [4]. Yet, will this success be short-lived? For $14.95/month (my students share an account), Chegg's® *Ask an expert* service will provide the following "Take a photo of your question and get an answer in as little as 30 mins*. With over 21 million homework solutions, you can also search our library to find similar homework problems & solutions" [2].

Others have taken the more-quizzes approach further and removed the grades from HW and replace that grading with quiz grades [3, 5]. The quiz grades correlate more strongly with exam

grades, exam grades are similar or stronger with the grading focused on quizzes, and the students report increased interest and motivation.

Another recent trend is to fight tech with tech. Web-based homework and tutorial systems tied to textbooks through publisher portals offer unique problems for each student, step-by-step checking of results, and immediate feedback for the students [6, 7]. Students do value the on-line HW tools [7], but the studies of the effectiveness are mixed and in an engineering dynamics course show a weaker correlation to exam scores than handwritten HW [8].

Self-graded homework can increase student learning of the material. Several papers have examined the use of self-grading, with grading based on the correctness of pre-graded solutions or the quality of evaluation and correction [9, 10, 11, 12, 13, 14]. Some reported improvement in related exam scores [9, 10, 11]. Others found the practice increased students' perception of their own learning [13, 14]. Other approaches similar approaches require post-grading HW and exam reflections where students must analyze their errors, reflect on what when wrong, and propose adjustments to their study moving forward [15].

Current Proposal/Methods

The following approach has been used in 3 courses, ranging from a first-semester mathematical methods for engineers course to a 400-level analytical mechanics and vibration analysis course. Consistent with others emphasizing quizzes and exams over HW for grading [3, 5], the transition in HW paralleled switching to a mastery-based grading scheme. Grading for the course is based on the number of skills the students demonstrate A-level mastery of on an exam/quiz rather than traditional partial credit across all skills [16]. In these HW schemes, the goal is to pivot HW from a tool to assess student learning to a tool strictly for developing skills and understanding.

In each course, HW was pivoted to an explicit training tool to develop mastery rather than an assessment instrument. Solutions to HW problems are provided by the instructor when problems are assigned. Grades in the courses are primarily based on individual-unassisted-proctored assessments (quizzes).

Initially, as others have used the assigned HW as an inventory of problems for students to master in preparation for an exam or quiz [5], entirely removing HW grading from the overall grade was initially used here. However, students requested that HW count for something, suggesting they struggled to motivate themselves to take HW seriously if it was not graded. They needed a 'carrot' or a 'stick.'

Both have been used, depending on the course. Stick: "If you do not participate in HW discussions at an acceptable level, your grade is reduced by 1/3 of a letter grade." Carrot: participating in HW at the required level increases final grade by 1/3 of a letter grade. Both effectively motivate student participation but can affect the overall grading structure. The stick model requires students to master at least one skill to earn a passing grade and allows for a larger pool of skills. For this reason, the stick model has been used more in courses that serve as prerequisites and the carrot model in upper-level courses.

The model proposed here is set up as a graded discussion board, implemented in the Canvas® learning management platform [17]. The Solutions are posted in Canvas® at the time problems are assigned. In most versions of this method, students had access to the instructor's solutions when they received the assignment. In this case, students were required to submit a discussion of worked problem(s): (1) Generalize to a solution strategy or algorithm – describe a new understanding, or (2) Explain the solution – must describe specifics (if you first did something wrong, explain why that was in error), or (3) describe what is confusing in the solution – ask a question.

Students can see other posts only after completing their first post. In Canvas®, both this and the graded discussion feature are check-box options on any discussion board. After posting their work, students are encouraged to review and respond to other posts. Students are assessed on the extent to which their posts indicate engagement with the assigned problems toward developing the required skills.

In the last 30 minutes before class, the instructor reviews the posts and identifies the frequent trouble spots identified by the students. At the start of class, students discuss the HW in their peer groups (4-5 students), bringing up unresolved questions with the instructor circulating through the room. Unresolved issues are discussed with the full class. Students with individual difficulties are encouraged to bring those concerns to office hours.

In the first-year course, students complete a higher volume of less complex problems, where the final answers are available, or an online system (WeBWorK©) checks their answer. Students submit discussion posts with the same prompt as above.

More recently, students started to skip solving the problems and went straight to reviewing the posted solutions, then discussing questions they had on those solutions. From several of the questions posted, it appeared students were not solving the problems on their own before consulting the posted solutions. To protect the students from this self-damaging tendency (or at least make it more difficult), solutions were suppressed until students first posted scans/photos of their work on all analyses assigned. Then, students were required to assess their work against the posted solution and discuss any trouble spots or difficulties. The suppression of the instructor's solutions can be done by simply moving the solutions from the initial discussion prompt for the assignment to a reply (again with the Canvas® setting to not allow students to see other replies until they have first posted a reply themselves).

Results

The described change in HW grading was implemented in parallel with a shift to a mastery-based grading structure for the course grades, making it difficult to compare test results between the two models. However, used with the Mastery-Based grading structure, student mastery of the four most important skills from a representative course increased from 50% to nearly 100% [16].

The goal of this discussion-based HW model was not to repair the broken correlation between HW and exams, but rather to increase engagement with the material and shift the focus of the

student work from getting the correct answer on the problems to developing skills. Qualitative evidence suggests that this is certainly happening. Students use the discussion board effectively. Over 95% of the enrolled students fulfill the HW requirement: after the lowest 20% of the HW grades are dropped, the remaining must average 90% (above 2.7/3.0) of expectations with a simple 3 point rubric (Table 1).

Table 1: Discussion HW grading rubric.

3	Full attempt on all problems. Specific question(s) raised or new understanding(s) described.
2	Incomplete attempt - you should have seen me, or a tutor, for help prior to the class session when this was due.
1	Minimal effort on the solution. Questions or comments not specific or helpful.
0	No Submission

For a typical set of problems, the instructor will often find 4-5 specific difficulties or questions among the student submissions. Often the first 1/3 of the next class session is spent discussing and resolving these trouble spots. Students routinely follow up after assignments to go over any lingering difficulties. Office hours are fully booked with students continuing discussion of HW topics after posting as they seek to gain mastery of each skill.

Discussion

I do feel nostalgic for the days, evenings, and early morning hours I spent with a group of peers slogging through intense weekly HW assignments for my physics and engineering courses as an undergraduate. I wish HW could serve as a proxy for exams and could be used both developmentally and as a measure of learning. However, those days seem to be passed, and maybe for many students, it was a mirage from the beginning, with a structure focused on getting the correct answers (even if with a lot of *help* from friends) over the goal of learning the material with those weekly assignments.

Students respond to prompts asking them to identify the areas they are having difficulty and do a great job expressing where they are struggling with applying the material. In class, they then expect to have those issues resolved. They are far more engaged in the process of mastering the skills with this HW structure than the previous model. In the previous model, students would seek out help to get the answers. Not surprisingly, their goals followed those set by the grading system – get the answers for the HW, worry about understanding at test time. With this HW model, students now come to office hours after a HW is closed to follow up on areas they are still struggling to understand.

To date, the grading system used has leaned toward a participation grade, with the assessment of learning residing in the mastery quizzes and exams. When students were simply reviewing solutions and asking questions about those solutions, the posts were often very in-depth and asked many great questions. Still, without working analyses themselves, they were not mastering the skills. Requiring a scan of their individual work before accessing the solutions mitigates this a bit, but does not prevent peer-to-peer sharing or consultation of Chegg®. However, students to

date have been forthcoming in their discussion posts when they have received help from others or on-line.

In this paper, numerous new approaches to HW have been discussed. All have limitations, including this discussion-based model. Here, students can game the system by posting great questions without putting in the sweat equity wrestling with the material to take advantage of the discussion of those questions fully. What has changed is the context of that deception. The key is to shift the narrative for HW, creating a structure where the goal is learning rather than answers. It has always been the goal, but the traditional answer based HW assessment masked that goal.

Any implementation of HW that can shift the assessment focus toward the development of skills over the assessment of mastery, and requires students to reflect on their understanding of the material, is a positive change. We must continue to evolve our pedagogies to create the best learning environment for our students in light of the constantly changing context currently reflected in access to web-based solutions.

References

[1] G. C. I. Brunnhoeffer, "Homework Is So 20th Century !," in *ASEE Anual Conference and Exposition*, Columbus, OH, 2017.

[2] Chegg, "Chegg Study: Textbook Solutions," 2020. [Online]. Available: https://www.chegg.com/study/tbs. [Accessed 23 January 2020].

[3] J. H. I. Allen, J. Fulcher and S. I. Selvaraj, "Assessment of Student Learning in Undergraduate Engineering Courses Using Quizzes In Lieu of Homework," in *ASEE Annual Conference & Exposition*, Colunbus, OH, 2017.

[4] A. Karimi and R. D. Manteufel, "Alternatives to Textbook Homework Assignments," in *ASEE Annual Conference and Exposition*, Salt Lake City, UT, 2018.

[5] D. E. Schmidt, D. V. Sanchez and S. J. Dickerson, "Increasing Student Engagement and Motivation by Replacing Homework with Assignment-Quizzes," in *ASEE Annual Conference and Exposition*, Columbus, OH, 2017.

[6] M. Basitere and E. N. Ivala, "An Evaluation of the Effectiveness of the use of Multimedia and Wiley Plus Web-Based Homework System in Enhancing Learning in The Chemical Engineering Extended Curriculum Program Physics Course," *The Electronic Journal of e-Learning,* vol. 15, no. 2, pp. 156-173, 2017.

[7] J. L. Davis and T. McDonald, "Students – Ask Them to Eat Their Vegetables!," in *ASEE Annaul Conference and Exposition*, Salt Lake City, UT, 2018.

[8] J. L. Davis, T. McDonald and J. Kloosterman, "Students – Ask Them to Eat Their Steaks!," in *ASEE Annual Conference and Exposition*, Tampa, FL, 2019.

[9] W. A. Friess and M. P. Davis, "Formative homework assessment strategies to promote student self-reflection and improve time management: a pilot study," in *ASEE NE*, Kingston, RI, 2016.

[10] N. Li, NancyWarter-Perez and H. Shen, "A Self-Assessment Based Homework Model," in *ASEE PSW*, Los Angeles, CA, 2019.

[11] R. J. Haddad and Y. A. Kalaani, "Flipping Homework: An Effective Homework Model," in *ASEE Annual Conference and Exposition*, Seattle, WA, 2015.

[12] K. Chang, "Homework Assignment Self-Grading: Perspectives from a Civil Engineering Course," in *ASEE Annual Conference and Exposition*, Tampa, FL, 2019.

[13] A. Badir and R. O'Neill, "Homework Graded by Students," in *ASEE Annual Conference & Exposition*, Columbus, OH, 2017.

[14] P. D. Kearsley and A. G. Klein, "Self-Corrected Homework for Incentivizing Metacognition," in *ASEE Annual conference and Exposition*, New Orleans, LA, 2016.

[15] K. J. Chew, H. L. Chen, B. Rieken, A. Turpin and S. Sheppard, "Improving Students' Learning in Statics Skills: Using Homework and Exam Wrappers to Strengthen Self-Regulated Learning," in *ASEE Annaul conference and Exposition*, New Orleans, LA, 2016.

[16] K. DeGoede, "Competency-Based Assessment in Dynamics," in *ASEE Annual Conference and Exposition*, Salt Lake City, UT, 2018.

[17] Instructure, "Canvas Home," 2020. [Online]. Available: https://www.instructure.com/canvas/. [Accessed 16 March 2020].