Latest Improvements in Metacognitive-Informed, Dual-Submission Homework Methods

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Abstract

Over the last decade, in response to increasing frequency of academic misconduct, engineering education has explored different methods for providing practice, feedback, and scaffolded learning experiences through homework. Though many innovative tools have been developed to provide immediate feedback to students, ultimately students need practice and critical thinking about their practice to engage in long-term effective learning and content mastery. This synthesis of the growing body of literature around metacognitive, self-graded, and dual-submission homework methods presents best practices for helping students get the most out of homework assignments and develop increasing competence in self-directed learning. In sophomore-level courses, the dual submission with reflection implementation asks students to submit initial attempts at the homework problems to earn credit for completion. Then the students use an instructor-provided solution to check and correct their work, also for completion-based credit. Alongside the dual submission homework problems, students may develop their metacognitive skills by completing short reflections on their learning. To increase student responsibility for content mastery in a junior-level course, initial submission with immediate assessment implementation asks students to check their own work without granting credit for corrections. In a senior-level course, an auto-graded with rework submission implementation gives students an opportunity to earn 100% credit regardless of initial accuracy, but students must develop reworked solutions from an instructor provided numerical answer, not a comprehensive solution. As more instructors employ metacognitive-informed dual-submission homework methods, instructors can adjust their implementations to scaffold increasing responsibility for self-directed, life-long learning and engineering accuracy. At every stage, students should experience learning, problem solving and evaluating their own work like a practicing engineer.

Introduction and Background

Within engineering education, homework is a widely accepted and widely used element in course design and implementation. Engineering instructors assign homework, and students submit homework, but all too often all parties go through the motions without any real thought about why. Any participant in an ASCE ExCEEd Teaching Workshop can report that homework provides practice in an unfamiliar context [1]. At the same time, the rise of crowd-sourced homework solution services makes finding and copying homework solutions (commonly referred to as “cheating”) exceptionally tempting for even the best students [2]. Clearly, the unquestioned role of homework in engineering coursework should be re-evaluated, clearly defined, and refined to accomplish its intended end.

Fortunately, ASEE’s active educator community has not been silent on this topic. For the purpose of this discussion, homework pursues a “three-fold goal… practice, instructor feedback, and self-assessment” while simultaneously considering “the challenges of time management, solution availability, shallow learning, and instructor fatigue” [3]. Homework has an important role to play in helping students align their mental models with objective reality and explore the ways engineering and math models truly (though not exhaustively) quantify that same objective reality [4], [5]. Problem solving practice and application of engineering concepts has long been

central to the development of innovative engineers [6]. Considering these various realities, objectives, goals, and challenges, a novel dual submission homework methodology has emerged bringing together the two streams of self-graded and metacognitive reflection methods. The most recent development in metacognitive-informed dual-submission homework methods from the literature provides the verification, motivation, and scaffolded practice to support the development of life-long learning skills in every level of a civil engineering program.

Self-grading Methodologies

Starting as early as 2013 at West Point, various educators have experimented with the self-grading of homework assignments [7]. These methods functionally consist of students attempting homework problems, then receiving the solution, correcting their homework, assigning a grade to their work, and resubmitting their work. The instructors then engage in an evaluation of a "good faith effort" on the initial and final attempt and provide their own grade for the assignment. This methodology provides practice and self-assessment while decreasing the grading load for instructors and reducing the temptation to copy third-party solutions [8]. In some cases, this methodology was effective [9], [10]. However, an emphasis on numerical or letter grade assignment by both students and faculty highlighted the differences between instructor and student evaluations of the quality of the work resulting in a negative impact on rapport [11]. The student-provided grade often resulted in weakened metacognitive development by taking attention off content mastery. Furthermore, instructors largely ignored the student assigned grade when providing a grade for the record [7]. To the extent that the overall homework grade was based on finding the right answer in the initial submission, students reported lower satisfaction with the methodology and only minimal reductions in stress or temptations toward copying other solutions [9], [11].

Metacognitive Methodologies

A second stream of developing homework methodologies directly assesses metacognitive development rather than just the work itself. Frequently, these methodologies look very similar to the self-graded approaches, as the self-graded approaches explicitly attempted to engage metacognitive critical thinking. The shift in emphasis that marks the explicitly metacognitive methodologies was an emphasis in right thinking about the problem rather than a grade for the accuracy of the solution [12]. Instructors emphasized the process over the outcome by evaluations of student-corrected work [13], [14], and/or through the use of student reflections [3], [12]. By decreasing the emphasis on first time accuracy, students experienced a reductions in workload, stress, and time demands consistent with lower temptations toward cheating and conducive to deeper learning [15]. This shift in thinking about homework equips students to practice life-long learning skills for long-term gain, rather than simple short-term metrics of assignment grades. When introducing the methodology to students, a metaphor from athletics proved helpful by emphasizing positively reinforced practice evaluated against an ideal [9].

Commonalities and Effectiveness

As the self-grading and metacognitive streams of homework administration have intermingled and developed, common practices have clearly emerged. Each homework set is managed in a multi-step process:

1. Instructor assigns homework problems
2. Students attempt homework problems
3. Instructor releases solutions to problems
4. Students assess homework based on instructor solutions

Each student submission may include a reflection, prompt or coversheet intended to improve metacognitive thinking about the problems and the purpose of homework. A recent synthesis of research on this topic has shown that students and faculty prefer the dual-submission homework methods to single-submission approaches and online homework portals [16]. The time commitment for students is about the same as other methods, but with far lower stress. Typically, instructor grading times are lower as well, bested only by auto-graded homework [9], [16]. The need for excellent instructor solutions requires significant initial time investment, but with an emphasis on process rather than first time correctness, the need for combative anti-cheating efforts decreases, reducing the need to generate new problems every semester [7]. Almost universally, students responded positively to surveys about dual submission homework methods.

Conceptually, the metacognitive-informed, dual-submission method meets the fundamental teaching needs of instructors: instructors observe student effort and can quickly process and identify student confusion through reflections [17]. More importantly, students engage in life-long learning practices employed by learners of every age: they practice problems, they check their work, and they consider what they have learned through the process [6]. Such holistic practice helps students learn how to “acquire new knowledge, skills and attitudes” consistent with the life-long learning objectives of the ASCE *BOK* [18].

A recent study has provided a methodology for evaluating the effectiveness of a dual submission homework method beyond simple perceptions or a philosophical reasoning [15]. This study showed quantitatively better learning outcomes for a dual-submission homework method over traditional homework methods. Though a metacognitive emphasis showed clear improvement in mastery, the grade earned did not correlate well with exam performance. Rather, the homework grade assessed “effort and engagement” requiring that comprehension and competence be assessed using other methods [15]. The model seeks to use homework to provide “practice, instructor feedback, and self-assessment” rather than an assessment of mastery [3].

Scaffolded Implementations

Clearly, a growing body of literature supports a metacognitive-informed dual-submission homework method, and students clearly benefit from conscientious awareness of their own responsibility for learning. The following sections outline homework implementations in several courses that aim to scaffold students toward greater self-directed learning practices.

Sophomore Level Mechanics Courses: Dual Submission with Reflections

Appendix A contains syllabus excerpts, coversheets, and rubrics consistent with implementation of the metacognitive-informed dual-submission homework implementation frequently used in sophomore mechanics courses. The dual-submission with reflection implementation rewards 60% credit on good faith efforts at the initial submission, 30% credit for a good faith effort at the self-assessment and correction, and 10% credit on finding the right answer in the initial attempt. Functionally, students who follow directions and submit all homework problems could earn 90% credit without ever answering a question correctly in the initial attempt. The final 10% credit is valuable in helping students have sufficient external motivation to truly attempt the problems. Given the high credit that can be earned on effort alone, the contribution to the overall course grade from homework should be no more than 10%-15%. Student perception of high self-determinacy with regards to their homework grade often provides sufficient rapport boosts with the instructor to permit more stringent grading on exams.

The initial submission consists of completed problems and a coversheet. The coversheet helps students strategize and reflect on their learning by asking a few metacognitive questions derived from standard classroom assessment techniques [19]. Additionally, the coversheet provides a punch list to help students (and instructors) evaluate whether their submissions are truly "good faith efforts" [15]. For mechanics courses like Statics and Dynamics, mastering the problem-solving process, drawing diagrams, and completing the work is key. Other courses might prioritize other features and modify the coversheets accordingly. Instructors should grade and return the first few assignments quickly; instructor adjustments to the punch list scoring trains students to evaluate the acceptability of their submitted work. Once students have embraced the instructor's expectations, the punch list can map directly onto a learning management system (LMS) rubric with only a cursory review of the actual student work.

Standard practice has homework due once a week. After the initial assignment due date, the assessment assignment opens with the instructor generated solution. Students typically have three days to correct their work and submit their self-assessment. Students first correct their work based on the instructor's solution. The self-assessment coversheet asks if, once corrected, the finished problem meets the expectations for a good faith effort. Additionally, students report if their initial attempt resulted in the correct answer. Students also complete a self-assessment on their initial attempt in a format recognizable to participants in an ExCEEd Workshop. Students may initially complain that correcting their homework requires more time devoted to homework assignments; instructors may respond that students should review instructor-graded homework anyway, meaning that the metacognitive-informed dual-submission methodology simply holds the student accountable for learning best practices.

Finally, a homework amnesty day policy allows students to submit any previously unsubmitted homework problem at the end of the semester with a self-assessment coversheet for 30% credit.

This practice allows the instructor to have an inflexible late work policy, while still encouraging students to work all assigned problems and maintaining student rapport. Students may simply copy the instructor solution, but this is more active than skipping homework problems.

Students report both in published surveys and course evaluations a preference for the dual-submission homework method [3], [14], [17]. Student engagement and average graded performance on homework is like other homework methods suggesting that students often sub-optimize, putting in the required work to achieve their individually targeted grade. Typically, this results in homework grade averages around 80% and median homework grades around 90%.

Junior Level Introduction to Environmental Engineering Course: Initial submission with immediate assessment

As students progress through the engineering curriculum, they should take more ownership of their time management and learning. Accordingly, the metacognitive-informed dual-submission homework method adjusts to scaffold for higher expectations and student independence for learning outcomes by shifting to initial submission with immediate assessment implementation. Appendix B provides an example for this implementation in a junior level course. During the junior year, once the metacognitive expectations are established among the student cohort in freshmen and sophomore year courses, instructors can reduce the number of submissions and streamline and/or automate grading. This method aligns more with the self-grading methodologies from literature while maintaining an emphasis on growth and development rather than initial mastery.

The initial submission with immediate assessment implementation deployed in a second-semester junior-year course eliminated the formal requirement for a second submission and has partially automated the grading process using the LMS. Paper cover sheets are no longer employed nor are the reflection questions explicitly asked, instead the self-reflective metacognition responsibility is placed solely on the student. Students are assigned 5 problems per week, the text of which is openly available to students. Students are instructed to complete all problems and create a single PDF scan of all pages before starting the homework assignment on the LMS. The assignment uses the LMS quiz format organized in three questions which are viewed separately and cannot be returned to after moving to the next question. The first question requires students to upload their scanned work. The second provides the students with a complete solution and consists of a "select multiple" question where students assess their work by checking the box next to the questions they answered correctly on their initial attempt. The third question allows students to submit any comments to the instructor that may lead the instructor to manually adjust points. There is no reflection submission where students submit a scan of their corrected work. The instructor communicates the expectation that students would correct their own work without receiving a grade.

Assignment grading is out of a total of seven (7) points. Students earn one point per problem for submitting a complete answer demonstrating effort, regardless of if it is correct or not. The instructor awards this grade by skimming the scan of the student work submitted to question one of the submission. Students' self-assessment of accuracy, via question three in the submission will automatically grade awarding 0.5 points for each of the five problems. Thus, the maximum possible score is 7.5 of 7 points (or 107%) when a student submits complete scans of all five problems and has accurate solutions for all problems. While the LMS automatically grades the "accuracy" points, the instructor can manually adjust the points while evaluating completeness if

they see a student misreported their accuracy. A student who attempts all problems but does not get any correct would receive a score of 5 of 7 (or 71%). Homework was 25% of the course grade. Thus, a student who demonstrates effort, but no accuracy for all homework assignments would earn 17.75% toward their final grade rather than 25% (or the maximum of 26.75% for complete homework assignments with all correct answers). In other words, two students (A and B) who have equal scores on tests and projects would be one letter grade different in their final course grade if Student A is complete and accurate on all homework while student B is complete and never accurate. For example, in Spring 2022, the homework grade category scores ranged from 66% to 104% with an average of 88%.

While the initial submission with immediate assessment implementation continues to incentivize students to attempt all problems through "completion" points, it removes the grade incentive for reviewing the instructor-provided solution. In this way, students must become more independent in their metacognitive skills and find ways to incentivize their own learning from mistakes. At the start of the semester, students ask multiple questions about the format requirements, but incomplete submissions resolve themselves after the first submission once students experience the revised format. Students frequently ask where to turn in their "reflection" or "corrected scan" on this first assignment; faculty emphasize the metacognitive skills that the student should exercise to benefit their own learning even if not for credit in the course. Such artifact forming behavior is verbally encouraged throughout the semester, but ultimately, the students should develop individual practices and accountability for their learning outcomes. The effectiveness of this implementation depends upon the well-established dual-submission with reflection homework experiences of three to six engineering courses in the freshman and sophomore years. Further independence is scaffolded into the next course in the sequence – a senior-level environmental engineering design course.

Senior Level Environmental Engineering Design Course: Auto-graded with Rework Submission

As students prepare to graduate, the emphasis on correct answers and intrinsically motivated, self-directed learning practices must increase. Appendix C provides sample formatting of one metacognitive-informed dual-submission homework implementation designed for mature learners. Students continue to grow in personal accountability for execution of skills that previously were awarded points. The auto-graded with rework submission is the most controversial among students because it is most like the traditional accuracy-only based homework methods used at other institutions, particularly in graduate school. Students going into industry should benefit from the increased personal accountability practiced in this implementation when they engage in self-directed learning of new technical and quantitative content on the job.

This first-semester senior-year course is sequenced immediately after the junior-level course described in the previous section. Thus, students who took the junior-level course from the same instructor are familiar with the LMS quiz submission format. In this course, students are assigned one set of practice problems per course topic. Each contains three to four problems with a variable number of subparts. These problem sets are openly available separate from the submission. The submission process is formatted as an LMS quiz (see Appendix C). Individual numerical answers for each part of a problem must be typed in by the student. The LMS allows the instructor to specify an allowable range for the numerical input which allows some level of

rounding error to be automatically granted full credit by the LMS. Once submitted, students retain access to the correct numerical answers, but are not given a complete solution.

In a second, optional, file upload assignment, students can make-up any points they lost on the initial submission by uploading a scan of their now complete and correct solution. The student develops the correct solution process to identify the correct numerical answer. The instructor manually reviews the uploaded document to ensure that sufficient work is shown for the problem and then awards one point for each problem.

For this course, due to the variable intensity of the different course topics, the corresponding homework assignments varied in weight (between 7 and 13 points per assignment). Via the optional, second rework assignment, students were able to earn back points for all questions initially answered incorrectly. Thus, through the combination of initial and rework submissions, all students could have 100% grades in the homework category. For those correctly answering most of the problems on the initial submission, they would have a shorter duration rework assignment since they would have fewer problems to rework. The intention was to both award those with initial accuracy via less overall time spent reworking the assignment, as well as rewarding the effort of those who need additional time and practice to develop a solution. A student who did not submit an initial set of numerical answers but instead submitted a complete scan of corrected solutions from the provided numerical answers would receive only 80% credit on the assignment.

The auto-graded with rework submission implementation returns to an explicit dual-submission format for each homework assignment and maintains the goal of incentivizing effort in homework rather than initial accuracy. All students can earn 100% scores in their homework grade category, and thus earn 24% toward their final course grade. However, this was not the case in Fall 2022; homework category grades for the semester ranged from 60% to 100% with an average of 87% (one outlier excluded). The average accuracy on the initial attempt was 50%; 36% of the students had at least one assignment where they earned full credit on the initial submission, but no student had more than three of the ten assignments where they received full credit without the rework submission. Only 16% of students never missed a rework submission. The remaining students skipped the rework assignment an average of 3.4 out of 10 assignments. This relatively high missed assignment rate may be tied to the most controversial part of this homework format: the lack of a complete instructor-provided solution. Students disliked the extra effort required to earn back the points after several semesters of a process where the second submission involved copying a provided complete answer (low cognitive activity) compared to the reverse engineering process (higher cognitive load). Additionally, the instructor workload before the initial assignment submission is higher because of the necessity of having a completely correct answer key. Students became very displeased when the LMS answer key was incorrect requiring an extra level of care from the instructor to maintain rapport.

This implementation of the metacognitive-informed, dual-submission method aims to minimize direct penalties for students who learn the material more slowly than others but invest significant effort. This implementation continues the scaffolding of independent utilization of metacognitive skills by removing explicit submission requirements to earn points toward a grade. However, the increased cognitive requirement for the rework submission was unpopular among students who has spent two or more years receiving points toward their grade for copying a provided solution. Future revisions of this format will provide a complete solution guide after the rework is

submitted so that students who are still unable to reach the final correct numerical solution have access to an additional study tool. More explicit conversations between the instructor and the students explaining why students should take on additional independent responsibility for learning in a senior design class compared to lower-level courses should increase student engagement. Ideally, students will transition toward the level of intrinsically-motivated, self-directed learning expected in graduate programs and/or future employment.

Future Work

As more instructors see the value in metacognitive-informed dual-submission homework methods, both the implementation methods and the measures of effectiveness should improve. Those instructors who choose to try the metacognitive-informed dual-submission homework method might consider collecting quantitative data using the previously published means [15]. The philosophical grounding of the method can also be better developed and defended especially responding and adapting to the promises of AI-driven adaptive learning [6]. Finally, the authors are considering ways of translating the metacognitive aspects of the homework reflection from merely active learning to cooperative learning [20].

Conclusion

Metacognitive-informed dual-submission homework methods are gaining increasing acceptance in engineering education. With a growing body of literature illustrating positive gains in student learning, instructor-student rapport, and the development of life-long learning skills, metacognitive-informed dual-submission homework methods can be implemented with greater and greater ease and effectiveness. As significant portions of engineering programs commit to a more thoughtful approach to homework, instructors can scaffold students to the level of accurate problem solving and self-directed, intrinsically motivated learning characteristic of graduate students and practicing engineers.

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Appendix A. Dual Submission Homework Methodology Implemented in Sophomore Mechanics Courses

Appendix A.1. Syllabus Excerpts

Individual Homework.

Homework is *for the student*, for his or her learning, practice, and assessment. Many of the homework problems represent intentionally challenging, real-world problems. Working engineers and engineering students must practice problem formulation, problem solving, and solution documentation. Therefore, a proper solution format is required (see Appendix A). Students may work together on homework assignments *to gain additional understanding*. More than any other academic activity, continuous practice of concepts establishes long-term mastery. The assigned homework is the *minimum* required practice.

Please consult the following book on problem formulation, solving, and documentation:

Polya, G., and Conway, J. H. (1945). *How to Solve It: A New Aspect of Mathematical Method.* Princeton University Press, Princeton, NJ.

Getting the most from the homework requires at least four separate events. First, students should strive to use the mental and mathematical models discussed in class and the textbook to solve the problem.

Second, before, during and after the process of solving each problem, students should consider why they are working the problem: What principle does the professor intend them to practice or explore? Why does the homework seem easy or hard? What questions remain after attempting the problem? Is the homework solution complete? The initial attempt coversheet explores and documents student answers to these questions.

Third, students must check their work against the solution. The solution should help answer remaining questions about the principles and processes explored in the homework. The student must make the correct processes and techniques his or her own to tackle similar problems on later homework, exams, and future courses.

Finally, students must consider how to align future homework attempts with the expectations of the instructor, and whether the questions about the concepts remain. The self-assessment coversheet provides opportunity for reflection.

Documentation

Students must document any help received from supplemental instruction, classmates, reference books, or the internet. Information from the course textbook (equations and outlines of procedures), class notes, or the professor is immediately available to all students and requires no documentation. For written homework, state who and/or what helped immediately after the provided content.

Solutions

The use of solutions during homework attempts is strongly *discouraged*. Relying on solutions from previous classes, the textbook, or the internet will result in poor performance during the exams. Nevertheless, if published solutions reveal errors, subsequent corrections require proper documentation.

Grading

Homework grading by problem emphasizes effort, completeness, timeliness, and accuracy. Each homework problem can earn up to 10 points. The grade is composed of 6 points for a complete, on-time homework attempt, 1 point if the attempt is correct, and 3 points for self-assessment of the homework attempt. An additional 2 points evaluate coversheet completion per submission.

1. *Initial Attempt:*

   The student will post their initial attempt on Canvas as a single PDF file.

   Each problem will be evaluated based on *timeliness*, *effort*, and *completeness* for up to 60% credit. An additional 10% will be earned for an *accurate* initial attempt. A problem missing any sections (see Mandatory Homework Structure), appropriate figures, and/or a good faith effort at the solution in the required homework format, even with a correct answer, may receive no credit.

   - Each solution attempt must follow the format, including a figure and an answer.
   - All problems in a homework set must be uploaded in a single PDF document. PDFs may be created using personal scanners, smartphone scanning apps (Microsoft Lens, Genius Scan, etc.) or the document scanners at the Daniel Library.
   - The first page must be a complete initial attempt coversheet.

2. *Self-Assessment:*

   The student will post self-assessed homework on Canvas as a single PDF file.

   The remaining 30% credit will be earned by submitting the set of *complete* and *self-assessed* homework problems on Canvas. The professor will provide a minimum of 36 hours access to the solutions before requiring homework assessment. An incomplete assessment may receive no additional credit.

   - Corrections must include drawing any missing figures and providing corrected work resulting in the correct final answer(s).
   - Use a different color to mark errors and make corrections.
   - Use check marks (√) by the answer where the initial attempt is correct.
   - The first page must be a complete self-assessment coversheet.
   - The second page must be the complete initial attempt coversheet from the initial attempt.

Amnesty Day

Late assignments will not be accepted between the due date and Amnesty Day, yet students should submit all homework problems. On Amnesty Day (typically the last day of class) *previously un-submitted*, *complete*, and *self-assessed* assignments may be submitted for 30% credit per problem with a complete self-assessment coversheet as the first page. Extra credit SI problems should be submitted to the Amnesty Day assignment and included on the coversheet.

Mandatory Homework Structure

Neat, well-organized, and beneficial homework requires effort. Each complete homework problem must contain the structure and information required for understanding the context, scope, process, calculations, and reasonableness of the solution. Engineers check their work and the work of others; therefore, calculations must be clear, thorough, and presentable. Industry and consulting engineers need new graduates capable of solving problems *and* producing acceptable engineering calculations. A solution should read like a textbook example problem with pertinent details and text explaining the analysis, steps, equations, etc.

The professor will review homework submissions and may make suggestions for improvement. However, disorderly, poorly formatted homework may receive no grade. Students must follow the instructions listed below and the format shown on the next page.

Additional homework requirements.

- Tools
  - Work in pencil.
  - Write on 8.5 in. × 11 in., gridded engineering paper.
  - Use a straight edge, compass, and/or protractor to draw figures.
  - Consider acquiring engineering tools: https://rb.gy/xm4eqp
- Presentation
  - Include no more than one problem per page.
    - Number pages per problem if more than one page is needed.
    - Write on only one side of each sheet.
  - Each problem should have a neatly drawn figure(s).
    - Figures should be large enough to be easily read.
    - Variables should appear on figures.
    - Variables should be described using words and symbols.
  - Write legibly, in clear, easy-to-read print.
    - Completely erase any extraneous material.
    - No crossed-out material should appear on the solutions.
    - Leave blank lines between steps, providing space for correction, assessment, and comment.
- Organization using Homework Format (next page).

Homework Format.

Submittal Date CIVL 202, Problem #, Page #/# Student Name

Problem #:

Statement: Briefly name the problem.

Given: Identify known values. Symbolically note all the given information; include necessary figures.

Find: Identify unknown values. State the desired result(s) using words and symbols.

Procedure: Briefly outline the general approach to solve the problem and identify appropriate fundamental concepts.

Solution: Write out in detail the formulation of the solution following the outlined procedure. Text and figures must be neat and professional. Show all the pertinent details of the solution approach.

- The solution should begin with an appropriate figure.
- From the figure write the general equation(s) symbolically.
- Simplify the equation(s) explaining simplifications.
- Populate the simplified symbolic equations with physical quantities represented numerically with units.
- Calculate the final answer, round to appropriate significant figures, and determine the final units.
- Consider and describe the reasonableness of the results.

Answer: Copy those variables identified in the *Find* section and calculated in the *Solution* section.

- Confirm the reasonableness of the answer.
- Check the answer with other sources.
- If there is a discrepancy, go back and rethink the analysis.
- Do not attempt to reverse engineer the correct answer; consult with peers, the SI instructor, tutor, and/or the professor as needed to identify mistakes.

Appendix A.2. Initial Attempt Coversheet

Strategize

Write one sentence that summarizes the concepts to be practiced in this homework set.

What principle(s) from the course should shape the mental models required by this homework?

What is the most important concept to be practiced in this homework set?

Initial Attempt

Attempt for the assigned problems from the Semester Homework Problems.

Check Punch List

Evaluate each homework problem solution (**√ / X**) based on *completion* for:

- *Format*: Is the solution formatted as described in the syllabus, providing meaningful information in each section?
- *Figures*: Does the solution include at least one fully labeled figure or diagram as part of the *Given* and/or *Solution* sections?
- *Complete*: Does the solution generate the values(s) identified in the *Find* section and were those value(s) copied to the *Answer* section?

Problem #	***Format***	***Figures***	***Complete***

Reflect

What was the muddiest point in this homework set?

Reflect on how class preparation, class, and study contributed to confidence (or lack thereof) on this homework attempt. What will change to improve confidence?

Submit

Submit a single PDF document scan on Canvas (LMS) including this coversheet as the first page.

Appendix A.3. Self-Assessment Coversheet

Correct

Correct the initial homework solution attempt(s).

- Corrections must include drawing any missing figures and providing corrected work resulting in the correct final answer(s).
- Use a different color to mark errors and make corrections.
- Use check marks (√) by the answer where the initial attempt is correct.

Problem #	*Format*	*Figures*	*Complete*	*Correct*

Check Punch List

Evaluate each *corrected* homework problem solution (√ / **X**) based the instructors solution:

- *Format*: Is the solution *now* formatted like the instructor solution?
- *Figures*: Does the solution *now* include a similar figure?
- *Complete*: Does the solution *now* lead the values(s) identified in the *Find* section and copied to the *Answer* section
- *Correct*: Did the solution generate the correct value(s) in the *Answer* section *before correction*?

Self-Assess

Identify strengths and areas for improvement based on the correction of the initial homework solution compared to the instructor solutions. Provide a check (√) in the appropriate column (*Needs Work/Good/Excellent*) for each category.

Category	Needs Work	Good	Excellent	Strengths	Areas for Improvement
Format					
Interpretation					
Planning / Procedure					
Solution Execution					
Figures					
Equations					
Units					
Checking Work					

Reflect

Reflect on how to improve concept mastery and homework performance in the next homework. Consider the Initial Coversheet *Strategize* and *Reflect* questions.

Submit

Submit a single PDF document scan of self-assessed problems on Canvas (LMS) including this coversheet as the first page and the initial coversheet as the second page.

Appendix A.4. Assignment Rubrics

Initial Attempt Rubric - 2

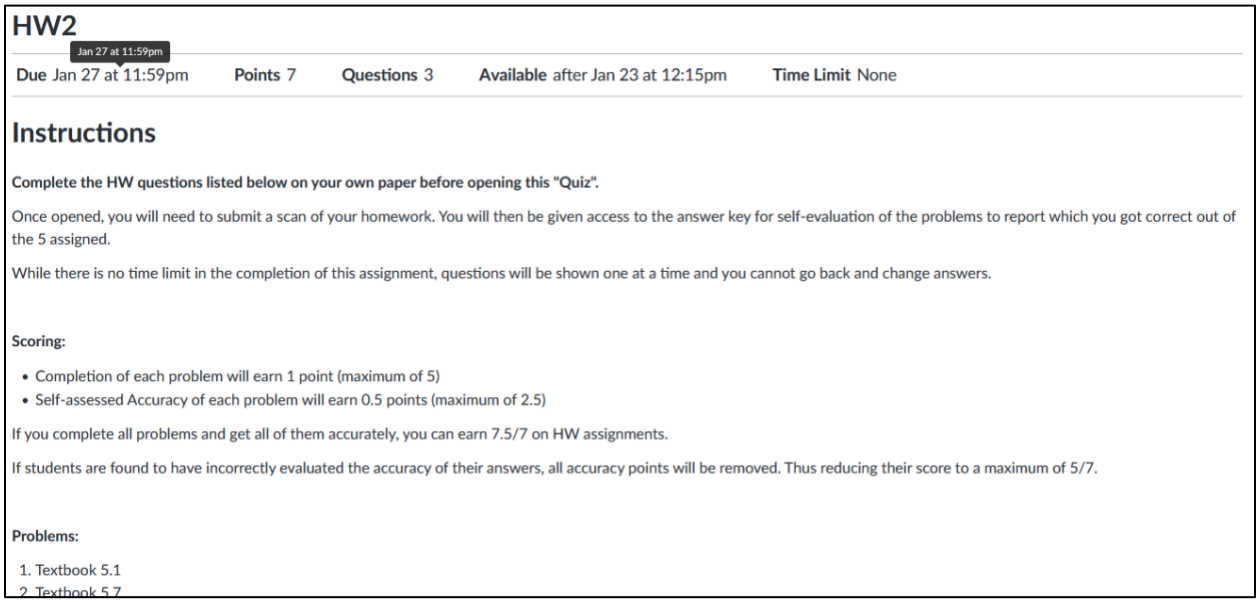
Initial Attempt Rubric - 2					
Criteria	**Ratings**				**Pts**
Initial Coversheet Followed instructions and used the initial coversheet correctly.	**2 pts** **Full Credit** Followed instructions AND meaningfully responded to all questions AND submitted problems on engineering paper AND submitted only one problem per page.		**1 pts** **Needs Work** Responded to some questions OR submitted problems on lined paper OR submitted multiple problems per page.	**0 pts** **No Coversheet** Initial coversheet not the first page of a single PDF submission.	2 pts
1st Problem Followed instructions and completed the problem with appropriate format, effort, and completeness.	**6 pts** **Completed 3 of 3 Required Elements** Followed the format AND included a figure AND found an answer.	**4 pts** **Completed 2 of 3 Required Elements** Failed to follow the format OR lacked a figure OR failed to find an answer.	**2 pts** **Completed 1 of 3 Required Elements** Only followed format OR included a figure OR found an answer.	**0 pts** **Inadaquate Attempt** Failed to follow the format AND lacked a figure AND failed to find an answer.	6 pts
2nd Problem Followed instructions and completed the problem with appropriate format, effort, and completeness.	**6 pts** **Completed 3 of 3 Required Elements** Followed the format AND included a figure AND found an answer.	**4 pts** **Completed 2 of 3 Required Elements** Failed to follow the format OR lacked a figure OR failed to find an answer.	**2 pts** **Completed 1 of 3 Required Elements** Only followed format OR included a figure OR found an answer.	**0 pts** **Inadaquate Attempt** Failed to follow the format AND lacked a figure AND failed to find an answer.	6 pts
					Total Points: 14

Self-Assessment Rubric - 2

Self-Assessment Rubric - 2						
Criteria	**Ratings**					**Pts**
Self-Assessment Coversheet Followed instructions and used the self-assessment coversheet correctly.	**2 pts** **Full Credit** Followed instructions AND meaningfully responded to all questions AND corrected problems in a different color.		**1 pts** **Needs Work** Responded to some questions OR corrected problems in a different color.		**0 pts** **No Coversheet** Self-assessment coversheet not the first page of a single PDF submission.	2 pts
1st Problem Followed instructions and corrected the problem with appropriate format, effort, and completeness.	**4 pts** **Correct and Complete** Followed the format AND included a figure AND found the CORRECT answer in a form similar to the instructor solution WITH a check mark by the answer.	**3 pts** **Completed 3 of 3 Required Elements** Corrected solution follows the format AND includes a figure AND finds an answer in a form similar to the instructor solution WITH complete corrections to the figure and/or solution.	**2 pts** **Completed 2 of 3 Required Elements** Corrected solution fails to follow the format OR lacks a figure OR fails to find an answer in a form similar to the instructor solution WITH some corrections to the figure and/or solution.	**1 pts** **Completed 1 of 3 Required Elements** Collected solution only follows format OR includes a figure OR finds an answer in a form similar to the instructor solution WITH insufficient corrections to the figure and solution.	**0 pts** **No Assessment** Initial attempt un-assessed: lacking a check mark by the correct answer OR corrections to the figure and/or solution.	4 pts
2nd Problem Followed instructions and corrected the problem with appropriate format, effort, and completeness.	**4 pts** **Correct and Complete** Followed the format AND included a figure AND found the CORRECT answer in a form similar to the instructor solution WITH a check mark by the answer.	**3 pts** **Completed 3 of 3 Required Elements** Corrected solution follows the format AND includes a figure AND finds an answer in a form similar to the instructor solution WITH complete corrections to the figure and/or solution.	**2 pts** **Completed 2 of 3 Required Elements** Corrected solution fails to follow the format OR lacks a figure OR fails to find an answer in a form similar to the instructor solution WITH some corrections to the figure and/or solution.	**1 pts** **Completed 1 of 3 Required Elements** Collected solution only follows format OR includes a figure OR finds an answer in a form similar to the instructor solution WITH insufficient corrections to the figure and solution.	**0 pts** **No Assessment** Initial attempt un-assessed: lacking a check mark by the correct answer OR corrections to the figure and/or solution.	4 pts
						Total Points: 10

Appendix B. LMS Sample HW Assignment- Junior Level Course

Before Assignment is Opened:



HW2

Jan 27 at 11:59pm

Due Jan 27 at 11:59pm **Points** 7 **Questions** 3 **Available** after Jan 23 at 12:15pm **Time Limit** None

Instructions

Complete the HW questions listed below on your own paper before opening this "Quiz".

Once opened, you will need to submit a scan of your homework. You will then be given access to the answer key for self-evaluation of the problems to report which you got correct out of the 5 assigned.

While there is no time limit in the completion of this assignment, questions will be shown one at a time and you cannot go back and change answers.

Scoring:

- Completion of each problem will earn 1 point (maximum of 5)
- Self-assessed Accuracy of each problem will earn 0.5 points (maximum of 2.5)

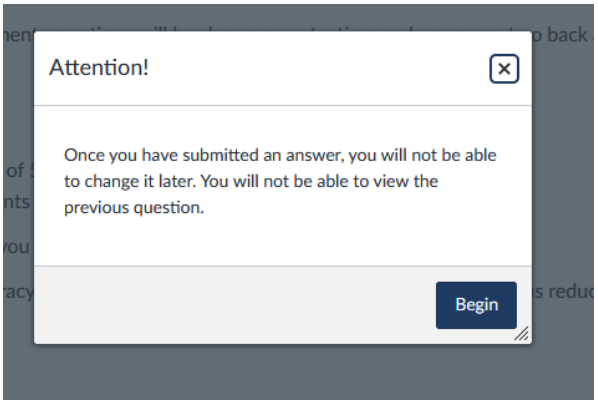
If you complete all problems and get all of them accurately, you can earn 7.5/7 on HW assignments.

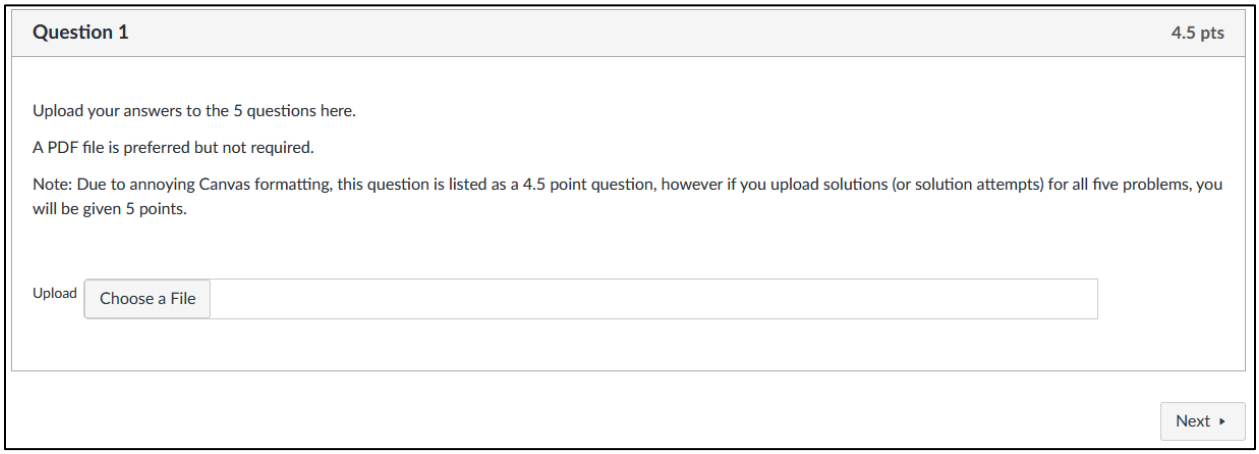
If students are found to have incorrectly evaluated the accuracy of their answers, all accuracy points will be removed. Thus reducing their score to a maximum of 5/7.

Problems:

1. Textbook 5.1
2. Textbook 5.7

Upon Opening Assignment:





Question 1 4.5 pts

Upload your answers to the 5 questions here.

A PDF file is preferred but not required.

Note: Due to annoying Canvas formatting, this question is listed as a 4.5 point question, however if you upload solutions (or solution attempts) for all five problems, you will be given 5 points.

Upload Choose a File

Next ▸

Question 2 — 2.5 pts

Based on the Answer Key: Civl322_HW2_Key.pdf

Check the problems that you got **correct.**

Be sure to read the comments to see if your solution counts as correct or incorrect regarding partially correct answers.

Regarding rounding errors: care should be taken to avoid rounding errors, however if you rounded in an earlier step of the calculation and it propagated, you can award yourself full credit.

Regarding unit errors: If the final answer is reported in the incorrect units, you may award yourself full credit. If you incorrectly converted units once in the solution, you may also allow for full credit. If multiple unit errors are present, no credit should be given.

- [ ] Problem 1: Must have A and B correct for credit
- [ ] Problem 2: C mix correct
- [ ] Problem 3: C (which is also C out) is correct
- [ ] Problem 4: Correct if at least one calc of C mix is correct and it is clearly stated that the criticism is unfair
- [ ] Problem 5: Cn is correct

Next ▸

Question 3 — 0 pts

If you have any comments for the instructor regarding your work or would like to see if a question should have been awarded a correct vs incorrect (the instructor can manually adjust points), please write them here.

Edit View Insert Format Tools Table

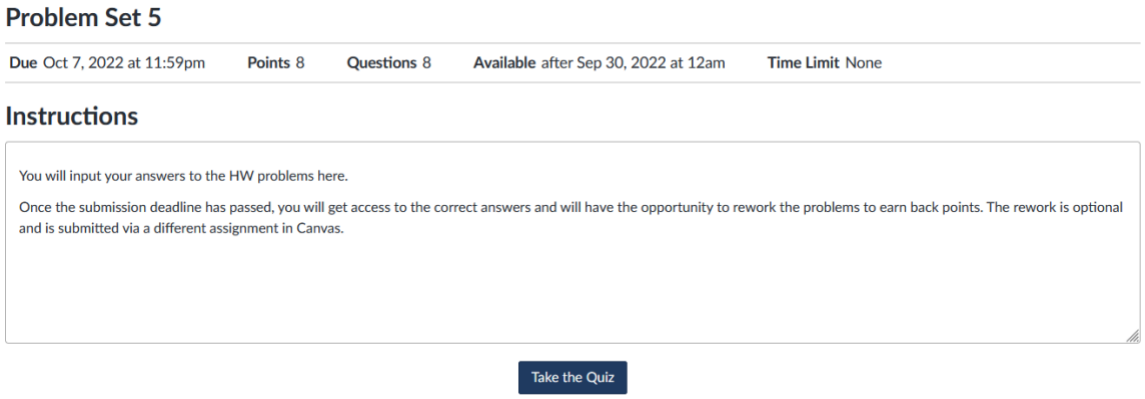
12pt Paragraph

p 0 words

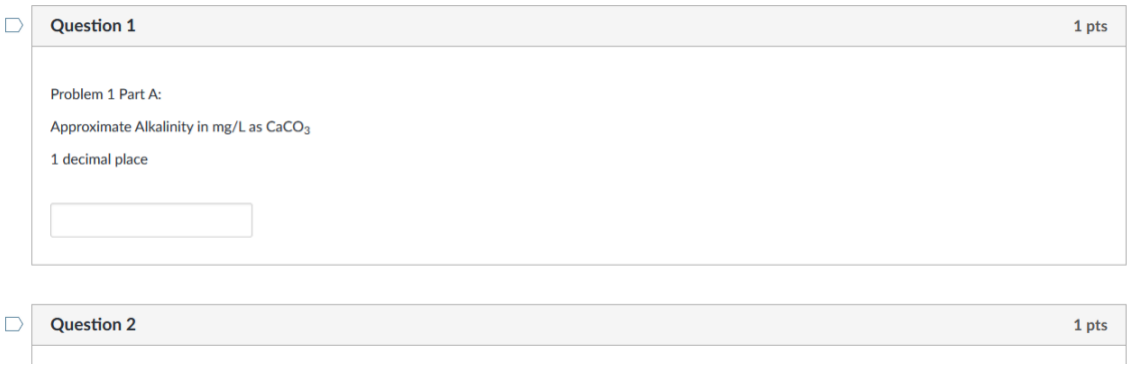
Quiz saved at 1:29pm Submit Quiz

Appendix C. LMS Sample HW Assignment- Senior Level Course

Before Assignment is Opened:



Upon Opening Assignment:



Rework Assignment Instructions in LMS: