Increasing Student Engagement and Motivation by Replacing Homework with Assignment-Quizzes

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Abstract

Digital access to data and reference materials has reshaped student learning and problem solving habits. The ability to query databases and forums for answers to daily questions invites students to believe that engineering solutions too, should be available with the potential to be leveraged in their education. These paradigms present challenges for cultivating student motivation, maintaining academic integrity and, ensuring deeper learning objectives are met because they invite the habit of “searching” for solutions instead of producing them. This study evaluates a paradigm shift with respect to course assessments by using Assignment-Quizzes as an innovative means to improve student engagement.

For each course, students are provided an inventory of problems along with detailed solutions and supplemental explanations as worked out by the instructor. Within a week, the instructor offers a quiz that includes a problem directly from the inventory. This method was motivated by the belief that providing reference material allows students to shift their focus and energy from searching for solutions to engaging the solution process thus enabling them to operate within a higher cognitive domain – shifting from understanding to application, analysis and evaluation.

The quiz assessment replaces the homework weight for the course thereby transforming the manner in which the instructor assesses student work product (i.e. precludes the prevalence of copying solutions). This technique is well suited for new instructors looking to increase student engagement and motivation.

Three separate engineering classes from three separate departments (Civil and Environmental Engineering, Electrical and Computer Engineering, and Mechanical Engineering) simultaneously adopted Assignment-Quizzes. An anonymous survey was used to collect information on student perceptions using Likert scales and prompts such as “I am more likely to study because of Assignment-Quizzes” and to gauge confidence, interest and motivation. With a response rate over 55% across all three departments, the analysis of 178 responses show that about 70% of respondents across disciplines report improved confidence and engagement with the material and over 80% of all respondents, across disciplines, “Agree” and or “Strongly Agree” that they learn from Assignment-Quizzes. Over 55% of respondents indicate a stronger interest in the material because of Assignment-Quizzes and over 75% of all respondents indicate a stronger interest in their fields of study.

Introduction

Homework is essential to undergraduate student development. Out-of-class learning activities reinforce topics presented in lecture and serve to expand student comprehension. The development of educational techniques to improve upon the efficacy of homework is an active research area [1-4]. While educators agree upon the positive impact of homework, the form-factor and delivery method continues to be a topic of discussion [5-7]. Additionally, student attitudes towards homework are also changing to reflect access to digital online modalities. While students often prefer an online presentation of homework, a recent study has shown that
performing homework online does not significantly impact final grade performance as compared to traditional methods [8]. These elements have created an evolving landscape with respect to role of homework. In a sense, our approach to homework has been formed by the established culture whereby “it has always been done this way.” We present an alternative approach to the assigning and assessment of engineering homework that addresses current needs.

The purpose of this study is to provide a method to assist new engineering educators in increasing student interests and motivation. Ideally, using assignment-quizzes would provide a host of benefits for new engineering educators. Specifically

1. Increasing student motivation to engage coursework
2. Increasing student interests in the material
3. Setting standards for student-product using your own examples
4. Decreasing the amount of preparation time used for creating homework and quizzes
5. Allows new engineering educators to obtain insight into how his/her problem types work in a timed assessment
6. Changing the students approach to solving problems.
7. New engineering educators would not need to know the typical “muddy” points that students often face in solution generation given that solutions to problems are provided.
8. Changing the way students prepare for class from searching for solutions to learning how to generate the solutions by inspection.

Perhaps the most significant impact to the traditional homework paradigm has been the recent increase in the availability of digital solutions. Student access to online modalities such as discussion forums and query databases have influenced their expectations with respect to the availability of engineering solutions. As a consequence, students routinely engage in the habit of “searching” for solutions instead of producing them. While this practice has the positive attribute of providing a resource for self-examination, it presents new challenges with regard to student motivation, academic integrity and fostering intended learning objectives. As technology has reshaped this landscape, we must examine our expectations and evaluate the role of homework in our educational strategies [9].

As suggested in the literature and summarized by Feldman [10, 11], homework can be associated with four instructional goals: practice, preparation, extension and integration. While each of these goals has a specific focus, they all require engagement and commitment on the part of the student. Students who inappropriately leverage existing solution sets often bypass the “struggle” that is required to engage the higher cognitive domains. Reviewing prepared solutions without clear objectives and context does not lead to a shift from understanding to application, analysis and evaluation. We believe that students need to be shown the importance of homework and its potential to impact their learning – shifting their mindset from obstacle to opportunity.

We propose the use of frequent quizzes based on focused problem sets to reinforce the value of homework. Our practice is to assign homework and offer comprehensive solutions at the same time; an approach that ensures students are studying from a relevant problem explanation. Often students use what they believe to be similar material for solutions extrapolation. Our rationale
for this approach is rooted in belief that students will seek out and use the solutions regardless of manner in which they are presented. The intent is to guide the manner in which the solutions are used. Solutions are carefully prepared by the instructor and are annotated with relevant scaffolding to illustrate the process to generate the solution. With the solutions in hand the students can focus their energy toward absorbing the material. Within a week, students are assessed with a short quiz that directly reflects one of the problems in the homework set. Quizzes are returned in class.

This Assignment-Quiz framework serves to immediately reinforce concepts covered during lecture. Students can choose how they utilize the provided solution material. As our results will indicate, some students only refer to the solutions after completing the problem while others quickly scan the process at the onset. Instructors may also utilize a hybrid form of solution distribution whereby solutions are presented in two parts; one part illustrates the brief scaffold of the solution approach while another part contains the complete solution. The hybrid approach is useful in addressing students who express difficulty “starting” the problem.

This framework has the benefit of sustaining student momentum throughout the course by guiding students to master topics in small subsets rather than cramming immediately before an exam. It has been demonstrated that shorter problem sets with frequent feedback improves the efficacy of homework [12]. The Assignment-Quiz framework provides feedback in a variety of forms. Students quickly identify areas where additional study is required as the timed setting of the quiz offers a perspective to their level of understanding. Exposure to cadence required to complete the problem is another mode of feedback. Students gain understanding of timeframe required to complete problem in an exam setting.

Improving student engagement with the material and course resources were primary motivators in the development this frequent quiz-based paradigm. Given the ubiquity of digital access to on-line materials, our intent is to refocus students’ efforts on learning by providing the entire student cohort with unified set study materials. Reviewing student comments highlights the fact that not all students will be successful in accessing published solutions and that these students feel that they are at a disadvantage. Access to a common reference set also promotes discussion and improves intra-student engagement. Finally, students who review the provided solution material are better prepared to pose questions during office hours.

Methods

Individual faculty members from the Mechanical Engineering and Materials Science (MEMS), Electrical and Computer Engineering (ECE) and Civil and Environmental Engineering (CEE) departments at the University of X simultaneously adopted Assignment-Quizzes method for an introductory course in their department. The courses selected were Mechanical Design, Introduction to Digital Logic and Computer Methods in Civil and Environmental Engineering.

Assignment Quizzes: for each course, students are provided an inventory of problems along with detailed solutions and supplemental explanations as worked out by the instructor. Demonstrating the level of solution detail a small example of a solution provided to the MEMS course can be seen in Figure 1.
Figure 1. A homework solution provided to students in a MEMS course at University of X. The figure provides an example of the level of detail of solutions given to students in course where the new engineering educator used the Assignment-Quiz methodology.

Within a week, the instructor offers a quiz that includes a problem directly from the inventory. The quiz is an in-class quiz that takes 15-20 minutes for students to complete. This method was motivated by the belief that providing reference material allows students to shift their focus and energy from searching for solutions to engaging the solution process thus enabling them to more
deeply engage the material—shifting from understanding to application, analysis and evaluation. The quiz assessment replaces the homework weight for the course thereby transforming the manner in which the instructor assesses student work-product from the students.

An anonymous survey was used to collect information on student’s interests, perceptions and experiences and, efficacy with the Assignment-Quiz methodology. The survey consisted of three parts.

1) Students answered whether or not they agreed or disagreed with the statement “Because of how the Assignment-quizzes are organized I am more interested in (insert specific course topic here). There were 5 options ranging from Strongly Disagree to Strongly Agree.

2) Students were asked to state whether the agree or disagree, on a Likert scale, with a series of statements their perceptions and experiences with Assignment-Quizzes in their course. Prompts included statements such as such as “I am more likely to study and do the work in this course because of Assignment-Quizzes”.

3) The third and final section of the survey asked students to rate themselves on a 0-100 scale across four dimensions with respect to four tasks. The four dimensions were “how successful they would be”, “their belief in their ability to perform the tasks”, “how motivated they would be to perform the tasks”, and “the degree of anxiety they would feel in performing the following tasks”. The four tasks were
   a. Identify a problem
   b. Formulate a problem
   c. Generate a problem solution
   d. Ability to evaluate appropriateness of generated solution in context.

Results and Discussion

The majority of students (over 70%) across all three departments agreed with the following statement “I am more likely to study and do the work in this class because of assignment-quizzes”. Out of the 187 respondents, over 75% of students agreed or strongly agreed that assignment-quizzes increased their interests in the central topics for their course in their respective discipline. For example over 79% of students in Mechanical Design agreed or strongly agreed with the following statement “Because of how the assignment-quizzes are organized I am more interest in Mechanical Design. Combining the results for all three courses shows that 51% and 24.6% of students agreed and strongly agreed respectively with equivalent statements in their respective departments. The results can be seen in Table 1.

The results demonstrate that the Assignment-Quiz framework has a positive impact on student motivation to engage the course assessments. Additionally, this methodology elicits an increase in student interest in the subject material thus having an impact on building the professional habits of life-long learning. For new engineering educators, this approach could not only-serve as a stepping-stone to other engaging approaches such as problem-based learning but, it could also provide a format to meet their specific student outcomes.
Table 1. Results showing student agreement to statements regarding increased interests in course topics due to assignment-quizzes. N = 187.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Subject</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total (n)</th>
</tr>
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<tbody>
<tr>
<td>MEMS</td>
<td>Mechanical Design</td>
<td>0.00%</td>
<td>1.96%</td>
<td>18.63%</td>
<td>55.88%</td>
<td>23.53%</td>
<td>102</td>
</tr>
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<td>MEMS</td>
<td>Engineering</td>
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<td>0.00%</td>
<td>18.63%</td>
<td>51.96%</td>
<td>29.41%</td>
<td>102</td>
</tr>
<tr>
<td>ECE</td>
<td>Digital Circuit Design</td>
<td>0.00%</td>
<td>9.23%</td>
<td>27.69%</td>
<td>43.08%</td>
<td>20.00%</td>
<td>65</td>
</tr>
<tr>
<td>ECE</td>
<td>Elect. &amp; Comp. Engr.</td>
<td>0.00%</td>
<td>1.54%</td>
<td>18.46%</td>
<td>55.38%</td>
<td>24.62%</td>
<td>65</td>
</tr>
<tr>
<td>CEE</td>
<td>Civil &amp; Environ. Engr.</td>
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<td>0.00%</td>
<td>25.00%</td>
<td>45.00%</td>
<td>30.00%</td>
<td>20</td>
</tr>
<tr>
<td>CEE</td>
<td>Numerical Methods</td>
<td>5.00%</td>
<td>10.00%</td>
<td>30.00%</td>
<td>40.00%</td>
<td>15.00%</td>
<td>20</td>
</tr>
</tbody>
</table>
Figure 2. Results depicting student perception and experiences of using Assignment-Quizzes in their courses. N = 187 students combined from all three engineering departments (MEMS, ECE, and CEE)

The students responded to having positive learning experiences and preferences with the Assignment-Quizzes by affirming the statements on the anonymous survey. Specifically, over 50% of respondents selected Agree or Strongly Agree for six out of the eight categories. These six categories include the following:

- I learn from assignment-quizzes
- I prefer assignment-quizzes to traditional homework
- I am more likely to study and do the work in this class because of assignment-quizzes
- I prefer assignment-quizzes to traditional quizzes
- I am more confident taking the quizzes with access to the solutions
- I feel that I am better prepared for the exam because of assignment-quizzes
- Compared to other engineering courses I enjoy this course more because of assignment-quizzes
- Assignment-quizzes reduces the anxiety I feel to maintain GPA
- I am more confident taking the quizzes with access to the solutions
- I feel that I am better prepared for the exam because of assignment-quizzes

For two of the eight categories less than half of the student respondents affirm the statements by Agreeing and or Strongly Agreeing. Specifically, only 40% of the students affirmed that their class was more enjoyable, compared to other classes, on account of the Assignment-Quizzes and only 45% of student respondents affirm that Assignment-Quizzes reduces the anxiety they feel to maintain their GPA.

Over 57% of the student respondents report that they would be successful in identifying a problem, formulating a problem, generating a problem solution and, the ability to evaluate the appropriateness of solution in context. This is a positive trend with respect to Assignment-quizzes since upwards of 75% of them rate their potential personal success in the upper range. The results are encouraging as they indicate a certain comfort level with the material. It is likely that because of the access to the instructor’s point of view with the solutions students are more understand what is expected and feel that they could generate solutions in a similar manner. The following figures, Figures 3 and 4 show a clear positive response with respect to their confidence and motivation across the 4 tasks. This is evident by the skew of the data to the right. Figure 5 shows that the Assignment-Quizzes have much less of an effect on student anxiety.
Figure 4. Student personal ratings (N=187) of the confidence in their ability to perform the following four engineering tasks (identify a problem, formulate a problem, generate problem solution, ability to evaluate appropriateness of generating solution in context)

The results clearly show that a majority of the student feel confident in their ability to engage the material in their respective classes. This is likely the result of students being able to see their instructor’s approach to generating a solution, understanding what is expected from them regarding the standards of their generated solutions and, being able focus their efforts on specific types of problems in small subsets. While some “muddy points” may have been removed and improved student confidence it is important to note that these this approach have not yet been shown to improve GPA and or exam scores.
Figure 5. Student ratings (N=187) of their personal motivation to perform the four engineering tasks (identify a problem, formulate a problem, generate problem solution, ability to evaluate appropriateness of generating solution in context)
Figure 6. Student ratings (N=187) of their personal anxiety with respect to four engineering tasks (identify a problem, formulate a problem, generate problem solution, ability to evaluate appropriateness of generating solution in context).

The results in Figure 5 affirm the findings in Table 1; that an increase in motivation is associated with this Assignment-Quiz approach. In Figure 6 we see that there are subsets of students that feel anxious with respect to performing the 4 tasks evaluated. Future work will evaluate the source of these anxieties and how Assignment-Quizzes can be used to decrease anxiety while engaging course assessments.

While we focused on simply using assignment-quizzes there are many variants of this approach that new engineering educators may want to consider including having worked out solutions with smaller homework assignments. As new engineering educators we were ultimately able to gauge students interests, perceptions, experiences and motivation as it relates to Assignment-Quizzes. With a response rate over 55% across all three departments, the analysis of 187 responses show that about 70% of respondents across disciplines report improved confidence and engagement with the material and over 80% of all respondents, across disciplines, “Agree” and or “Strongly Agree” that they learn from Assignment-Quizzes. Over 55% of respondents indicate a stronger interest in the material because of Assignment-Quizzes and over 75% of all respondents indicate a stronger interest in their fields of study.

References


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