

Journal Keeping in Engineering Disciplines

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Abstract

Journal keeping is commonly used in liberal arts disciplines as a means for students to hone writing skills, practice expression, document their work, and improve recall. This concept, however, is less frequently used in science and engineering education. In this paper an adapted use of journaling in an engineering mechanics class will be discussed. The journal took the form of a problem solving notebook. In addition to regular graded homework assignments, students were required to maintain a notebook of practice problems which was collected for a grade periodically throughout the term. Students were allowed to select any problems from their textbook they wished, including worked examples, and were graded only on the number of problems completed. Student impressions were polled in a survey at the end of the term. Responses to the concept were largely positive with the most frequently cited benefit being in test preparation. Students found that when they went to study for exams, they felt that they already knew the material because they had already practiced problems by putting them in their notebooks. In essence students were forced to space their repetition which improved their subject recall. Negative responses were mostly related to the additional time required to complete the notebook. In spite of the benefits evident to the students, they tended not to complete notebooks unless they were collected for a grade.

Introduction

A maxim exists in education, which is perhaps for many other human endeavors, that states simply “you can expect what you inspect” meaning students naturally focus their efforts towards tasks that are evaluated and deprioritize others. Students acutely feel the pressure of inspection and naturally prioritize their efforts towards each successive inspection of their work be it a homework assignment, lab report, or examination. Since students take multiple courses throughout each term and are frequently working or are involved in various extracurricular activities the default mode of study is ramp up their study time or cram as exams approach¹. Unfortunately in this case human nature runs counter to the currently regarded best learning practices. Modern educational theory suggests that learning is optimized when study time is distributed and interleaved with other tasks either in single sessions or multiple sessions¹. Taylor and Rohrer for instance show that mixing tasks is more effective than tackling tasks in blocks². As to the lasting effects of learning Rohrer and Pashler note that learning is more durable when spaced and distributed³. Surprisingly, students often fail to recognize the utility of spacing and interleaving practice, even when they have just employed these strategies successfully. In an experiment conducted by Kornell and Bjork, students were shown paintings from different artist

that were either interleaved or blocked by artist⁴. The students were then shown previously unseen works from the artists they had just studied and were asked to identify the artist. Students who viewed the interleaved art were more successful at identifying the unknown artwork. Students were later polled as to which technique they thought would result in higher test scores and the majority favored blocking over interleaving, despite having already been shown evidence to the contrary. As noted by Dunlosky *et al*, students need training in distributed learning to overcome some of the natural driving force towards blocking. Merely experiencing the benefits of interleaving is not enough¹.

How then can the educator then make the student recognize the need for distributed learning? By going back to the expectation-inspection maxim; in other words simply devise a way to enforce distributed learning by inspecting it. Requiring that students maintain a journal throughout the term offers one possible solution. Journaling has long been used in fields outside of engineering. For example psychologists have shown that journaling about traumatic events is related to decreased distress, depression, and results in positive changes in the immune system. Simply expressing emotion in written form is beneficial to mental health⁵. Journaling in education is used as a tool for keeping a list of thoughts and ideas, honing writing skills, and providing an active means for the monitoring and evaluating student work for the instructor⁶. Research suggests that simply trying to link concepts by writing about them helps students establish the conditions for learning the objectives⁷. Journaling also acts as a means to enforce revision and repetition of course material⁶. In this study, the efficacy of journal keeping in an engineering mechanics course as a means to promote subject mastery was investigated. Students were asked to maintain a homework notebook containing student selected problems from their mechanics textbook to see whether by forcing distributed learning test scores could be improved.

Approach

Students in a junior level engineering mechanics class were instructed to keep a homework journal. In typical liberal arts class a journal might involve exploring at topic through a series of frequent writing assignments. The study of engineering mechanics is more reliant on practice problems to develop a broader problem solving skill set. As such the more traditional journal format was modified for the purpose of this work to focus on problem solving in mechanics rather than writing assignments. Journals were collected periodically for a small percentage of their final grade (10%). For full credit students were to complete at least five problems per week from their textbook (Hibbler 13th edition, Engineering Mechanics, Statics and Dynamics). No specific recommendations for problems were given, though the suggestion was made that students attempt problems relevant to the course material being covered in class that week. Students were allowed to include solutions to example problems from the text or examples worked in class, but were encouraged to try harder problems from the end-of-chapter problem sets. Students were also encouraged to attempt problems without prompting from the solutions and for problems with partial solutions in the text, the students were instructed to complete the missing steps. In addition to the homework notebook, traditional homework assignments were collected and graded. Students were also given an oral examination and three traditional exams over the span of the semester. The homework notebooks were collected periodically throughout the first two thirds of the semester. After the second exam students were

encouraged to continue working problems as before but were told the homework notebook would no longer be graded.

Results

Students on average completed 5.4 problems per week over the first two thirds of the semester which is slightly higher than the five problem requirement. Exams were given at roughly one third intervals throughout the semester. The class averages for exam scores for the first two exams were 83 and 79 respectively. The final average drops significantly relative to the first two exams with a class average of 65. This drop-off may also be attributed to removing the incentive of having the homework notebook collected for a grade, though typically some drop-off is expected as the material increases in difficulty as the semester progresses and external demands from other classes increase.

In an informal survey given at the conclusion of the semester, students were asked to rate the effectiveness of the homework notebook in terms of overall usefulness, usefulness beyond the normally assigned and graded homework, and usefulness in preparing for exams. Students were also given the opportunity to express their own thoughts. Of the twenty four students enrolled thirteen responded to the survey. Students, when asked how effective keeping a homework notebook was for the class in a general sense, gave an average rank of 3.7 on a scale of 0 being not useful and 5 being very useful. Students felt rewarded for their study efforts.

“I feel the homework notebook idea was fantastic. While in most classes you are not rewarded for studying other than how you do on your exams, the homework notebook allowed for a grade based purely on the fact that you were indeed studying. While it was easier in general than regular homework; I know in my case it helped me greatly by reviewing examples and filling in the skipped steps/equations. I wish this was offered in all of my courses in the future.”

“... helps act as a reward for students to do more than just the minimum of regular assigned homework.”

“Overall, my final grade was better than expected and better than most other comparable classes. Very good idea...”

When asked if keeping homework notebook helped beyond the regularly assigned and graded homework assignments, students also answered affirmatively with a 3.4 on a similar 0 to 5 point scale, though some students expressed concern that the homework notebook requirement took time away from other required work.

“I think the idea is good but it’s not something I focused on that much. I was much more worried about doing the labs and getting the other assigned homework done.”

“I felt like it was a good idea but I never had any time to do it because of my other classes.”

“At points where the student is stressed in the semester, the homework notebook becomes just

another assignment to do. And if the student doesn't have much time, they are more inclined to just copy an example out of the book instead of trying to figure out a problem on their own.”

Perhaps the greatest benefit came in the form of exam preparation. Students ranked usefulness of the homework notebook in preparing for exams as 3.8 on the 0-5 point scale.

“I did not like the idea of the Homework Notebook at all in the beginning of class, it seemed to be way more work than it was worth. Once the first test came around and while I was studying I realized I already knew all the material.....my perspective changed. I started to do extra problems after that and not only did I not have to study hard for the tests, my test scores improved over previous courses...”

Interestingly students were able to recognize the benefits on their own and found ways to improve their work.

“It took me a while to get used to it. The first time I did it, I think I just copied through the example problems and did the easy ones. It was sort of a "do it a day before" thing. The last one was due, I'm pretty sure, right before an exam. I did really well on this one, because I figured, "Well, if I'm gonna have to study for the exam, I might as well get points doing it." and so I used that as my main study tool and that's the exam I did best on.”

Students also reported that having the notebook helped them stay more organized which assisted them in exam preparation:

“Doing problems for the test and being able to look back on old problems helped. For most classes I try to write out more problems when studying on extra paper or where ever I can. This provided an outlet.”

Not all students found the method effective. One student in particular ranked the usefulness very low in all aspects because he or she already kept a notebook:

“I normally do a lot of practice problems before an exam. I filled my notebook with these problems. If there wasn't a notebook portion for this class I still would have done my own practice problems before the exams. I just used the notebook as a place specifically to put my exam practice problems.”

When asked if students would use the homework notebook concept in other classes they responded with a 3.5 on scale with 0 equal to not at all to 5 equal absolutely.

“Think more professors should use this as it gives the students more reason to work problems outside of class.”

After the second exam students were told that they were no longer required to maintain their notebooks. The usefulness of the notebooks was discussed several times in class in reference to the quality of scores on the first and second exams. These discussions suggested that the students seemed to understand that they benefited from the notebook requirement in terms of exam

preparation. Unfortunately in spite of this apparent understanding of the benefits students either did not continue working in their notebooks or completed fewer problems than were previously required once they were no longer required to do so. None of the respondents said that they continued at the previous level. As mentioned previously the final exam score average also dropped by eighteen and fourteen percentage points relative to the first and second exams respectively. That the students stopped utilizing their notebooks is not too unexpected result given the findings of Kornell and Bjork that suggested that students will often do things contrary to their own best interests in spite of the evidence before them⁴.

Summary and conclusions

Based on the results from the end of class survey, the majority of students found keeping a homework notebook to be useful, especially for exam preparation. Collecting the notebook throughout the semester appeared to have the intended effect of creating distributed study time. Although no control group was used to make a direct comparison, based on experience in teaching other similar courses, scores for the first two exams seemed above average while the notebook was being collected and graded. Those students who responded negatively to the homework notebook generally listed two complaints. First, the extra requirement was a burden that took away from other academic pursuits and second, they already had incorporated similar techniques into their study habits on their own. The drop in exam scores at the final tends to indicate that the journal should be required and graded throughout the entirety of the semester to maximize benefit.

Based on the experience gained in this experiment, several of additional ideas are suggested to improve the efficacy of journal keeping in engineering. In addition to having students work textbook problems as a means to encourage distributed learning, more traditional journaling elements could be incorporated into the journal assignments. As suggested by Towndrow *et al*, journaling can be used as a generative strategy⁸. For example, students could be asked to write briefly about a topic they found interesting. This process would serve to help enforce revision and create repetition and cement concepts in their minds. Second, students could be asked to suggest topics that they feel merit additional discussion in class. Often the instructor has one vision of what the students are learning in class, and the students may have an entirely different perception or a lack of understanding on a given topic. By the time an examination takes place, the time is too late to take corrective action if the two visions do not overlap. By having the students express their concerns throughout the term these issues can be readily addressed in class as needed to fill in any gaps in understanding. This strategy was shown by Towndrow to decrease the learning gap between lower and upper achieving students⁸. Finally, Hampton and Morrow in their study of reflective journaling in engineering showed that having students draw from their own experience enhances retention of information⁷. Students rated personal experiences highly, instructor experiences next in terms of effectiveness and textbook examples least effective in helping them learn. The world surrounds us with examples of engineering mechanics problems and with some guidance students could be assigned to find their own problems related to specific course objectives. After collection and examination of the homework journal good problems could be brought back to class to share with other students and

the instructor could model this behavior by bringing in his or her own examples. In summary, with some improvements, such as including a mix of traditional problem solving and short writing assignments journaling in engineering disciplines shows good potential to improve learning and information retention.

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