HOW TO FIX IT WHEN IT'S NOT BROKEN!
EXPERIENCES FROM APPLYING SMALL TEACHING PRACTICES

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Abstract – In this paper, two ‘small teaching methods’, namely retrieval and prediction were added to the standard delivery of a third year circuits course. Students were asked to ‘retrieve’ their course knowledge frequently by answering questions in lectures and tutorials using educational software tools. They were also asked to occasionally ‘predict’ the answers to questions about topics they have not seen before. The student performance on the midterm exam showed a noticeable improvement in comparison to previous years. There was also a noticeable reduction in percentage of students with C and D grades. A student survey at the end of the semester revealed that a substantial portion of the students claimed that they paid more attention and retained more of the course material due to the small teaching practices.

Keywords: small teaching, flipped classroom, retrieval and prediction, student reflection

1. INTRODUCTION

Inspired by a workshop on “Small Teaching” [3] offered by CEEA-ACEG Institute for Engineering Education Teaching (IET) in 2018, the author implemented a few “small teaching” practices in a third year circuits course. This paper presents the methodology and the results observed from implementing those practices.

The author has taught the course presented in this paper for a number of years using a mostly traditional lecture style. The course includes 3 hours of lectures, 1 hour of tutorial and 2 hours of labs per week. While the lab exercises consisted of hands-on activities, the lectures and tutorials consisted of the instructor writing notes and solving problems. The course has consistently received excellent student ratings in the past, i.e. the course was not “broken” as the title of the paper suggests.

Fig. 1 shows the student evaluation of the course in Fall 2017, the year prior to implementation of the ‘small teaching’ methods. The student evaluations, however, do not always represent students’ learning or mastery of the topic [5]. In other words, even this course could benefit from evidence-based approaches to enhance student learning.

Retrieval and prediction are two of the small teaching methods discussed in [3]. The author adds applications of those principles to the Fall 2018 offering of the same course to see what impact, if any, they will have on student performance in summative assessment and the course evaluations. The students are also asked to reflect on the small teaching practices and their perceived effectiveness.

The results indicate an improvement in performance for the 2018 cohort in comparison to the 2017 class. The student also reported an increase in attention in class and retention of course material.

Section 2 presents the methodology in applying small teaching in this course. Section 3 presents the results and discussion, followed by the conclusion in Section 2.

2. METHODS

2.1. Retrieval

The retrieval principle simply refers to the act of forcing learners to recall learned information or concepts from their memory. The impact of the retrieval principle has been demonstrated in a number of experiments. In [1],
the authors used frequent quizzing as a form of retrieval practice for middle school students. The authors discovered that students scored higher on the material that was quizzed frequently and the positive results of the experiment also continued far into the future.

In the 2017 offering of the course, retrieval was not applied in a formal and systematic way. In the 2018 offering, the following changes were made to incorporate retrieval:

1. At the end of every lecture, an educational software tool (TopHat) was used to ask a short question from the students about the day’s concepts. Fig. 2 shows a sample TopHat question that was presented at the end of a lecture on electrical power. As an incentive for the students to respond to the TopHat questions, 2% of the final grade in this course was contingent on the student answering at least 70% of the questions in the semester (correctly or incorrectly).

2. The tutorial content was delivered using videos that were available ahead of time. Students used the scheduled tutorial time to answer a quiz about the material. The tutorial quiz was held online using the Learning Management System (D2L in this case.) Students were allowed to collaborate on their submissions. The flipped tutorial quiz represents a weekly retrieval exercise. As an incentive to attempt the quizzes without introducing exam anxiety, the tutorial quizzes accounted for 3% of the final grade in this course.

2.2. Prediction

Another small teaching principle, this technique refers to asking students to predict the answer to a question they have not learned yet, even when their prediction is incorrect. Research has shown that unsuccessful predictions were “remarkably more effective than spending the same time studying answers to be recalled later.” [2]

Using the same educational software tool, TopHat, students were occasionally asked to answer questions for which they have not seen the answer yet.

3. RESULTS AND DISCUSSION

The impact of the changes to the 2018 offering of the course was studied along three dimensions: Student performance, students’ perception of the small teaching techniques, and course evaluations.

3.1. Student Performance

The midterm exam grade, the final exam grade, and the letter grades are compared between the 2017 and 2018 offering of the course to assess the impact of the small teaching technique.

The midterm and final exams are both summative assessments for this course. The midterm exam is held after around 50% of the course material is covered while the final exam is held at the end of the semester. The final exam, while being cumulative, focuses more on the last 50% of the course. To measure the impact of the retrieval principle, the lecture TopHat questions were used almost daily in the first half of the course (prior to the midterm) and they were used sparingly in the second half. The average grade for both exams in 2017 and 2018 is shown in Fig. 3.

![Fig. 3: Student grades in midterm and final exams](image)

The 2018 cohort did noticeably better on the midterm exam than the 2017 class. They performed very similarly on the final exam. The final examinations for both years were nearly identical and the midterm examinations were...
of the same level of difficulty. To rule out the possibility that the 2018 cohort’s improved performance on the midterm is because of that group’s higher academic aptitude, the students’ performance in a different course was studied. The final exam grades from a different course are shown in Fig. 4. This particular course was chosen because it was another core, mandatory, and technical course for this group of students, and because it had a final exam of similar level of difficulty in both years.

In [4], the students in an introductory chemistry course were asked to answer a simple question at the end of every lecture – a technique very similar to that studied in this paper. The researchers noticed that while A and B students performed relatively similar, the C and D students improved after implementing the retrieval principle. Similar observation was also made by the author.

### 3.2. Student Perception

To gauge students’ perception of the changes in the course and its effectiveness, a survey was conducted at the end of the semester. Some of the questions and the responses are presented in this section.

In the first question, students were asked if the class participation marks associated with the TopHat questions in lectures impacted the number of classes they attended. They were asked to pick one of the following two choices:

- I attended more lectures because of the ‘TopHat question’ mark than I would have otherwise
- I would have attended about the same number of classes regardless of class participation marks.

The response to this question is shown in Fig. 6. The marks associated with the retrieval exercises provided enough incentive for 20% of the students to attend more lectures than usual. The TopHat questions accounted for only 2% of the final grade in the course. A question for future consideration would be to increase the weight of the TopHat questions to study its effect on class attendance and performance.

Another question in the survey asked the students to select one of the following choices:

- I paid more attention in class because of the TopHat questions
- I paid about the same amount of attention

The results in Fig. 4 show that the 2018 cohort was not necessarily academically stronger than the 2017 group.

Another noteworthy observation can be made about the students’ letter grades in this course before and after implementing the small teaching techniques. Fig. 5 shows the letter grade distribution for the two cohorts studied in this paper. It can be seen that the number of C and D students decreased after the small teaching tools were deployed. This matches the results from the study performed in [4].
The results are shown in Fig. 7. More than 40% of the respondents reported that they paid more attention in class in order to answer the TopHat questions correctly. If for no other reason, this results alone can justify incorporating small teaching practices in the classroom!

Students were also asked to reflect on how they thought the retrieval practices affected their retention of course material. They were asked to select one of the following choices:

- I retained more information from the lectures because of the TopHat questions
- The TopHat questions had no effect on my knowledge retention

The results are shown in Fig. 8. More than 2/3 of the students believed that the small teaching practices helped them with knowledge retention.

As the TopHat questions were only worth 2% of the final grade and students only had to answer 70% of the questions (correctly or incorrectly) to receive credit, it would be tempting for students to simply guess the answers or copy their friend’s answer, or more generally, do not put any effort towards answering the questions. As part of the survey, students were asked to estimate the percentage of TopHat questions in the semester that they put zero effort towards. The results are shown in Fig. 9.

A similar question was asked about the tutorial quizzes, which were another regular retrieval exercise in the semester. Students were asked to estimate the percentage of tutorial quizzes in the semester that they put no effort towards. The results are shown in Fig. 10.

While the TopHat questions and the tutorial quizzes were both implementations of the retrieval principle, it is noteworthy that students put more effort towards the tutorial quizzes as evident from comparison of the results in Fig. 9 and Fig. 10. Both elements counted for about the same portion of the final grade (2% and 3% for the TopHat questions and tutorial quizzes, respectively) so the extra effort may not be explained by grade motivations. Tutorial quizzes had a more formal title and the students were provided with 20 minutes to answer the questions (as opposed to 2-3 minutes for the TopHat questions in lecture.) These factors could have contributed to the higher effort levels in the tutorial quizzes.
3.3. Course Evaluations

To see what effect, if any, the changes to the course had on student evaluations, the results from the 2018 offering are shown in Fig. 11.

Fig. 11: Student evaluations for Fall 2018 (after 'small teaching')

Comparison of the results in Fig. 1 and Fig. 11 shows that the students' evaluation of the course did not change significantly after implementation of the small teaching methods. This is a promising result as changes in successful courses can often be met with resistance and/or decline in student evaluations.

4. CONCLUSION

In this paper, two of the small teaching methods discussed in [3] were implemented in fall 2018 in a third year circuits course while keeping the rest of the course similar (if not identical) to the previous offering. The performance of the 2017 and 2018 cohort of students was compared to gain insights into the impact of the methods. The students were also surveyed at the end of the semester to gauge their perception of the methods.

The 2018 cohort’s performance in the midterm exam is a promising signal that small teaching methods can improve students’ performance. Also, as shown in other research, this method helped C and D students achieve better grades in comparison to standard delivery models without small teaching.

Perhaps the most significant results came from the student survey at the end of the semester. A substantial portion of the students claimed that they paid more attention and retained more of the course material due to the small teaching practices implemented in 2018. Students also put more effort towards retrieval exercises that appeared more formal and had more allotted time.

Implementing the small teaching exercises in 2018 required additional time and resources compared to the standard delivery of the course, but the end results were rewarding and satisfying. In future implementations of the small teaching practices in this course, more methods such as interleaving, self-explaining, expanding, etc. can be included. Also, the implementation of TopHat questions and tutorial quizzes can be modified to assess the impact of different variables such as final grade weighting, marks for correct answers, etc.

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