

Problem

A major challenge in teaching technical courses, such as those that involve coding in R or Python, is creating exercises for hands-on learning. Yet creating exercises that are useful for students and efficient for instructors poses practical and principled challenges. Exercise creation is time-consuming for instructors and therefore may be crowded out by other priorities. Instructors who are developing new courses, for instance, may instead use their energy for course organization, lecture material, and student assessments. Because exercises are often not strictly necessary, they may end up relegated to later iterations of a course, depriving current students of learning opportunities. Furthermore, exercises are most beneficial when they address weak points in students' knowledge. These weak points will be inherently well-known to students more than to instructors. Students thus have a unique set of knowledge that may allow them to create exercise material that address those weak points for other students. Finally, creating exercises may itself be a useful learning opportunity. Recent research shows that engaging students in knowledge creation can increase learning [3], often to the benefit of students who need it most [5].

Scaling up learning with an exercise-creation task

To address these challenges, this project investigates the use of an assignment that asks students to create exercises from the course material in a Master's social media data analysis course. It builds on research that advocates involving students in creating active learning exercises themselves [4, 1]. This project thus evaluates the educational benefits to students of creating exercise material in the form of basic coding exercises. The assignment asks students to select one of the topics from the course; select a dataset to develop an exercise for; write instructions and R code that will be given to other students to complete; and write an answer key. Instructions for the exercise can be found [here](#).

The potential benefits of this assignment, broadly, are twofold:

- Student learning:** Increase learning by requiring students to *know* the material well enough to *teach* it by creating a relevant exercise.
- Scaling up content:** Increase the number of exercises available to students to study for the final exam.

There are also potential drawbacks. First, because in the present case, the assignment is not mandatory, students may not take the assignment seriously. Second, the exercises may be poorly executed, and thus not be useful for other students to learn from. Third, students may not *perceive* the task of creating an exercise beneficial, even if it actually benefits learning [2].

Measurement

To measure the success of the exercise-creation assignment, it was assessed along three dimensions:

- Exercise quality:** Are the exercises sufficient to be used as exam preparation material?
- Student learning:** Does the task of generating an exercise itself increase learning?
- Perceptions of exercise benefit:** Do students perceive the task as beneficial for exam preparation?

Measurement (continued)

Given the size of the class ($n = 43$), students were not experimentally assigned at random to complete or not complete the exercise. Rather, success of the exercise is assessed quantitatively through survey-based measures of student perceptions of the exercise, and qualitatively through my subjective assessment of the exercise quality. In the survey, students were asked (1) whether they chose their topic because it was challenging; (2) whether their own exercise is of high quality; (3) what the exercise was useful for exam preparation; (4) whether they learning substantially more about the topic they chose; and (5) whether they believe the exercises of others would be beneficial for exam preparation.

Results

In total, 33 out of 43 students (so far) completed the assignment. Of the 33 students who completed the assignment, 19 completed the survey, which I analyze here.

To analyze the results, Figure 1 presents the distribution of survey responses for each outcome. The responses on the horizontal axis are those from a Likert scale, from "Strongly disagree" (SD) to "Strongly agree" (SA).

To begin, the top left panel of the figure shows that students generally chose what they believed to be a challenging topic for their exercises. Encouragingly, this suggests that students use opportunities like this assignment as a way to increase their technical knowledge in areas that they recognize they may be lacking in. Turning to the middle top panel, we see that students also indicate putting relatively substantial effort into the exercise, suggesting that they take exercises like this seriously. Furthermore, in the top right panel, we see that students believe that the exercise-creation task is itself useful for studying for exam.

Turning to the bottom row of Figure 1, we see that students believe that doing the exercises by other students would benefit their learning as preparation for the exam. Finally, as the bottom middle panel shows, students believe that creating an exercise was valuable as a *learning* task—that having to *teach* material is beneficial for learning it. Because this may be the most important outcome from an instructors' perspective, it is notable that it has highest strong agreement among students.

I also qualitatively assess the success of the exercises by reading student group's exercise instructions and answer keys. Overall, the quality of the exercises was high, with only a few exceptions. Although there were a number of cases in which the exercises themselves needed to be edited for mild coding inaccuracies, the exercises are well done. Moreover, consistent with students' evaluations of the topics that they choose, most students created exercises for the more challenging topics in the course.

Finally, an open-ended question in the survey asked students to reflect on the benefits and drawbacks of the exercises. Some students noted its benefits for learning. For example, one student stated that "it is a good idea that we have to create our own exercises instead of just doing some created by the professor, since it forces us to understand the topic a little better." Others noted that the exercise itself would be more useful if (1) it was mandatory and (2) student groups were assigned a topic so that all topics were covered. There are, however, drawbacks to the latter suggestion. If the primary purpose of an exercise assignment is to encourage student learning rather than to create exercises for exam preparation, then students may benefit most from selecting topics themselves, even if not all topics are covered.

Results

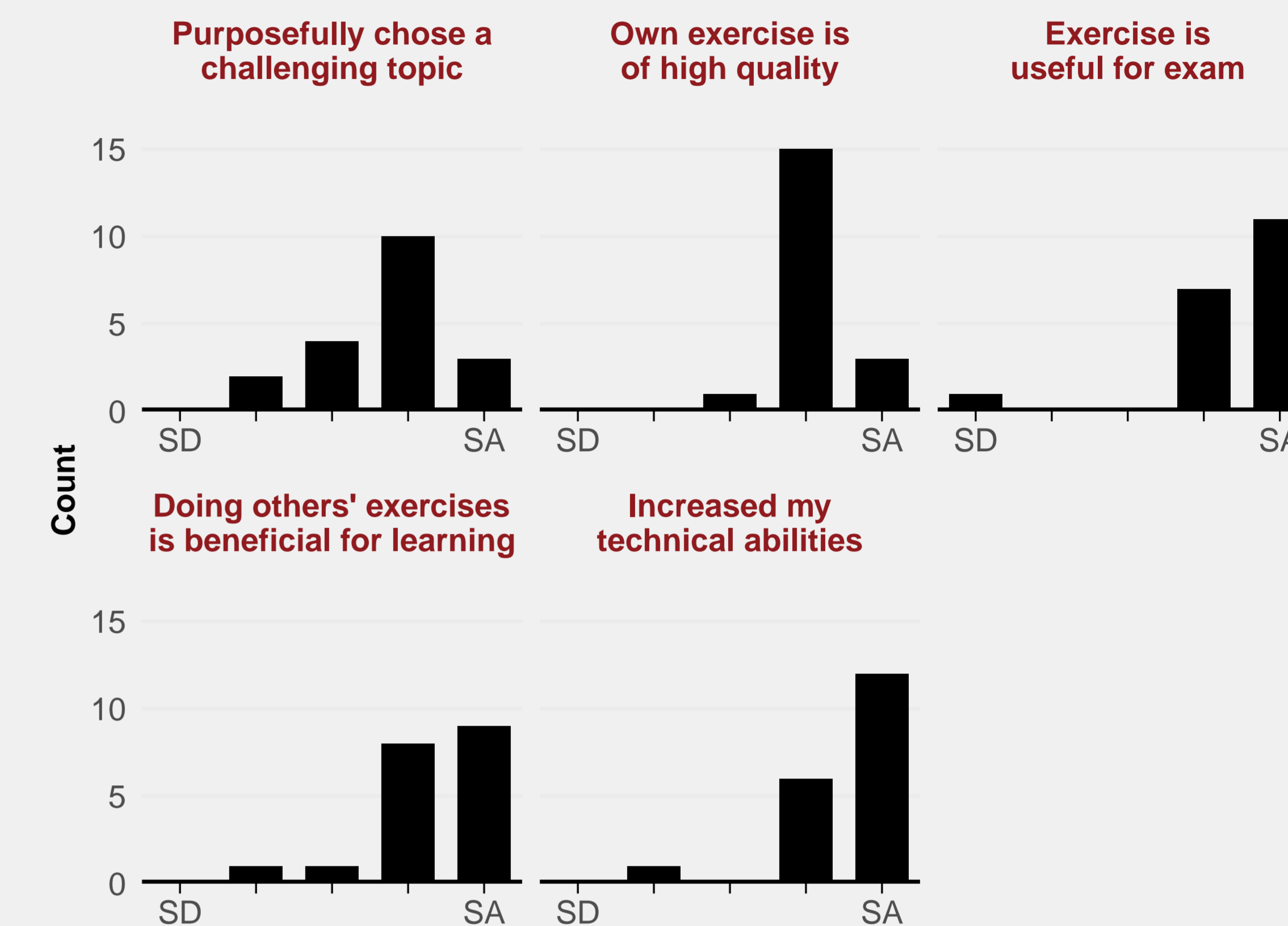


Figure 1. Student perceptions of exercise-creation assignment

Conclusions and implications

Taken together, the results suggest that students and instructors can greatly benefit from assignments that engage students in actively developing exercises in hands-on technical courses. On the practical side, instructors benefit by redistributing course development to students themselves, and freeing up time for other course- and research-related work. For students, active engagement in creating exercises increases (perceptions of) their ability to conduct more complex technical coding tasks. Finally, exercise-creation tasks scale up active learning by creating a large set of material that other students can then use to learn other aspects of a course.

References

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