ONE-A-DAY PROBLEMS FOR IMPROVING STUDENT LEARNING AND STUDY HABITS

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Abstract –At the University of Waterloo, Mechatronics Engineering students take their first programming course in their first academic term. In 2016, Waterloo introduced a two-day long fall break immediately following the Thanksgiving weekend. The fall break back-to-back with their midterm week means students have as many as 18 days between programming lectures. The breaks also interrupt the schedule of weekly assignments that provide students' primary means of practicing programming.

In an attempt to mitigate any negative effects of the break on those students who are not experienced programmers and may not know how to use their time effectively, "One-a-Day Problems" were tried. Students were expected to work on that one problem for the day, which was expected to take roughly 30-minutes to complete, and were encouraged to contact the instructor or other members of the teaching team with any questions or concerns. The problems remained available on the LMS throughout the term and no solutions to these problems were posted on the LMS.

Students enjoyed receiving extra practice problems using this format, and engaging with these questions resulted in higher performance on both the midterm and final exam. Engagement with the problems was lower than desired, however, especially with students with no prior programming experience.

Keywords: Academic support, computing skills, study behaviours

1 INTRODUCTION

Fall breaks are rapidly becoming the norm at Canadian universities, and are justified for a variety of reasons ranging from mental health to improved competitiveness in the recruitment of high school students. However, the impact that these breaks are having on current undergraduate students, both their mental health and academic performance, is largely unstudied (are notable exceptions).

The University of Waterloo hosts one of Canada's largest schools of Engineering, with approximately 7500 undergraduate students. In September 2018,

Waterloo Engineering welcomed approximately 1800 first-year students into 14 direct-entry programs; Waterloo Engineering is 100% co-operative education, and organizes programs into so-called four-stream and eight-stream, indicating the number of months a student spends in class before the start of their first work term. Mechatronics Engineering's (MTE) 230 students are almost equally split between four- and eight-stream.

In September, orientation events ran exclusively on Tuesday and Wednesday, September 4 and 5. Classes started on Thursday, September 6 with orientation events scheduled to continue on an optional basis throughout the day and into the evenings. Thanksgiving Monday occurred on October 8, and was followed by the Fall Break days on Tuesday and Wednesday, October 9 and 10. Classes resumed on Thursday and Friday October 11 and 12. Classes were cancelled for the majority of first-year engineering students (those in 12 of the 14 programs) for the week of October 15-19 and midterms were scheduled at a rate of roughly one per day (depending on the program).

A recent survey conducted at the University of Waterloo has recommended another Fall Break pilot, this time extending the Fall Break to be a full week, starting with Thanksgiving Monday and the subsequent four days with a pilot scheduled for September 2019. Contrary to the broad support for a longer break, a prior study conducted by the authors showed negative impacts of the break on students' academic success in programming, and in the semester as a whole.

1.1 Successful Study Habits

As previously indicated, very little work has been published around the effect of study breaks in higher education, however there is significant literature around the effect of breaks on grade school children. Cooper et al in their meta-analysis of 39 studies found evidence that relates time away from studies with test performance, and found time away from studies was most detrimental to student performance in math-related subject areas. Suggested explanations for the findings include the differential availability of opportunities to practice different academic material over summer (with

reading practice more available than math practice) and differences in the material's susceptibility to memory decay (with fact- and procedure-based knowledge more easily forgotten than conceptual knowledge). Cooper et al. conclude their analysis by posing the question of: "how much time can pass between lessons and tests before there is an overall negative influence on the instructional program?"

While it is difficult to know the impact of time away for undergraduate students, the literature is clear on what they should be doing to maximize the impact of their time studying. Ericsson and Charness describe the process of *deliberate practice* as being a critical requirement to developing mastery. Deliberate practice occurs when an activity is repeated to improve performance at that task. Campitelli and Gobet, in a study of chess masters found deliberate practice to be a necessary step in gaining mastery, in addition to other individual factors. They describe deliberate practice as "training activities... [that are] effortful and not enjoyable, [and] should be carried out for just a few hours per day". Ambrose et al. in summarizing the work of others, suggest providing students with problems that are reasonable, yet challenging, and that learners need to accumulate large quantities of practice to reach high levels of performance. They further recommend that the course provide multiple opportunities for practice (i.e. a high number of diverse assignments).

In conclusion, to mitigate any negative effects brought on by a break away from classroom-based learning, students should be engaging in short-duration, deliberate practice of challenging problems on a regular basis, ideally with expert feedback on performance.

2 DESCRIPTION OF INTERVENTION

In light of the student struggles seen in 2017, the course instructor of GENE 121 (Digital Computation) began looking for a way to better support students when they are away from the classroom for long periods of time (e.g. during a reading break, or between when classes end and when they write the final exam). In the fall 2018 term, the last new lecture material was presented on Friday, October 5. The students then had their reading week from Oct. 8-10. The course instructor presented a summary lecture on Friday, Oct. 12. Weekly assignments, completed in pairs, were given during both weeks. Students then wrote midterms the following week with no lectures, labs, or tutorials happening. With the GENE121 midterm on Wednesday, Oct. 17, students went 12 days since the last new lecture, 5 days since the last time they were in the GENE121 classroom, and 5-6 days since their last tutorial. The final exam had a similar break between the last lecture and when the exam was written; in this case, classes ended Dec. 3 and students wrote the exam on Dec. 10.

The literature is clear on the need for frequent practice when developing skills, and so with this in mind, the instructor planned a set of questions that would be released one question per day for the entire time that students are away from the classroom. These "one-a-day" questions in GENE 121 are old exam questions, not otherwise posted on the course learning management system (LMS). The course instructor has always posted a subset of recent old exams in their entirety on the course LMS for students to study from, and this did not change with the addition of the one-a-day problems. Leading into the midterm and final exams, these one-a-day problems were heavily promoted in lecture as a good means to. In fall 2018, questions were released daily from Oct. 2 to Oct. 16 for the midterm, and from Nov. 12 to Dec. 6 for the final exam (extenuating circumstances prevented the release of the questions from Dec. 7-9).

The questions tended to be challenging design questions from past exams, and topics varied from day to day, for example a C++ array question would follow the C++ class question, followed by a RobotC event-driven question requiring students to design and implement their own functions. Easier practice questions were posted on days where the students' schedule was heavy (e.g. on a day when another exam was scheduled). There were two advantages to posting them once daily rather than just providing the full exam paper: students could be told to devote 30 minutes to working on the problem each day (as opposed to the 2.5 hr exam); and it allowed for some curation of the questions, ensuring only "better" exam questions were posted, with a higher percentage of design questions (that tend to be challenging).

In addition to the one-a-day problems, the course LMS site was used for posting a range of information including course administration, weekly assignments, the course project, lecture notes and videos, the URLs of useful external websites, and a variety of practice problems. In 2017, the practice problems included simple drill type questions, introductory problems for some of the harder topics such as array and classes, and 3 to 4 examples each, of old midterms and finals. In 2018, this set of practice questions was supplemented by the addition of the one-a-day problems.

3 METHODS

To investigate the impact of this new initiative, the authors conducted a formal study of the effect of the one-a-day problems on students. This study has posed the following research questions:

1. What resources are students accessing on the course LMS leading up to an exam?
2. Are there differences in how the different types of students access extra problems?

3. What, if any, are the links between accessing these problems and success in the course?
4. How do students view the one-a-day problems?

To address these research questions, data was collected through three main channels: LMS access data was collected, surveys were offered to students at the start and end of the term, and focus groups were conducted with students in the winter 2019 semester.

For both 2017 and 2018, files listing the topics accessed by each student, the number of accesses, and the date and time of last access were downloaded from the LMS. Date and time of last access were used because this information was readily available from the LMS system. It means that the results will have a bias towards later dates if a student chose to return to something at a noticeably later date. This information was then combined, and student midterm and final grades were added. Histograms were produced to show the number of students who accessed each type of resource, as well as accesses for particular days. Many of the histograms showed similar patterns, for example the accesses on the two fall break days (Oct. 9 and 10 of 2018), so only representative ones are included in this paper.

Two surveys were offered to 1A MTE students in their first semester: a start of term survey in the first two weeks of September, and an end of term survey that opened in the last week of classes, but closed before the students wrote the GENE 121 final exam. The start of term survey asked students to rate their prior experience with programming plus several other questions. The end of term survey included questions asking students to describe their experience with the many active learning strategies present in the term, questions asking students to reflect on how they spent the fall break in October, and other questions. These data were then combined with demographic data (e.g. 4- or 8- stream) and course grades to conduct statistical analyses. All statistical analyses were performed using STATA 15.

The research presented in this paper is part of a larger study investigating the effects of the fall break on student course performance. The focus groups were conducted under the guise of this larger study, though insights from these focus groups are useful here as they relate to research question #4. This information was supplemented by examining the course critiques for 2018, as a small number of students did comment on the one-a-day questions.

4 RESULTS

4.1 Research Question 1

To investigate what resources students accessed leading into the exams, the access logs from the course LMS were downloaded, date stamped, and combined into categories. Figure 1 and Figure 2 below summarize

the number of students who accessed the one-a-day problems and the old exams one week before the midterm (Oct. 10) and the day before the midterm (Oct. 16). Figure 1 shows that few students are accessing these resources one week before the midterm (162 students accessed no one-a-day problems, and no one accessed old exams), while Figure 2 shows that nearly half the class are still not accessing either resource the day before the midterm exam.

Figure 1 Histogram of LMS resource access, Oct. 10/18

Figure 2 Histogram of LMS resource access, Oct. 16/18

Figure 3 and Figure 4 are the equivalent graphs of student accesses leading into the final exam. Here, students are repeating the same behavior with even fewer numbers of students accessing the one-a-day problems. One reason for this could be due to the instructor falling ill and discontinuing the one-a-day problems earlier than expected, though that does not explain why so few students look at the old exams.

With these access patterns, it is difficult to say how students are studying for their exams in GENE 121. It's possible that students downloaded these questions earlier in the term and were accessing local copies, though that seems unlikely. More likely is that students are repeating the assignment questions from the term which they have already solved, and received feedback on (thus reducing their usefulness as a study tool).

Figure 3 Histogram of LMS resource access, Dec.4/18

Figure 4 Histogram of LMS resource access, Dec.10/18

While the above figures show that few students are using the available resources, the results do show a noticeable improvement when compared to the previous year. Figure 5 shows a histogram of LMS resource access on the comparable day to Figure 1 (Oct 11, 2017). The number of students accessing the old exams is similar to 2018. Similarly, the usage for Oct 17, Dec 5, and Dec 11, 2017 for old exams resembles those of 2018. So, it seems students were not just shifting practice from old exams to one-a-day problems, rather the one-a-day problems are being used by at least some to prepare for their exams in a different way in 2018 than in years past.

Figure 5 Histogram of old exam accesses, Oct. 11/17

4.2 Research Question 2

One-way ANOVA tests were calculated to explore the differences in the types of students that were accessing the extra resources on the LMS. These ANOVAs examined if there were any differences in the LMS accesses based on the students' prior programming experience for the one-a-day problems, and all available problems both before the midterm, and before the final. All available pre-midterm problems included one-a-day problems, old midterms, and fall break tutorials. All available pre- final exam problems included final one-a-day problems, and old final exams.

Leading in to the midterm exam, the differences in accesses (for students with varying levels of prior experience) to just the one-a-day problems was bordering on statistical significance ($p=0.07$). When looking at all available problems pre-midterm, the differences in how students accessed the LMS were statistically significant ($p<0.05$). The means, standard deviations, and frequencies by prior programming experience for the midterm are summarized in Table 1 below. For the final exam, there were no differences in the accesses of either the one-a-day problems, or all available items pre- final exam ($p=0.74$, and $p=0.74$, respectively).

These data show that students with no prior experience accessed the fewest resources on the course LMS, followed by students with the most prior experience. This is concerning, as the students who most need the practice seem to be engaging in it the least (at least before the midterm). However, there is some optimism, as these students seem to correct their behavior before the final exam.

Table 1 Summary of prior programming experience with LMS accesses pre-midterm – Mean (SD)

Prior experience	One-a-day only	All Accesses	n
None	5.2 (4.6)	7.45 (5.2)	33
Very little	8.2 (5.5)	11.30 (6.4)	20
Some	9.0 (5.0)	11.81 (5.7)	27
One course	6.8 (5.2)	9.60 (5.8)	65
Multiple courses	6.9 (5.8)	9.20 (6.5)	51
Total	7.02 (5.3)	9.61 (6.0)	196

4.3 Research Question 3

The same instructor has taught GENE 121 for many years, and has used a similar exam question style since the introduction of the course project in 2011. The midterms and final exams were of similar difficulty when comparing 2017 and 2018, and the instructor does not recall any noticeable differences between the two

groups of students. A simple examination of the exam averages shows that the 2018 students performed better on both midterm (2017 at 68% and 2018 at 75%) and final exams (2017 at 73% and 2018 at 76%).

The differences in accesses noted in Table 1 would not represent an issue if it had no impact on course grades, so correlations between LMS accesses of all extra problems, and exam grades were calculated. Spearman correlations were calculated in both cases due to the heavy left skew to the grade distributions. There was a statistically significant positive correlation ($\rho=0.27$, $p<0.001$) between midterm grade and student LMS accesses of all extra pre-midterm problems (see Figure 6 below for a graphical representation of these data). Similarly, for the final exam there was a statistically significant positive correlation ($\rho=0.23$, $p<0.001$) between final exam grade and student LMS accesses of all extra pre-final exam problems.

These results support the instructor's intuition that these extra problems are a good way to study for the exams in GENE121, as an increase in the number of problems accessed correlates to higher scores on exams.

Figure 6 Midterm grade (%) vs. number of LMS accesses of all extra problems, pre-midterm

4.4 Research Question 4

A focus group was run in late January 2019 with five students, three male and two female, who had taken GENE121 during the Fall 2019 term. These students indicated that they enjoyed the one-a-day problems:

- *I thought they were so nice. Like I couldn't do all of them, it's like one a day and sometimes you don't have that time but it was nice to just have a whole set of problems you could just attempt and they're really similar to what would be on the exam*
  - *It's not even the time frame they're in, it's literally just having a big database of questions. Super useful.*
- When further prodded about the one-a-day feature of these problems versus just being a collection of

questions, students thought the daily reminder may help some students (even if they didn't feel it helped them):

- *I mean, for some people [it] probably would help a little bit because it is one a day if you can get yourself to do that you can get yourself in that pattern but personally, for me, it's like hey they're all there. When I have time, I sit down for an hour or two and just do a whole bunch of them in a row.*
- *I thought releasing one a day was a good way to do it but for me because like because if it was just like oh there's a bunch of practice questions I should probably do those at some point, it's kind of different from oh you have 2 and you should have done them by now, you know, something like that*

Next, the frequency of releasing the questions once per 24 hours was probed. When asked if the students enjoyed the daily reminder aspect of the one-a-day problems, they had the following to say:

- **Interviewer:** *I see some nodding. Did anybody else look at them, sort of one a day or one-ish a day?*
- *I did one a week, I think [laughter] ... because I felt, um because there's so much adding on to it while you're doing other stuff so like the questions are building up, daily, and so I have this question to do, now it becomes like 7 in a week and you're like "which one do I start with?" And pressure and so when you're going through the questions like, I don't know that I'm as smart as my friend over here who will remain anonymous, who was able to continue to do that and sit down and all that stuff so it's just a bit different for me handling the questions, I'd say. Just from my perspective, I think like when you've had like 7 in a week I would try to do 1, realize I couldn't do it, go to the next one, could do it and be like, "ok cool, I can do it" by myself so yeah*

A feeling of being overwhelmed by all of the questions piling up started to have a negative effect on some students' motivation. When queried about the timing of accessing the one-a-day problems, the students indicated that they didn't really start looking at them earlier (e.g. during the Fall Break), but rather let them accumulate until much closer to the exam:

- **Interviewer:** *Did you access more in November, then less at the end? Did you access them more frequently at the start or ...*
- **S4-** *No, it was the opposite for me. It was definitely like ...*
- **Interviewer:** *... now I'm getting ready for the final*
- **S4-** *... now it's time to sit down and do all the ones I didn't do before*
- **Interviewer:** *so it's not the timing part, it's now I have all of them so I can get ready for the exam.*
- **S1,2-** *yes. [laughter]*

Compared to other sources of help, the students didn't seem to distinguish the quality between one-a-day

problems, the more typical collection of past midterms or finals, and other resources. When asked whether the students preferred past exams to the one-a-day problems, the answers were:

- *S2- I thought GENE[121], like all the TAs, what they released for exam prep, everything that they did was perfect.*
- *S3- And GENE did release old midterms*
- *S2- Mmhhh, and the one a day*
- *S5- That was very, very nice. The one a days, the past finals, and the other practice... there was so much practice.*

From the quantitative data provided for 2018 (see Figure 2 and Figure 4), we see that roughly half of students didn't access course resources the day before the midterm. In conversations with the students in the class, this was not because they had previously downloaded or printed the files they needed for studying. When asked what they did instead of attending help sessions, one of the student responses in the focus group indicated:

- *I studied on my own and then I'd meet my friend and end up studying and we'd like go back and forth with practice questions. We felt that was like a better use of our time*

Solution sets to both one-a-day and old exam problems were not released to students. If they were stuck or needed help, they were directed to seek out help from a member of the teaching team. One way of getting this help before the exams was through a dedicated exam help session. Students had the following to say about those:

- **Interviewer:** *So, what about when you got stuck? [... removed section]*
- *S2- I went to pretty much all of the help sessions over fall break. Um, I think that I was a lot farther behind than everyone else in GENE[121] so going to those help sessions...*
- **Interviewer:** *there's some nodding and some head shaking going on [unclear... laughter]*
- *S2- I don't know, like you get in a room with some people in our class and it feels like, really, it almost feels like aggressive, like they're asking these questions that are way above...*
- *S5- "what if you did it this way?" I don't even understand how we're doing it right now!*
- *S2- yeah, exactly! So that's kind of what Carol's help sessions felt like... It felt like the top people were running the class, so it didn't feel... it felt more helpful for me just to go home and practice before going to those...*
- **Interviewer:** *so would you say that the sessions were hijacked by the better students?*
- *S2- yes, yeah. That's how I feel a lot [laughs]*

Interestingly, this last section of student feedback was provided by the two female students who participated in the focus group, both of whom identified as beginner programmers. This is especially troubling since these are the group of students who are not accessing the one-a-day problems or past tests for practice at midterm time (see Table 1), and are feeling out of place at the in-person help sessions.

When asked if the students would have preferred a solution set to be posted, since no formal solution set is posted on the LMS, some initially said yes. But, the students with no prior programming experience recognized the variability in possible answers to the exercises and the need to work with or seek guidance from one of the experts running the course, such as a course TA (a "WEEF TA"):

- **Interviewer:** *Would you have preferred to have all the answers at the end or would you be asking the WEEF TAs?*
- *S4- one of the things with the one-a-day problems was, including GENE in general, was the different ways to do them, so they don't put one specific answer. But, I would have preferred to have something to look back on, guidelines or something, if I didn't know how to do a question.*
- *S3- I agree with that, but... You absolutely think you have to have the WEEF TA as well [agreement from others] Like if they gave me one answer, I'd be like "but I did this so differently" and it might have worked, I don't know, but you still have to go talk to the WEEF TAs.*
- *S2- I think the WEEF TAs being good were really, really important. Like I think a lot of us would have had a lot more trouble getting through those one a day problems if the answers weren't posted and the TAs were bad, like if you have bad TAs but decent answers*

Finally, students were asked if they adapted the one-a-day model to their other courses. The students admitted that they did not extend the one-a-day practice behavior to their other courses, and they would like other professors to implement similar models:

- **Interviewer:** *would this sort of idea of problems being released daily, would it be good for other courses, thinking to this term or getting ready?*
- *S4- I'd say yeah. Especially right before midterms and finals. Yeah, it's better than just releasing them in chunks because it feels more manageable, encourages you to actually do them, at least for me.*
- **Interviewer:** *So it's something that you wouldn't do yourself, like say "here's a past midterm. I'm going to break it into 3 chunks and tackle it..."*
- *S4- no.*
- **Interviewer:** *lots of heads shaking "no"*
- *S4- it would be like 2-3 days before the midterm.*

- S2- *I'm sorry... um, yeah, I want more one a day practice problems for all my subjects. That'll actually get me to do practice problems.*
- **Interviewer:** *so the daily prodding...*
- S2- *yeah. I like it.*
- S3- *I do find that, I guess you'd figure this out through experimentation or something, but like it felt like if you didn't do it for a couple of weeks, it got a little overwhelming just the amount of stuff you had. So, I don't know if it would be a better idea to do one every two days or something like that. I definitely like the time thing, I don't know what the ideal length is in between, where it's like I could definitely make time every two or three days or if it's like one day where most people could make time, I'm sure there are some....*

In the surveys run throughout the term, no open feedback provided by the students made reference to the one-a-day problems., though three students provided feedback on the end of term course critiques, all of it positive: "The one a day questions were very useful" and "I really enjoyed the one a day practice problems. They were great practice and an awesome study tool."

5 DISCUSSION

In order to be admitted to engineering at Waterloo, students need very high entrance averages, and likely had a variety of extra-curricular activity and work experience. As a consequence, most believe they have good study skills because their approach has worked well in the past. However, many are not prepared for the rigor of university study, and they tend to use unsophisticated approaches to studying such as re-reading course notes or the textbook, and repeating assignment problems. They also tend to focus on one course at a time, with the assumption that there will be sufficient time to complete a deliverable or study for other courses once the next deadline has passed. This is in contrast to the more efficient approach of repeated daily practice. The addition of a fall break before the exam period meant that first year students are given a large block of time that few know how to use efficiently to study for their upcoming exams (with a similar problem occurring before final exams).

The approach of providing one-a-day problems is meant to ease them towards better study habits and to improve their learning as measured by their performance on exams. It isn't feasible to provide daily practice with graded problems, whereas it is fairly easy to administer the one-a-day problems, assuming a suitable question bank is available. It does take more time than making old exams or other practice problems available, but students appreciated the subtle daily reminder. In addition, first year students tend to focus on the specifics of how to get a good grade on an

upcoming test or other assessment rather than on improving study skills. Thus, they are more receptive to the message of trying a specific set of practice problems, compared to a general message on how to learn/study.

The results in the previous section show that there is some merit in the one-a-day approach. Students who are using the questions to study are performing better on their subsequent exams. Anecdotally, students in pre-exam help sessions seemed more confident compared to previous years with regards to their abilities, particularly for the midterm exam which is one of their first university midterms. The course instructor has theorized the one-a-day questions are providing the most help, and confidence boost, to these students.

While the students don't seem to pay attention to the source of the one-a-day questions, by using old exam questions the students are practicing at the level of difficulty that they will be expected to demonstrate on the exam. Thus, the problems are not meant to help introduce a course topic, but rather require that students can demonstrate the mastery of course concepts. The use of old exam questions has an added benefit that TAs can be given the old grading rubrics and thus are better prepared to guide students as to the significance of any errors. With this level of feedback, students receive a more accurate picture of their abilities.

A challenge going forward with the one-a-day approach is how to improve student engagement with the questions. In 2017, students were reminded several times about the availability of old exams for studying. There was less emphasis on the old exams in 2018 without a corresponding drop in access. The one-a-day problems were heavily promoted in 2018, mentioned repeatedly in the course announcements by the instructor, and were often given as a response from the TAs to the question of how to study for the exam. The heavy exposure likely contributed to the higher percentage of accesses, along with the perception that it is easier to do just one question, or a few small questions for topics like recursion, than it is to complete an entire old exam paper. However, there are still many students who are not accessing this resource. The perceived effort in doing the questions appears to be a key point given the focus group comments. Indeed, going forward for another year, the instructor is considering the possibility of having warm up questions that could be accessed by those who are struggling, and to give more guidance on how to start the set of questions if one has fallen behind the daily routine. These, or similar measures, may be able to increase the number of inexperienced students who are accessing the questions, particularly for the midterm where there is a notable difference in accesses for inexperienced students.

The other remaining challenge is how to improve transferability of the approach to other courses, and to have one-a-day type practice to become an ingrained

habit. The focus group data showed that students wish other instructors would use the approach, but they have not yet reached the point where they are applying the approach themselves. It may be that the habit should be encouraged throughout the term, although this would require effort to produce suitable questions, or perhaps the approach should be broadened to other courses if those instructors can be convinced of its merit. There may also be some opportunity to explicitly make the connection between what they are doing with programming to a broader discussion on study skills.

6 CONCLUSIONS

The one-a-day problems are successfully helping students to prepare for their upcoming exams. Of the available practice problems, the one-a-day questions are the most popular approach, particularly when the exam is not imminent, and during the fall study break. However, the results do show that many students are either not studying at all, or if they are studying, they are not doing so by trying any sort of practice problem. The lack of engagement is particularly troubling for the students who are the least experienced programmers, as this group of students appears least likely to access the one-a-day questions. Fortunately, some gains are made by the final exam, where only the most experienced programmers show a dip in the number of accesses.

Comparing exam grades from 2017, without the one-a-day problems, and 2018, where they were available, shows an increase in the average grade. Further analysis showed that there was a statistically significant positive correlation between midterm grade and student LMS accesses of all extra pre-midterm problems. Similarly, for the final exam there was a statistically significant positive correlation between final exam grade and student LMS accesses of all extra pre-final exam problems.

Generally, the students like the one-a-day questions, particularly that there is a large number of practice questions available, and there was a daily reminder to practice. However, some students, particularly the least experienced programmers did find the questions themselves difficult and became overwhelmed when they failed to keep up with the questions. Further refinement of the approach is being considered to see if there is a way to mitigate this issue while still retaining the advantages inherent in the approach. Certainly, the success, even though limited in scope, means that the course instructor will use the approach next year, and has encouraged other instructors to use the approach for similar skills-based courses.

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