



Collaborative cloud-based documents for real-time bi-directional feedback in large lecture activities

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Abstract

This paper presents a pilot project that uses cloud-based documents to provide bi-directional feedback on open-ended contextualized activities. The course setting is a first year engineering design and professional practice course of approximately 700 students, taught in three sections, at Queen's University, a medium-sized research-intensive institution in Canada. Students were assigned to groups, and assigned shared directories in Google Drive. In most lectures students were assigned an activity requiring a response that was completed in a document in Google Drive, e.g. open-ended design problems, brainstorming, evaluation of information sources, etc. The course instructor, and a teaching assistant (TA) who attended each class, were able to view samples of students work and select some to anonymously discuss with the class. Thorough well-thought responses were highlighted, and misconceptions or misdirection was addressed. In this way students received some feedback on common issues in constructed response tasks immediately, rather than waiting for submission and grading of assignments. Student response to this approach was mixed, with about half the class feeling that the approach helped them learn, and that feedback was useful. About a third were neutral to the idea, and the rest felt it was not useful. There was no correlation between students' use of Google Docs and their grades on the two major reports. The instructor felt that this is a useful approach that helped many students, and would be improved in the future by using classrooms designed for team activities, improving the quality of tasks assigned in class, and assigning completion grades for in-class activities.

Introduction

Instructors seeking to improve engagement in lectures turn to a variety of approaches to provide activity and receive feedback on performance. The degree and quality of bi-directional feedback, both from students to instructor and from instructor to students, has been shown to have one of the most significant impacts on learning. In a comprehensive synthesis of over 800 meta-analyses, Hattie showed that one of the most significant effects on learning is feedback from student to the instructor.^{1,2} According to Hattie,

...the most powerful feedback occurs when feedback is to the instructor: about how well they have taught, who they taught well, what they have or have not taught well. The trickle-down effect from such assessment that informs the instructor down to the student is much greater than the teaching and learning that comes from assessment directly to the student.²

When teachers seek, or at least are open to, feedback from students as to what students know, what they understand, where they make errors, when they have misconceptions, when they are not engaged, then teaching and learning can be synchronised and powerful.²

In higher education feedback between instructor and student is most commonly limited to that from the instructor to the student in the form of grades for correct and incorrect solutions to

problems, and occurs relatively infrequently over the duration of a course. Advancements in computer technology are beginning to enable faster and more regular feedback by computerized scoring of student work³ and computer-supported peer review⁴, and considerable success has been found by enhancing lecture time using an interactive classroom format and frequent in-class assessment.^{5,6} When combined with small group work in approaches like peer instruction, regular-in class feedback has been shown to yield significant learning gains as measured by concept inventories.⁵

Audience response systems have been widely used to provide feedback to the instructor about and their impact on engagement and learning has been presented widely. These include handheld dedicated transmitters, often known as clickers^{7,8}, and web-based response systems that allow students to use their laptops, tablets, smartphones, and SMS to interact with the instructor.⁹

These systems, however, are limited in their ability to support bi-directional feedback on complex open-ended tasks. They tend to focus on multiple choice, short answer, or numeric response questions, though some include the ability to submit larger text responses. All of the systems provide the information to instructor only when the student submits the material. When the class involves longer-term activities e.g. activities requiring 10-15 minutes of student discussion and work to craft a response, it is useful to be able to watch the student response in development.

The development of cloud-based collaborative documents (e.g. Google Docs, Microsoft Office 365, etc.) allows students to collaborate, and an instructor to view activity, in real-time. The New Media Consortium (NMC), an international community of experts in educational technology, has identified collaborative technologies as one of the key trends in higher education technology. Their 2013 Horizon Report said:

*Education paradigms are shifting to include online learning, hybrid learning, and collaborative models... Online learning environments can offer different affordances than physical campuses, including opportunities for increased collaboration while equipping students with stronger digital skills.*¹⁰

Previous work in has demonstrated the utility of collaborative documents in higher education; one used a collaborative document system as part of a system for assignment submission, analysis of how assignments progress over time (process mining), and generating automatic feedback to engineering students.¹¹ Cloud-based documents like Google Docs have been used for continuous formal assessment.^{12,13}

This study presents the use of Google Docs in a large lecture environment (approximately 230 students in each lecture) for bi-directional feedback on open-ended first year engineering activities. In this approach, the instructor may (a) observe the process students go through in addressing a presented problem, and (b) pick out samples of student work while students are working, rather than waiting until students have submitted it. The instructor can then present samples of work to the class, and provide feedback. This approach allows the instructor to understand how students are solving problems, and provide feedback to help students develop the ability to solve problems better.

Course context

The study was set in the first year of the undergraduate engineering program at Queen's University, a medium-sized university in Canada. APSC-100 is a team-based, project-based course designed to promote a sense of curiosity about engineering, and develop open-ended problem solving skills. The course is divided into three modules (each roughly the equivalent of a standard one-semester course): Module 1-Problem analysis and modeling; Module 2-Experimentation and measurement; Module 3-Engineering design. Each of these is one semester long and equivalent in weight to a standard one-semester engineering course. This study was embedded into the delivery of the problem analysis and modeling module (module 1).

The problem analysis and modeling module (module 1) is a semester-long integrative experience that uses concepts from engineering sciences, natural sciences, and mathematics courses to solve complex open-ended problems. The course is structured around two complex problems known as model-eliciting activities (MEAs) that were addressed sequentially over the semester. MEAs are problems used in class and subsequently finished by small teams and submitted for grades, that are set in a realistic context that requires the learner to document not only the solution to the problem, but also their process for solving it.^{14,15} The situations described in the MEAs require students to create and use a mathematical model of a physical system using MATLAB, and deal with professional issues including ethical dilemmas, conflicting information, and incorrect/missing information.¹⁶ The first MEA (MEA1) involved investigation of a cable ferry failure, and modeling the failed system. The second one (MEA2) involved modeling heat transfer in a laptop, and proposing a new product using the heat transfer model.

The module learning outcomes are such that open-text responses to complex situated problems are desirable; the learning outcomes are:

1. Apply a prescribed process for solving complex contextualized client-driven problems (ill-defined, multiple constraints, problems, unknown information)
2. Create and apply appropriate quantitative model and analysis to solve problems.
3. Effectively communicate technical information following a prescribed format and using standard grammar and mechanics.
4. Apply concepts including occupational health and safety principles, economics, law, and equity to engineering problems.
5. Identify and resolve a simple ethical dilemma by applying professional codes of ethics and engineering standards.
6. Apply critical and creative thinking principles to solve contextualized problems.
7. Apply numerical modeling tool (MATLAB) to create model used for solving complex problems.

The course was structured help students develop confidence and skills in solving complex engineering problems – problems for which all information is not known, in which there is ambiguity, where the goals are not necessarily clearly defined, and where multiple solutions are possible. The course was taught in three lecture sections and 10 MATLAB studio sessions. All the Google Doc activities occurred in the lecture, which was one hour per week.

In-class activities using collaborative documents

In the first week students formed themselves into 239 teams of two or three, and spreadsheets containing students' information were uploaded to Google Drive and separate folders were created for each lecture section. Using Google Apps Scripts the students' sections and group information was read from the uploaded excel files and corresponding folders for each team were created. At the time the folders were created many students had not created their Google Drive accounts, which forced the TA to add all students to folders manually. The course instructor owned all the directories, allowing him and the lead teaching assistant (TA) access to the material.

Although the Google script showed some limitations in the beginning, it was relatively simple to use it later when there was a need to add new folders inside the previously created folder. Using the Google script the course teaching staff could add new folders very fast. Also the folders security settings could be changed using the Google script.

In most weeks the one-hour lecture followed a structure like:

- The instructor presented a recent problem or news article related to the lecture objective
- The instructor presented or reviewed the problem being solved during the three-week session, generally one of the MEAs.
- The instructor led a short discussion on a topic related to the problem being studied
- Students work on some component of the problem in their teams; in many cases this included using Google Docs (GD) to respond to a contextualized scenario used for one of the assignments.

A weekly overview of course activities that used collaborative documents is shown below in Table 1. The students had a small activity (a mini-MEA) completed in-class in weeks 2 and 4 that was handed in at the end of week 4. In weeks 5-11 the activities in class contributed to one of the two larger MEAs, which were highly weighted components of the students' final grade.

While students were working on their documents the course instructor and TA reviewed the work, and pasted samples in a document to show the class. When it appeared that students misunderstood an instruction, or where there was a problem with the approach being used, the instructor would pause the class activity and show anonymous examples of student work that was either a very good, or had problems that were common to multiple teams.

Analysis of Google Docs activity

At the end of the semester all documents in the GD directories were downloaded and analyzed. There were 239 teams who submitted reports, and all but 20 had files in their Google Documents directory. Each team should have had 9 files in their GD directory, but most used it for collaborating on team reports. Figure 1 shows an analysis of files created over the semester.

The last-modified date stamp plot in Figure 1(a) showed that students' use of GD peaked when reports were due (October 6, October 30, and December 1), and had significant use on lecture dates which used GD for in-class activities as described in Table 1 (e.g. Oct 9-10, Oct 16-17, Oct 23-24, etc.). Figure 1(b) shows that files were consistently created by teams during lectures. The median number of reports in a directory was approximately 23, and 149 groups (or 62%) had at

least 9 files in their GD directory. Figure 1(c) shows the number of files created by each group. Some teams had a very large number of files in their directory, generally because they used it to collect resources and compile versions of their major reports. Many students used these folders to share their ideas, and files with their group members; this sharing system enabled them to work on their projects as a team even when they were geographically not at the same places. Some groups used this folder for sharing the notes they took during each session between the group members.

Table 1 – In-lecture activities involving collaborative documents

Week	Dates	Activities involving collaborative documents
1	Sep 11-13	Students signup in groups. Each student instructed to create Google Docs (GD) account Google Apps Scripting used to create directories for all teams.
2	Sep 16, 19	Seating plan used to help students sit in their group of three in lecture. Gravity Light Scenario: analysis and modeling of product for potential investment in lecture. Collaborative team work in GD.
3		N/A
4	Oct 2-3	Teams finish Gravity Light activity in GD. Completed task handed in Oct 6.
5	Oct 9-10	Teams completed hazard analysis of classroom in GD: list hazards, assess the consequences, investigate causes, and safeguards to reduce probability or severity of injury
6	Oct 16-17	Teams created a concept map used to investigate causes of an accident, and created a table to evaluate information sources
7	Oct 23-24	Each team did a brainstorming exercise using a single document in GD to record individual ideas, sort/rank ideas, and select top priority
8	Oct 30-31	Each team created an evaluation matrix. MEA1 due.
9	Nov 6-7	Each team responded to an ethical issue, identifying stakeholders and impact of various options on stakeholders
10	Nov 13-14	Teams used a spreadsheet to calculate net present value of specific cash flow
11	Nov 20-21	Teams identified legal/professional issues in a scenario
12	Nov 27-28	N/A. MEA2 due.

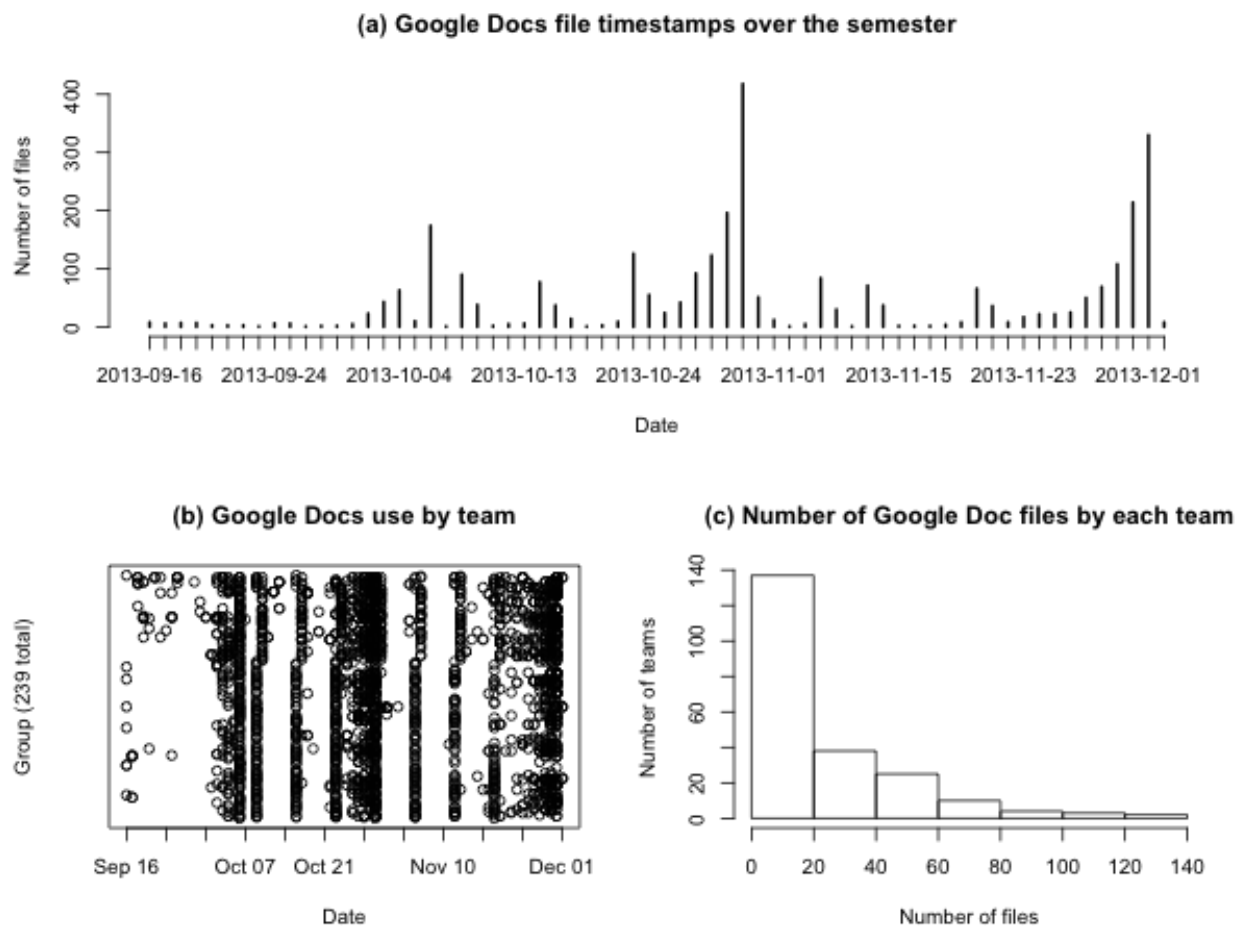


Figure 1: GD files at the end of the semester. (a) shows the dates of last modification of all files, (b) shows one dot per file per group, highlighting weekly use in class, and (c) shows a histogram of number of files created by each team.

Team performance

The performance of each team on their first major project (labeled MEA1) was examined to see if there was a correlation with use of Google Docs. There was no significant correlation between the either of the major project performance (MEA1 or MEA2) and either the sum of all files in the student directory, or number of files. There was a high correlation between the sum of size of the files used by each team, and the number of files ($\rho=0.91$), but no correlation between performance on the first major assignment and either total file size ($\rho=-0.05$) or number of files ($\rho=-0.06$).

There were 20 teams that did not use Google Docs at all; the average of their mark on the first report was slightly lower than the teams that did use Google Docs (median of 67.5 vs. median of 70), as shown below in Figure 2. However, this is not a statistically significant difference (Welch Two Sample t-test gives $p=0.24$). A similar result is observable for the second major report, as shown in Figure 3.

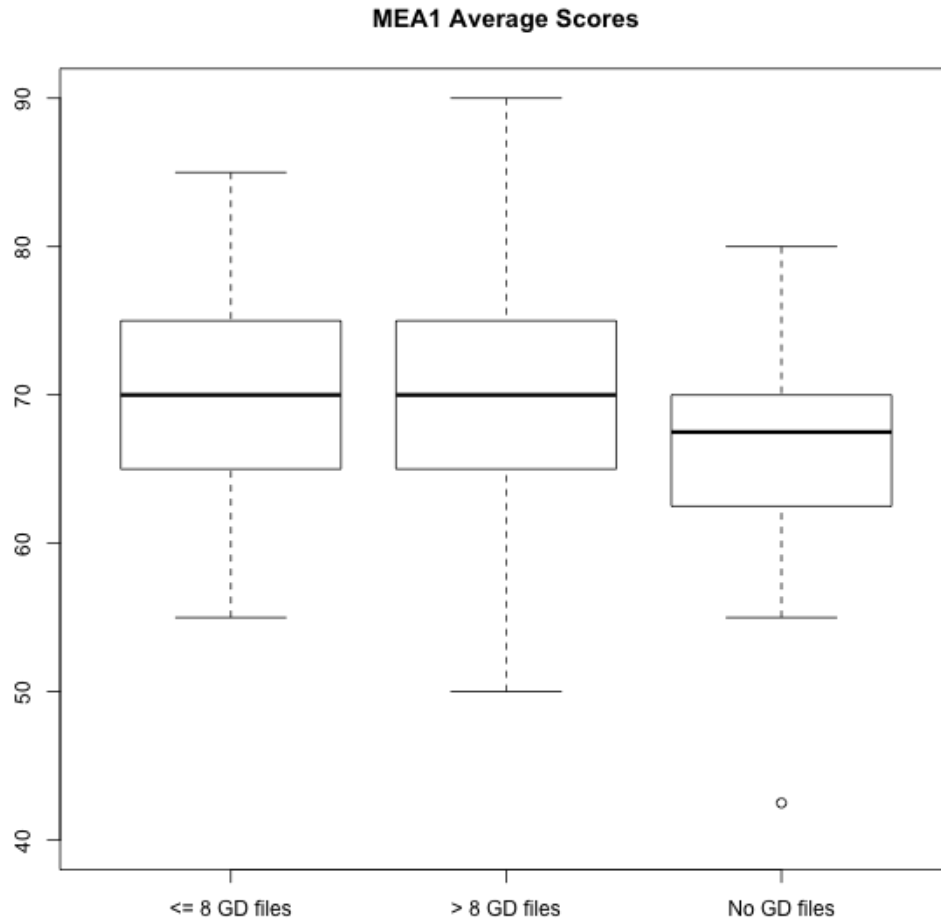


Figure 2: Distribution of marks on the first major report, categorized by number of GD files.

Student feedback

At the end of the semester a final web-based course survey asked four questions related to the use of Google Docs. The questions were:

- I found that the activities in the lectures (using Google Docs) useful for meeting the course objectives (*5-point Likert scale – strongly agree to strongly disagree*)
- I found that the feedback in the lectures (using student work from Google Docs) helped me to learn. (*5-point Likert scale – strongly agree to strongly disagree*)
- Generally my group was able to use Google Docs in class without significant technological problems. (*5-point Likert scale – strongly agree to strongly disagree*)
- Generally my group completed the assigned lecture tasks (using Google Docs). (*every week, majority of the weeks, occasionally, rarely*)

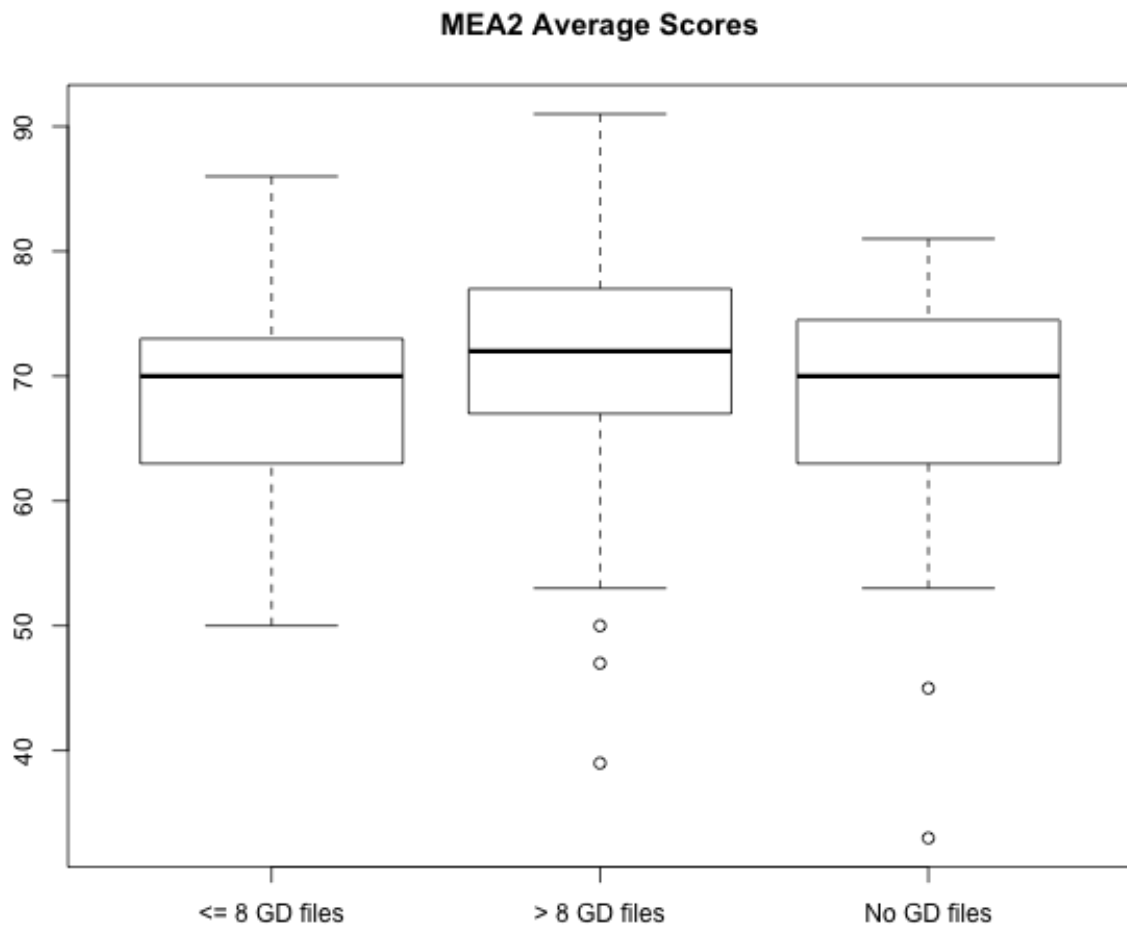


Figure 3 - Distribution of marks on the second major report, categorized by number of GD files.

There were approximately 390 responses to the survey in the course of approximately 700 students summarized in Figure 4 below. On the individual survey 136/390 (35%) said they completed Google Doc tasks occasionally or rarely, so 65% used it regularly. This corresponds closely to the percentage of teams (62%) who had at least 9 documents in their directory, which was the number of assignments done in class.

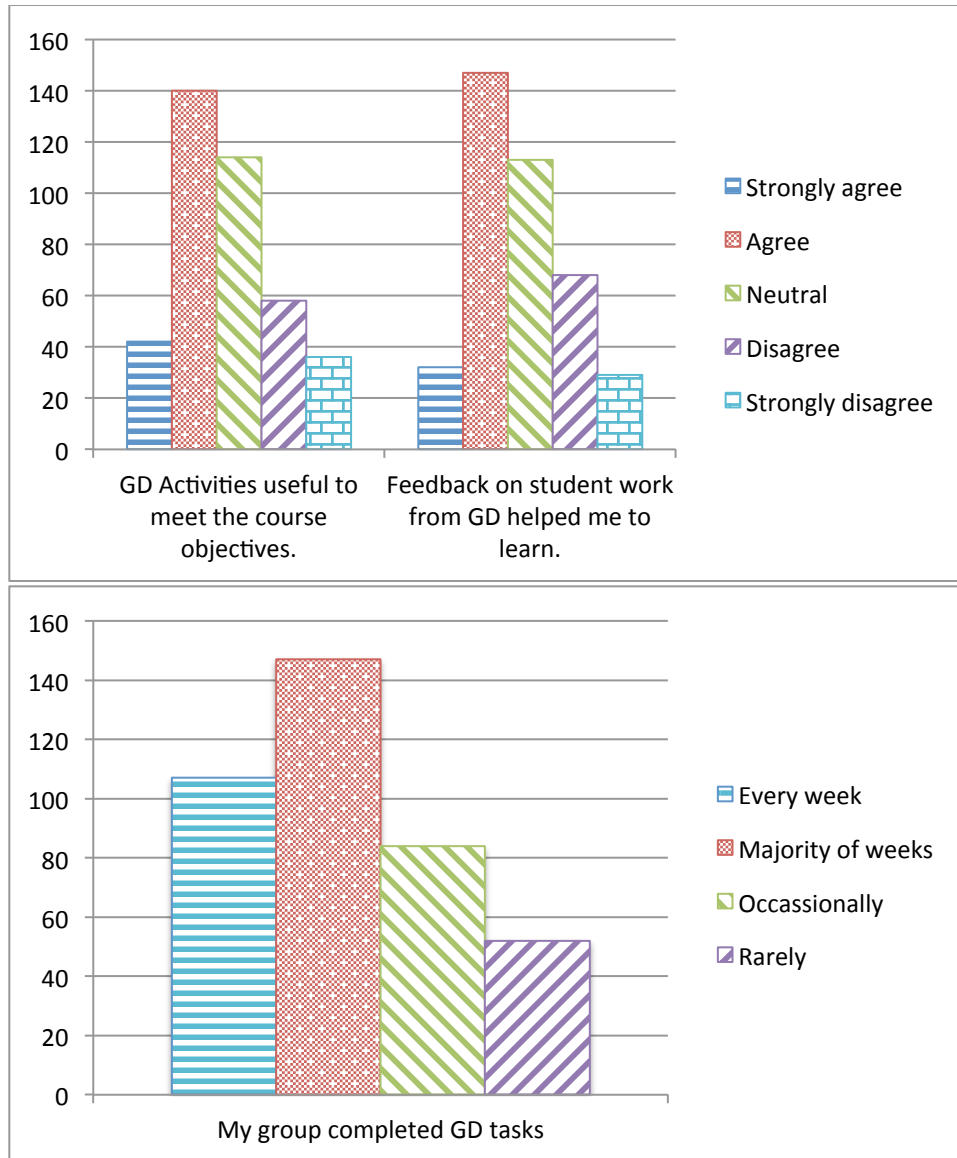


Figure 4: Student responses to survey questions about Google Docs.

Approximately 46% of the students agreed or strongly agreed that the Google Docs activities were useful for meeting the course objectives, and a similar percentage felt that feedback from the instructor in class on Google Doc performance helped them learn. About 30% were neutral about those two points. Approximately 31% of the students said they had some technological problems with using Google Docs in class. Over the semester some students had issues sharing their documents with their teammates, though the TA resolved these as soon as they were discovered. Some students stated that they had network connectivity issues. These activities took place in a standard tiered lecture hall, which is not an ideal space for group work, which likely negatively impacted student perceptions.

Instructor/TA perspective

During the semester, Google Drive provided an opportunity for the teaching staff to monitor the students' activities in the class in real time. The instructor and TA were able to monitor students' process for solving problems while they were still working on the problem and show them both good and poor examples in the class. This real time feedback, first, encouraged the students to work on their activities since they knew that the instructors were monitoring their work on the Google doc. Second, looking at some good and bad ideas of their friends reinforced the learning process and gave them new ideas. Third, getting immediate feedback on how successful the teaching approach was provided this opportunity for the instructor to resolve any learning issues in that session and tweak the approach for the next sections.

It would be possible to analyze the documents after each lecture to identify the groups that are doing well in the course and the groups that were not performing. It could also be useful to provide completion grades for activities in class. This was done for one of the activities, but because of significant spread in time required to complete the tasks it was not done for most activities.

The instructor noticed a significant improvement in the quality of work on the projects compared to the previous years. Student scores on the first report (MEA1), which was very similar over the past two years, were significantly higher this year, with a mean score in 2012-2013 of approximately 61%, and this past year approximately 70%. Since there were several changes including timing of projects, number of projects, and using Google Docs, the improvement cannot be attributed to the use of cloud-based documents. However, the improved performance, instructor perception, and student survey results suggest that this approach is promising and worth pursuing. Using a classroom designed for team activity would likely improve student interactions in class, the quality of work and student perceptions. Use of appropriate space, with more reliable network access, would allow use of completion grades for regular low-stakes in-class activities with rapid feedback.

Conclusions

Collaborative cloud-based documents offer the ability to support collaboration not just in independent work, but also during course activities. Instructors can assign short activities and observe the process used to solve the problem. Instructors can also analyze student work very quickly and provide feedback more rapidly than is usually possible. In this pilot student response to the approach was mixed, with about half the class feeling the approach is useful for learning. This initial pilot is a promising approach to support quality feedback on open-ended activities in large lectures.

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