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A Personalized Automated Email Tool to Connect Faculty with Students in Large STEM Courses

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Abstract

Undergraduate student success in science, technology, engineering, and mathematics (STEM) majors often hinges on the satisfactory completion of large gateway introductory courses such as general chemistry. First-year or transfer students' achievement in such courses may be affected by their first exposure to the large class format. Specifically, a sense of belonging, a factor shown to be important for student engagement and effort in STEM classes, may be difficult to attain in large classes. We report here on the development and implementation of a personalized, automated email tool as a way for instructors to connect with students, signal their concern for students' performance, and offer them support. Instructors across the two-semester sequence in a large university general chemistry course used a spreadsheet to sort students into email categories based on their exam performance, differentiating by degree of grade improvement or decline. The corresponding messages offered advice, encouragement, or cautions and invited students to avail themselves of various resources. The emails were sent batchwise but personalized using a Google script function. In an end-of-course survey, students indicated that the emails made them feel the instructor cared, helped support and encourage them, lessened their feelings of anonymity, and helped them improve. This tool provides an easy way for instructors to create a sense of connection and caring in a large class and contribute positively to students' motivation and achievement.

Keywords: In the Classroom, general chemistry, large courses, student motivation, student belonging, email

Introduction

Undergraduate student success in science, technology, engineering, and mathematics (STEM) majors often hinges on the satisfactory completion of large gateway introductory courses. General chemistry, for example, is a prerequisite course for students planning to concentrate in the biological sciences and/or pre-medical fields as well as those studying chemistry or certain engineering disciplines. Challenges to students' achievement in such courses often include their prior preparation in science and mathematics as well as their ability to keep up with the rapid pace of content coverage. In addition, however, in university settings such introductory courses also represent the first exposure students entering from high schools or community colleges have had to the large class format—enrollments of 100-300 students or more in many cases. In these situations, students may experience a number of affective challenges. Specifically, a sense of belonging in the class has been shown to be important for student engagement and effort in STEM classes (1). Such a feeling may be difficult to attain in a large class in which some students may feel like a “face in a crowd” (2). One of the ways that active learning may enhance student persistence is by fostering feelings of connection, even in large classes (3).

The instructor plays an important and multifaceted role in creating a classroom climate that engenders students' sense of belonging and cultivates their engagement (4, 5). For example, in one study in a large anatomy and physiology course, students' commitment and engagement in active learning positively correlated with their trust in the instructor, measured as “instructor's understanding, acceptance, and care” (6). Similarly, in a large study of 73 introductory STEM

courses across 15 colleges and universities encompassing more than 2800 students, Gasiewski et al. (7) found that students were more engaged in courses in which instructors regularly exhibited behaviors showing their commitment to helping students succeed. In addition, one large longitudinal institutional study found that classes taught by faculty who had a fixed mindset about students' abilities (i.e., felt that student potential was innate) showed racial achievement gaps twice as large as classes taught by faculty with growth mindsets (8). In that study, the amount of time students reported studying or preparing for class was the same regardless of the instructor's mindset—what varied was the students' motivation.

One simple way instructors can enhance students' feeling of connection, and hence, their motivation, is by knowing their names. In a study of a large enrollment upper-level biology course, Cooper et al. (9) asked students why it was important that instructors knew their name. The most common responses were that they felt more valued, more invested in the course, more comfortable seeking help, that the instructor cared about them, and that it built their relationship with the instructor. The instructor could create this feeling without actually knowing every student's name.

In this paper we report on the development and implementation of a personalized, automated email tool as a way for instructors in a large class to connect with students, signal their concern for students' performance, and offer them support. The emails were implemented by the two instructors across the two-semester sequence in a large university general chemistry course taught using an active learning, flipped format. After each exam, the instructors created groups of emails with individual student names that were targeted to students' level of performance. The emails encouraged students either to continue with effective practices or seek further help to succeed in the course. The emails conveyed the instructors' concern for students'

achievement, their belief in students' abilities, and their willingness to help. Students responded very positively to the emails as noted in their answers to a survey at the end of the course. This automated tool provides an easy way for instructors to create a sense of connection and caring in a large class and potentially contribute positively to students' motivation and achievement.

Context and Methods

This intervention was conducted in the first and second semesters of general chemistry for science majors at a midsize public research university in the U.S in the spring, 2019. We provide information below on the evolution of the general chemistry sequence, noting specific changes that were made to address student retention and success issues over the years, and a description of the classes the semester the emails were implemented. We then describe how we developed and deployed the tool and assessed student perceptions of it.

General Chemistry at our Institution

At our institution, there is one general chemistry course sequence that serves all chemistry, biochemistry, biology, pre-med and engineering students that require chemistry. The multi-section first semester course (CHEM 101) serves a total of 800-900 students in the fall semester and 250-300 students in the spring semester. The second semester of the sequence (CHEM 102) serves 500-600 students in the spring semester and 200-250 students in the fall semester. The course has evolved significantly over the past 15 years with many different approaches implemented to enhance student engagement and learning. Beginning in 2005, a weekly discussion section modeled after the Process-Oriented Guided Inquiry Learning approach (10) was developed (11). The course lecture itself has been changed significantly since 2007 by adding a number of new ongoing approaches including: use of clickers beginning in 2007, addition of online homework since 2008, use of flipped classroom pedagogy beginning in 2011,

utilizing undergraduate learning assistants and reading quizzes since 2013, and instituting a metacognition lecture (12) after the first exam since 2016.

The email intervention was implemented in CHEM 101 and 102 sections in the spring, 2019. CHEM 101 had one lecture section taught by one instructor and CHEM 102 had two lecture sections taught by a different instructor. Each lecture section had around 275 students after the withdrawal date. Students completed assignments using the ALEKS system (13) and completed reading quizzes to hold them accountable for preparing for class (14). During class, the instructor alternated between lectures with slides and questions conducted via a classroom response system (15). Students worked together on these questions, and undergraduate learning assistants assisted throughout the lecture hall. In addition to the large lecture component of the course, students were divided into smaller discussion sections (11). Each section had a maximum of 72 students, and students worked on problem-solving activities in groups of four.

Summative assessment in the course was achieved with four multiple choice exams and one cumulative final exam. Students in each course were often encouraged to complete exam reflections (16) for a bonus usually of about 3-4% on their exam score. Students were able to get help learning concepts via instructor office hours, department tutoring, tutoring in the campus learning resource center, and sessions with the Supplemental Instruction program (17).

Design and Use of the Automated Email Feedback Tool

The instructors instituted the email intervention to reach out personally and encourage students to take advantage of the many learning resources in the courses. To facilitate the composition of emails, the instructors experimented with two approaches. Initially, the instructors used Microsoft Excel to evaluate student exam scores and trends. Utilizing the sorting feature within the spreadsheet, the instructor could easily place each student into an email

category. Once students were assigned to a category, the body of the email for each category was composed and copied into a designated column. Columns for student name and email address were also included in the spreadsheet. The instructor was able to copy the email addresses for each category and blind copy each student in a mass email sent to each category. This method allowed the instructor to email all students in batches but did require navigating between Excel and the email platform. This approach did not, however, allow for the personalization of the email with the student's name.

A second approach (instituted after the second exam in CHEM 101 and the first exam in CHEM 102) allowed the instructors to personalize the emails using students' names. Google Sheets was used to sort and categorize the students as in the method above. The enhancement in the second approach was the use of a script to send automated emails through the instructor's Gmail account that allowed the emails to include the name of the student. The script can be found at https://developers.google.com/apps-script/articles/sending_emails.

Students were placed into categories based on their performance which determined the message they received in the email. Broadly, emails were sent to students who were either steady in performance, improving in performance, or declining in performance. A few examples can be seen in Table 1. The motivation behind these categories was to encourage those that were improving or maintaining strong performance, caution those that were declining or continuing a weak performance, and invite students in need of help to seek out the instructor. Email messages after the first exam were adjusted for students who were repeating the course versus those taking it for the first time. For example, emails after exam one compared students' performance on that exam to that in a prior course attempt (if appropriate). In addition, after each exam instructors composed emails to capture differences in student trends in grades. For example, messages after

exam three for all students noted how that exam grade compared to grades on their other exams and how it should inform their actions as they completed the semester. Instructors could make the distinctions between emails as fine as they wanted by setting the sorting criteria for categories in Google sheets to recognize specific grade changes. Given the wide variability in student performance across exams, instructors exploited this sorting ability to personalize the emails in particularly pertinent ways.

Survey of Student Perceptions

We asked students about their perceptions of how the instructor emails affected their attitudes about the courses using a survey with a five-point Likert scale (Table 2). The survey probed how the email affected their feelings about themselves and their relationship with the course and the instructor. This survey was administered at the end of the term for an opportunity for bonus points. Student consent to use their responses was acquired as part of the survey. Students who completed the survey received the bonus whether they consented to be included in the survey compilation or not.

Student Perceptions and Responses to Emails

Student response rates on the survey were high (65% for CHEM 101 and 77% for CHEM 102). Their answers indicated that students felt the emails showed the instructor cared, helped them feel supported, increased their motivation, lessened their feelings of anonymity, and encouraged them. Over half of the respondents felt that the emails helped them improve their performance on the next exam. Some students noted, however, that the emails increased their feelings of anxiety about the course. In all responses, students' feelings were somewhat stronger (as evidenced by higher percent agreement) in the students in the first semester course (101) than

in the second semester course (102) though differences in the responses were not statistically significant.

A small percentage of students responded via email to the instructors' emails (about 10% of students in CHEM 101 and 10-18% in CHEM 102). In these emails, students expressed appreciation for the instructors' suggestions, requested individual appointments (e.g., to take advantage of learning strategy suggestions or ask how to get more help), shared their learning strategies (in the cases where they succeeded), explained their personal concerns (factors they believed contributed to poor performance), noted strategies they changed between exams (that contributed to increase/decrease in their performance), and/or shared their excitement and pride (when they improved/did well).

Implications for Future Study

Given the importance of the feeling of belonging to student motivation in STEM, one can hypothesize that this email intervention may affect student learning outcomes or persistence in large gateway courses. Unfortunately, we were unable to test this idea during our implementation due to a change in exam content distribution in CHEM 101 and student demographic differences in CHEM 102 that affected the statistical validity of our analyses. We plan future work to explore the effect of this intervention on prompting students to seek further help, such as attending office hours, meeting with the instructor, and using supplemental resources such as tutoring or Supplemental Instruction. Such a study may provide information on whether this intervention does indeed help students become more proactive about their own learning as their survey responses suggest.

Conclusions

Instructors of large STEM courses can make a meaningful impact on students' motivation and achievement through their behaviors. For example, in a study of the large biology sections at one institution, authors found that, of the various strategies used to make the large class feel smaller and more connected, students felt that the behavior of the instructor had the biggest effect (18). In this paper we have shared a personalized email tool as a way to help the large class feel small. Anecdotal accounts suggest that such personalized, supportive emails can nudge students into more productive behaviors, enhancing their performance (19). Our experience indicates that taking the time to compose and send such emails using this expedited tool is appreciated by students and may contribute to students' positive attitude toward the course.

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TABLE 1: Sample Instructor Email Text	
<i>After Exam 1 for students who had not taken the course before</i>	
<i>Students earning an A or B</i>	I wanted to congratulate you on earning an A on exam 1. I'd love to hear about what you did to prepare for exam 1. Keep up the great work!
<i>Students earning less than the exam average</i>	I am reaching out to you because I see that while your score is passing, it was lower than the exam average. The material for exam 2 will be more challenging than that on exam 1, and the material will continue to get more difficult. I want to encourage you to take action now to see if you can identify how you might improve your learning strategies. I hope you complete the exam reflection. I also really hope you can come to my workshop on Friday. I am going to discuss learning strategies that are proven to work. You can also book an appointment with me to discuss learning strategies.
<i>Students earning a failing grade</i>	I am reaching out to you with concern over your exam score in CHEM 101. You are in great danger of not passing the course. I want to encourage you to take action now to see if you can identify how you might improve your learning strategies and bring your grade back up. Otherwise, it is likely that you will not pass the course. I hope you have completed the exam reflection and if not, you should do so. I also really hope you can come to my workshop on Friday where I will be discussing learning strategies that are proven to work. You can also book an appointment with me to discuss learning strategies.
<i>After Exam 1 for students repeating the course</i>	
<i>Students who did better on the exam than in a prior course attempt</i>	You did great on exam 1! I can see that your grade has improved from exam 1 in Fall 2018, and I would love to hear what new strategies are working for you. If you're looking to hear about any other strategies, I will be presenting a workshop on Friday all about learning strategies that are proven to work. You can also book an appointment with me to discuss learning strategies if you would like.
<i>Students who did well, but not as well as in a prior course attempt</i>	You did great on exam 1! But, I am reaching out to you because I noticed though that your exam performance this semester is slightly worse than your exam 1 attempt in Fall 2018. I've had a lot of students in the past tell me that they didn't think that they needed to study because they are repeating the course. I will be presenting a workshop on Friday all about learning strategies that are proven to work. You can also book an appointment with me to discuss learning strategies.
<i>Students who were on the same low achievement track as in a prior course attempt</i>	I am reaching out to you with great concern over your exam score in CHEM 101. I can see that your performance on exam 1 this semester is about the same as exam 1 score in Fall 2018, and unless something changes your score puts you at risk of not passing the class. I've had a lot of students in the past tell me that they didn't think that they needed to study because they are repeating the course. But, keep in mind that you are repeating the course because you didn't learn the content the first time. If you don't change your strategies, you are likely to keep getting the same results. I will be

	presenting a workshop on Friday all about learning strategies that are proven to work. You can also book an appointment with me to discuss learning strategies if you would like.
<i>After Exam 3 for all students</i>	
<i>Students who continued to do consistently well on exams</i>	I want to congratulate you on your performance in CHEM 101 so far! You are on track to earn an A in the course and have been very consistent on exams. This is awesome and you should be very proud of yourself. Keep up the good work, share your learning strategies with your friends and continue to soar!
<i>Students who improved on exam 3 compared to exam 2</i>	I want to congratulate you on improving your score from exam 2 to exam 3. I did notice that the score still wasn't as high as your exam 1 score, but you have certainly improved your grade in the course. I encourage you to think about what worked, and what didn't, for all three exams as you begin (now!) to prepare for exam 4 so that you can continue to improve our final grade in the course. Keep up the great work!
<i>Students who were passing with a C</i>	I want to congratulate you on your perseverance through the semester so far. You are currently on track to get a C in CHEM 101. There is some wiggle to this because I am only looking at your exam average, but a student's exam average after the first three exams is often a good predictor of their grade in the course. Can you still earn a B? Maybe. You can use the grade calculator in the course folder to estimate what grade you would need to get on the remaining exams in order to earn a B in the course. I want to encourage you to think about what worked, and what didn't, for all three exams as you being (now) to prepare for exam 4. Keep going - we believe in you!
<i>Students who had declining exam scores</i>	I am reaching out to you because I have noticed that your exam scores have declined as the semester has gone along. I am very concerned because if this pattern continues, you could be in danger of not passing the course. I really don't want to see that happen after all of the hard work you have put in. I encourage you to reflect on what may be causing your exam scores to decline. If you cannot identify the cause and would like to meet with me, please schedule an appointment as soon as possible via the link on Blackboard. You want to start preparing for exam 4 now so that you do not lose your passing grade.

TABLE 2: Percent of Students Agreeing or Strongly Agreeing on Survey Questions		
The personal emails I received from Dr. (instructor) after each exam regarding my performance:	101 (N = 184)	102 (N = 400)
Helped me feel supported in the class.	93.5	85.3
Increased my motivation to learn in this class.	88.0	77.5
Increased my anxiety about my performance in the class.	39.7	27.5
Helped me feel that the instructor cared about my performance in the class.	91.3	90.0
Encouraged me in this class.	89.7	75.5
Made me feel less anonymous in such a large class.	78.8	72.3
Helped me improve my performance on one or more subsequent exams.	63.0	56.8
I do not recall receiving emails from Dr. (Instructor) about my exam performance.	1.6	1.0
I did not read the emails from Dr. (Instructor) about my exam performance.	1.1	1.8