STATISTICS FOR NURSING AND ALLIED HEALTH AT SAINT LOUIS UNIVERSITY IN THE SPIRIT OF SUMMIT-P

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ABSTRACT
This paper describes the renewal of a consumer-based elementary statistics course to benefit students in the nursing and allied health disciplines. While the goal of the course transformation was initially to update the pedagogy of the course and ensure students are able to make connections between the course material and their majors, that goal expanded to include the needs and objectives of the client disciplines. This expanded goal was accomplished by incorporating insights gained from a SUMMIT-P business school collaboration and was based on the Curriculum Foundations project recommendations. The paper addresses course projects, instructor development, faculty roles, and interactions with stakeholders. The influence of SUMMIT-P on the course renewal as well as sustainability plans are also shared.

KEYWORDS
consumer-based statistics, statistics for healthcare, course development

This paper describes the process of renewing a statistics course for nursing and allied health, STAT 1100, at Saint Louis University. The interactions between mathematics and client discipline faculty throughout this process were intentionally modeled after those Father May employed when reforming a business school course for a different project as part of a National Consortium for Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnership (SUMMIT-P). In both cases, the course renewal project started with an attempt by mathematics faculty to improve their teaching by implementing reforms recommended by professional organizations. The goal was to develop a sustainable unit of change and institutionalize the reform across all sections of a multi-section course. In the case of the statistics course, motivations for reform also were based on client discipline concerns about student knowledge retention, instructors' discontent with the lack of substance in the course, and an interest in developing a generic, project-driven, quantitative reasoning/statistics course.

With both courses, a faculty member implemented reform in a pilot section and then established a dialogue about the course with the associate deans of the colleges housing the client disciplines. When the associate deans affirmed that the course changes aligned with the course goals in the client disciplines, faculty representatives from them were brought in to collaborate and help further refine the course. The collaboration between mathematics and client disciplines was formalized with the formation of structured meetings with stakeholders. The use of this model, developed through the SUMMIT-P partnership, has helped ensure that the efforts are sustainable and stable.

The discussions regarding STAT 1100 led to initiating larger structural changes in how introductory statistics courses are structured and maintained by the mathematics department. In particular, we started having once-a-semester meetings with stakeholders of introductory statistics courses, to ensure the courses offered align with the partner discipline needs. In the short term, the renewal process is being applied to a second introductory statistics course, with a higher mathematics prerequisite, which provides an in-depth study of theory and computations, and includes analyzing large data sets using the statistics software package R. In the medium-term we are planning to apply the renewal process to create a different version of the introductory consumer-based statistics course, working with a different set of partner disciplines.

The Scenario at Saint Louis University: Department Climate and Course Renewal

The Department of Mathematics and Statistics (referred to in this paper as the department) is a Ph.D. granting department whose faculty members have interests in course development, project-driven or flipped courses, and client discipline outreach activities. The department is supportive of pedagogical development, with clusters of faculty members working together on courses.

For service courses, the department tends to teach multiple sections of each course, each of which is capped at 30-35 students. These courses are often taught by adjuncts or graduate students, with the percentage of courses taught by full-time faculty diminishing in recent years. Unfortunately, the service courses for disciplines that are not mathematics intensive are often a low priority for both the department and the partner disciplines.

On a bigger scale, the university has been making strides in the past few years in breaking down discipline, department, and college silos, including those relevant to the delivery, and content of non-major courses by several initiatives including: (1) brown bag lunches about STEM teaching, (2) stakeholders meetings for course clusters, and (3) a new set of core

requirements for all undergraduates based on the necessary conversations to make these kinds of changes.

An Overview of a Typical Course Renovation Process

The course renewal process almost always starts with a single faculty member looking at the course and saying "we can do better" in course delivery. The individual's work involves making a particular improvement as well as the effort to utilize the wisdom of the profession when deciding what "better" means. If the changes to the course are to be sustainable, the effort will have to broaden beyond a single faculty member's inspiration in order to become department policy. For courses geared toward students in partner disciplines, the faculty representatives from these disciplines also need to be involved so that the students are getting the same message from both the mathematics instructors and the partner discipline faculty. Ideally, consultations are structured to ensure the sustainability and growth of the course renovation. This renovation process can be thought of in four intertwined stages. The stages listed below are written specifically for our undertaking:

- Recognize that we can do better with the course we are teaching.
- To effectively teach a service course, secure the support of the students' home departments. We need to move the discussion from which courses students should take to the student learning objectives and how those objectives fit into the curriculum.
- Teaching a better course generally means asking the students to work harder, or at least to work in a manner that is different from the way they are accustomed. To make the worthwhile change, we need to consistently employ better pedagogical practices across all sections of the course. We also need to align our suggested changes with the recommendations of professional organizations, so we can explain why we are asking the students to make adjustments to their learning practices.
- Establish structures that will sustain the effort and the cooperation between mathematics and partner discipline faculty.

The Course Renovation Process for the Consumer-Based Statistics Course

The renewal of the consumer-based statistics course, STAT 1100, was informed by earlier pedagogical projects in the department, including May et al. (2020), a SUMMIT-P business school and mathematics collaboration. The recommendations described in the *Curriculum Foundations Project: Voices of the Partner Disciplines* (Ganter & Barker, 2004) developed by the Curriculum Renewal Across the First Two Years (CRAFTY) committee of the Mathematical Association of America, the *CUPM Curriculum Guide 2004* developed by the Committee on the Undergraduate Program in Mathematics [CUPM], and the *Guidelines for Assessment and Instruction in Statistics* ([GAISE], 2016) were highlighted during the initial discussions. Once the general structure of the course was in place, it was time to consult with partner disciplines about incorporating discipline-specific applications into the course.

A Culture that Provided Readiness for Course Renovation

CRAFTY recommends (Ganter & Barker, 2004) that mathematics courses should emphasize (1) conceptual understanding, (2) problem solving skills, (3) mathematical modeling,

(4) communication skills, and (5) provide a balance between perspectives. These are five principles that many faculty within the department believe are valuable for courses at all levels. These recommendations were explicitly discussed when the department debated the available choices of reform calculus textbooks over two decades ago. The result was that the department chose textbooks embracing these CRAFTY principles. These areas of emphasis are still brought up during the department "Calculunches". Several members of the department were involved in a SUMMIT-P project, which explicitly uses CRAFTY principles outlined in Ganter and Barker (2004) and MAA (2004). However, outside of the SUMMIT-P work, the CRAFTY principles were mainly considered when deciding how to make mathematics classes more effective for business students. The work on that project (May et al., 2020) was the basis for discussions about models for collaborating with other disciplines and about building structures to support the sustainability of pedagogical reform.

The lead innovator on the statistics project, K. Druschel, worked on the creation of STAT 1100 over 10 years ago. Her ideas for the course grew out of her experience with including projects in calculus, statistics, and computer science courses in which students were encouraged to share examples that were of interest to them. As the Director of Computer Science in the Department of Mathematics and Computer Science, she developed the Scientific Programming course, which included projects, in response to input from the client disciplines in the College of Engineering. When she revisited the STAT 1100 course after several years of teaching other courses, she realized that her impetus to include projects, as well as some healthcare applications, had dwindled. She took on the task of making the course better and of doing it in a way that would make the changes sustainable.

The Application of CRAFTY Principles

Druschel's work was initially informed by the CRAFTY and GAISE principles by happenstance. Rather than starting by reading the CRAFTY reports (CUPM, 2004; Ganter and Barker, 2004), she applied lessons she had learned by teaching a variety of courses that had been refined based on discussions with like-minded members of the department. Of the five CRAFTY principles listed above those that most strongly informed the changes to STAT 1100, a consumer-based statistics class, are conceptual understanding, communication skills, and a balance between perspectives. The primary components included in the updated course are the use of a semi-flipped class model for more active learning and the inclusion of group projects. Projects for this course require students to interpret the statistics in context, to submit an organized presentation, and to write clearly. These requirements are reinforced by the specific provisions for these elements in the grading rubric for the projects. In these projects, students analyze Medicare Hospital Care Compare data (Center for Medicare and Medicaid Services, 2022) using a variety of descriptive and inferential statistics tools. Students also consider how statistics is useful to their field. In this way, the balance between perspectives is incorporated into the group projects.

The CRAFTY recommendations (Ganter & Barker, 2004) include priorities for content, topics, and courses. The recommendation of most value to STAT 1100 is that statistics be offered during the first two years of the college experience and that the material covered in the course be motivated by a variety of examples and real data sets, including data collected by students. This recommendation is similar to the recommendation found in the GAISE standards stating that courses should "integrate real data with a context and a purpose" (GAISE, 2016).

Students take a deep dive into the Medicare Hospital Care Compare website and dataset (Center for Medicare and Medicaid Services [CMS], 2022) and the Medicare Mapping Healthcare Disparities website (CMS Office of Minority Health, 2022). Students also report on the use of statistics in articles that they read in their fields.

CRAFTY also has recommendations (Ganter & Barker, 2004) on the uses of instructional techniques and technology in courses. There have been regular departmental conversations about the use of different teaching methods and technology and the inclusion of projects since the days of calculus and differential equations course reforms. A variety of technologies have been used in calculus and business calculus. In conversations concerning the two introductory statistics courses, client disciplines have clearly delineated those majors which require a consumer-based course with minimal use of technology and those majors which require a different course using the statistical software R.

Additionally, CRAFTY (Ganter & Barker, 2004) recommendations encourage improvements to interdisciplinary cooperation. This can be unwieldy at times, as improving interdisciplinary cooperation needs to take place at a departmental level and requires time and negotiation. Efforts to improve interdisciplinary partnerships in a course are most fruitful when the mathematics department does not start with a clean slate but instead begins by determining what the client disciplines want the course to accomplish and then work to make adjustments and specifications. Such was the case with the SUMMIT-P business school and mathematics collaboration (May et al., 2020) as well as with the collaboration between statistics, health sciences, and other client disciplines for the renewal of STAT 1100. In particular, the supportive efforts of Associate Dean Gockel-Blessing in the Doisy College of Health Sciences and Associate Dean Laurie Russell in the College of Arts and Sciences propelled this interdisciplinary partnership forward.

In stakeholder meetings with client disciplines, Druschel and May presented the course format and the required projects. They indicated that projects are a sizeable portion of the course grade. They also noted that exams have less weight than what is typical for a standard statistics course and that the exams are not multiple choice. Stakeholders were very happy with the full course package, including the planned assessment measures. Thus, without addressing the recommendation explicitly, the CRAFTY (Ganter and Barker, 2004) call to "emphasize the use of appropriate assessment" is part of the course structure.

In Fall 2017, as Druschel piloted the updated STAT 1100 course, she participated in a university-sponsored trip to an American Association of Colleges and Universities STEM education conference. While she was aware of the CRAFTY recommendations (CUPM, 2004; Ganter & Barker, 2004) and May et al. (2020) SUMMIT-P work, the first time she focused explicitly on the CRAFTY recommendations was during a CRAFTY workshop at the conference on the fishbowl practice to listen to and understand client disciplines' needs. This workshop also piqued the interests of other faculty representatives from other disciplines on campus which resulted in conversations about potential future collaborations for calculus reform.

After the conference, several members of the faculty group attending the conference organized the university's first brown bag discussion on STEM education. Druschel also initiated departmental seminars on innovation in mathematics education which paved the way for other STEM-focused brown bag discussions. During the mathematics teaching seminar, Druschel met a graduate student, K. Radler, and learned of her strong interest in reform education. These connections led to the development of projects for STAT 1100. The CRAFTY workshop also reminded Druschel of the value of outreach to client disciplines which led to working with May

in Spring 2018 to revisit the client discipline discussions on STAT 1100. This, in turn, led to cross-discipline collaborations to work on course development for a renewed version of STAT 1100 and the implementation of a multi-section pilot of the course.

Historical Perspective of STAT 1100

STAT 1100 is taught in sections of 35 students with about ten sections offered per year. While there had been some full-time faculty involvement when the course first came into existence, because of cutbacks, the course was primarily taught by adjunct instructors and graduate teaching assistants with little oversight. Students paid little attention to standard PowerPoint lectures and multiple-choice exams were given which resulted in minimal retention of the course content. In fact, a statistics knowledge quiz given to students in a follow-up nursing course indicated that students retained little of what they learned in STAT 1100. This correlated with anecdotal observations shared by instructors in follow-up courses.

Development Stages of a Multi-Section Consumer-Based Statistics Course for Healthcare Majors

Stage One – An Internal Pedagogical Project

In Fall 2017, in response to concerns from instructors as well as the department chair that the course lacked sufficient content and students were not engaged in the course, in addition to concerns by some client disciplines about knowledge retention, Druschel piloted a STAT 1100 course that featured group projects. To address these concerns, one natural solution was to add more opportunities for discipline-focused interpretations of statistics. So, in the pilot course, students found discipline-related (mostly healthcare) articles containing examples of the statistical concepts covered in class and subsequently answered a series of questions about them. The instructor provided short lectures on the course material, followed by the students completing worksheets in small groups. It was a lively course and students did well on the projects, as well as on exams. They indicated on an end-of-course survey that they were satisfied with the learning experience. In response to a survey question about whether they learned more as a result of completing in-class work, 10 strongly agreed, 15 agreed, 1 had no opinion, 5 disagreed, and 1 strongly disagreed. For a question about in-class work fitting their learning style, the distribution was 11, 14, 3, 2, 2, respectively. And for a question about in-class work preparing them for other courses or their career the distribution was 4, 14, 7, 7, 0, respectively.

Stage Two – Starting Negotiations with Client Disciplines

In Spring 2018, Druschel and May consulted with faculty in nursing and other non-pre-med health sciences about their students' statistics course needs. They shared information from the pilot course, including the projects and student satisfaction and assessment data. By using the cross-discipline collaboration listening techniques advocated by CRAFTY and successfully implemented in the May et al. (2020) business school SUMMIT-P project, they learned about the content of courses in the disciplines with a statistics course prerequisite and about how students use statistics in their senior projects. The client discipline faculty confirmed that the students should be able to read and apply statistical studies, and rarely need to work with large datasets, which is a requirement of another introductory statistics course. Representatives from the client disciplines shared sources for articles and datasets that would be relevant to the students and

discussed collecting statistics knowledge retention assessment data in follow up courses. The client disciplines suggested the use of Hospital Compare data (Center for Medicare and Medicaid Services, 2022a & 2022b) for students in these disciplines who will take STAT 1100. The faculty representatives from the client disciplines were enthusiastic about the form, content, and outcome of the pilot course and asked that the course be implemented in the same format across course sections. The next question was whether the pilot could be implemented across all STAT 1100 sections and how instructors could be encouraged to participate.

Stage Three – Institutionalizing the Reforms, Involving Other Instructors

A larger pilot for Fall 2018 was implemented. In Summer 2018, Druschel and Radler created a template and a syllabus for a multi-section STAT 1100 course. The template included the routine online homework and a set of 10 projects based on some modifications to the projects used in the pilot course. For example, some projects were changed from "find an article in your discipline and answer these questions about the statistics in the article" to "make a brief poll and collect and appropriately analyze the collected data."

The syllabus outlined that the course format would follow a partially flipped classroom format. Exams counted for less than a third of the final course grade. Exams were not coordinated across sections, but sample exams were shared. The exams consist of short response questions with a few open-ended questions.

The Center for Teaching and Transformative Learning (CTTL) was consulted about engaging other instructors to teach a partially flipped course with group projects. Two instructors for three courses agreed to teach the course using the projects. They took part in training on using the prepared and shared materials. A website with teaching resources was also provided.

Survey data indicated students who completed the revised version of STAT 1100 did not feel the partially flipped instruction model and the projects fit their learning style or added interest to the class, or helped prepare them for further courses. For example, on a scale from 1 (strongly agree) to 5 (strongly disagree), for a question about learning style the mean for each instructor was 3.52 and 3.56, respectively. The average responses for a question on being prepared for future courses were 3.48 and 3.78, respectively. For a question about in-class work making the class more interesting, the mean responses were 3.10 and 3.04, respectively. Lastly, for a question on satisfaction with the learning experience, the mean responses were 3.71 and 1.93, respectively.

We realized through analysis of the assessment data and survey comments, and from conversations with instructors, that part of the students' dissatisfaction was due to the fact that the new version of the course required students to develop a deeper understanding of the content which, in turn, required more work on the part of the students. However, the data also indicated that there was a need to have more uniformity across all the sections of the course and better communication with students about the reasons for the course structure.

Stage Four – Institutionalizing the Reforms, Standardizing Sections

By Spring 2019 all sections of STAT 1100 were being taught in a partially flipped model format with group projects. Instructors were assigned to sections of the course based on their willingness to teach the course in this format. Instructors were given training in best practices for this instructional method. They also participated in regular instructor meetings throughout the semester. The projects were revised to remove the burden of finding articles from the students. However, students were still required to search for examples of real-world data and the use of

statistics in their field. We elaborate on how we engaged students in exploring data and the related statistics in the projects section below. Pre-and post-course student surveys were conducted. Results indicated an increase in student confidence in their numerical skills with 63% agreeing or strongly agreeing that their confidence had increased. There was also an increase in the belief that statistics is relevant to their field.

Stage Five – Institutionalizing the Reforms, Training Instructors

Using feedback from instructors who taught the course in Fall 2019, Druschel and Radler engaged another graduate student, S. Salihovic, and an adjunct instructor, L. Miller, in a revision of the projects. During this time, instructor meetings and training continued. These efforts helped build a community of instructors with more enthusiasm for teaching the course. Graduate student and adjunct instructor involvement in the development of a course is not a standard practice in the department, but certainly seemed beneficial.

In addition, a presentation outlining the course renovation was made by May, Druschel, and Radler to Associate Dean Gockel-Blessing on the feedback from the course and resulting adjustments to the projects and other course components. In a similar fashion to what took place during the earlier SUMMIT-P work with partners in business (May et al., 2020), this led Dean Gockel-Blessing to schedule stakeholders' meetings about the revised course.

Stage Six – Dealing with Disruptions due to the COVID-19 Pandemic

In Spring 2020, as COVID necessitated that courses be taught online, the structure of the projects allowed for their use in an online format. It should be noted that the article reports and projects account for about a third of the course grade, which puts less emphasis on exams. This worked well for the online format. The main modifications that were made to the course included the development of mini-lecture videos and adjustments to exams that could not be proctored in person. Many instructors opted to allow extended completion times for exam and include more essay style questions. Projects were completed in small groups using Zoom breakout sessions. Additionally, the issues with academic dishonesty from cheating on exams was significantly ameliorated, due to the fact that a sizeable portion of the grade was based on students working on projects in small groups as well as reporting on discipline-specific articles and data they found.

Stage Seven – Adapting to Online Education

In summer 2020, Druschel taught a totally asynchronous version of course using the projects. She added more examples of hospital comparison data to the mini-lecture videos and developed a Blackboard template for the course. She also incorporated more data from Hospital Compare data or other healthcare measures into exam questions and developed an R template for generating multiple versions of exams. These materials were adopted by some instructors who taught the course in an asynchronous format in Fall 2020, Spring 2021, and Summer 2021. The exams became part of the library of exams that is shared by instructors.

Stage Eight – Peer Review and Involving Senior Faculty

In-person classes resumed in Fall 2021. Two sections of the course were taught by the department chair, Dr. Clair, and another section was taught by a graduate student, M. Silverglate. Both instructors have extensive statistics backgrounds and teaching experience, but they had not taught a consumer-based statistics course before that semester. All materials and projects from previous course offerings were shared with them. Clair made some improvements to the projects.

Their feedback in casual conversations as well as during scheduled meetings provided additional information for course modifications and also provided evidence that the course structure is amenable to both students and faculty. They also suggested further changes for the projects and the development of a more robust bank of articles for students to use for the article reports. Additionally, Druschel observed Silverglate's class and noted her extensive use of interactive Desmos slides in the lecture portion of class prior to the student work on the projects. As a result, Silverglate developed additional Desmos slides using the heath care data. These slides were used in Spring 2022 by some instructors.

Stage Nine – A New Sustainable Normal

The cadre of instructors for Spring 2022 included four instructors who have previously taught the course as well as one new graduate student and one new adjunct instructor. Course materials including PowerPoint slides, videos, exams, Desmos slides (updated by Silverglate), projects, an online homework template, and a website with active learning resources were shared with the instructors. During a pre-semester meeting, the partially flipped class model was shared with the instructors along with the rationale behind and logistics for using the projects. Veteran teachers shared their experiences with the faculty who were teaching the course for the first time. Throughout the semester additional instructor meetings took place to provide further support to the instructional team. The feedback from the instructors throughout the semester was positive. However, some instructors had difficulties fitting in all projects and opted to exclude some portions of the projects. This is an issue that will be addressed in further iterations of the course.

Article Reports and Projects

STAT 1100 has two basic types of group projects: (1) article reports that students complete outside of class and (2) in-class projects. Projects are geared towards the students' interests and their areas of study, which, in this case, are predominantly in healthcare fields. Of great benefit is the fact that the course structure, which combines finding articles with statistics related to majors and projects exploring substantial and relevant real-world datasets as consumers of statistics, are transferrable to other clusters of majors.

Article Reports

Students complete two article report projects, one in the first half of the course and the other in the second half of the course. Students are given an extensive and diverse list of articles to choose from. Resources to find their own articles if they so choose were also provided to the students. Students have the option to earn extra credit for doing so. The first article report covers study design, graphical representations of data, descriptive statistics, and the normal distribution. It may take a combination of two to three articles to cover all the topics. The second project addresses probability, regression, and inference. Students' reports are generally well-written, including cogent summaries of the articles and fairly accurate reports on the relevant statistics. The article analysis serves as a preview for what students can expect in subsequent courses which have STAT 1100 as a prerequisite. Examples include evidence based nursing or clinical research and design in physical therapy.

Vignette – Lee University

I use a similar assignment in my class Introduction to Research Methods and Statistics, a sophomore-level course for students majoring in psychology, at Lee University. In my version of the assignment, students must find empirical journal articles that address a topic of their choice. Students then select a few questions to answer from a list of provided questions, all of which are designed to help students identify the major components of a journal article (e.g., What are the researchers' hypotheses? What were the key results from the study? What are the strengths/limitations of this research?). In addition, students complete this assignment twice during the semester. When writing their second paper, students answer the same questions about a different empirical article, in addition they must also attend more carefully to APA style formatting requirements. Anecdotally, students have reported that this assignment is a useful introduction to finding and summarizing journal articles, and a helpful springboard for the literature review assignment they complete later in the semester. – Bryan Poole, Associate Professor of Psychology, Department of Behavioral & Social Sciences

In-Class Projects

There is generally one in-class project for every one or two chapters of course material. The projects occur during the second half of the class period and are designed to reinforce material covered during the first half of the class period. The course begins with a mini-project which asks students to imagine how statistics might be used in their fields or areas of interest and to provide examples of discipline-focused observational studies and experiments. Besides providing a motivational on-ramp for students, this project is intended to introduce students to working in Google docs and turning in a group project.

The activities in the remaining projects are mostly centered on data related to the Hospital Compare website (CMS, 2022b), a website maintained by Medicare that allows healthcare consumers to compare many typical aspects of patient care such as costs, readmission rates, wait time for emergency care, and patients' ratings of their experience at hospitals. The use of this dataset was specifically recommended by partner discipline faculty. The goal in these project activities is to have students look deeply at a substantial and extremely relevant scenario that involves a coherent dataset, explore the data, and view the scenario both as consumers and as makers of the hospital data and statistics. By tailoring the projects from the public website's information and the provided background data, the instructor may determine the balance between consumer-based analysis and data manipulation for the statistics course.

The questions included in the projects are of two types. Students find data on the website for their choice of hospitals and answer statistics questions about that data or use the data to complete basic calculations. The students are then asked to interpret the results within the healthcare or community context or make conjectures about the results. There are also activities which rely on graphs, tables, or statistics created by Druschel from datasets on over 4,000 hospitals from CMS (2022a) which provides the data for the Hospital Compare website. On the website one can only compare data from three hospitals at a time and students select hospitals that are familiar to them or hospitals in a select region.

Other activities include making conjectures about and reporting on how various statistical concepts are used in their own fields, finding and describing graphs about the COVID-19 pandemic, and analyzing information and graphs from the extensive Medicare Healthcare Disparities website (CMS Office of Minority Health, 2022).

Project Activities

This section briefly describes highlights of activities for seven course projects. These descriptions are not exhaustive in nature, as the projects are extensive and illustrate almost every topic covered in the textbook. These projects are located on the project website (Clair, et al. 2022).

The first project is designed for students to explore the basic vocabulary in statistics: variables, data types, populations, bias, percentages, and statistical studies. Students list variables in their field for each of the given types, such as numerical and discrete. Students are introduced to the Hospital Compare website (CMS, 2022b) by choosing three hospitals from the website (searchable via location) and reporting on data for each of them. They describe the data type (such as qualitative and ordinal), discuss the types of error that might occur and determine whether the variable should be labeled as explanatory or response. They then compare several hospital variables values to practice working with percentages.

A further activity introduces the basic notion of confidence interval and statistical significance. Students complete a quick calculation with the hospital data. For example, they might use a confidence interval for infection rates. They then provide an explanation about how the value compares to the national or state average.

The second project allows students to explore graphs, basic descriptive statistics, and false positive values. The first task in this project is to find three different types of graphs for COVID-19 data, and then identify the components and the information conveyed in two of the graphs. Another question asks students to determine how false positive or negative values might occur for an example in their field. They use a website to calculate the percentage of false positives and false negatives and determine the accuracy for their example according to prevalence, sensitivity, and specificity. Students next analyze histograms and box plots created from Hospital Compare data (CMS, 2022b) and compare the values for their hospitals to the graphs. They consider, for example, the quartiles that the values fall in and the percentage of hospitals that are comparatively better than one of their hospitals. Students explore the value of side-by-side boxplots, providing, for example, boxplots of southern states hospital emergency room wait times and making conjectures about the reasons for similarities and differences. To assess individual learning and contribution, all projects have an individual portion which includes a question about the contribution of each person to the group portion of the project. For this project, the individual portion also requires students to report on graphs found in Medicare's Healthcare Disparity website (CMS Office of Minority Health, 2022).

For the third project, students analyze three histograms and fitted normal curves, as well as descriptive statistics, for hospitals' readmission rates and patient approval ratings. Students identify the 68%-95%-99.7% locations or related proportions in the normal distributions or determine the probability that an arbitrary hospital does better than one of their chosen hospitals according to one of these measures.

Project four is a light introduction to probability with problems about: (1) the statistical significance of various hospital measures, (2) expected cost of an ER visit, (3) a Venn diagram that includes different measures of ER wait times and (4) probability statements about the categories of nurse communication effectiveness from data from Hospital Compare (CMS, 2022b).

The fifth project addresses scatter plots and linear regression. It includes a scatter plot of two measures of ER wait times for hospitals in Montana. Students identify a few outliers in the plot, find the towns for those outliers from a given list, and make conjectures about why they are

outliers. Another task consists of deciding whether a given hospital is above the value predicted by the regression line. Students match correlation coefficients with four different scatter plots for various measures for California hospitals, discuss the strength of the correlation for a given pair of variables and the reasons for the occurrence. They then search for data for one California hospital and analyze how the hospital fits within the various scatter plots. They determine which hospital they would prefer to go to based on information provided in a scatter plot and provide statistical reasons for their selection.

The sixth project highlights the sampling distribution, confidence intervals and hypothesis testing. Students mimic a random sample by searching for data on the average payment for hip/knee replacement for various hospitals, then compute the sample average and compare it to the true population average and evaluate the difference between the two values. Students are given a graph of a sampling distribution for this measure. Students then compare the distribution to the histogram for the entire population of hospitals. Other questions include calculating a confidence interval for the proportion of patients who reported their nurses always communicate well and testing a hypothesis about the average payment for heart attack patient care at a given hospital.

Project seven covers hypothesis testing for proportions, the t test, the Chi-square test and ANOVA. Students apply a Chi-square test to data for Missouri hospitals to determine whether patient ratings of hospital cleanliness and patient ratings of hospital quietness are independent. They also calculate a confidence interval for the average payment for pneumonia patient visits. Students use an ANOVA test to determine whether there is evidence that the mean average wait times at hospital emergency rooms varies for four different states. Hypothesis testing is also employed to analyze whether the rate at which severe sepsis is treated properly at a given hospital is better than the 2019 national average.

Instructor Development

The professional development provided to graduate students and adjunct instructors teaching courses in the department include a meeting at the beginning of the academic year and mandatory mid-semester classroom observations. Feedback is provided to both the instructor and the supervisor of introductory courses. The Center for Transformational Teaching and Learning (CTTL) offers a certificate in University Teaching Skills. Graduate students often participate and, as part of the program, are mentored by a department faculty member.

In the past decade, most mathematics courses which are not primarily taught by fulltime faculty have a standardized calendar and online homework templates. This was not the case for STAT 1100. There had been intermittent meetings of instructors for the introductory statistics courses convened by Clair or Druschel, but no uniform structure had been created for the courses. Part of the impetus for the renewal of STAT 1100 was complaints by instructors at the meetings.

Through the second pilot study of the revised STAT 1100 course taught by adjunct and graduate student instructors, it became clear that the nature and rationale of the course needed to be better communicated to prospective instructors. In subsequent semesters the training occurred during multiple meetings in addition to impromptu hallway conversations, emails before and during the semester, and shared course materials. Additionally, Druschel often observes STAT 1100 instructors and so she can advise them on the course structure and explain what to expect

during student small group interactions. She also served as a faculty mentor for three graduate students who enrolled in the CTTL program described above who also taught STAT 1100.

There are certain aspects of the course that are new to many instructors. These include a consumer-based, non-computational statistics course with more emphasis on analysis and interpretation, the partially flipped classroom model, the emphasis on projects including the use of real-world health care data, and the reports on articles in fields that instructors may not be familiar with. Each of these aspects are addressed during the beginning of the semester meetings. The rationale for these course components is shared with the instructors along with practical tips for facilitation. Discussions continue during follow-up meetings throughout the semester. There is also a webpage with instructor resources addressing all of the course components.

While the projects have been a significant factor in the redesign of STAT 1100, it has been the hope of the course developers that the course format and projects are a formative ground to which instructors can add their own instructional style. Over the years different instructors have included mastery quizzes or interactive Desmos slides. These ideas are available to instructors by accessing a dedicated resource website. With the project revisions almost complete, the next area of focus will be to formalize the instructor training process.

Instructor and Client Discipline Feedback

At the end of Fall 2019, a poll of course instructors revealed that 100% of the instructors thought that teaching the course using small in-context group projects enhanced student learning. They also reported that they would be more inclined to use active learning techniques in future courses. In addition, 71.4% of the respondents stated that the group article project and the projects using the Hospital Compare data enhanced student learning. The instructors who were less on board with the projects tended to have less experience with active learning. Two instructors noted that they 'really enjoyed' teaching statistics this way; another expressed initial skepticism with the course format, but now believes it is a very effective system.

From Spring 2020 to Summer 2021, due to the COVID-19 lockdowns, we were only able to provide minimal support to instructors and also only received minimal feedback from them. For Fall 2021 courses, the feedback from the instructors, including the chair, was very positive. One said they "had a blast teaching the course" in spite of being initially concerned about teaching a consumer-based statistics course. Both instructors reported that students seemed to enjoy the projects. With the return of in-person formal instructor meetings, the collection of additional data from instructors and students, as well as opportunities for impromptu hallway discussions concerning the course will continue to advance this project.

The stakeholders' meeting in Fall 2020 was attended by faculty representatives from almost all partner disciplines whose students take this course. Information about the course structure, student projects, and data on student performance and polls was presented to the attendees. There was a wildly enthusiastic response from the stakeholder representatives. Suggestions of ways stakeholders could contribute to the course were identified along with ideas on ways to promote statistics with the student population taking the course. Ideas included providing a bank of articles for student article reports, including articles written by the healthcare faculty, creating short videos about how statistics is used in the professions and by students in their senior projects.

Faculty Roles, Course Sustainability, and Future Growth

Druschel was the main innovator of the course renewal, and, with valuable input from Radler, designed the projects and course structure. She regularly discusses the course with instructors, collects and analyzes course and instructor data, makes revisions and updates to projects, and is involved in cross discipline presentations and conversations. She also organizes meetings for the graduate students and instructors and works with them on course data analysis, project revisions, and presentations.

May coordinates with the department on the efforts to institutionalize the course reform. His goal is for the STAT 1100 renovation project to reach a point of stability, so the efforts of the renovation are not lost when Druschel needs to move on to a new project. As lower division supervisor in the department, May makes teaching assignments with a view to supporting the project, development of graduate student instructors, and facilitating discussions both in the department as a whole and between the department and client disciplines at appropriate times. His experience in SUMMIT-P has directly and indirectly kept this project on track. In particular, his experience with collaboration and outreach has been essential. He motivates and encourages team members when there are stumbling blocks in this momentous project that require revisions and adjustments.

Associate Dean for Student and Academic Affairs in the Doisy College of Health Sciences, E. Gockel-Blessing, is the lead contact for the partner disciplines. She represents the needs of the partner disciplines and, when necessary, includes faculty from other colleges in meetings and assigns tasks as part of the collaborative effort. Her knowledge about the college programs and the students' needs has been invaluable. She has been the main organizer and the driving force behind the statistics stakeholder meetings.

Course sustainability has been reinforced by enlisting the support of the mathematics department and the departments of client disciplines. The client disciplines are, by all accounts, very satisfied with the course and are interested in contributing support to it in different ways. The mathematics department has been supportive by providing funds to hire graduate students to help with projects and also providing additional support and encouragement.

Furthermore, course sustainability is built into the course through the multiple revisions to course projects including use of content from a wide variety of partner disciplines. This allows for portions of projects to be removed as needed. In addition, support structures have been developed, including the webpage of instructor resources and the meetings to prepare instructors to teach the course. These structures have been instrumental in creating a community of these instructors. As one indication that we are well on the road to sustainability, one instructor noted that they had never taught such a well-organized course designed for multiple sections. Another instructor likes the projects so much that they want to use a similar course format for a statistics for social justice course. The development of such a course would substantially add to the pool of quantitative reasoning courses appropriate for liberal arts majors, as well as add to the sustainability of the current course.

Ongoing sustainability needs consist of updating projects as the data and websites change, continuing improvements to the instructors onboarding process, and further development of the instructor community. This approach requires more instructor involvement than a routine course. This is a significant factor for adjunct instructors and graduate teaching assistants. The materials are available. The main issues are with instructors taking the time to adequately review the material and incorporating a more active approach to both teaching and assessing course

content. Each of these items have potential solutions including developing detailed guides for the projects, providing additional coaching and training on active teaching and the flipped classroom model, developing apps to allow students to interact directly with the Hospital Compare data (CMS, 2022a; 2022b) and perhaps even check their work.

Future growth areas that have been discussed with the client disciplines include the development of videos of interviews where students or faculty talk about their use of statistics in senior projects, discipline-specific courses, or their profession and incorporating faculty-selected articles in the bank of articles for report projects. This will further help healthcare students appreciate the role of statistics in their fields. We are also investigating formal training for instructors of the course. This could include a small module which briefly introduces instructors to the typical training or curriculum for the healthcare student. Critical to the above efforts are the guidance and connections that Associate Dean Gockel-Blessing provides. Future growth areas for Druschel and May include analyzing and collecting more data on the course and collaboration on the development of a social justice version of the course.

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Author Note

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