

## **ABSTRACT**

This project is designed to develop and implement technology-focused projects into two applied mathematics courses, MAT 210 Mathematical Computing and Typesetting and MAT 361 Operations Research, and to assess how the implementation of this approach will impact students' proficiency in mathematical computation. The assessment will be conducted in both courses during the Fall 2024 semester. Each course, taught by the investigators, will require a series of projects tailored to a specific software language, including Python, Excel, Minitab, and Gurobi, as well as L<sup>A</sup>T<sub>E</sub>X. The projects will be assessed using rubrics designed by the investigators that align with the Department of Mathematics SLO 5 rubric. Students' performance as well as their proficiency in and attitude towards mathematical computation will be measured and the corresponding data will be collected and analyzed using appropriate statistical methods.

## **DETAILED BUDGET**

The investigators are seeking this assessment grant to fund the summer stipend \$2500 (benefit included) for each investigations. In particular,

- For Summer 2024, \$1400 for part time work on this project for each PI in June, July, and early August 2024. The investigators will design the MAT 210 and MAT 361 projects with corresponding guidelines and rubrics, and prepare/organize the technology resources for both courses. Investigators also work on the assessment design including the surveys, the evaluation, data collection, the analysis of the various statistical approaches.
- For Summer 2025, \$738 for part time work on this project for each PI in May and June 2025. The investigators will complete the data analysis and prepare to disseminate the results.

## **PROJECT GOALS AND INTENDED OUTCOMES**

The main goal of this project is to provide an educational experience involving technology-

focused projects for our students in two of our applied mathematics courses and to assess the impact of this experience on SLO 5 of the Department of Mathematics. This specific learning outcome is for our students to demonstrate proficiency in the use of technology in mathematics. The majority of this project will be carried out during the Fall 2024 semester in MAT 210 Mathematical Computing and Typesetting and MAT 361 Operations Research. Both of these courses are built around a technological component and the course material requires computational software for solving problems and reporting results. MAT 210 was created to introduce students to mathematical computing software and to  $\text{\LaTeX}$ , which is the standard typesetting language for writing documents and creating presentations in the mathematical sciences. MAT 361 is a classical approach to linear programming that typically involves large scale application problems that can only be solved using computational software. The mathematical software in consideration include Python, Gurobi, Excel, and Minitab. Therefore, both classes are ideal for implementing structured technological exercises and projects that instill a better understanding of mathematical computing and typesetting while at the same time providing a framework for future assessment initiatives related to SLO 5.

There are a total of seven mathematics courses, including MAT 210 and MAT 361, that are in the assessment map for SLO 5. In the department's five year assessment report, action is needed to better understand how to deliver technological content to the students effectively and consistently. Moreover, the Department of Mathematics has struggled to consistently assess SLO 5 because of the difficulty in integrating technology-related content and assignments. A key component of this project is to devise a structured course framework complete with course materials and templates that can be used in future iterations of MAT 210 and MAT 361. Although the majority of the project will take place during the semester, development of the course materials will take place prior to the start of the semester. The investigators will create a GitHub Repository to store all necessary program files and templates that will be used by the students. Students, then, will be

able to download the material to their home or campus machines to be used during the semester. Therefore, the intended outcomes of this project are threefold: (1) a collection of course materials and professional documents that instructors can use in future iterations of each course offering, (2) results of a pilot study on how to address the difficulty in implementing relevant technological projects into applied mathematics courses, and (3) the enhancement of students' proficiency in mathematical computing and typesetting as well as an enrichment of the content in each course. Overall, the desired outcome is that this project and the accompanying materials will provide a good first step in integrating computational software into these courses so that accurate assessment of SLO5 can follow.

#### **RELATIONSHIP OF PROPOSED PROJECT TO CURRENT ASSESSMENT ACTIVITIES**

The current assessment strategies for SLO 5 are inadequate. Because technology is very broad and always changing, incorporating technology into mathematics courses can be a challenge. Assessing the effectiveness of such implementation strategies can prove even more daunting. SLO 5 has been under almost constant discussion within the department for several years. The discussion centers around what is meant by demonstrating proficiency and what are the components of proficiency. Certain members of the department interpret it as exploring mathematical software to reach the best solution, while others view it as utilizing technology to convey mathematical findings. The intended results of this study aim to clarify these unknowns.

Moreover, the department struggles to reach a consensus on the appropriate method of teaching students the proper use of technology. Due to the diverse approaches in technology utilization within the classroom and in student instruction, consistency in its application has been lacking. This inconsistency significantly complicates the assessment of SLO 5, prompting discussions about potentially eliminating it altogether. However, the investigators advocate for the retention of SLO 5 and believe that is an important and necessary learning objective for our students. Our intention is to use this project as a starting point to integrate technology into relevant courses via popular computational software languages

so that students are equipped with the essential skills needed in today's technology-driven workforce. The objective of this study is to establish a degree of consistency in teaching technology-related content and, ideally, develop an initial framework for evaluating this SLO.

## **DESCRIPTION OF PROJECT AND ASSESSMENT METHODS**

The implementation of the technological experiences will vary with the course. In MAT 210, the plan is to construct six individualized projects that have real-world value that are directly formulated from industry. The content of the course will be structured around each project and necessary mathematical theory will be introduced and explained alongside appropriate syntax needed to solve or demonstrate each problem. Each project will be completed by the student and assessed based on a rubric created by the investigators. The rubrics will be aligned with SLO 5, which emphasizes exploration (such as problem interpretation and formulation), computation (including the proper implementation into relevant computational software and evaluation of solutions), and communication (writing the formal presentation of an optimal solution expressed in appropriate terms), but with a specific focus on the course being taught. Each project will be associated to a specific computational software, including Python, Excel, and Minitab, and have an industrial focus. MAT 210 will run as a Preparation for Industrial Careers in Mathematics (PIC Math) course, where students work closely with local companies to complete a problem posed by an industrial liaison. During the semester, the students will collaborate with their industrial partner to ensure they are solving the problem correctly. The projects will be completed using appropriate technological knowledge developed throughout the course and a report and presentation will be given by each student group using L<sup>A</sup>T<sub>E</sub>X.

For MAT 361, there will be three total individual projects. The first two projects are smaller with a focus on different software packages, including Python, Excel, and Gurobi. The course content is driven by the use of the associated software package. In this case, however, one project may be solved using two different computer languages. The last project

is more comprehensive and the students will have their choice on what software package to use to make it more inclusive. All projects will be assessed using the designed rubrics that align with the department's SLO 5 and a final L<sup>A</sup>T<sub>E</sub>X report and video presentation will be required.

To evaluate the impact of technological experiences on computational proficiency, the investigators will administer pre- and post-course surveys to students. The pre-course survey will gauge their initial proficiency of, confidence in, and attitude toward the designated programming languages and L<sup>A</sup>T<sub>E</sub>X. After the conclusion of the last project, a post-course survey will be administered to assess any improvement in proficiency and/or confidence levels, and to investigate the impact of the technology-focused projects on SLO 5. After the semester ends, the investigators will compile the results from the surveys and the project evaluations to formulate appropriate conclusions about the impact of the technological projects.

#### **PLAN FOR DATA ANALYSIS AND EVALUATION OF PROJECT OUTCOMES**

As mentioned above, the investigators will collect the data from MAT 210 and MAT 361 courses during Fall 2024 to assess students' mastery of technology to solve applied mathematics problems through projects, and their effectiveness of mathematics communication through video presentations and written reports with required use of mathematical software L<sup>A</sup>T<sub>E</sub>X (their scores will be evaluated based on the rubrics). Investigators will also collect the data from students' pre-course and post-course survey (administered both before the introduction of the technology and after the completion of the last project at the end of the course) to determine how the proposed practice has positively impacted students' background in technology, their confidence level, and attitudes towards their technology use for mathematics problem solving and communications. Furthermore, the data from the post-course survey will be compared with the data from the pre-course survey to determine whether students who completed technology focused projects achieve more proficiency in technology learning outcome. Finally, the assessment result will also be compared with the

previous assessment results on the Program's student learning outcome 5 to determine if the proposed practice has a positive impact.

The statistics software Minitab or similar will be used to perform statistical analysis on the collected data to determine if the proposed practice has achieved the intended outcomes. The investigators will explore and apply appropriate statistical testing to determine whether the proposed practice will positively impact the Mathematics Program's student learning outcome 5. Findings from these analyses will be used to evaluate the project's anticipated outcomes and determine ways to improve the practice for future years.

#### **DETAILS ON INTENDED USE OF FINDINGS FOR PROGRAM IMPROVEMENT**

The results of this project will be used to provide useful information for the instructors who are interested in teaching or are currently teaching MAT 210, MAT 361, or applied mathematics courses in general. This study investigates needed approaches for assessing proficiency of technology use in mathematics, and the results will not only benefit individual instructors, but also the higher education teaching community as a whole. All findings will be shared with the department chair and other colleagues in the Department of Mathematics, as well as the Department Assessment Committee, to solicit their feedback and potential support for continuation. Moreover, the investigators hope to present the results at a national conference, for example the Joint Mathematics Meeting or MathFest.

#### **PROJECT TIMELINE**

The project will start on June 3rd, 2024, and end on July 1st, 2025, if funded. Specifically,

- June 3rd, 2014 – August 5th, 2024: Investigators will design the MAT 210 and MAT 361 projects with corresponding guidelines and rubrics, and prepare/organize the technology resources for both courses. Investigators also work on the assessment design including the surveys, the evaluation, data collection, the analysis of the various statistical approaches.
- August 26th, 2024 – December 13th, 2024: Investigators teach MAT 210 and MAT

261 where students are asked to learn and apply technology to complete and present their projects. The data from the project evaluation with focus on students' technology proficiency, and both pre- and post-course survey will be collected during this period.

- January 2nd, 2025 – May 16th, 2025: Investigators will perform statistical analysis on the collected data (direct and indirect) to determine if the proposed practice has achieved the intended outcomes, and investigate the possible reasons which might lead to the observed data.
- May 26th, 2025 – July 1st, 2025: Investigators' findings will be organized to be shared with the Departmental Assessment Committee and colleagues in and out of the Department of Mathematics.

#### **OUTLINE OF PROJECT STAFF RESPONSIBILITIES**

The project will be developed, organized, conducted, and assessed by the two investigators. They will have all responsibilities including but not limited to:

- prepare and organize the technology resources for Fall MAT 210 and MAT 361 courses;
- design the course projects, including the guidelines, resources, and rubrics;
- design the pre-course and post-course surveys;
- conduct the assessment and collect data;
- analyze the data using appropriate statistical approaches;
- investigate the proposed practice's achievement on the intended project outcomes and its impact on Departmental student learning outcome 5, and determine areas for future improvements; and

- share the findings with the Departmental Assessment Committee, as well as the colleagues in the Department of Mathematics and the greater Kutztown University Community.