CENTER FOR INNOVATION GRANT PROPOSAL

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Project Title. Curriculum Development for Project-Based Applied Mathematics Courses

Project Description. We wish to develop curriculum for two new elective courses to be run out of the mathematics department. The first course, tentatively titled "Applied Mathematics: Theory and Practice of Logic through Digital Circuits," would give students a deep dive into the theory of mathematical logic and its application to the design of digital logic circuits and micro-controllers. The course will be focused on building hands-on projects (using both hardware and software) that apply the mathematical theory and will culminate in a capstone project in which students can design their own final products. In addition to a hardware component, there will be a coding component to the course as well. The second course, tentatively titled "An Introduction to Computational Mathematics and Numerical Analysis," would give students an introduction to algorithms and scientific computing. Students will study and understand algorithmic techniques for root-finding, cryptography, cybersecurity and computing solutions to linear systems and then use the Python programming language to code and build these algorithms themselves. In addition to teaching some important algorithms, we also wish to provide students with an introduction to statistical analysis and basic regression methods using the Python programming language. Python is widely considered the industry-standard for implementing scientific computing packages, and our hope is that this course will give students a robust foundation in a skill that they can take into college and the marketplace.

CFI Priorities.

(1) Design Thinking
(2) Project-based Learning
(3) Coding
(4) Instructional Research and Implementation

Alignment with CFI Priorities. Our main goal for this project will be to develop a detailed and robust curriculum in the areas mentioned above. We believe the topics selected for these courses align strongly with the priorities of CFI. In particular, our first course on Digital Logic Theory and Practice would be a course centered around both mathematical theory and projects. In building digital circuits and programming micro-controllers, students will be able to practice their design-thinking, prototyping and debugging skills. Furthermore, they will get exposure to both the hardware and software implementations of mathematical ideas. The capstone projects will also provide students with choice in the classroom so that the experience in these courses is student-centered and personalized. In our second course, there will be a large emphasis on coding and developing solutions using an

industry-standard programming language. We hope to provide the students in this course with exposure to ideas and practices that are used in STEM fields, using tools which they can use well beyond their years following high school. A particular goal of our curriculum would be to develop both these courses as a means to illustrate the importance of interdisciplinary work in the fields of Mathematics, Science and Engineering.

Impact. The most direct impact of our work will be to our students. In both of these courses, we hope to be exposing them to new and interesting applications and ideas. In addition, we wish to teach them important practical skills (such as writing their own code, developing algorithms and algorithmic thinking, reading circuit diagrams and wiring circuits, making calculations, etc) which they can use in a variety of settings following the classes. A major goal of the curriculum would be to shape their view of mathematics as a discipline; that is, we wish to illustrate the far reaching nature and application of mathematics through the use of projects and hands-on activities. In addition to impacting our students, we believe our work can also impact fellow teachers both inside and outside our school district. We hope that these ideas could provide a springboard for the development of more curriculum in applied mathematics and within the STEM fields.

Scalability. Because of the interdisciplinary nature of the ideas we are putting forth, we believe parts of this curriculum could be implemented on a smaller scale in a variety of different departments within Scarsdale High School at the different grade levels. Our curriculum could be adapted and used by other mathematics courses at the High School and also potentially in the Science, STEAM, Computer Science and even Humanities departments who wish to incorporate a hands-on project into their curriculum (some of the algorithms we hope to cover in the second course could be applied in the social sciences as well - AT Economics, for example).

Timeline. We would like to spend the next 9-12 months developing the curriculum and projects for these two courses. Specific monthly milestones will be set based on approval of the grant.