Integrating Engineering Design and Microelectronics in a Range of Pre-College Courses (Resource Exchange)

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Tamara J. Moore, Ph.D., is a Professor in the School of Engineering Education, University Faculty Scholar, and Executive Co-Director of the INSPIRE Institute at Purdue University. Dr. Moore's research is centered on the engineering design-based STEM integration in K-12 and postsecondary classrooms.

Siddika Selcen Guzey, Purdue University, West Lafayette

Dr. Guzey is a professor of science education at Purdue University. Her research and teaching focus on integrated STEM Education.

Dr. Greg J Strimel, Purdue University, West Lafayette

Greg J. Strimel, Ph.D., is an associate professor and assistant department head for Technology Leadership and Innovation as well as the program lead for the the Design and Innovation Minor at Purdue University. Dr. Strimel conducts research on design pedagogy, cognition, and assessment as well as the preparation of P-12 engineering teachers.

Dr. Morgan M Hynes, Purdue University, West Lafayette

Dr. Morgan Hynes is an Assistant Professor in the School of Engineering Education at Purdue University and Director of the FACE Lab research group at Purdue. In his research, Hynes explores the use of engineering to integrate academic subjects in K-12 cla

Dr. Kerrie A Douglas, Purdue University, West Lafayette

Dr. Douglas is an Associate Professor in the Purdue School of Engineering Education. Her research is focused on improving methods of assessment in engineering learning environments and supporting engineering students.

Dr. Molly H Goldstein, University of Illinois Urbana-Champaign

Dr. Molly H. Goldstein is a Teaching Assistant Professor and Product Design Lab Director in Industrial and Enterprise Systems Engineering at the Grainger College at the University of Illinois. She is also courtesy faculty in Mechanical Science and Engineering, Curriculum & Instruction (College of Education) and Industrial Design (School of Fine and Applied Arts). Dr. Goldstein's research focuses on student designers through the study of their design actions and thinking.

Rachel E. Gehr, Purdue University, West Lafayette

Rachel is an NSF Graduate Research Fellow pursuing her PhD in Engineering Education at Purdue University. She has earned a BS in Civil Engineering from LeTourneau University and MS in Environmental Engineering from Purdue. Rachel's current research focuses on assessment of K-12 and college microelectronics curriculum, but she also has experience in photochemistry, water quality, PFAS remediation, and disinfection.

Emily M. Haluschak, Purdue University, West Lafayette

Emily M. Haluschak is a PhD student in the school of Engineering Education at Purdue University. Emily is interested in leveraging integrated curriculum development in K-12 settings to positively impact underserved populations in the field of engineering. She utilizes past experiences in STEM program evaluation, education policy, and chemical engineering research.

Ms. Azizi Penn, Purdue Engineering Education

Azizi Penn is a professional software engineer, a California State University, Sacramento adjunct professor, and an engineering education Ph.D. student at Purdue University.

Ms. Breejha Sene Quezada, Purdue Engineering Education
Deana Lucas, Purdue University, West Lafayette

I am a Ph.D student in the Technology Leadership & Innovation Department, focusing on STEM Education Leadership at Purdue University.

JaKobi Burton, Purdue University, West Lafayette
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Mary Pilotte is a Professor of Engineering Practice in the School of Engineering Education at Purdue University, West Lafayette, Indiana. She is an instructor for Multidisciplinary engineering coursework, and is Director of the undergraduate Interdiscipli

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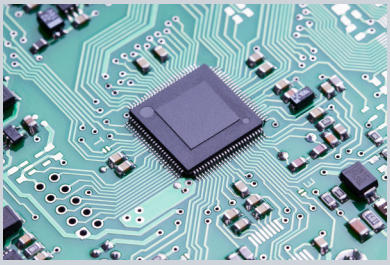
SCALE K-12 Curriculum

The curriculum units can be found through the QR code above or the following link: https://www.scalek12.org



Curriculum Framework: Using the engineering design process, students will learn content area knowledge needed to solve a real-world problem given by the client. In each unit, students work in teams to collect evidence used to justify their design decisions which they will then communicate to the client. State standards were integrated into all lessons which allows for the substitution of these units for existing K-12 content.

SCALE K-12
SCalable Asymmetric Lifecycle Engagement
Precollege Microelectronics Workforce Development

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Curricular Units Overview: One of the main goals of SCALE K-12 is to integrate engineering design and microelectronics-related (ME) content, contexts, and career awareness into the pre-college classroom. Curriculum units were codeveloped with participating teachers and were tested in their classrooms. There are 11 units for secondary students that have been created to meet a call for integration of ME across the curriculum. The core content areas for the created units include science, mathematics, English language arts, technology, business, and are designed for implementation in grade levels ranging from 5th - 12th grade.

SCALE K-12 Project

SCALE K-12 is part of a workforce development project, SCALE, that has been funded in response to the need to develop an industry-ready workforce as the U.S. brings microchip manufacturing back within the country's borders in order provide a supply of trusted and assured ME. SCALE K-12 works with targeted school districts in Indiana and Illinois to implement ME integration across their entire school systems. The project works with Teacher Fellows in each district to develop curricular units that are implemented and tested in their classrooms with the support of a classroom coaching structure. Drafts of these curricular units are hosted on nanoHUB with online professional development for widespread access.

SCALE K-12 Curriculum

1	**Stressed Out!** (10th – 12th, Pre-Calculus & Algebra II)
ME Fuse: pulse sensors connected to micro:bit to collect data on human heartbeat Goal: Design a stress intervention method using heartrate as an input	
2	**Let the Good Ideas Roll** (6th – 9th, Engineering Technology)
ME Fuse: Ohm's Law; electrical circuits; micro:bit & Sphero BOLT processing signals & use of sensors Goal: Create a Sphero BOLT electronic expansion pack for a toy company	
3	**Lock it Up!** (9th – 12th, Integrated Physics and Chemistry)
ME Fuse: Ohm's Law; electrical circuits; micro:bit processing signals & use of sensors Goal: Design a deterrent device that can be added as a modification to a carrying cases	
4	**CSI: Carbon Sink Investigation** (9th – 12th, High School Biology)
ME Fuse: sensors connected to a micro:bit to detect CO2 levels Goal: Create a carbon sink algae farm	
5	**Game On!** (5th – 10th, English Language Development/Arts)
ME Fuse: micro:bit processing signals from inputs & outputs; coding Goal: Design a game to share with their target demographic	
6	**Water Water Everywhere But Not a Drop to Drink!** (8th, Earth and Space Science)
ME Fuse: comparing tradiational and digital methods of detecting various properties of water Goal: Design an efficient method of filtering water to potable quality	
7	**Make Sense Inc.** (9th – 12th, Engineering Technology)
ME Fuse: properties of computers, microcontroller, system- on-chip, and sensors Goal: Design and code smart home systems	
8	**SAFE Chips** (9th – 12th, Business, Engineering Technology)
ME Fuse: ME manufacturing & supply chain (business); micro:bit processing signals from inputs & outputs (EngrTech) Goal: Develop a proposal for relocating microchip manufacturing to the US (business); Design lock to protect physical classified files (EngrTech)	
9	**Let the Chips Fall Where They May** (7th – 10th, Geometry)
ME Fuse: microchip manufacturing process Goal: Design an efficient layout for microchip dies on a silicon wafer	
10	**The Past, Present, and Future of Microelectronics** (7th – 9th, Career Preparation)
ME Fuse: ME products, careers, impact and importance Goal: Debate the use of ME from ethical, social, economic, and environmental perspectives	
11	**You Light Up My Life!** (10th – 12th, Algebra II & Pre-Calculus)
ME Fuse: micro:bit processing signals from inputs & outputs, coding, & control of LED lights Goal: Design custom party lights for a school dance committee	

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