Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE

Paper ID #49126

PROJECT RISE: Professional Development of Civics Teachers on Engineering Design Thinking and Lessons Learned from Pilot Implementation (Works-In-Progress)

Dr. Tamecia R. Jones, North Carolina State University at Raleigh

Tamecia Jones is an assistant professor in the STEM Education Department at North Carolina State University College of Education with a research focus on K-12 engineering education, assessment, and informal and formal learning environments. She is a 2024 NSF CAREER awardee.

Siddika Selcen Guzey, Purdue University at West Lafayette (PWL) (COE)

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

Dr. Chrystal S Johnson, Purdue University

Chrystal S. Johnson is Associate Professor of Social Studies Education in the College of Education at Purdue University. She is the Project Director/PI for Project RISE.

Jennifer Sdunzik, Purdue University at West Lafayette (PWL) (COE)
Wilella Burgess, Purdue University at West Lafayette (PPI)

As an interdisciplinary researcher, professional evaluator, and director of Purdue's Evaluation and Learning Research Center (ELRC), Burgess has over 30 years of experience developing and evaluating formal and informal education programs and methodologies for a variety of audiences. Her current work focuses on innovations that improve learning, well-being, and personal or organizational development and capacity. Inspired by her Ecology background, Burgess uses a context-centered systems approach to research and evaluation that strives to understand what works, why it works, for whom, and under what conditions. For example, Burgess recently led a multinational team evaluating the effects of primary education models on diverse populations of learners in Somalia. Results from this evaluation inform educational programming and policy in Somalia and contribute to our understanding of educational best practices in post-conflict and fragile environments more generally. The ELRC collaborates with faculty in all colleges across campus, as well as Colleges and Universities, Foundations, Government Agencies, and NGOs, both domestically and internationally. ELRC is a partner on Federal awards to Purdue totaling more than $48 million, including support from NSF, NIH, USDA, HRSA, USAID, and the U.S. Department of Education. ELRC also partners with external entities on projects funded by HHMI, Gates Foundation, Lumina, and many other sources. Burgess uses her extensive education and evaluation experience to inform external evaluation of the RISE project.

PROJECT RISE: Professional Development of Civics Teachers on Engineering Design Thinking and Lessons Learned from Pilot Implementation (Works-In-Progress)

Introduction

Project RISE is a five-year transdisciplinary K12 teacher training project which aims to develop and implement innovative digital civics instruction modules that integrate engineering design thinking. The RISE curriculum, written by social studies educators, historians, science educators, and engineering educators, intends to innovate civics education by breaking down silos between disciplines and integrating technology. The goal of Project RISE is to engage youth to solve problems rather than depending solely on political leaders and government. To do so, students must understand civics. To innovate teaching and learning, they can apply engineering design thinking. We define engineering design thinking as "the iterative process of problem-solving that integrates creativity, systematic analysis, and user-centered considerations to develop solutions[1]. This approach is increasingly recognized as valuable in non-STEM fields, including civics education, where complex social challenges require structured problem-solving strategies [2]. Civic engagement, within the context of Project RISE, is *the active, informed, and justice-oriented participation of individuals in their communities and democratic institutions*. It encompasses the development of civic knowledge, skills, and dispositions that enable individuals to critically analyze societal challenges, collaborate across disciplines, and employ problem-solving frameworks—such as engineering design thinking—to address real-world issues.

This works-in-progress paper presents the work from Project RISE's curriculum pilot, in which middle and high school teachers attended a 5-day residential workshop to learn about and implement the RISE curriculum. We describe curriculum, the professional development activities, present results from the evaluation of the professional development, preliminary teacher feedback from implementation of the pilot, and curricular updates for the next professional development session. We will also demonstrate the mobile application that complements the curriculum and student interaction, previously described in past work[3].

Literature Review

Prior research on interdisciplinary teaching highlights the benefits of integrating engineering and civic education to enhance student engagement and problem-solving skills [4]. Studies by Parker et al. [5] emphasize the need for deeper civic understanding through project-based approaches, which aligns with the justice-oriented pathways in the Project RISE curriculum. Project RISE's curriculum advances civic engagement beyond traditional participation (e.g., voting, volunteering) by incorporating design thinking as a civic tool. Through justice-centered pathways (e.g., transportation justice, gentrification, environmental, health), students and educators learn to frame problems, prototype solutions, and implement change, demonstrating an active, solutions-oriented approach to civic engagement. Project RISE's definition of civic engagement aligns with contemporary civic education research, which emphasizes civic reasoning, interdisciplinary problem-solving, and participatory democracy [6] [7] [8].

Curriculum Overview

Guided by the Understanding by Design framework [9], the RISE curriculum is organized into two PILLARS and five PATHWAYS (Figure 1) with essential and compelling questions. The PILLARS (*Civics Education* and *Engineering Design Thinking*) provide foundational skills and knowledge so that teachers could guide students through PATHWAYS. The CITIZENSHIP pillar has four parts, including: *What is an Effective Citizen?*, *Principles of Democracy*, *Democratic Processes and Institutions* and *Authentic Civic Actions*. The ENGINEERING DESIGN THINKING pillar has two sections: *Problem Definition* and *Solution Generation*. PATHWAYS are modules that center justice and intentionally spotlight historic challenges or trends within local communities[3]. They also show systemic connections and consequences of engineering artifacts that are the result of or motivated by social policy. The justice-centered pathways are: Health Justice, Traffic and Transportation, Economic Justice, Gentrification, and Environmental Justice. As seen in Figure 1, after teachers take students through the two pillars, they can select any Pathway. Each pathway includes case studies of cities across the United States including Pittsburgh, Billings, New Orleans, Portland, Seattle, and
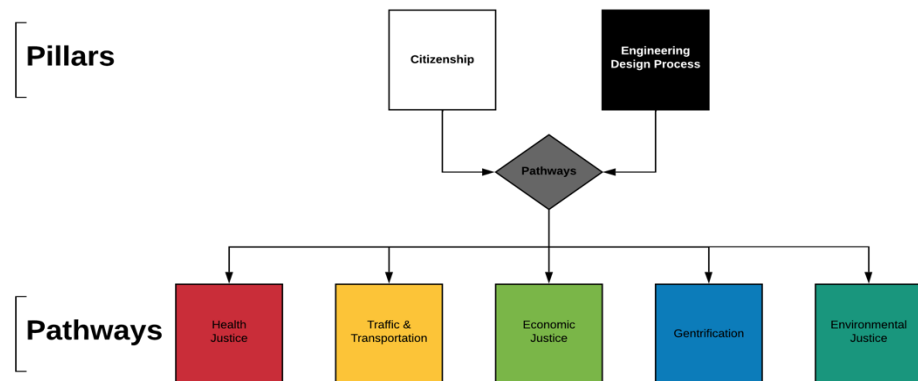

Figure 1 RISE Curriculum Overview and Organization

Georgetown, South Carolina. Each of the 16 cases may have examples of justice opportunities in one or more of the pathways. One case is included in the ENGINEERING DESIGN THINKING Pillar so all students practice using a case model.

Research Design

This study employs a qualitative research design, drawing on thematic analysis of teacher reflections and professional development evaluations [10]. Data sources include post-workshop surveys, focus group discussions, and implementation reports, allowing for a comprehensive understanding of teachers' experiences and challenges.

Participants

There were six middle and high school teachers from across the country who traveled (expenses paid) to the residential workshops. There were 4 men and 2 women. The teacher experience ranged from one year to 18 years.

Overview of Professional Development

The Project RISE Curriculum workshop equipped educators with a practical framework for implementing an integrated civics and design thinking curriculum. The professional development was a four and a half day intensive residential workshops with a full day schedule. Teachers

engaged in discussions about social studies standards and assessment. They explored the integration of engineering design and design thinking into their practices, which fosters a more interdisciplinary and hands-on approach to social studies education. Emulating the student experience, teachers participated in brainstorming sections where they generated ideas and examples for context, and analyzed problems. They then modeled brainstorming, constraints and criteria-setting, and data collection. They also discussed various strategies for integrating engineering design thinking into social studies content and practices. The accompanying Project RISE Handbook featured curriculum modules, each containing a series of mini-lesson ideas designed to support student learning. These modules provided educators with flexible, practical tools to engage students in meaningful civic education and problem-solving activities. Teachers were encouraged to adapt mini-lesson ideas to accommodate their local context and the unique needs of their student populations, ensuring the curriculum was both relevant and inclusive. We instructed teachers how to navigate the cases to best fit their school year content or sequence goals. Together, the workshop and handbook empowered educators to create dynamic learning experiences that prepared students for active, informed citizenship. Each day ended in a reflection session with the evaluation team, and we adjusted the next day's activities with this feedback as much as possible without compromising the complete schedule.

Civics

The workshop emphasized active learning, collaboration, and critical thinking to prepare students for meaningful civic engagement. Through interactive sessions, teachers explored strategies for tailoring instruction to meet the diverse needs of their students. Morning sessions began with an introduction to the RISE Inquiry Model (Figure 2), which provided a foundation for inquiry-based learning and guided educator understanding how the curriculum connected critical thinking, collaboration, and real-world problem-solving.
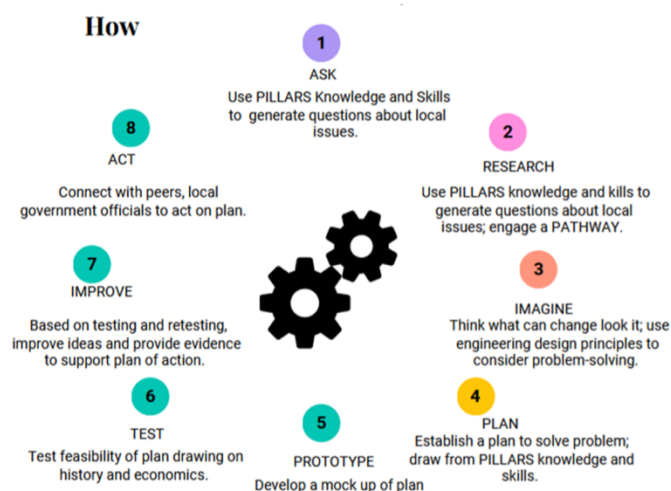

Figure 2 Project RISE Inquiry Model

Educators engaged in discussions on how the RISE Inquiry Model aligned with the curriculum, focusing on those big ideas, essential understandings, essential questions, predictable misunderstandings, and core knowledge and skills identified for effective civic instruction. These components structured impactful and accessible mini-lessons, empowering teachers to observe purposeful, student-centered learning experiences.

Design Thinking

The Design Thinking Pillar of the RISE curriculum has two components: Problem Identification and Solution Generation. To highlight the difference between design thinking and engineering, we defined engineering as "the design, manufacture, and operation of efficient and economical technologies (i.e., structures, machines, processes, and systems) to purposeful ends through a creative and carefully planned application of scientific

Figure 3 Relationship between RISE Engineering Design Thinking Framework, Design Thinking, and Engineering Design Process

and mathematical principles." We introduced the social studies teachers to various design thinking processes and engineering design processes from Stanford [11], IDEO [12], and NASA [13]. These processes were the foundation for how we conceptualized our Engineering Design Thinking modules (Figure 3). This provided teachers with external resources to help them further their understanding of design thinking and the engineering design process.
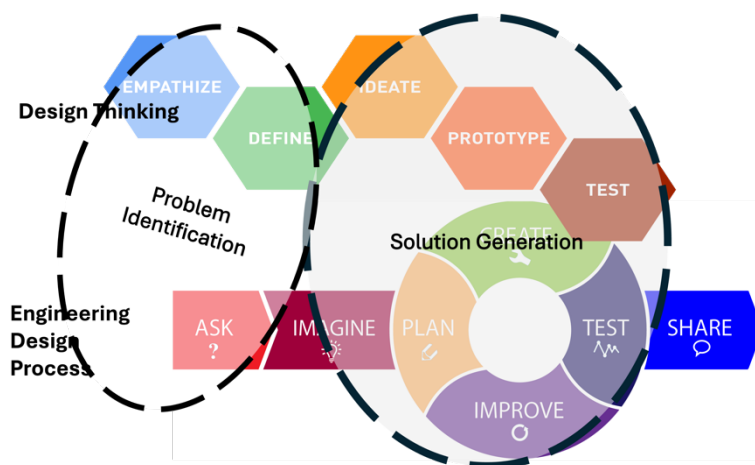
In the Problem Identification lessons, we concentrate on identifying problems with a focus on articulation and boundaries of the problem. We created explicit empathy exercises for the teachers so that they could practice developing empathy, observations, and reflection that they would ask their students to do[14-16]. We modeled a disability and travel with the Wheelchair Exercise. We shared User Profile templates to help narrow the focus to human-centered[17, 18] rather than a systems-centered problem lens. In Solution Generation lessons, we focused on brainstorming techniques and strategies and understanding constraints and criteria. We presented teachers with decision matrix examples. Teachers worked in groups to address the Electoral College and Party System as a challenge within their context, taking it through the entire design thinking process and presenting to peers for feedback. Finally, on the last full day, we went on a field trip throughout the city to collect data as if they were students using mobile phones.

Pathways

Each pathway had its own workshop. During each pathway workshop, we shared any definitions based on government agency guidelines, examples of prompts, media resources, and provided introductory questions teachers could use with students. Then we took teachers through a scenario to practice applying the design thinking skills that they had been introduced.

Findings & Discussion

Teachers expressed a need for additional implementation support, aligning with existing research that underscores the importance of ongoing coaching in professional development [19]. Future

iterations of Project RISE will address these concerns by incorporating virtual mentorship and structured implementation guides [20].

Evaluation

The external evaluation sought teacher feedback regarding the relevance, ease-of-use, and effectiveness of the RISE curriculum content, structure, and methodology in supporting teaching and student engagement and learning in social studies and civics classrooms. Overall, teachers appreciated the structure and content of the professional development and the connections they were able to develop with other teachers. Teachers were especially grateful for the RISE team approach to professional development that treated teacher participants as respected peers and collaborators.

Teacher participants provided valuable formative feedback during daily reflections identified areas of concern or uncertainty – allowing the team to make immediate adjustments. Overall, participants appreciated the workshop agenda, that purposely left space for participants to process and apply information to real world challenges – modeling the Project RISE approach. While teachers saw value in this approach, they found it challenging to replicate in their classrooms. Only 2 of the 6 workshop participants reported implementation activities during the fall semester after training. Teachers expressed a desire for more structured support and a more directed approach to curriculum implementation that requires a lower teacher cognitive load – finding it easier to tweak or extend an existing lesson plan. Teachers also expressed a strong desire – or even a need – for continued feedback loops to check on their progress and provide implementation support and ongoing impetus for implementation.

Future Work

We are currently in the process of refining the RISE curriculum for ongoing online components and restructuring the residential workshop to support the teachers' stated needs. We are also developing asynchronous training materials. The mobile app will be fully functional, so we will also be able to collect usability data from teachers to help improve the classroom implementation experiences.

References

[1]   C. Dym, A. Agogino, O. Eris, D. Frey, and L. Leifer, "Engineering design thinking, teaching, and learning," *Journal of Engineering Education,* vol. 94, no. 1, pp. 103-121, 2005, doi: 10.1002/j.2168-9830.2005.tb00832.x.

[2]   T. Brown*, Change by design: How design thinking creates new alternatives for business and society*. New York: HarperCollins Business, 2009.

[3]   T. Jones, C. Johnson, and S. Guzey, "Project DECIDE: A K12 Civics and Engineering Education Curricular Partnership (Works in Progress)," in *2024 ASEE Annual Conference & Exposition*, 06/2024 2024, Portland, Oregon: ASEE Conferences, p. 47881, doi: 10.18260/1-2--47881.

[4]   Committee on Integrated STEM Education, National Academy of Engineering, and National Research Council, M. Honey, G. Pearson, and H. Schweingruber, Eds.

STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research. Washington, D.C.: National Academies Press (in English), 2014, p. 180.

[5] J. Herrington and J. Parker, "Emerging technologies as cognitive tools for authentic learning," *British Journal of Educational Technology,* vol. 44, no. 4, pp. 607-615, 2013, doi: 10.1111/bjet.12048.

[6] W. Parker, *Teaching democracy : unity and diversity in public life*. New York: Teacher's College Press (in English), 2003.

[7] P. Levine, *The Future of Democracy : Developing the Next Generation of American Citizens*. Hanover, NH: University Press of New England (in English), 2007.

[8] J. Westheimer and J. Kahne, "What kind of citizen? The politics of educating for democracy," *American educational research journal,* vol. 41, no. 2, pp. 237-269, 2004.

[9] G. Wiggins and J. McTighe, *Understanding by design*. Alexandria, VA: ASCD, 1998.

[10] J. W. Creswell and C. N. Poth, *Qualitative inquiry & research design : choosing among five approaches*. Los Angeles: SAGE (in English), 2018.

[11] Stanford d. School, "An Introduction to Design Thinking Process Guide," ed: Hasso Plattner Institute of Design at Stanford, 2010.

[12] IDEO. "Design Thinking Defined." https://designthinking.ideo.com/ (accessed 2024).

[13] NASA. (2022). *Engineering Design Process Educator Notes*. [Online] Available: https://www.nasa.gov/wp-content/uploads/2022/07/engineering_design_process_classroom_connections_508.pdf

[14] C. M. Gray, S. Yilmaz, S. R. Daly, C. Seifert, and R. Gonzalez, "Idea Generation Through Empathy: Reimagining the 'Cognitive Walkthrough'," presented at the 122nd ASEE Annual Conference & Exposition, Seattle, WA, June 14-17, 2015, 2015.

[15] E. Kim, S. Purzer, C. Vivas-Valencia, L. B. Payne, and N. Kong, "Problem Reframing and Empathy Manifestation in the Innovation Process," in *ASEE Virtual Conference*, Virtual, 2020.

[16] M. Kouprie and F. S. Visser, "A framework for empathy in design: stepping into and out of the user's life," *Journal of Engineering Design,* vol. 20, no. 5, pp. 437-448, 2009, doi: 10.1080/09544820902875033.

[17] M. Garreta-Domingo, P. B. Sloep, and D. Hernández-Leo, "Human-centred design to empower "teachers as designers"," *British Journal of Educational Technology,* vol. 49, no. 6, pp. 1113-1130, 2018, doi: 10.1111/bjet.12682.

[18] K. Krippendorff, "Propositions of Human-centeredness: A Philosophy for Design," in *Doctoral Education in Design: Foundations for the Future: Proceedings of the conference held 8-12 July 2000, La Clusaz, France*, D. Durling and Friedman Eds. Staffordshire (UK): Staffordshire University Press, 2000, pp. 55-63.

[19] M. Fullan, *The new meaning of educational change*. Teachers College Press, 2007.

[20] R. DuFour, "What is a professional learning community?," *Educational Leadership,* vol. 61, no. 8, pp. 6-11, 2004.