Engineering is an important component of the Next Generation Science Standards (NGSS). However, resources for supporting teachers in implementing these standards are scarce. This project will address the need for resources by applying an innovative pedagogy called Imaginative Education (IE) to create NGSS-aligned middle school engineering curricula. In IE, developmentally appropriate narratives are used to design learning environments that help learners engage with content and organize their knowledge productively. To fully exploit the potential of this pedagogy, this project will combine IE with transmedia storytelling. In transmedia storytelling, different elements of a narrative are spread across a variety of formats (such as books, websites, videos and other media) in a way that is more immersive and emotionally engaging than traditional delivery channels. For example, users might read a novel in which the plot merges with a coordinated online experience. Secret passwords dispersed throughout the book could unlock enriching content such as character profiles; custom videos that expand the story's world; podcasts from new characters that add new perspectives; and animations that illustrate concepts from the storyline. Once created, the curricula will be implemented in classrooms to research its impact on (1) increasing learners' capacities to engage in both innovative and direct application of engineering concepts, and (2) improving learners' science, technology, engineering, and mathematics (STEM) identity. This research will be led by Smith College and Springfield Technical Community College in collaboration with Springfield (MA) Public Schools (SPS). Additional expertise in evaluating the findings will be provided by the Collaborative for Educational Services and an external advisory board of leaders in STEM education and transmedia storytelling. The project will result in the development of a transmedia learning environment that includes two NGSS-aligned, interdisciplinary engineering units and seven lessons that integrate science and engineering.

The research study will be implemented in four phases in eight SPS middle schools. Approximately 900 students will participate each year. In Phase 1, the project team will collaborate with SPS teachers to create engineering units, lessons, and standards-based achievement measures. The research team will also identify the best measures of STEM identity and develop instruments for assessing student capacity to innovate with engineering concepts. Finally, in this phase schools will be designated as either a treatment or control group using a stratified random assignment to ensure groups are equivalent in school sizes represented and the proportion of students with economic disadvantage status. In Phase 2, teachers in the treatment group will participate in professional development (PD) workshops covering IE, transmedia learning environments, structure of the curriculum, and connections to NGSS. The curricula assessment tools developed in Phase 1 will be piloted and revised as needed. In Phase 3 the curricula will be implemented in treatment classrooms and both treatment and control group students will be assessed. In Phase 4, testing and assessment will continue in SPS schools and will be expanded to rural and suburban classrooms. Teachers in these classrooms will use online multimedia PD that will ensure scalability and mirrors the structure and content of in-person PD. Data analysis will provide evidence of whether this imaginative and transmedia educational

approach improves students' capacities for using engineering concepts and enhances their STEM identity. These findings will not only provide insight into teaching engineering, but will also show the potential of using IE and transmedia as ways to engage students with all NGSS disciplinary core ideas, cross-cutting concepts, and science / engineering practices.