Science teacher education is facing a critical time when the need to prepare high-quality science teachers is at a peak. Although we recognize that learning to teach science is a career-long endeavor, we believe that a strong foundation must be laid during the science teacher preparation program. In order to improve science teacher preparation, the field must attend to the preparation of future science teacher educators. Our doctoral programs must develop, in addition to adept researchers, informed and skilled science teacher educators who understand who their students are, how to develop meaningful curriculum and effective instruction, and how to assess the development of science teacher knowledge.

The Rise of STEM Education

Hui-Hui Wang, Neil A. Knobloch, in International Encyclopedia of Education(Fourth Edition), 2023

Challenges to implementing a broader approach to integrated STEM learning

Integrated STEM education should be intentional and purposeful in blending multiple disciplines to help students meaningfully learn and apply academic content through real-world problems. These problems should be framed in designed complex systems and grounded in career and technical contexts that facilitate multidisciplinary, interdisciplinary, or transdisciplinary learning for the development of life-long and workforce development connections and skills. By implementing integrated STEM with CTE career clusters, students will be engaged to solve complex real-world problems and help bridge cross-disciplinary learning to increase the potential of reaching transdisciplinary learning.

We acknowledge that teachers and integrated STEM education specialists will face challenges when implementing this more holistic and broader STEM integration approach in the current K-12 education system and teacher educators, curriculum developers, school administrators, and professional development specialists can play important roles in helping teachers to navigate these challenges. First, K-12 teachers are traditionally trained to teach domain-specific content. Domain-specific teacher preparation programs impact teachers' beliefs (e.g., teaching philosophy) and classroom practices (Taconis et al., 2001; Wang et al., 2020). Teachers feel neither they have enough expertize to incorporate subject outsides of their disciplinary (Baker et al., 2015; Graves et al., 2016), nor do they have abilities to align their domain-specific content with other subjects through the lens of interdisciplinary collaboration (Frykholm and Glasson, 2005). Consequently, how teachers trained in one of the STEM domains are not equipped to incorporate other STEM subjects into their teaching becomes a growing concern to promote integrated STEM instructions. Second, STEM integration needs a high level of on-going planning and coordination among different subjects (Herschbach, 2011; Capraro and Jones, 2013). However, inflexible class schedules, overloaded daily work, and stringent timelines for implementing curricula discourage the interdisciplinary nature of integrated STEM curricula and instructions (Lesseig et al., 2017; Wang et al., 2020). Finally, the STEM integration reform movement is widely recognized in science education (Bybee, 2010, 2013; NRC, 2014), but not in other subject areas. For instance, in the US, secondary science teachers are under stress to adapt their teaching from disciplinary silos to become more integrated styles, but not in other subject areas. Additionally, current secondary education, such as high schools, are structured in ways that continue to encourage teachers to stay in their teaching disciplinary silos (Boyd, 2017). The culture and structure of secondary education might hinder interdisciplinary collaboration to develop and implement integrated STEM curricula and instructions.