



THE SEPUP RESEARCH BASE

Evidence of Efficacy for the Issue-Oriented Approach

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RESEARCH INTO PRACTICE

SEPUP (Science Education for Public Understanding Program) is a science and engineering education program that has been designing innovative secondary science instructional materials with an issue-oriented approach for over 30 years. SEPUP materials put educational research into practice, drawing on seminal research studies from outside experts in the field and our own research with classroom teachers to inform our design and development.

HIGHLIGHTS

Here, we highlight the research that undergirds our issue-oriented approach to teaching science, and we provide evidence demonstrating that:

- an issue-oriented approach consistently leads to substantial student knowledge gains,
- significantly boosts student engagement, and
- effectively supports equitable science learning for all students.

WHY ISSUES? WHAT THE RESEARCH SAYS

SEPUP science curricula are designed to engage students with real-world issues and problems, integrating science and engineering practices, cross-cutting concepts, and disciplinary core ideas. Research from experts in the field shows this approach captures students' interest and enhances their understanding of scientific concepts and processes.¹ By centering science education around socioscientific issues (SSIs), students are able to analyze multiple perspectives, incorporate their lived experiences, and make informed decisions about meaningful issues.^{2,3} This approach not only helps students learn about science, but it also allows them to see the relevance of science and engineering practices in addressing real-world problems, eliminating the question, **"Why are we learning this?"**

SOCIOSCIENTIFIC ISSUES DRIVE STUDENT KNOWLEDGE GAINS AND BOOST ENGAGEMENT

Research has shown that using SSIs for framing science improves student learning and boosts student engagement. Below are three examples:

- Significant student knowledge gains were evident from pre- to post-curricular assessment when secondary science teachers used a three-week model-based climate change curriculum using an SSI framework.⁴
- The average student content knowledge scores from pre-to post-SSI intervention assessment showed statistically significant gains when secondary science teachers at different schools in the southeast taught about biotechnology in the treatment and identification of sexually transmitted diseases.⁵
- A study on high school science students' perceptions of the SSI approach showed that when students engaged in a unit with a focus on the SSI of vaping, they found the unit to be 1) more relevant to their lives, 2) more interesting than traditional science learning experiences, 3) beneficial for student learning (including helping them think critically), and 4) supportive of student agency.⁶

SOCIOSCIENTIFIC ISSUES SUPPORT EQUITABLE SCIENCE LEARNING

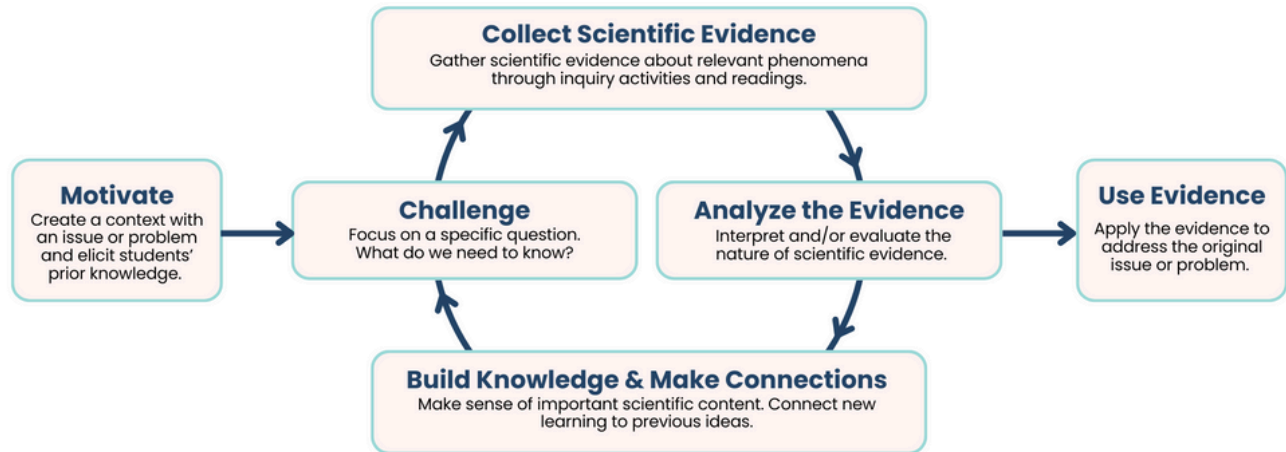
Using an SSI approach improves learning for students from diverse backgrounds and provides an equitable learning experience for all. Below are four examples:

- Students with disabilities were just as successful as other students at learning science in a secondary biology classroom where the teacher enacted an SSI-based unit on vaping. This teacher created equitable outcomes by explicitly connecting the content to all of her students' lives, ensuring her students were taught to think critically, and scaffolded and adapted to support students with challenges.⁷
- The critical role of the students' personal experiences and narratives was highlighted in a 2023 study of an SSI-based unit on COVID-19. Students were able to better understand the systemic factors that lead to inequality in marginalized communities by studying these issues at the local level and developing potential solutions.⁸
- An additional study⁹ engaged students in a socioscientific modeling unit on COVID-19 in conjunction with a justice-centered pedagogical approach¹⁰ to build on students' funds of knowledge.¹¹ Incorporating an SSI-based modeling of COVID-19 contributed to students' academic learning in science. Specifically, the socioscientific model allowed students to construct explanations that aligned with their own experiences and engaged them in high-level reasoning during this unit.
- In a justice-centered AP chemistry class, students showed evidence of complex thinking and a commitment to their urban community and cultural origins.¹² This class explored a closed coal power plant and the effects of pollution on the soil, all in alignment with the Next Generation Science Standards.

HOW SEPUP PUTS RESEARCH INTO PRACTICE

In every SEPUP curriculum unit, **students delve into a real-world socioscientific issue that challenges them in authentic ways to use science concepts to address the issue**.¹³ Some issues driving SEPUP units include extreme heat events, emerging diseases and pandemics, and natural resource consumption. This SEPUP approach of drawing on real-life examples helps students relate science to their everyday experiences.

THE SEPUP SOCIOSCIENTIFIC ISSUE (SSI) APPROACH



An overview of the SEPUP socioscientific issue approach that is used in each middle school and high school unit

In alignment with published research, our extensive field testing, and best practices in science teaching and learning, SEPUP units:

- Motivate students with relevant and engaging issue-oriented science so that students can make a personal connection to what they are learning;
- Make frequent connections to diverse everyday real-life examples to allow science understanding to grow out of students' lived experiences;
- Give students opportunities to design solutions to problems;
- Provide students with opportunities to use multiple learning modalities enhanced by accompanying hands-on materials;
- Embed instructional supports within each unit;
- Use inclusive language, and explicitly represent diverse backgrounds and experiences throughout the text (e.g., in referenced examples of scientific contributions); and
- Are complex enough to foster discussion and debate about more than one possible decision or solution.

WHAT EDUCATORS SAY ABOUT SEPUP

In developing our programs, SEPUP conducts rigorous classroom field testing to inform the design of our materials. Teacher feedback from our field testing research corroborates the value of our issue-oriented approach to science learning. First, teachers report that the issues that drive the learning helped motivate and engage their students. For example, **high school teachers described how the real-world issues in the Science and Global Issues: Biology program engaged their students:**

They commented that experiencing the COVID-19 pandemic made this activity [on emerging diseases and pandemics] urgent/relevant. They took it more seriously.

...Love it! Students also really get into being able to think about real issues like this, and consider how they would solve it.

Furthermore, teachers speak to how **the focus on socioscientific issues created more opportunities for students to localize their learning** and to leverage more of their community's cultural wealth for learning. One teacher in the Midwest noted,

"The [open-ended] questions made the students think and be able to bring their own life experiences into the classroom. The students enjoyed sharing their own fishing experiences with the class."

Teachers also mentioned how **the socioscientific issue of the unit enhances student sensemaking and understanding of the content.** For example, a teacher in New England commented,

"It was interesting to me to see how the students did not understand how many people [in this region] depend on seafood for a food source. It led to a great discussion and a better overall understanding."

Teachers also report that the SEPUP curriculum's **focus on socioscientific issues fosters a more inclusive and equitable learning environment.** Middle school teachers shared how their diverse learners and English learners benefit from the *Issues and Science* program:

"[My diverse learners] did well because they were able to use their creativity... The activity allowed their voice to be heard in the group."

"My ELLs benefited from all the included visuals for sure. I think I actually saw a difference in the overall understanding of students once we got to the next lesson."

THE IMPACT OF SEPUP'S ISSUE-ORIENTED APPROACH ON SCIENCE EDUCATION

In conclusion, SEPUP's issue-oriented approach is a valuable and proven method for enhancing science education by engaging students with relevant, real-world issues. Decades of research from external science education experts shows that an issue-oriented approach can improve student knowledge, foster greater engagement, and encourage critical thinking, particularly for students from diverse backgrounds. Furthermore, SEPUP's own extensive field test research echoes these research findings from experts in the field. By incorporating socioscientific issues, SEPUP helps students see the connections between science and their lived experiences, promoting deeper understanding and application of scientific concepts.

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- ² Topcu, M. S., Sadler, T. D., & Yilmaz-Tuzun, O. (2010). Preservice Science Teachers' Informal Reasoning about Socioscientific Issues: The influence of issue context. *International Journal of Science Education*, 32(18), 2475–2495.
- ³ Zeidler, D. L. (2003). *The role of moral reasoning on socioscientific issues and discourse in science education*. The Netherlands: Kluwer Academic Press.
- ⁴ Carroll Steward, K., Gosselin, D., Chandler, M. & Forbes, C. (2023). Student Outcomes of Teaching About Socio-scientific Issues in Secondary Science Classrooms: Applications of EzGCM. *Journal of Science Education and Technology*. 33.
- ⁵ Sadler, T. D., Romine, W. & Topçu, M. S. (2016). Learning science content through socio-scientific issues-based instruction: a multi-level assessment study, *International Journal of Science Education*, 38:10, 1622–1635.
- ⁶ Ke, L., Sadler, T. D., Zangori, L., & Friedrichsen, P. J. (2020). Students' perceptions of socio-scientific issue-based learning and their appropriation of epistemic tools for systems thinking. *International Journal of Science Education*, 42(8), 1339–1361.
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- ⁸ Ke, L., Kirk, E., Lesnefsky, R. and Sadler, T. D. (2023). Exploring system dynamics of complex societal issues through socio-scientific models. *Front. Educ.* 8:1219224, pg 9.
- ⁹ Lesnefsky, R.R., Kirk, E.A., Yeldell, J., Sadler, T.D. and Ke, L. (2023) Socioscientific modelling as an approach towards justice-centred science pedagogy. *London Review of Education*, 21 (1), 30.
- ¹⁰ Morales-Doyle D. (2024). *Transformative Science Teaching: A Catalyst for Justice and Sustainability*. Harvard Educational Press.
- ¹¹ Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms. *Theory Into Practice*, 31(2), 132–141.
- ¹² Morales-Doyle D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Sci Ed.* 101, 1034–1060.
- ¹³ Jackson, W. M., Binding, M.K., Grindstaff, K., Hariani, M. and Koo, B. W. (2023). Addressing sustainability in the high school biology classroom through socioscientific issues. *Sustainability*, 15, 5776.