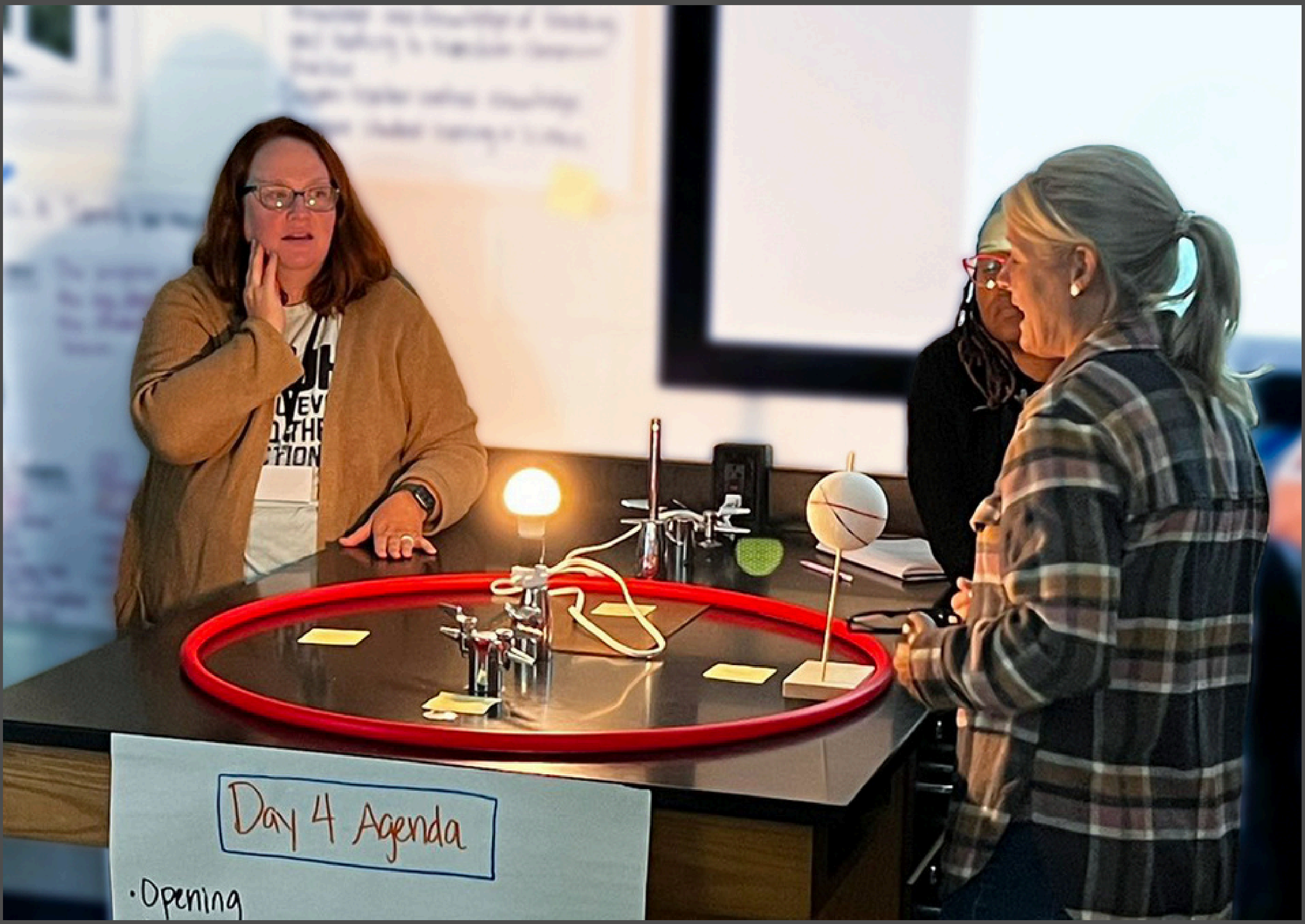
ANNUAL REPORT 2023



BSCS
SCIENCE LEARNING

CONTENTS

LETTER FROM THE EXECUTIVE DIRECTOR

"...THE REASON WE DO RESEARCH IS NOT TO FIND REASONS TO PAT OURSELVES ON THE BACK. WE DO IT TO LEARN HOW TO IMPROVE SCIENCE EDUCATION."

Dear friends,

BSCS celebrated its 65th anniversary in 2023. Throughout our history, our work has been driven by research on teaching and learning. This means our work is informed by our own research and the research of others.

For example, in 2023, Senior Research Scientist Brian Donovan shared an exciting announcement with staff: the latest findings from his Humane Genetics team's research on genetics education were going to be published in *Science*. In fact, *Science* published two papers from the team earlier this year. As you'll read in this report, the papers explore how genetics education for adolescents can either promote or counteract racist and sexist beliefs. In one of the studies, BSCS researchers discovered that the most widely used biology textbooks in the country are probably contributing to gender stereotyping and discrimination. We view these findings as a call to action for biology textbook authors—*including ourselves*.

Initially, I was disheartened by the textbook analyses, particularly because one of BSCS's programs was included in the study and was found to have important shortcomings. But the reason we do research is not to find reasons to pat ourselves on the back. We do it to learn how to improve science education.

Fortunately, we were able to use the evaluation criteria from this study when we created our newest high school biology program, *BSCS Biology: Understanding for Life*, which we published in 2022. We used these criteria during the writing process to avoid the pitfalls identified by this research. As a result, our research-driven approach has enabled us to go from falling short to serving as a model in just a few years.

BSCS has produced significant findings across an array of research and development projects in recent years. We've investigated the impact of different approaches to science teaching and professional learning in classrooms, universities, museums, and elsewhere. You'll find highlights of our findings throughout this report, and I encourage you to click the links and take a deeper dive into the research programs.

Thank you for your continued investment in our work. You are an important partner in our pursuit of a better future—where everyone is inspired and prepared to use science for good.

Sincerely,

Daniel C. Edelson, PhD

OUR WORK

Educators often complain that students don’t relate to science curricula designed for a broad audience because these “universal” curricula don’t connect to students’ personal experiences. BSCS, of course, is known for programs designed for national use. This concern has led BSCS researchers to explore ways to combine the benefits of the kinds of carefully designed instructional sequences that can be found in curricula designed for broad use with the benefits of locally developed curricula that focus on students’ own communities. BSCS researchers are investigating this question in two ongoing projects.

CLIMATE EDUCATION PATHWAYS

Today's young people will soon be responsible for leading the fight against climate change. What can we do to help all students understand and care about a global crisis this massive? One appealing idea is to consider climate change from a local, community perspective. BSCS's *Climate Education Pathways* project, led by Dr. Lindsey Mohan, is investigating the promise of localized education for climate change.

To study the promise of localization, the project developed a unit that allows teachers to combine foundational lessons about climate change written by BSCS curriculum developers with teacher-designed lessons that focus on local climate change impacts.

In the first stage of the study, the research team investigated what kind of support would be required for teachers to write localized lessons. In this stage, 25 teachers from across the country participated in 60 hours of virtual professional learning to deepen their content knowledge and adapt the unit for their local contexts.

Our research on this stage showed that the level of support that BSCS provided enabled teachers to create powerful lessons around local phenomena. For example, a teacher from Georgia integrated lessons on declining Georgia peach harvests into her unit, and her students produced an educational cookbook for their community that combined family peach recipes with scientific explanations of climate change impacts on the local peach industry. A teacher from Oregon focused on the struggles of the Southern Resident Orca population resulting from declining chinook salmon populations. His students partnered with a local bison ranch to restore riparian habitat where salmon spawn.

In the second stage of the study, researchers compared outcomes from students who experienced the localized unit to the same teacher's students from the previous year who experienced a “business as usual” climate change unit that covered comparable, but non-local, content. This preliminary study showed signs of promise for the new approach. They found positive effects of the localized units on student knowledge of climate change and students’ sense of agency. The *Climate Education Pathways* team is now seeking funding to conduct a more extensive and conclusive study of the localization approach.

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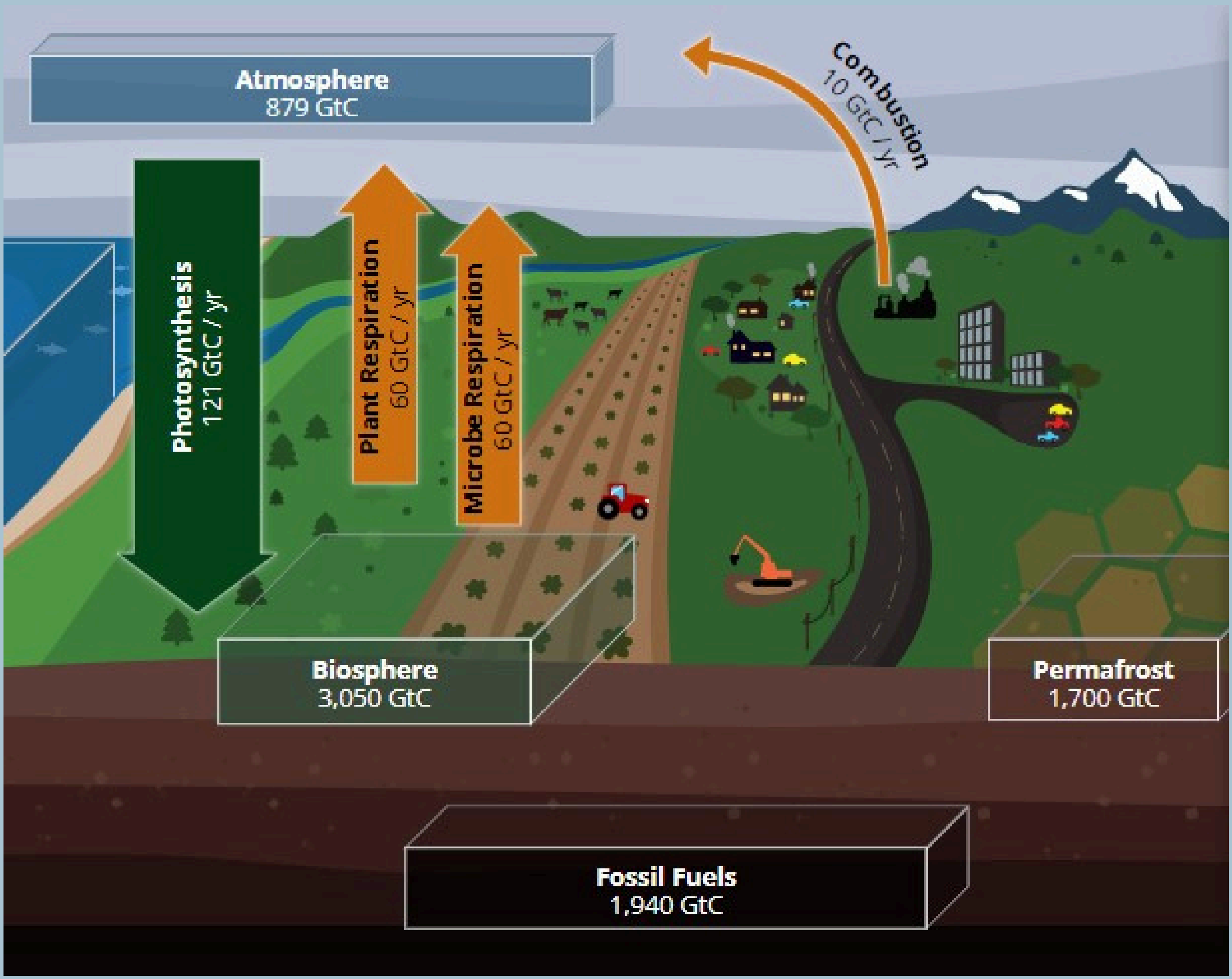

PLACE-BASED SCIENCE LEARNING FOR SCIENCE AT SCALE

In 2020, BSCS teamed up with the Maine Mathematics and Science Alliance to explore localization at the elementary level. Led at BSCS by Dr. Emily Harris, the research team is investigating how to design science units that invite elementary school teachers to incorporate local phenomena into units with the goal of helping students see connections to their experiences and communities.

In an initial study, the team explored how 12 teachers from across the country went about adapting two NGSS-aligned units for their local contexts. Through this work, they identified promising curriculum design features that would enable teachers to incorporate local phenomena into units, with support in curriculum-based professional learning.

They landed on an approach that provides teachers with options at various phases of a unit. In this approach, teachers are given full lesson plans for all options but can choose the version that focuses on the phenomenon that is most relevant for their region. For example, in an Earth science unit developed by the project, teachers across the country can follow the same carefully designed instructional sequence. However, a teacher in New England could ask her students how and why giant boulders ended up in a field, while a teacher on the West Coast could ask his students how and why sand ended up on a highway. These design features offer flexibility so teachers can “choose the adventure” they find most relevant to their students while maintaining a coherent storyline.

In studies of how teachers implement these units, the research team found that the teachers value the level of support provided by the complete lesson plans whether they follow them closely or modify them substantially. They also found that teachers localize the units increasingly on subsequent rounds of teaching them.

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MAKING WAVES WITH RADIO

Dr. Sherry Hsi joined BSCS in 2020 with the goal of expanding where and how science is learned. In her time here, she has been opening doors for BSCS to engage directly with youth, educators, and the public in museums, science centers, and community science workshops.

Hsi's *Making Waves with Radio* project explores how informal science learning can build understanding of the invisible phenomenon of electromagnetic waves that we call radio. How do radio signals work, which technologies make it work, and why does this matter to society? Hsi's team introduces instructional resources for educators and hands-on activities for youth and families to investigate these questions in a meaningful way.

One setting for this work is one-week summer camps for middle school-aged youth that give kids opportunities to work with radio concepts and activities. In one such camp at a science museum in New Mexico, kids participated in planning, designing, and coding a model radio communication system for their community—using BBC micro:bits, paper templates, and circuits. Research found that this format enabled the participants to develop multiple solutions to problems and demonstrate empathy while engaged in crafting radio-oriented design solutions for their community. This initial study—conducted at Explora Science Center and Children's Museum in partnership with the University of New Mexico learning scientists—sparked enthusiasm to further explore the potential impact of youth radio camps. Hsi and her collaborators continue to design and research new camps today.

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Photo Credit: Emily Maletz

STELLA CO^2

Over the last decade, BSCS has helped thousands of in-service science teachers shift their instructional approaches to meet the expectations of new science standards. This work with practicing teachers led BSCS researchers to ask how we can help teacher education programs prepare preservice teachers. A team led by Betty Stennett, Dr. Connie Hvidsten, and Dr. Abe Lo developed the STeLLA CO^2 program to study how university education and science faculty can work with mentor teachers to improve the effectiveness and coherence of their science teacher preparation programs.

Specifically, the team explored the role that BSCS's signature STeLLA professional learning program could play in secondary science teacher preparation. They chose to conduct the work in BSCS's home state of Colorado.

In 2019, the research team convened a community of science and education faculty from three Colorado universities with the classroom teachers who host their preservice teachers for their field experiences. This community developed an understanding of BSCS's STeLLA approach and co-created a standards-aligned vision for effective secondary science teaching. Each university team had the autonomy to choose how they wanted to integrate STeLLA strategies and video-based resources into their existing programs for preservice teachers.

As expected, there was a lot of variability in how university faculty customized STeLLA for their courses. And as hoped, the customized approaches worked. The research revealed significant shifts in preservice science teachers' classroom practices. In an analysis of videos from the classrooms, they saw more use of standards-aligned strategies in treatment classrooms compared to the business-as-usual classrooms.

The STeLLA CO^2 community approach also had a positive effect on the participating faculty and classroom teachers. And the research team noticed the "rise of the mentor teachers," who not only informed the teaching of university courses but also had the chance to co-teach them. The team believes this work only scratches the surface of ways that BSCS can support efforts to improve science teacher preparation.

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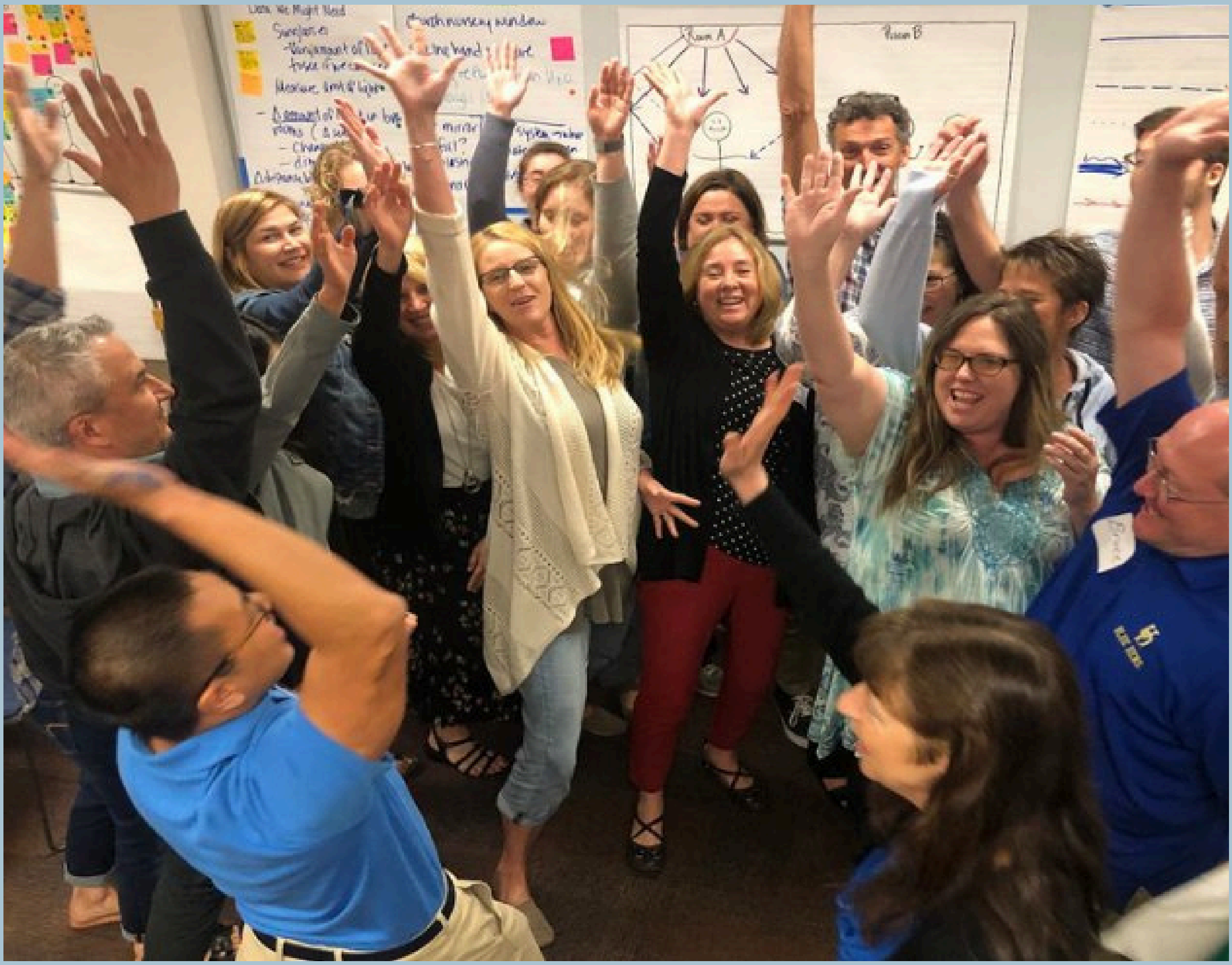

MODEL-BASED EDUCATIONAL RESOURCE (MBER)

The work of Dr. Cindy Passmore and her colleagues at The University of California, Davis on a model-based approach to science teaching and learning has been widely influential. We embraced the opportunity to collaborate with her on a study of the high school biology course they developed to implement the model-based approach.

Over the last few years, a BSCS research team led by Dr. Chris Wilson has studied learning outcomes for students in classrooms using Passmore's *Model-Based Biology* course. His team investigated: What is the impact of *Model-Based Biology* on high school students' science achievement, and what factors influence that impact?

Model-Based Biology's impact was clear. Students in the treatment group, who developed and revised models for a range of phenomena throughout the study, demonstrated significantly higher increases in their ability to use model-based reasoning in biology than students in the comparison group. In addition, the research team discovered a factor that explained why some *Model-Based*

Biology teachers were more effective than others. The study revealed that students in classrooms led by teachers with greater tolerance for ambiguity outperformed students of teachers with lower tolerance for ambiguity. The research team believes that this is because the model-based approach calls for teachers to allow students to develop understanding over time, rather than "giving them the answers" right away.

This is an important finding for the project team and all curriculum developers who strive to support next generation science learning. It also indicates a need for professional learning to help teachers become comfortable with delaying resolution of students' questions.

LEARN MORE

HUMANE GENETICS

Genetic essentialism is the biologically inaccurate belief that genes give certain groups of people or organisms an "essence" that makes them distinct from other individuals of the same species. Belief in genetic essentialism has been shown to contribute to racial and gender bias. A line of rigorous research at BSCS shows that education about genetics can either promote or counteract genetic essentialist thinking during adolescence. The stakes are high in how we proceed—as genetic essentialist thinking can lead to stereotyping and discrimination.

Earlier this year, Dr. Brian Donovan and his Humane Genetics research team published two papers with their findings from research completed in 2023 in *Science.*

"HUMANE GENOMICS EDUCATION CAN REDUCE RACISM"

What happens when high school biology classrooms move beyond the basics of genetics to tackle the complexity of inheritance for the purpose of refuting genetic essentialist views about race? A lot of good things. Donovan's team found that genetics instruction designed by BSCS researchers to combat essentialism leads to an increase in students' genetics knowledge, a decrease in students' racial biases, and an increase in students' beliefs that racism is a problem to be addressed. The paper describes the promise of rolling out this instruction more broadly.

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"SEX AND GENDER ESSENTIALISM IN TEXTBOOKS"

This paper explores what BSCS researchers discovered when they analyzed six of the most widely used biology textbooks in US high schools. They documented how sex and gender were described in the genetics chapters of those textbooks—and they found that biology textbooks are failing to communicate the scientific consensus on those topics. Instead, textbooks are communicating biologically inaccurate information that could lead to gender stereotyping and discrimination.

LEARN MORE

Note: Brian Donovan accepted a position with the University of Colorado, Boulder in September 2024 after eight years at BSCS. We are proud that we were the home for his groundbreaking research and grateful for his contributions to our community. We wish him the best.

5D ASSESSMENT

The National Research Council's (2012) A Framework for K-12 Science Education called for a change in not only what to teach but also how to teach science. The Framework asks educators to take an integrated approach to instruction and assessment in which students use disciplinary core ideas, science and engineering practices, and crosscutting concepts to make sense of phenomena or problems that connect to students' interests and support the development of students' science identities. Together, these five dimensions can support meaningful science learning.

While instructional materials aligned with the NRC Framework are now available, teachers still need support for assessing this learning. A BSCS research team led by Dr. Abe Lo, with colleagues at the University of Colorado, Boulder, are addressing this challenge.

The 5D Assessment Project team designed and tested the efficacy of an online professional learning program to help 55 science teachers from 13 states develop "5D" standards-aligned assessments. They decided to focus specifically on rural teachers, who often lack access to opportunities for professional learning. The research team used what they learned from a rapid ethnography of rural science teachers' needs and contexts to help inform the design of this program. The online course provided access without requiring travel and fostered collaboration among a community of rural teachers, who are often the only science teachers in their building or district.

Research findings indicate the course was highly effective. The study revealed significant shifts in participating teachers' vision for science teaching and in their assessment practices. This work led to more teachers wanting to use this approach not only in future assessment design but also in instruction. Although this study focused exclusively on rural teachers, the researchers argue that their asset-based approach to professional learning design would be effective in other contexts as well.

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FUNDER ACKNOWLEDGMENTS

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Climate Education Pathways: Award no. 2100808

Place-based Science Learning for Elementary Science at Scale: Award no. 2009613

Making Waves with Radio: Award no. 2053160

STeLLA CO^2: Award no. 1725389

Model-based Educational Resource: Award no. 1813538

Humane Genetics: Award no. 1660985 and Award no. 1956152

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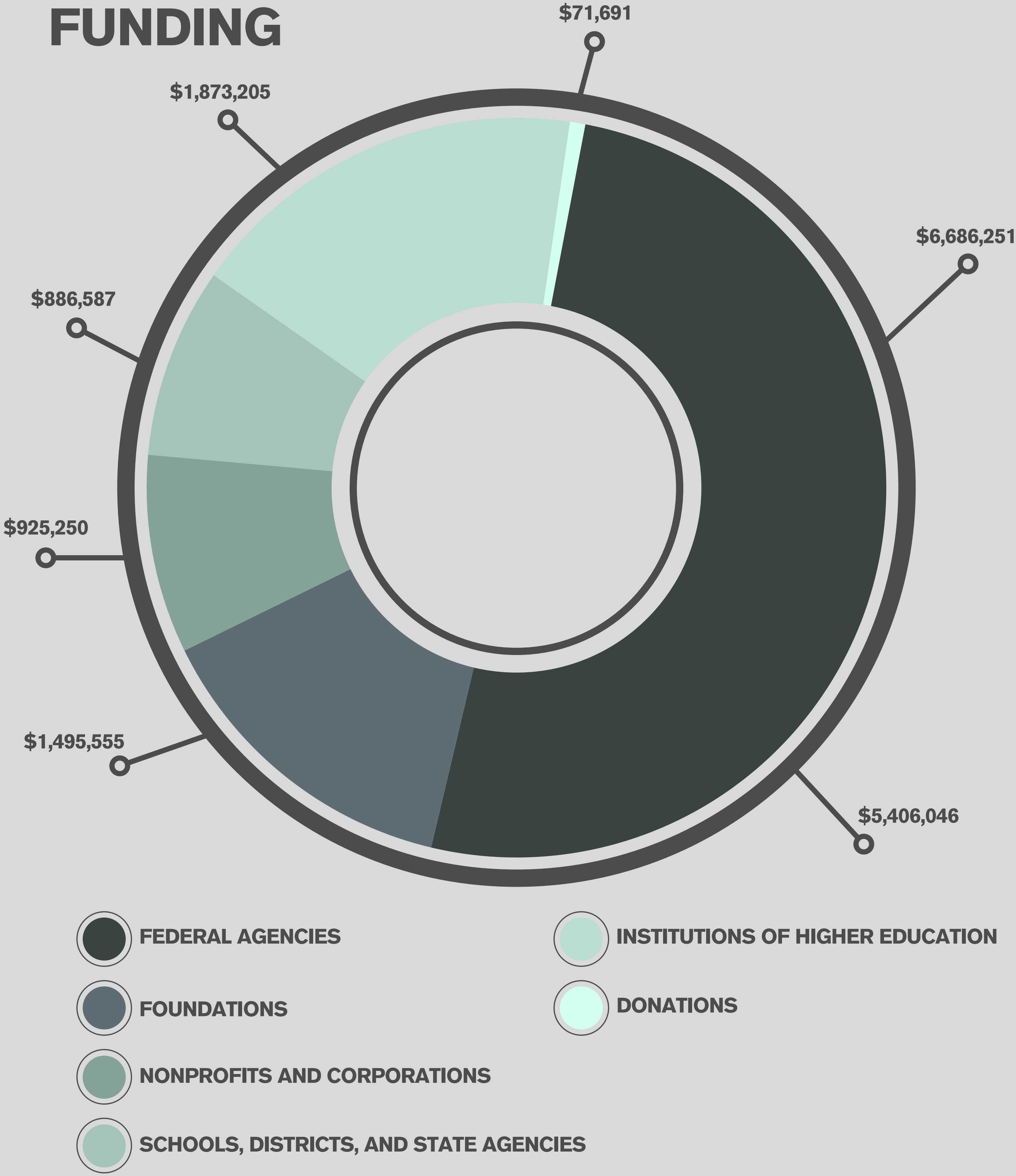

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FINANCIAL ACTIVITY AND ASSETS FOR FISCAL YEAR 2023
January 2023–December 2023

OPERATING REVENUES	Unrestricted	Donor Restricted	Total	FY'22
Contributions				
Federal and State	6,686,251	—	6,686,251	6,524,402
Foundation	1,715,540	1,034,543	2,750,083	2,606,873
Other Grants and Contributions	39,916	31,775	71,691	833,666
Total Released from Restrictions	1,178,283	(1,178,283)	—	—
Revenues from Contracts				
Contract Services	1,150,309	—	1,150,309	1,381,388
Other Income	29,968	—	29,968	51,507
Royalty/Sales/Participant Fees	99,958	—	99,958	27,179
Total	**$10,899,865**	**($111,965)**	**$10,787,900**	**$11,425,015**

OPERATING EXPENSES	Unrestricted	Donor Restricted	Total	FY'22
Program Services	8,036,453	—	8,036,453	8,162,554
General and Administrative	3,500,624	—	3,500,624	2,924,792
Fundraising and Development	69,503	—	69,503	17,174
Total	**$11,606,580**	—	**$11,606,580**	**$11,104,520**
Operating Revenue Less Expenses	**($706,715)**	**($111,965)**	**($818,680)**	**$320,495**

NONOPERATIONAL INCOME	Unrestricted	Donor Restricted	Total	FY'22
Realized Gain (loss) on Investments	(25,323)	—	(25,323)	299,770
Interest Income	37,402	—	37,402	32,340
Interest Expense	(20,243)	—	(20,243)	(9,062)
Unrealized (loss) Gain on Investments	151,036	—	151,036	(751,594)
Total	**$142,872**	—	**$142,872**	**($428,546)**

NET ASSETS	Unrestricted	Donor Restricted	Total	FY'22
Change in Net Assets	(563,843)	(111,965)	(675,808)	(108,052)
Net Assets - Beginning of Year	1,882,034	1,031,120	2,913,154	3,012,206
Net Assets - End of Year	**$1,318,191**	**$919,155**	**$2,237,346**	**$2,913,154**

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