

# “Welcome to the Den of Learning! I love Biology”

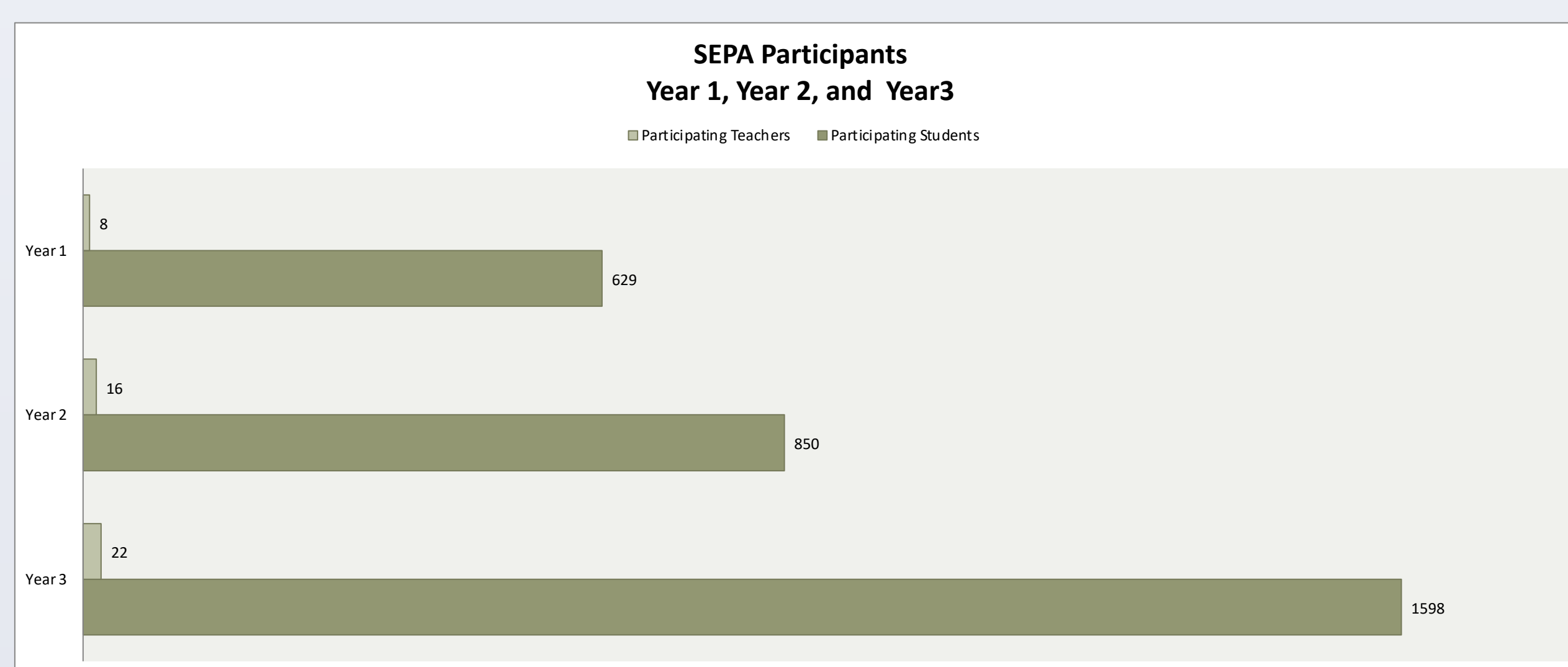
## Encouraging Inquiry Based Learning in Environmental Science

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### INTRODUCTION TO UWM’S SEPA PROGRAM MODULES

The Science Education Partnership Awards (SEPA), supported by the U. S. National Center for Research Resources, is designed to improve science literacy throughout the nation through innovative educational programs. SEPA-supported projects create partnerships among biomedical and clinical researchers and K-12 teachers and schools, museums and science centers, media experts and other educational organizations.

This SEPA project – “Biology-Environmental Health Science Nexus: Inquiry, Content and Communication” – is an effort of the University of Wisconsin-Milwaukee (UWM) Children’s Environmental Health Sciences Core Center. The project is designed to help high school science teachers to engage their students in doing classroom-based research with an environmental health focus. It seeks to provide high school teachers with the background, the experimental curriculum modules, and the educational tools to enrich their science courses with experiments, concepts, and information about environmental health. The program has expanded rapidly and served nearly 1,600 students last year.



The project seeks to help students understand that substances harmful to human health are found in both natural environments and environments altered by humans – and to understand the consequences of exposure to these substances.

Selected high school teachers participated in a week-long workshop which focused on environmental and human health issues and, specifically, on teaching three modules:

- *Zebrafish as Models: Studying the effects of environmental agents on human health* – Effects of ethanol, nicotine and caffeine exposure on embryonic development;
- *Nerve and Muscular Basis of Earthworm Movements* – Effects of physical and chemical environmental agents on earthworm burrowing behavior; and
- *Integrating Physiology and Behavior: Using Fathead Minnows to Model the Effects of Environmental Agents* – Effects of lead on fathead minnow reproductive behaviors.

### THE PROJECT CYCLE



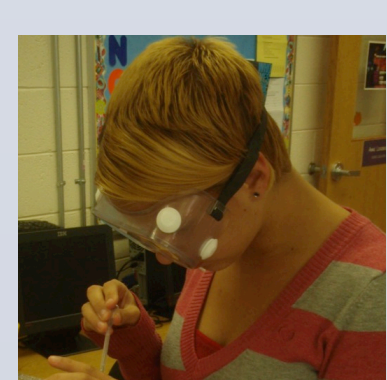
Teacher workshops during the summer provide high school teachers with the background, the experimental curriculum modules, and the educational tools to enrich their science courses with experiments, concepts, and information about environmental health.



During the academic year teachers receive science education support and facilitate interaction between their students and the scientists at UWM. Equipment and live specimens for the modules are provided by the project.



Students work with the live organisms and environmental toxicants in each module. The work dovetails with each teacher’s plan for the academic year and emphasizes scientific inquiry and research. Students design their experiments and collect data.



Students engage fully with center scientists to learn more about the organisms. They interact with other participating classrooms during the year to share data with their peers. They access a SEPA website blog, as well as Skype and receive classroom visits from center scientists.



Students are challenged to work on research papers and posters and learn how to effectively communicate their results to the scientific community.



Student papers and posters are shared at the NIH Student Research Conference. Students have the opportunity to view the work of their peers and hear more about the work of center scientists and graduate students who work with the organisms they studied during the year.

### THE EVALUATION

The evaluation process makes use of a combination of formative and outcome measures and tools, adhering to National Science Education Standard positions on assessing science education. The evaluation documents the extent to which the SEPA program:

- increases the ability of participating teachers to understand and utilize new inquiry-based science modules and curriculum,
- enhances students’ success in inquiry-based learning related to life and environmental health science research, and
- has a sustained institutional impact on participating schools, as reflected in expanded inquiry-based science, greater enrollment in higher level science courses, and other documented change.

Instrument	Respondents	Format	Description
Teacher Workshop Evaluation Survey	SEPA Teachers	Hard Copy	Provide detailed feedback about the teacher development workshop.
Mid-Year Focus Group	SEPA Teachers	In Person	Designed to provide teachers an opportunity to share experiences with the yearly program.
Student Conference “Report Card” Survey	SEPA Students at Conference	Hard Copy	Designed in “report card” format; measures satisfaction with various components of the student conference.
Teacher Conference Evaluation	SEPA Teachers at Conference	Online	Provide detailed feedback about various components of the student conference.
Teacher Follow-Up Survey	SEPA Teachers	Online	Module specific online survey in which teachers report student accomplishments and reactions to the module.
Student “Report Card” Pre-Test and Post-Test/Survey	SEPA Students	Hard Copy	Designed in “report card” format; measures knowledge gained and interest in and satisfaction with modules and science classes.
High School Principal Interview Survey	High School Principals	Telephone Interview	Provide detailed feedback on the awareness and support of participating schools’ principals.



Students complete pre-tests, post-tests and conference surveys following each module or event. Matched pre-tests and post-tests form the basis for analysis of gains in student knowledge and interest in the subject.

Teachers complete surveys about their training in the summer workshop, their experience with the module in the classroom, and the NIH Student Research Conference.

### RESULTS: PARTICIPATING TEACHERS

During the third program year (2012-2013), 22 teachers exposed nearly 1,600 students to the SEPA modules which link basic life science content to contemporary biomedical and environmental health problems.

The project received high marks from participating teachers on several measures.

- Teachers reported being able to integrate the module into their curriculum, appreciated the opportunity to participate in the program, valued the support of the center scientists, and felt that the scientific information in the module had been presented with clarity.
- All but one (97%) of the teachers felt that the zebrafish, fathead minnow and earthworm modules improved their students’ scientific and analytical skills and, also, their students’ environmental health science literacy.
- All but one (97%) of the teachers “strongly agreed” or “moderately agreed” that their students demonstrated an increased understanding of the relationship of toxicants to zebrafish embryo development; of lead exposure on fathead minnow reproduction; and of the effects of toxicants on earthworm burrowing behavior after exposure to the modules.
- Four of five (80%) of the module teachers responding to follow up surveys reported that their students were generally more interested in the module than in their standard life or environmental science curriculum.
- All 15 teachers of the zebrafish module, seven of the nine teachers of the fathead module, and all six teachers of the earthworm module planned to use the SEPA modules again during the 2013-2014 school year.
- Teachers were able to document several ways in which the program had contributed to their professional development: 87% of the teachers reported gaining new understanding or skill in teaching high school science using an inquiry-based approach through presenting their module. All but one (97%) reported using the program materials and handouts. In addition, nearly three-quarters of the respondents shared handouts and materials with other teachers in their school: 20% “a great deal,” 43% “somewhat,” and 13% “a little.”

### RESULTS: PARTICIPATING STUDENTS

Third year evaluation results indicate significant changes in knowledge and attitudes related to environmental health science for students who experienced the zebrafish, fathead minnow, and earthworm modules. Student respondents also reported satisfaction with all three modules. They reported enjoying the “hands-on” approach and said it was helpful to their learning. Regardless of the module they took part in, about three-quarters of the students felt that the module content and activities were appropriate for high school students. With regard to specific modules:

#### Zebrafish Module

Results indicate that zebrafish module student opinions shifted significantly for three statements included in the survey from the time the pre-test was administered to the time of the post-test. At the time of the post-test, significantly more students agreed that:

- ✓ environmental agents acting upon fish act upon humans;
- ✓ experiments with fish demonstrate how the environment affects humans; and
- ✓ doing experiments with fish helps to inform decision making about how the environment affects human health.

Zebrafish module students demonstrated increased knowledge about the specific toxicants effects on the organisms.

Student responses indicated a positive experience with the zebrafish module. For example,

- ✓ Nearly three-quarters (74%) strongly or moderately agreed that, “After doing the zebrafish module, I have a better understanding of the effects of toxins on zebrafish and human embryo development.”
- ✓ Over half (56%) strongly or moderately agreed that, “I would like to do lab experiments like the zebrafish in future science classes.”

#### Fathead Minnow Module

Results indicate that fathead minnow student opinions shifted significantly for three statements included in the survey from the time the pre-test was administered to the time of the post-test. At the time of the post-test, significantly more students agreed that:

- ✓ environmental agents acting upon fish act upon humans;
- ✓ experiments with fish demonstrate how the environment affects humans; and
- ✓ experimentation with fish might help make decisions about how the environment affects human health.

Fathead minnow module students demonstrated increased knowledge about the effects of lead exposure on fish and on children.

Student responses indicated a positive experience with the fathead minnow module. For example,

- ✓ 81% strongly or moderately agreed that, “After doing the fathead minnow module, I have a better understanding of the effects of toxins on fathead minnow reproductive behaviors.”
- ✓ Nearly two-thirds (64%) strongly or moderately agreed that, “Learning about the fathead minnow taught me things about the environment that I didn’t know before.”
- ✓ Over half (52%) strongly or moderately agreed that, “I would like to do lab experiments like the fathead minnow in future science classes.”

#### Earthworm Module

Results indicate that earthworm module student opinions shifted significantly towards preferred responses for three statements included in the survey from the time the pre-test was administered to the time of the post-test. At the time of the post-test, significantly more earthworm module students agreed that:

- ✓ environmental agents acting upon worms act upon humans;
- ✓ experiments with worms demonstrate how the environment affects humans; and
- ✓ worms can become sick and even die if there is too much pollution in their environment.

Students who were taught the earthworm module demonstrated increased knowledge about factors impacting worm’s burrowing behavior.

Student responses about the earthworm module indicated a mostly positive experience. For example,

- ✓ Two-thirds (66%) strongly or moderately agreed that, “Learning about the earthworm taught me things about the environment that I didn’t know before.”
- ✓ Over half (57%) strongly or moderately agreed that, “I enjoyed doing the earthworm module.”
- ✓ Over half (55%) strongly or moderately agreed that, “I would like to do lab experiments like the earthworm module in future science classes.”

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