**5. Broader Impacts**

Proposed research will leverage off of ongoing, productive multidisciplinary collaborations between PIs X,Y and Z, aimed at elucidating the subcellular processes and chemical signatures that are mechanistically driving the interplay and outcome of calcification, ecophysiology and virus infection of *E. huxleyi*. The project provides funding support for PI X, a female research professor, who is responsible for generating her entire salary through extramural funding, as well as resources for technical support and three PhD students (2 at Institution X and one at institution Y). The graduate students will have distinct yet complementary projects focused on the interplay between calcification, photosynthesis, lipid chemistry, and virus infection. This project will also nurture ongoing interactions between X and Y with Prof W, an ecosystem and biogeochemical modeler at institution V. PI Y and Prof W have had an NSF-funded project (NSF award #) examining host-virus interactions under different nutrient regimes and their biogeochemical impact by incorporating mechanistic into mathematical models (see Results from Prior NSF Support). One important anticipated outcome from the proposed work will be to provide quantitative physiological data for key parameters for the costs and benefits of calcification so coccolithophores can be better modeled in the global ocean.

Proposed research activities will uniquely reinforce and expand PIs’ collective broader impact (BI) footprint, with activities and goals designed around creating a career-long approach to science communication and societal engagement in ocean science. We aim to create a meaningful science experience for learners through innovative activities that highlight science research practices, with the rationale that they are critical to current K-12 education reform efforts needed for compliance with the Next Generation Science Standards {States, 2013 #2616}. The biggest conceptual shift from previous science education standards to the NGSS is the focus on three interwoven scientific themes that students are expected to master over their K-12 careers. Those themes are the ‘*Disciplinary Core Ideas’*, ‘*Crosscutting Concepts’*, and ‘*Practices of Science and Engineering’*. ‘*Disciplinary Core Ideas’* have broad importance across multiple sciences or engineering disciplines and are a key tool for understanding a wide range of scientific processes. ‘*Crosscutting Concepts’* are the intuitive understanding that a scientist brings to the exploration of contents or a field. Finally, ‘*Practices of Science and Engineering’* refer to the ways of knowing and doing that scientists and engineers use to study the natural world. The goal of the NGSS is to move science instruction away from disconnected facts and toward inter-related ideas, which learners can use to explain scientific concepts and solve problems {Krajcik, 2014 #2614}.

With the help of previous NSF support, PI’s X and Y and educator Q created ‘*Science Videos’* {PI X, 2017 #2624}, a series of educational videos and hands-on lessons designed to help learners explore the nature and process of science through the NGSS (See Facilities, Equipment and Other Resources). Our ultimate goal with the Science Videos program is to support learners and increase their identity as scientists and build on their reasoning and sense making skills, using this proposed research in molecular microbial ecology as an engaging context. Next steps for the TOS platform is to engage a broader group of educators, develop new NGSS ready materials to support the classroom implementation of the current videos, and evaluate the impacts of the project.

Key tasks of our BI program include:

1) An educator fellowship program: The mission of our Fellowship program is to improve K-12 education by providing relevant, professional learning and leadership development for teachers through innovative collaborations with our research team. We propose to provide professional development opportunities for high school teachers designed to: a) Build capacity for bringing current research and accurate science content into classrooms in an engaging, inquiry-based style; b) Develop innovative standards-based curriculum resources that use our research to investigate science and engineering content; and c) Increase student understanding of science content and their practical application of science process skills. A connected team of teacher leaders will emerge that leverages the expertise they have gained from their individual fellowships and allow them to make an even bigger contribution to the improvement of teaching and learning.

2) Develop new NGSS ready materials to support the classroom implementation: The teacher fellows will co-develop new lessons/ideas for facilitating *Science Videos* in learning environments (in and out of school). We are exploring using the NSF funded Earth Science Puzzles {Kastens, 2010 #2615} as a template for the data lesson. University X educator has twenty-five year experience working collaboratively with educators to develop and implement research rich projects in K-12 classrooms.

3) Evaluate our program: A professional evaluator (Dr. V) will develop survey instruments to measure both the formative and summative impact of the project, using a combination of pre- and post- surveys with students and educators, and interviews to collect this data.

**Budget Justification Summary**

Task 1:

* 15% of FTE educator in years 2,3, and 4 of this four-year award
* Teacher fellowship stipends (6 teachers, 15 days@$200/day)

Task 2:

* 15% Research Translator and technology support in years 2 and 3 of this four-year award
* Teacher stipends to support lesson plan development (2 teachers 10 @$200/day)

Task 3:

* 5% of FTE evaluator in year 3
* Project team member and 1 teacher to present at conference in yr. 4: regional conference @$600/person, and c) national conference @$1,200/person
* Misc. supplies, printing, postage, fax, etc. @ $300/year for years 2,3,4

**Facilities section text**

Science Videos is a series of educational videos and hands-on lessons designed to help students explore the nature and process of science. These short videos are designed to introduce the science and engineering practices from the point of view of practicing scientists. The videos focus on the research of Drs. X and Kim Y of virus infections of coccolithophores in the North Atlantic. The videos are meant to illustrate the non-linear, cyclical nature of the scientific process and the creative vision and skills needed to conduct cutting-edge, impactful scientific research. They have been used successfully in both undergraduate and high school classrooms. For the K-12 community, these videos and associated materials have been produced to support the implementation of the Science Framework for K-12 Science Education and the Next Generation Science Standards (NGSS). The long-term aim of this project is to produce supporting material (lesson plans, discussion prompts, and demonstrations) to complement each of the eight NGSS practices.

The University ABC’s Education and Outreach group works to promote ocean literacy through the development of a broad range of products and services that use the unique scientific resources and assets of the university. The E&O group serves a variety of clients,including:

* K-20 students and teachers,
* informal science learning centers and other non-profit organizations,
* local, regional, state, national, and international government agencies,
* the news media,
* the legislature, and
* the general public.

Scientists and engineers work directly with members of the E&O group to ensure adequate translation of oceanographic products, programs and services to meet the needs of the individual user communities. These efforts are coordinated by a jointly appointed Data Translator, who ensures the operations group is aware of the visualization and content needs of E&O efforts, and provides the E&O group with access to upcoming data products and research findings for story development.