

## EVALUATION

# Global Viewport to Deep-Sea Vents

December 2014

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# **Global Viewport to Deep-Sea Vents Project Evaluation Report**

**A "Global Viewport" for Virtual Exploration of Deep-sea vents: Using Spherical Displays to Advance Public Literacy in Earth System Science**

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## EXECUTIVE SUMMARY

The Global Viewport project was an integrative collaboration between the Woods Hole Oceanographic Institution (WHOI) and the New Bedford Oceanarium Corporation dba Ocean Explorium at New Bedford Seaport (hereafter, Ocean Explorium). The main thematic area that was addressed is *Improving Public Earth System Science Literacy*.

A main objective of the Global Viewport project was to address Goal 1 of the GEO Education and Diversity Strategic Plan (2010-2015): *“Advancing public literacy in Earth System Science.”* For this evaluation the public interacted with spherical display content in an informal educational setting in order to increase their understanding of interconnected and interdependent non-living and living systems. The project’s content was developed for spherical display systems, and was specifically evaluated on the Science On a Sphere® (SOS) system.

To evaluate the projects effectiveness an anonymous self assessed post test survey format was chosen that could be accessed by participants online, on handheld devices using a QR code, or as a printed copy. An internet survey website, eSurveys Pro, was used to build a survey with seven questions. The first three questions were related to demographics. These three questions were made mandatory by the survey software. The next three questions related to the literacy principles that were addressed by newly developed SOS productions. These three questions were designed to self assess awareness, knowledge, or understanding of new content knowledge. The final question was a self measure of engagement or interest in the new knowledge presented.

Demographic questions categorized the respondents in three groups; Student (youth under age 18), Life-long learner (age 18 or older), or Educators. These three categories aligned with goals as outlined in the U.S. NSF GEO Education and Diversity Strategic Framework (2010-2015). The Student category addressed the goal of *“Development of the Future Geoscience Workforce,”* while the over 18 Lifelong learner category addressed *“Life-long learners have access to informal science education opportunities that utilize and/or leverage GEO research”*. The third category, Educators, addressed the NSF goal *“Educators understand and use the big ideas and principles of Earth System Science literacy in formal and informal learning venues.”*

The content gains for Students from viewing the Life without Sunlight movie and the docent-led presentation showed very small variations. The results show that Student participants are coming away from either presentation with some new content learning. While increased learning was reported after both presentations, the movie presentation Student participants reported highest learning results. However, the opposite results are true when the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents for the presentation. These results indicated that the docent-led presentation generated more excitement than the movie, and none of the Students from the decent led presentation reported no excitement at all.

The content gains for Students from viewing the Smoke and Fire Underwater movie and the docent-led presentation showed some variations in the content learning. In most cases with Student survey participants the results show that Students are coming away from either presentation with some new learning. The results indicated that both the movie and the docent-led presentation generated much excitement, with 100% excitement being reported by those Students who saw the Smoke and Fire Underwater movie. And no one in either presentation reported “no” excitement at all.

After viewing the Life without Sunlight presentation Educators reported that they had gained new knowledge that they would incorporate into their classrooms. Only n=2 (8%) of the Educators felt they probably won’t use this information, while n= 9 (36%) of the respondents reported that they probably will use their new knowledge for educational activities, and n=14 (56%) respondents felt they would definitely incorporate their new learning in the classroom.

The content gains for Educators from viewing the Life without Sunlight movie and the docent-led presentation showed the following variations. In most cases with Educator survey participants the results show that Educators are coming away from either presentation with some new learning. While increased learning was reported after both presentations, the docent-led presentation participants reported highest learning results. When the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents for the presentation, the results indicated that both presentations generated excitement and none of the Educators from either presentation reported ‘no’ excitement at all.

The content gains for Educators from viewing the Smoke and Fire Underwater movie and the docent-led presentation showed some variations of their content learning. The results show that Educator participants are coming away from either presentation with some new learning. While increased learning was reported after both presentations, the docent-led presentation Educator participants reported highest learning results for questions 1 & 2. However increased learning was reported from the movie presentation for question 3. The results indicated that both the movie and the docent-led presentation generated much excitement, with 100% excitement being reported by those Educators who saw the Smoke and Fire Underwater movie. And no one in either presentation reported ‘no’ excitement at all.

The content gains for Life-long learners from viewing the Life without Sunlight movie and the docent-led presentation showed small variations favoring the movie presentation. In all cases with Life-long learners survey participants the results show that Life-long learners are coming away from either presentation with some new learning. While increased learning was reported after both presentations, the movie presentation Life-long learners participants reported highest learning results. When the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents for the presentation their results indicated that the movie presentation generated highest excitement, and none of the Life-long learners reported ‘no’ excitement at all.

The content gains for Life-long learners from viewing the Smoke and Fire Underwater movie and the docent-led presentation showed some variations in their content learning. The results show that these Life-long learner participants are coming away from either presentation with some new knowledge. While increased learning was reported after both presentations, the docent-led presentation participants reported highest learning results for questions 1, 2 and 3. The results indicated that both the movie and the docent-led presentation generated much excitement, with 100% excitement being reported by those Life-long learners who participated in the Smoke and Fire Underwater docent-led presentation. And no one in either presentation reported no excitement at all.

This project was successful for “Improving *Public Earth System Science Literacy*”. The overall survey results demonstrated that Students, Life-long learners, and Educators increased their knowledge of Earth Science and Ocean Literacy. A majority of survey respondents, for the Life without Sunlight and Smoke and Fire Underwater reported increased learning of the new content. However, the overall survey data showed few differences between the movie vs. the docent-led presentation for the respondents grouped as Students, Life-long learners, or Educators. Additionally, the majority of participants felt high levels of excitement towards the deep vent science.

This report of the project data leads to a recommendation for additional study of differences and additional uses of movie and docent-led presentations, and further study could also be done to test whether the size and technology of other digital globes available in today’s market affects learning outcomes.

Members of the project team attributed much of their success to the tight collaboration between scientists, Educators, and graphic artists in developing the content for public audiences.

# EVALUATION PURPOSE

This proposed Track 2 project was an integrative collaboration between the Woods Hole Oceanographic Institution (WHOI) and Ocean Explorium). The main thematic area that was addressed is *Improving Public Earth System Science Literacy*.

A main objective of the Global Viewport project was to address Goal 1 of the GEO Education and Diversity Strategic Plan (2010-2015): “*Advancing public literacy in Earth system science.*” For this evaluation the public interacted with spherical display content in an informal educational setting in order to increase their understanding of interconnected and inter-dependent non-living and living systems.

Three goals were established to align the project with the GEO Education and Diversity Strategic Plan objective: *the Development of the Future Geosciences Workforce, Educators understand and use the big ideas and principles of Earth System Science literacy in formal and informal learning venues, and Life-long learners have access to informal science education opportunities that utilize and/or leverage GEO research.*

To meet the goal of *the Development of the Future Geosciences Workforce*, the Global Viewport presentations were designed to engage under-represented and minority students and teachers from SouthCoast Massachusetts schools. Four free activities were offered by the project program including, school field trips for students to the Ocean Explorium highlighting the new content, two family nights and one visitor exchange between the Explorium and WHOI.

This Track 2 project was geared towards informal science education but also included a component for teacher professional development from schools in towns with populations underrepresented in STEM fields to obtain key principles of Earth Science Literacy and Ocean Literacy. The survey measured the increased learning of the big ideas and principles of the Earth System Science and the intended use of this learning in their educational pursuits as a method to specifically address Goal 1.2: “*Educators understand and use the big ideas and principles of Earth System Science literacy in formal and informal learning venues*”.

The new content created for the spherical display systems was designed to address key principles of Earth Science Literacy and Ocean Literacy with the intent of connecting the public to Earth’s history and dynamic processes, linking the lithosphere, hydrosphere, and biosphere as a way to meet the goal, “*Life-long learners have access to informal science education opportunities that utilize and/or leverage GEO research.*”

## PROJECT BACKGROUND

The partnership between the Woods Hole Oceanographic Institution and the Ocean Explorium in New Bedford, Massachusetts, USA (<http://oceanexplorium.org/>) was funded to create new content for NOAA's Science On a Sphere® (SOS) [http://sos.noaa.gov/What\\_is\\_SOS/](http://sos.noaa.gov/What_is_SOS/) with the intended purpose of addressing Goal 1 of the GEO Education and Diversity Strategic Plan (2010-2015): “*Advancing public literacy in Earth system science*” by educating and exciting the public about geophysical and biological processes and exploration in the deep ocean.

The project called the “Global Viewport to Deep-Sea Vents” was named in honor of the launching of the new HOV *Alvin* in 2014 with its improved viewports for scientific observations. For this endeavor Woods Hole Oceanographic Institution scientists formed a partnership with The Ocean Explorium, which is one of over 100 science museums in 19 countries around the world that presently host an SOS ([http://sos.noaa.gov/What\\_is\\_SOS/sos\\_map.html](http://sos.noaa.gov/What_is_SOS/sos_map.html)). The SOS is a room-sized digital globe that can be used to tell a story with global datasets. Using SOS technology new content was created using global datasets, including locations of Earth's known deep-sea hydrothermal vents from the InterRidge Vents Database, and imagery from deep-sea vehicles, including HOV *Alvin*, HOV *Shinkai 6500*, ROV *Jason II*, ROV *Quest 4000*, and more.

Two educational pieces, “Life Without Sunlight” and “Smoke and Fire Underwater” were created. Each piece focused on a different set of Earth Science and Ocean Literacy Principles. Each education package includes a four-minute movie matched to interactive, docent-led presentations and datasets, SOS playlists, and scripts.

Life without Sunlight (LWS) dives beneath the sunlit ocean to the darkness of deep-sea vents, where food webs are fueled by chemosynthesis, and specifically targets Ocean Literacy Principle 5, “*There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms.*” Smoke and Fire Underwater (SFU) asks if the viewer knows that there are volcanoes in the deep sea with vents spewing hot water, and specifically targets Earth Science Literacy Principle 4.5 “*Many active geologic processes occur at plate boundaries.*” Both educational pieces integrate a number of other datasets available for the SOS, including Bathymetry, Volcano Locations Globally, and Age of the Seafloor.

For the purposes of this project, newly created SOS content will serve as programming for both public and professional audiences at the Ocean Explorium and the WHOI Exhibit Center informal science venues. For the public presentations the content will provide spherical display systems, the setting up of interactive exhibits at the Ocean Explorium and the WHOI Exhibit Center, and conducting a visitor exchange program between the two institutions. The visitor exchange program will enable families from communities that are underrepresented and underserved in STEM fields (New Bedford regional area) to meet scientists at a world-renowned scientific facility in Woods Hole. Additionally, informal education professionals and volunteer interpreters, we will develop training materials and conduct training sessions, including



spherecasting/webcasting to SOS users as well as training sessions on site at Ocean Explorium and WHOI.

In addition, because this project addresses Goal 1 of NOAA's 2009-2029 Education Strategic Plan, specifically Outcome 1.4: *"Life-long learners are provided with informal science education opportunities focused on ocean, coastal, Great Lakes, weather, and climate topics."* aligns with Goal 1 of the GEO Education and Diversity Strategic Plan (2010-2015), *"Advancing public literacy in Earth system science."* This project's target audience will extend to any informal science education center, which uses the exhibitions and online programs that allow the visualization and exploration of data supporting the interpretation of ocean, coastal, Great Lakes, weather and climate sciences in informal learning settings for public audiences and for professional development programs geared to STEM Educators.

## EVALUATION METHODS

To evaluate the project's effectiveness, an anonymous self assessed post test survey format was chosen that could be accessed by participants online, on handheld devices using a QR code, or as a printed copy. An internet survey website, eSurveys Pro, was used to build a survey with seven questions. The first three questions were related to demographics. These three questions were made mandatory by the survey software. The next three questions related to the literacy principles that were addressed by newly developed SOS productions. These three questions were designed to self assess awareness, knowledge, or understanding of new content knowledge. The final question was a self measure of engagement or interest in the new knowledge presented.

Demographic questions categorized the respondents in three groups; Student (youth under age 18), Adult (age 18 or older) Life-long learners, or Educators. These three categories aligned with goals as outlined in the U.S. NSF GEO Education and Diversity Strategic Framework (2010-2015). The Student category addressed the goal of *"Development of the Future Geosciences Workforce,"* while the over 18 Life-long learner category addressed *"Life-long learners have access to informal science education opportunities that utilize and/or leverage GEO research"*. The third category, Educators, addressed the NSF goal *"Educators understand and use the big ideas and principles of Earth System Science literacy in formal and informal learning venues."*

By including the second demographic question we were able to identify our targeted audience of underrepresented students from schools in the Massachusetts SouthCoast Region which includes the cities of New Bedford, Fall River, and twelve surrounding towns. (2010 data from U.S. Census Bureau: State and County Quickfacts).

The third demographic question determined the respondent's level of educational attainment which in the SouthCoast region is reported to be low when compared to the states averages. (2010 U.S. Census Bureau: State and County Quickfacts).

For the questions related to the literacy principles that were addressed by the newly developed SOS productions we chose a format for the for self-reporting of knowledge gained, based on the four-category Likert scale for a single response: "Not at all," "A little," "Some," or "Quite a bit.". Each of the questions was framed by writing out the targeted literacy principle then asking "As a result of seeing today's presentation, my knowledge of the above subject has increased:," and then provided a four-category Likert scale for a single response: "Not at all," "A little," "Some," or "Quite a bit."

For the self measurement of interest we used the same four-category Likert scale as for the literacy principles but we framed the question "After today's presentation, how excited are you about the great unexplored deep ocean frontier and the exploration and research of deep-

sea vents?” We chose to use the concept “excited” from the Positive and Negative Affect Schedule.

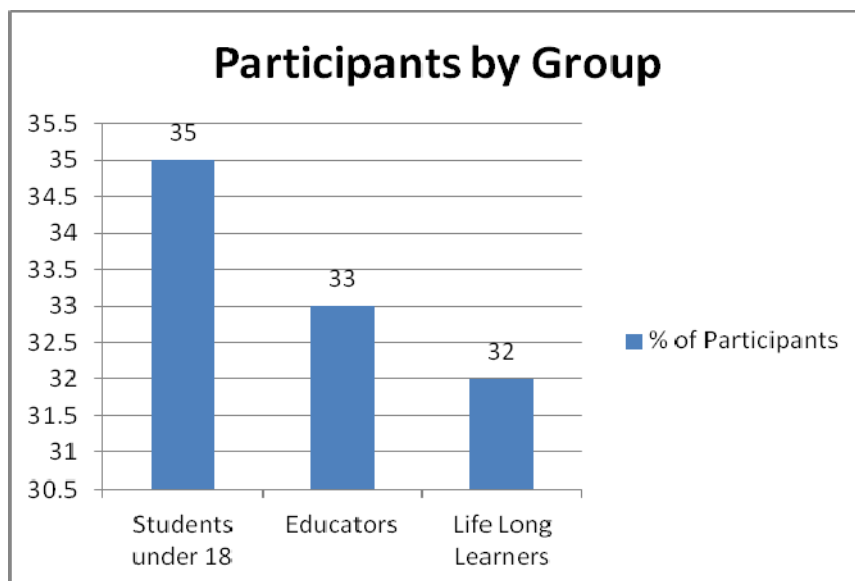
In order to collect survey data public events, including two free family science nights were held at the at the Ocean Explorium, These evenings highlighted the Life Without Sunlight or the Smoke and Fire Underwater narrative, respectively. Additionally, the new content was presented during school field trips and a teacher professional development workshop at the Ocean Explorium.

# FINDINGS

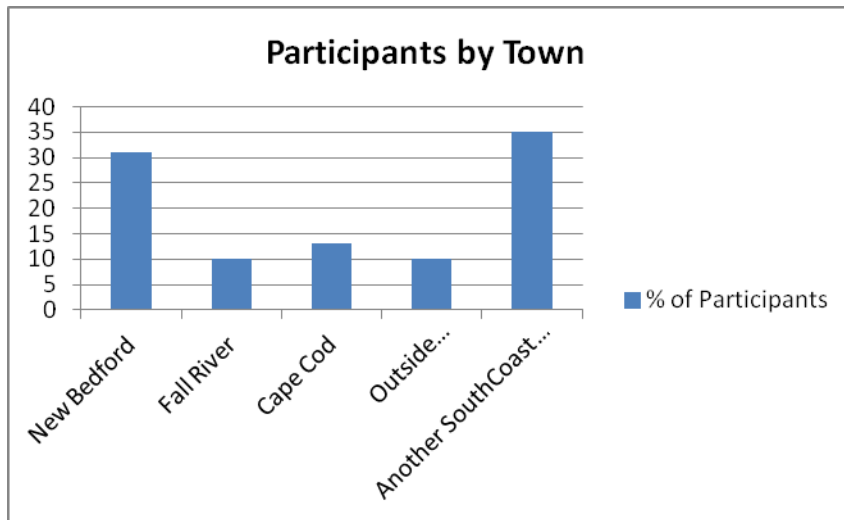
This Track 2 project was an integrative collaboration between the Woods Hole Oceanographic Institution (WHOI) and the New Bedford Ocean Explorium). The main theme of this project was *Improving Public Earth System Science Literacy*. Data reported below are used in a manuscript submitted for peer review (Beaulieu, S., Emery, M., Brickley, A., Spargo, A., Patterson, K., Joyce, K., Silva, T., and Madin, K. 2014, submitted. Using Digital Globes to Explore the Deep Sea and Advance Public Literacy in Earth System Science).

The Global Viewport's main objective was to address goal 1 of the GEO Education and Diversity Strategic Plan (2010-2015): "*Advancing public literacy in Earth system science.*" For this evaluation the public interacted with spherical display content in an informal educational setting in order to increase their understanding of interconnected and inter-dependent non-living and living systems. The survey data was collected over four free of charge activities: including school field trips for students to the Ocean Explorium highlighting the new content, two family nights, and one visitor exchange between the Explorium and WHOI.

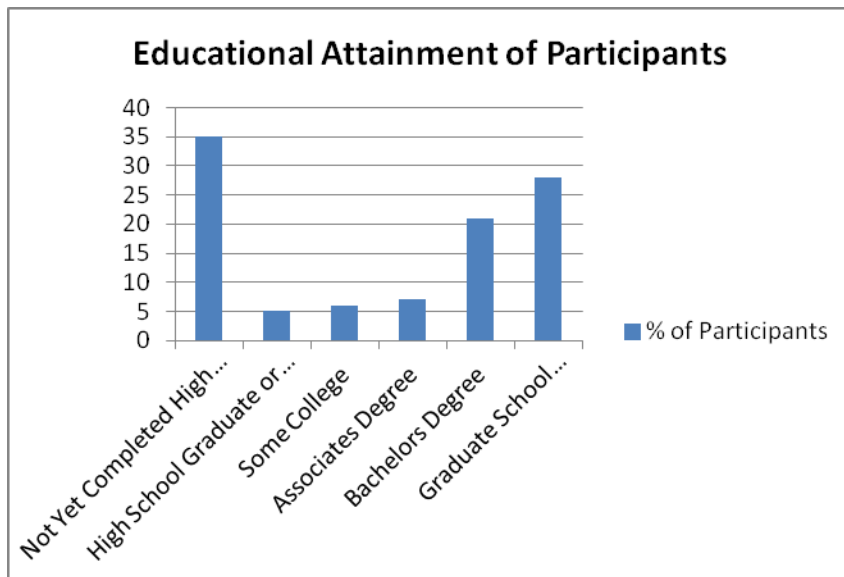
The 135 participants included n=48 (35%) Students, n=44 (33%) Educators, and n=43 (32%) Life-long learners



Study participants lived in the cities of New Bedford n=44 (32%), Fall River n=14 (10%), towns of Cape Cod n=17 (13%), areas outside Southeastern MA n=13 (10%) and other SouthCoast towns n=48(35%) of Carver, Middleboro, Lakeville, Taunton, Freetown, Mattapoisett, Wareham, Fairhaven, and Pembroke and Dartmouth.



For their level of educational attainment, most Students' selected "Not yet completed high school. Life-long learner participants represented all six categories, including "Not yet completed high school." The Educators level of educational attainment exceeded the Life-long learners, with more than half (58%) of the Educators having graduate degrees.



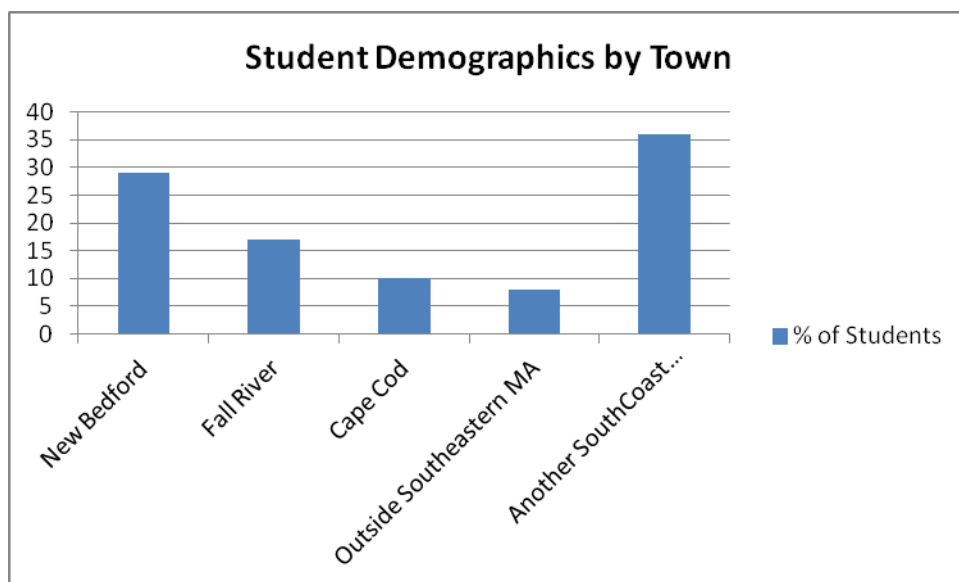
\*It should be noted here that our Bachelor Degree participant data is inconsistent with published data that reports only 16.4% of SouthCoast students go on to attain a college degree, compared to 33.2% for the state. Source: U.S. Census 5-Year estimates, 2007-2011 (residents 25 years of age and older), CFP

## Student Demographics

One project goal, that is, “the *Development of the Future Geosciences Workforce*” was addressed by the Global Viewport in the presentations which were designed to engage under-represented / minority students and teachers from SouthCoast Massachusetts schools.

The Students who participated in these events fall within the Massachusetts SouthCoast Region including the cities of Fall River and New Bedford and twelve surrounding towns. According to the U.S. Census of 2006, New Bedford has a diverse demographic: 10% Cape Verdean, 8% African-American, 8% Hispanic, and 1% Asian. Of the 73% remaining Caucasian population, 22% are foreign-born and 30% of these are Portuguese. Additionally, statistics show that only 16.4% of SouthCoast students go on to attain a baccalaureate, compared to 33.2% for the state. The high school graduation rates of 58% for New Bedford, 64% for Fall River and 68% for the SouthCoast are low compared to the state rate of 81%. 06, 65% of the students in New Bedford, 58% of the students in Fall River, and 38% of students in the SouthCoast were classified as low-income, compared to 28 % for the state. (from U.S. Census Bureau: State and County Quickfacts).

The results of the project survey demonstrated that n=48 (34%) of the survey respondents were under 18 years old. Of that group n=14 (29%) live in New Bedford, from Fall River n=8 Students (17%) Cape Cod n=5 (10%); and Outside Southeastern MA, n=4 (8%) SouthCoast towns; n=17 (36%) of Carver, Middleboro, Lakeville, Taunton, Freetown, Mattapoisett, Wareham, Fairhaven, and Pembroke.



The participation of these Students meets the project's goal for *the Development of the Future Geosciences Workforce*.

### ***Student Results for Docent-led Life without Sunlight Presentation (LWS)***

Students who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms and hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life had increased: not at all n= 1 (11%), a little n= 1 (11%), some n=2 (22%), quite a bit 5(56%)

Students who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Earth is a complex system of interacting rock, water, air, and life and all Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior had increased: not at all n= 1(11%), a little n=2 (22%), some n=2 (22%), quite a bit 4 (45%)

Students who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the ocean is the last and largest unexplored place on Earth, this is the great frontier for the next generation's explorers and researchers had increased: not at all n= 1 (11%), a little n=4 (45%), some n= 1 (11%), quite a bit n= 3 (33%)

The measure of overall engagement or interest (in) the docent-led Life without Sunlight presentation indicated that after the presentation, the Students rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little n= 1 (11%), some n=1 (11%), quite a bit n= 7 (78%).

### ***Student Results for Life without Sunlight Movie (LWS)***

Students who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms, and Hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life had increased: not at all n= 1 (7%), a little n= 1 (7%), some n= 4 (28%), quite a bit n= 8 (57%)

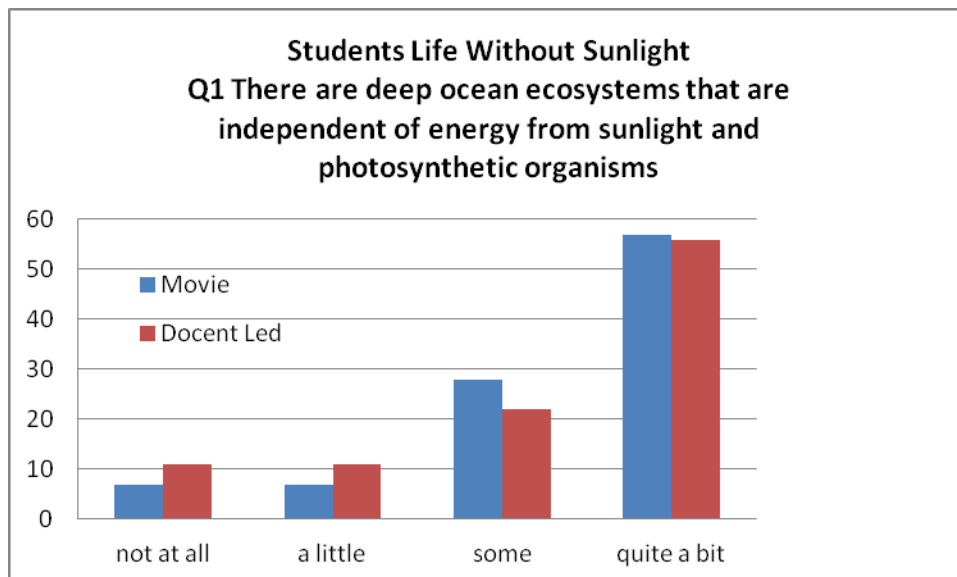
Students who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Earth is a complex system of interacting rock, water, air, and life and all Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior: not at all n= 2(14%), a little n= 1 (7%), some n= 9 (29%), quite a bit n= 7 (50%).

Students who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the ocean is the last and largest

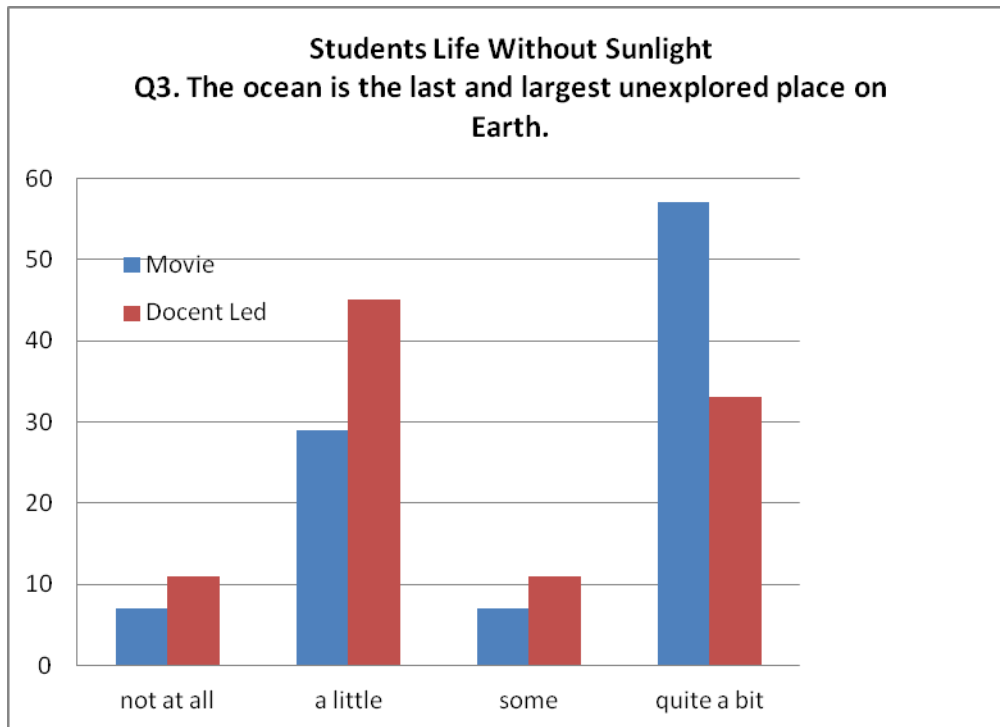
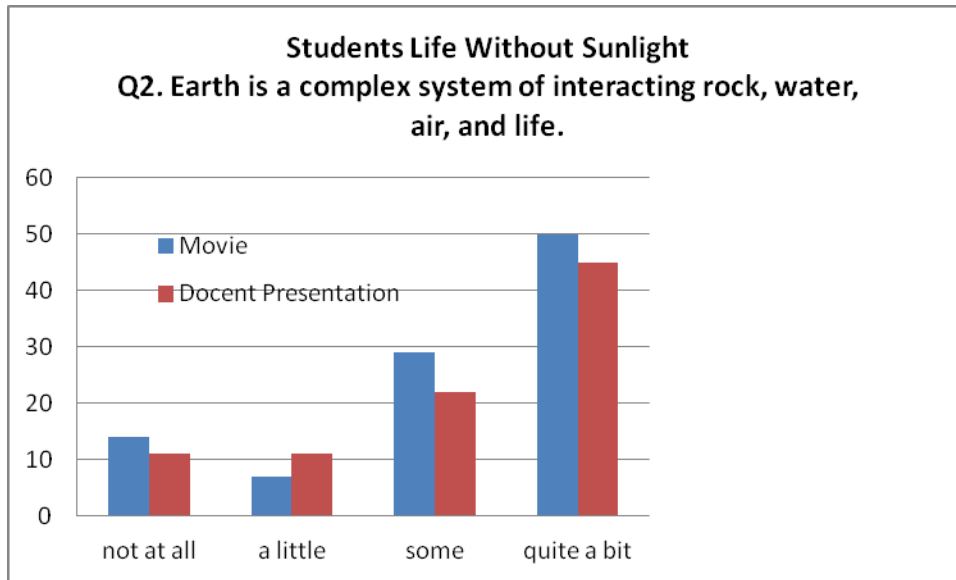
unexplored place on Earth, this is the great frontier for the next generation's explorers and researchers had increased: not at all n= 1 (7%), a little n= 4 (29%), some n= 1 (7%), quite a bit n= 8 (57%)

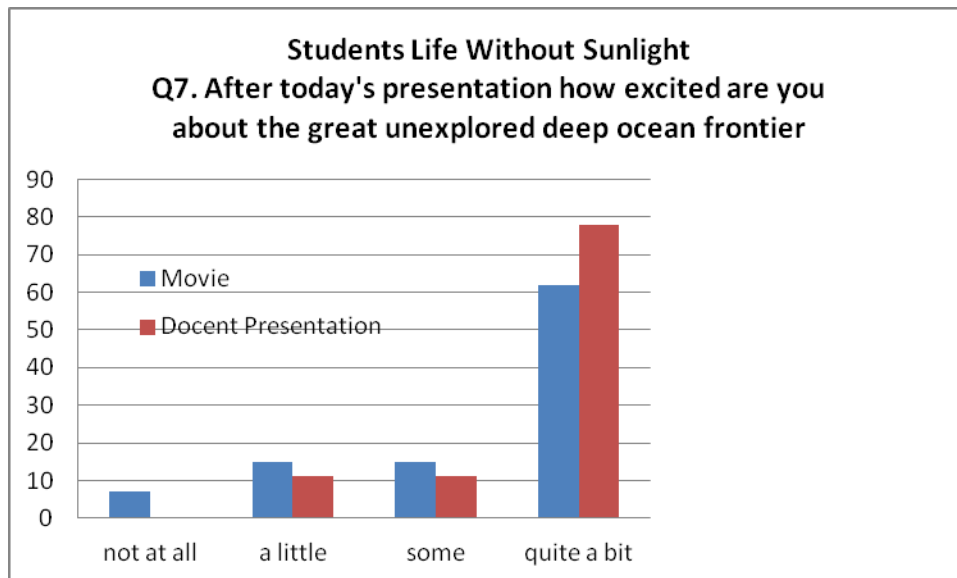
The measure of overall engagement or interest in the Life without Sunlight movie presentation indicated that after the presentation, the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all n=1 (7%), a little n=2 (15%), some n=2 (15%), quite a bit n= 8(62%).

The content gains for Students from viewing the Life without Sunlight movie and the docent-led presentation showed very small variations. In all cases with Student survey participants the results show that Students are coming away from either presentation with some new content learning. While increased learning was reported after both presentations, the movie presentation Student participants reported highest learning results. However, the opposite results are true when the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents for the presentation. These results indicated that the docent-led presentation generated more excitement than the movie, and none of the Students from the decent led presentation reported 'no' excitement at all.









### ***Student Results for Docent-led Smoke and Fire Underwater presentation***

Students who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Life occupies a wide range of Earth's environments, including extreme environments at seafloor vents where hot fluids escape from the oceanic crust: not at all (0%), a little n= 2 (20%), some n=5 (50%), quite a bit n=3 (30%)

Students who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that many active geologic processes occur at plate boundaries and that Plate interactions affect the locations of volcanoes and the distribution of resources and living organisms had increased: not at all n=1 (10%), a little n=1 (10%), some n= 3 (30%), quite a bit n= 5 (50%)

Students who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that new technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean increased: not at all (0%), a little n=3 (30%), some n=2 (20%), quite a bit n=5 (50%)

The measure of overall engagement or interest (in) the docent-led Smoke and Fire Underwater presentation indicated that after the presentation, the Students rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little n= 1 (10%), some n=2 (20%), quite a bit n= 7 (70%).

### ***Student Results for Smoke and Fire Underwater Movie (SFU)***

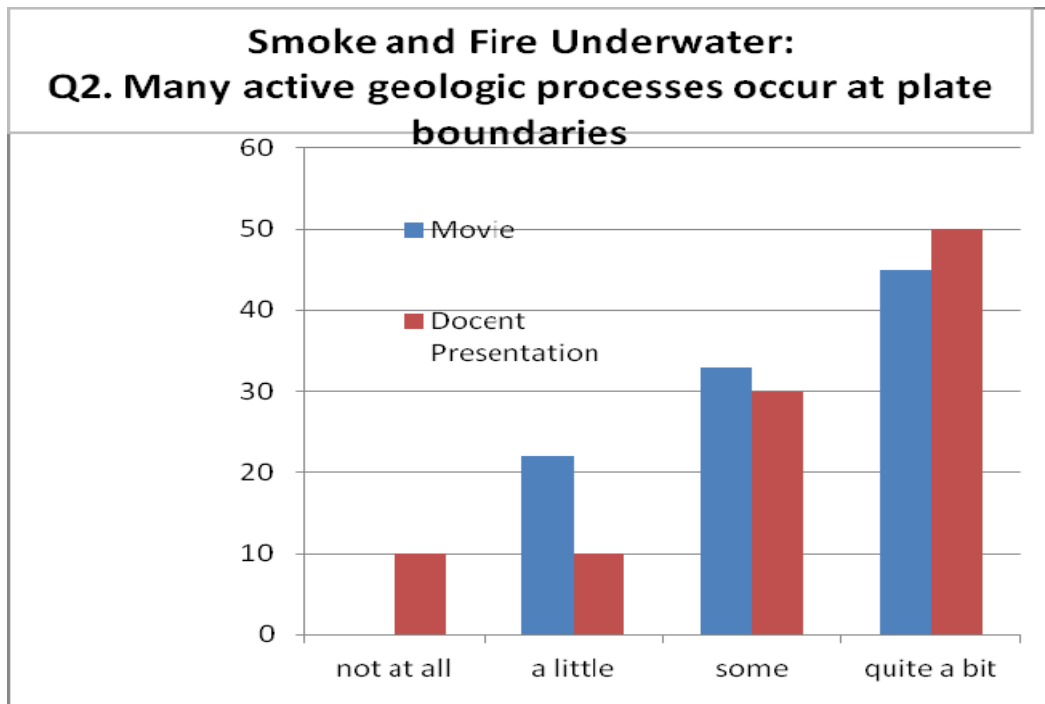
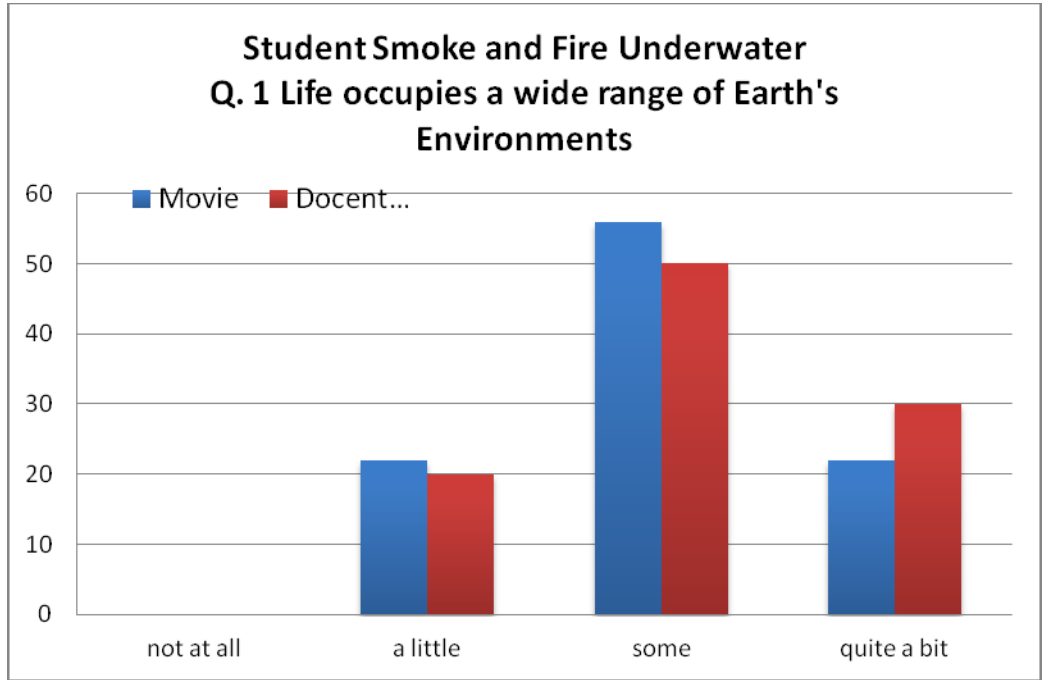
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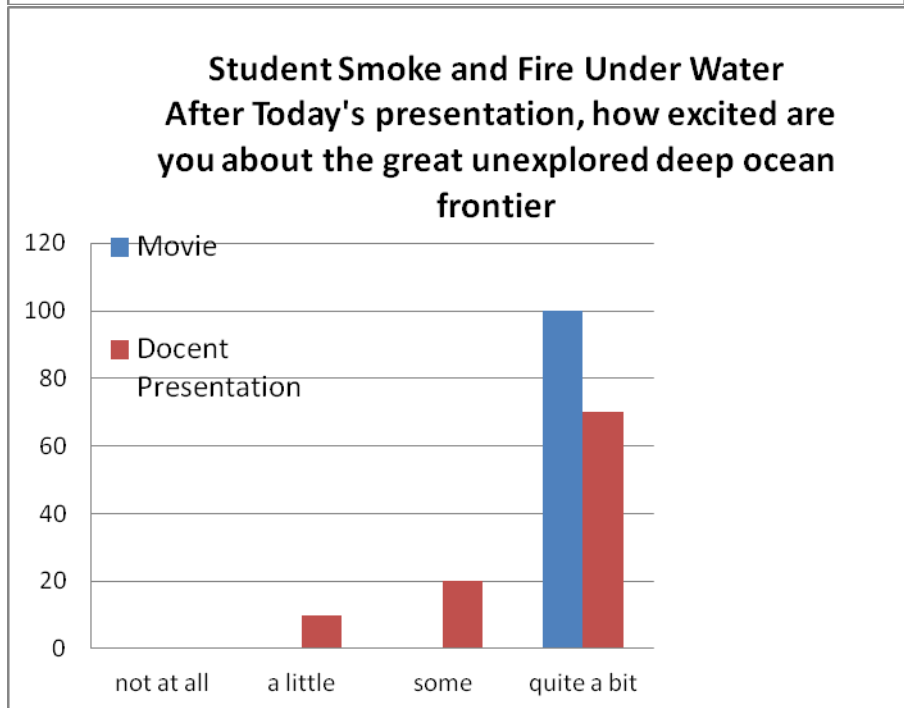
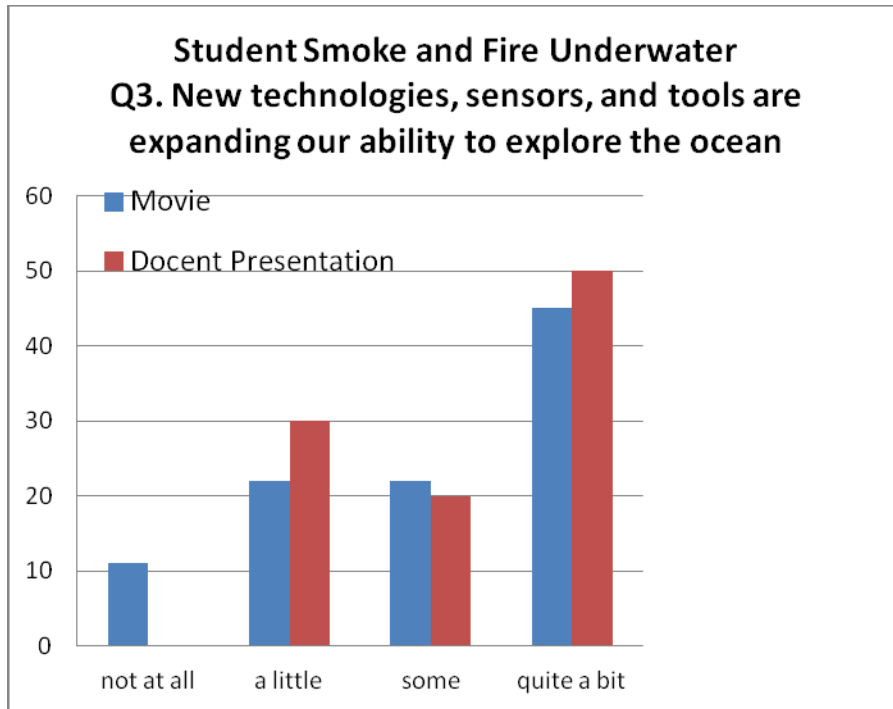
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Students who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that new technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean had increased: not at all n= 1 (11%), a little n= 2 (22%), some n= 2 (22%), quite a bit n=4 (45%)

The measure of overall engagement or interest (in) the Smoke and Fire Underwater movie presentation indicated that after the presentation, The respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some (0%), quite a bit n= 9 (100%).

The content gains for Students from viewing the Smoke and Fire Underwater movie and the docent-led presentation showed some variations in the content learning. In all cases with Student survey participants the results show that Students are coming away from either presentation with some new learning. Increased learning was reported after both presentations, additionally, the results indicated that both the movie and the docent-led presentation generated much excitement, with 100% excitement being reported by those Students who saw the Smoke and Fire Underwater movie. And no one in either presentation reported 'no' excitement at all.

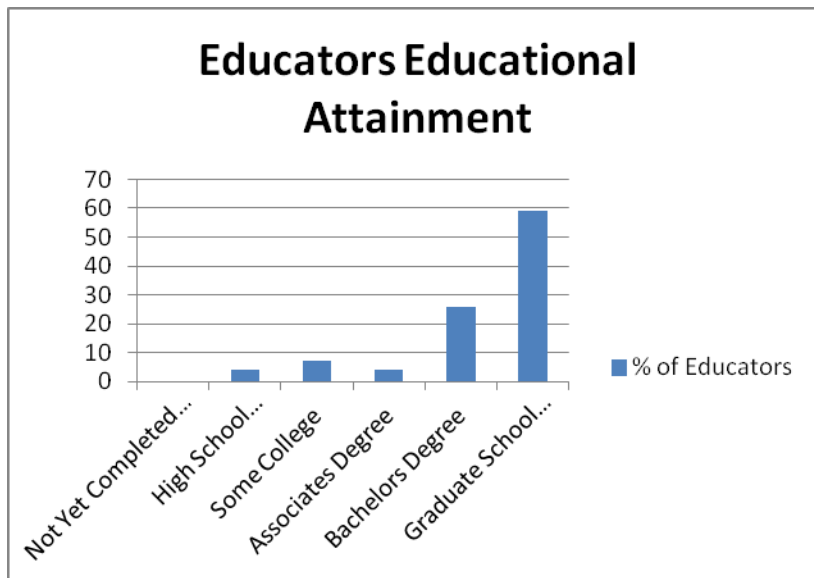
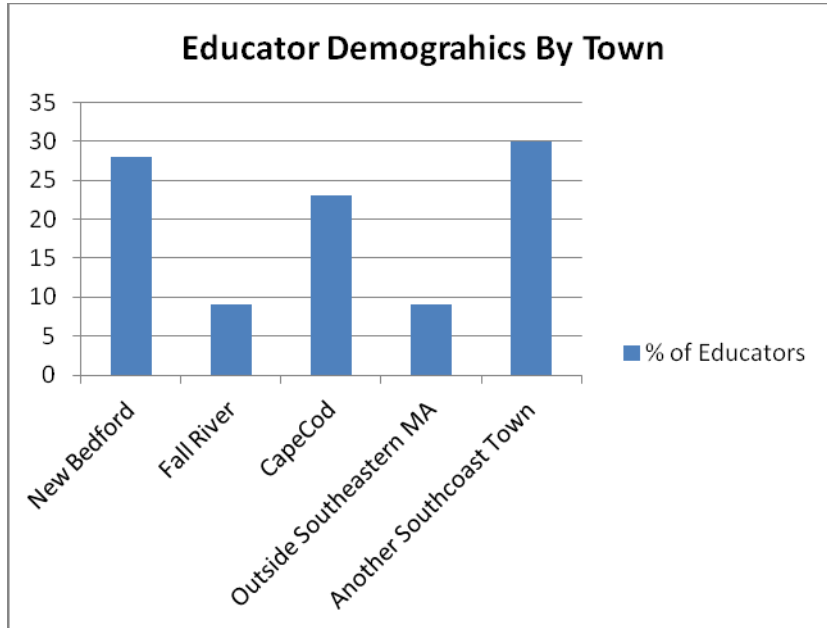




This introduction to Ocean science exploration to under-represented / minority students as a goal of this project should be considered successful. The new learning as self reported by the Students provides evidence that this program did serve to develop the Future Geosciences workforce for the future.

## Educator Demographics

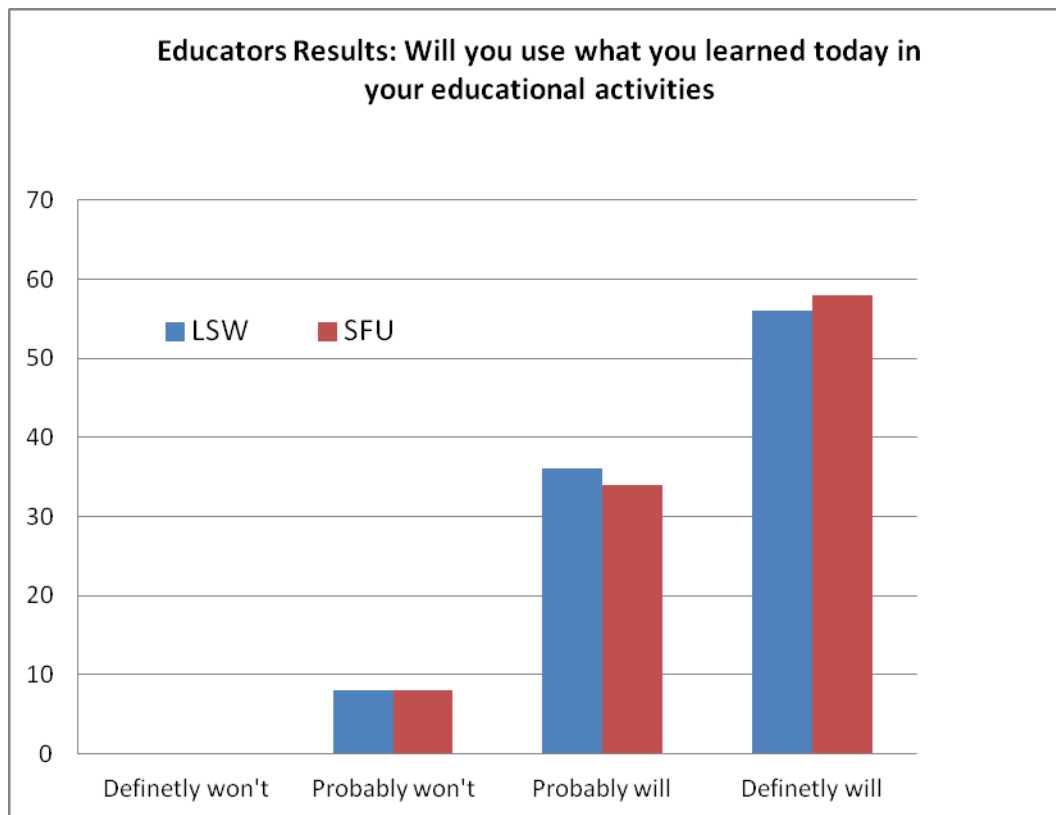
The Global Viewport project was geared towards informal science education but also included a component for teacher professional development to obtain key principles of Earth Science Literacy and Ocean Literacy. A majority of the Educators who participated in the survey are from the underrepresented school districts of New Bedford n=12 (28%), Fall River n=4 (9%) and from other Southcoast towns n= 13 (30%). These towns include Westport, Fairhaven, Plymouth, Mattapoisett, and Dartmouth.



A second objective of this project was to specifically address Goal 1.2: “Educators understand and use the big ideas and principles of Earth System Science literacy in formal and informal learning venues”. The survey measured the increased learning of the big ideas and principles of the Earth System Science and the intended use this learning in formal and informal learning venues. The results follow.

After viewing the Life without Sunlight presentation Educators reported that they had gained new knowledge that they would incorporate into their classrooms. Only n=2 (8%) of the Educators felt they probably won’t use this information, while n= 9 (36%) of the respondents reported that they probably will use their new knowledge for educational activities, and n=14 (56%) respondents felt they would definitely incorporate their new learning in the classroom.

Similar results are seen by the Smoke and Fire Underwater presentation, Educators reported that they had gained new knowledge that they would incorporate into their classrooms. One n=1 (8%) of the respondents reported that they probably will not use their new knowledge for educational activities, while four n= 4 (34%) felt they probably would incorporate their new learning in the classroom. Seven n=7 (58%) of the Educators who participated in the Smoke and Fire Underwater presentation said they would definitely incorporate their new learning in the classroom.



### ***Educator Results for Docent-led Life without Sunlight presentation (LWS)***

Educators who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms and hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life had increased: not at all n=1 (7%), a little n=1 (7%), some n=6 (43%), quite a bit n= 6 (43%)

Educators who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Earth is a complex system of interacting rock, water, air, and life and all Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior had increased: not at all n=1 (7%), a little n= 2 (15%), some n=8 (62%), quite a bit n=2 (16%)

Educators who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the ocean is the last and largest unexplored place on Earth, this is the great frontier for the next generation's explorers and researchers had increased: not at all n=1 (7%), a little n=2 (14%), some n=6 (43%), quite a bit n=5 (36%)

The measure of overall engagement or interest (in) the docent-led Life without Sunlight presentation indicated that after the presentation, the Educators rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some n=6 (43%), quite a bit n=8 (57%).

### ***Educators Results for Life without Sunlight Movie (LWS)***

Educators who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms, and hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life had increased: not at all n=1 (8%), a little n=1 (8%), some n= 6 (50%), quite a bit n=4 (34%)

Educators who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Earth is a complex system of interacting rock, water, air, and life and all Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior had increased: not at all n= 2 (16%), a little n=2 (17%), some n=5 (42%), quite a bit n=3 (25%)

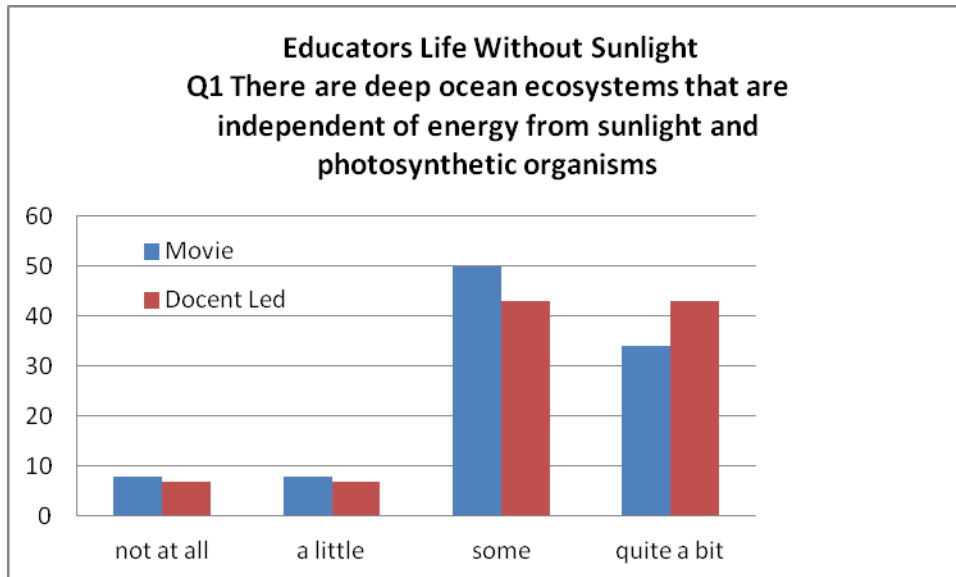
Educators who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the ocean is the last and largest unexplored place on Earth, this is the great frontier for the next generation's explorers and

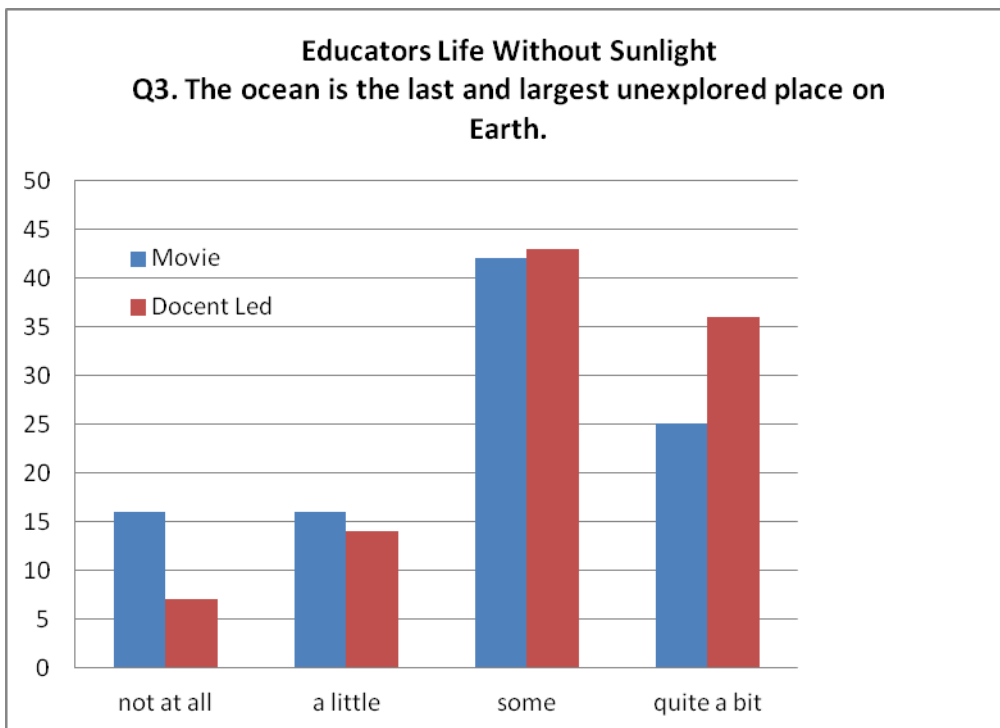
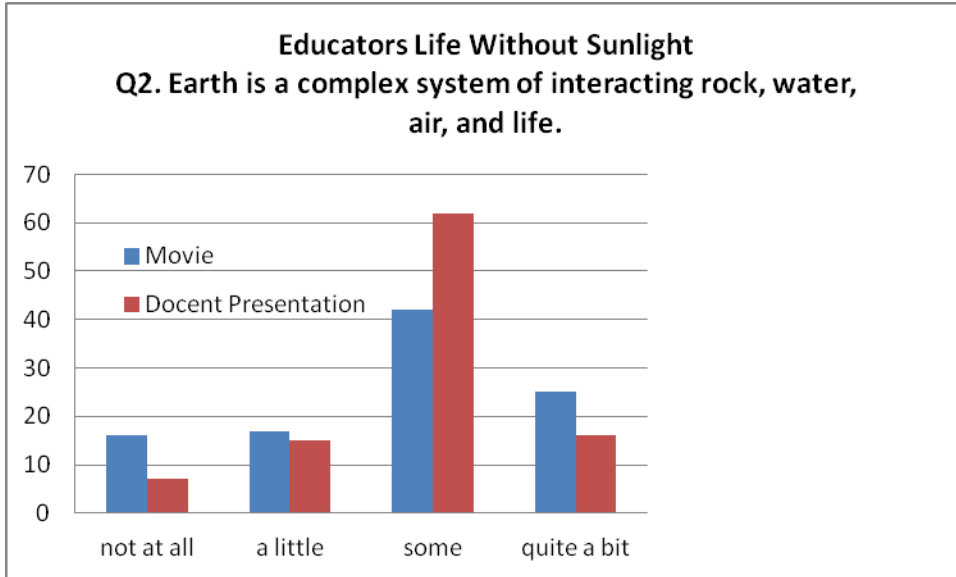


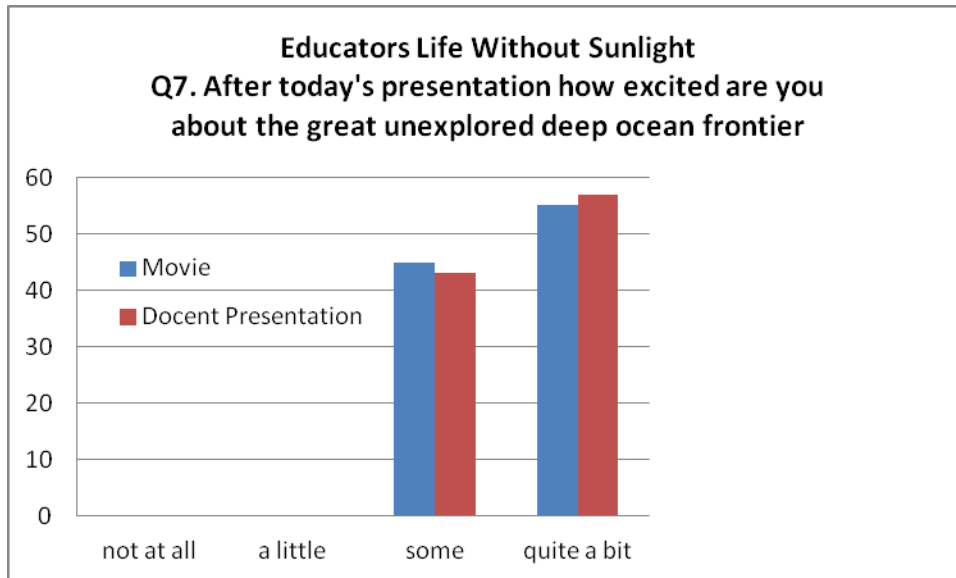
researchers had increased: not at all n=2 (16%), a little n= 2 (16%), some n=5 (42%), quite a bit n=3 (25%)

The measure of overall engagement or interest (in) the Life without Sunlight movie presentation indicated that after the presentation, The Educators rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some n=5 (45%), quite a bit n=6 (55%).

The content gains for Educators from viewing the Life Without Sunlight movie and the docent-led presentation showed the little variation. In most cases with Educator survey participants the results show that Educators are coming away from either presentation with some new learning. While increased learning was reported after both presentations, the docent-led presentation participants reported highest learning results. When the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents for the presentation, the results indicated that the docent-led presentation generated more excitement than the movie, and none of the Educators from either presentation reported no excitement at all.







### ***Educator Results for Docent-led Smoke and Fire Underwater presentation (SFU)***

Educators who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Life occupies a wide range of Earth's environments, including extreme environments at seafloor vents where hot fluids escape from the oceanic crust life had increased: not at all n= 1 (25%), a little n= 1 (25%), some 0%), quite a bit n= 2 (50%)

Educators who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are many active geologic processes occur at plate boundaries and that Plate interactions affect the locations of volcanoes and the distribution of resources and living organisms had increased: not at all (0%), a little n= 1 (25%), some (0%), quite a bit n= 3 (75%)

Educators who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept new technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean had increased: not at all n=1 (25%), a little n= 1 (25%), some n= 2(50%), quite a bit (0%)

The measure of overall engagement or interest (in) the docent-led Smoke and Fire Underwater presentation indicated that after the presentation, the Educators rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some n=1 (33%), quite a bit n=2 (67%).

### ***Educator Results for Smoke and Fire Underwater Movie (SFU)***

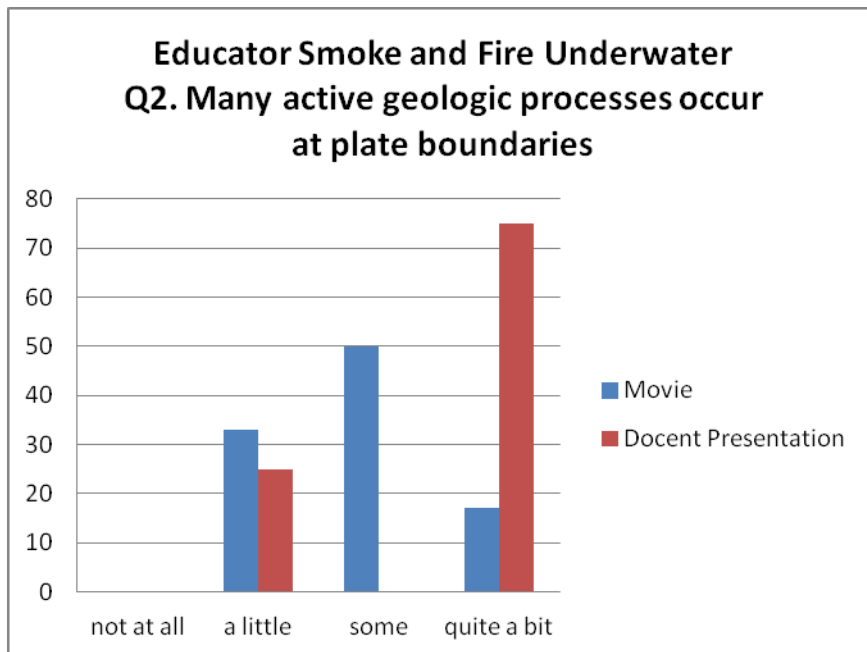
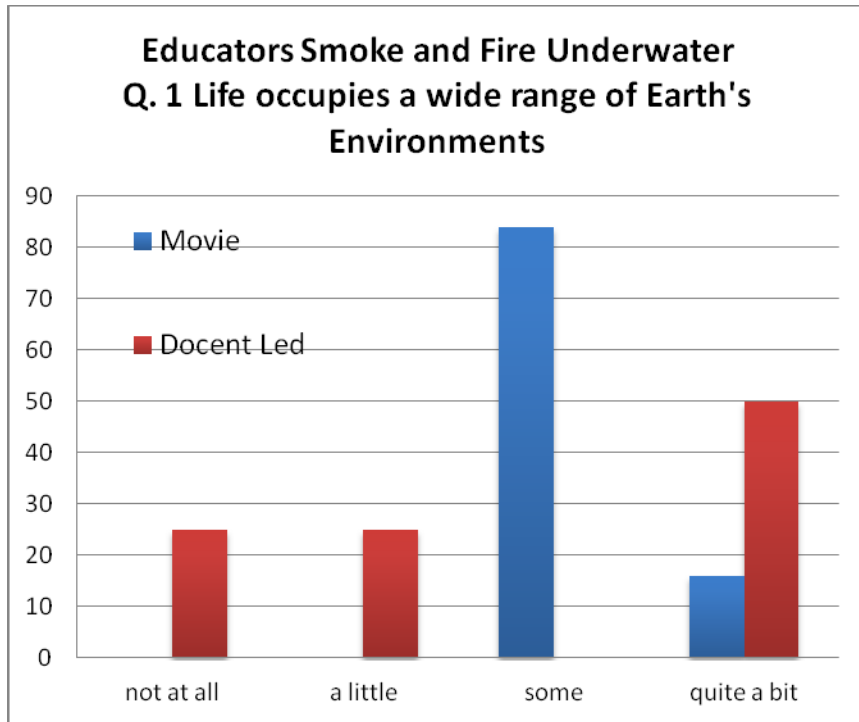
Educators who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Life occupies a wide range of Earth's environments, including extreme environments at seafloor vents where hot fluids escape from the oceanic crust life had increased: not at all (0%), a little (0%), some n= 5 (84%), quite a bit n= 1 (16%)

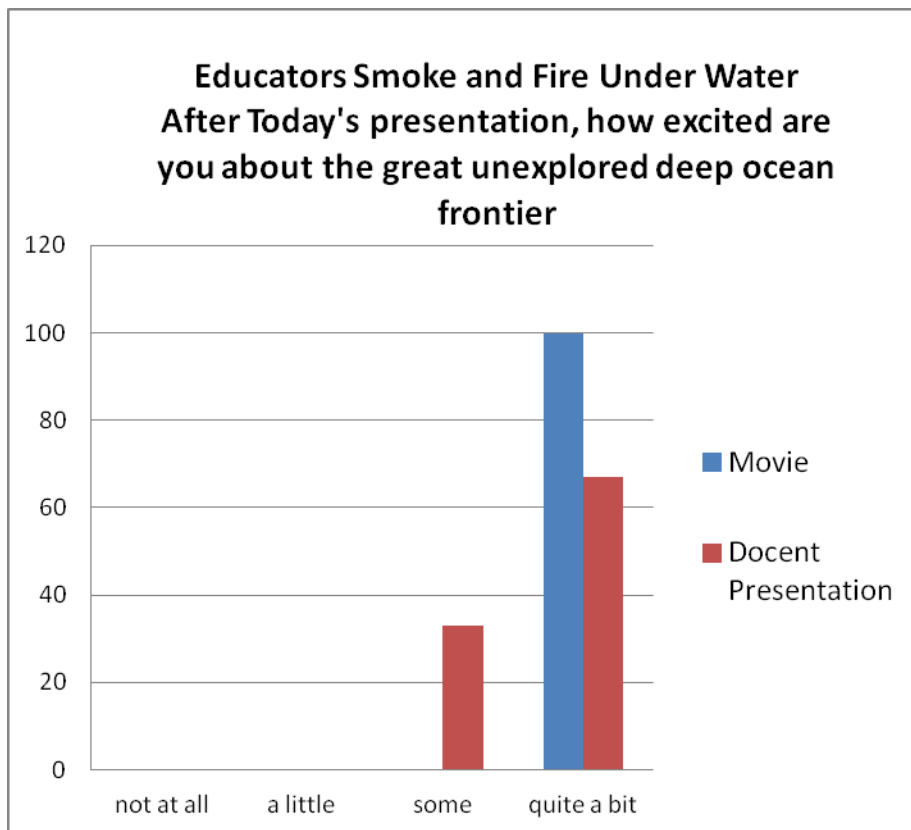
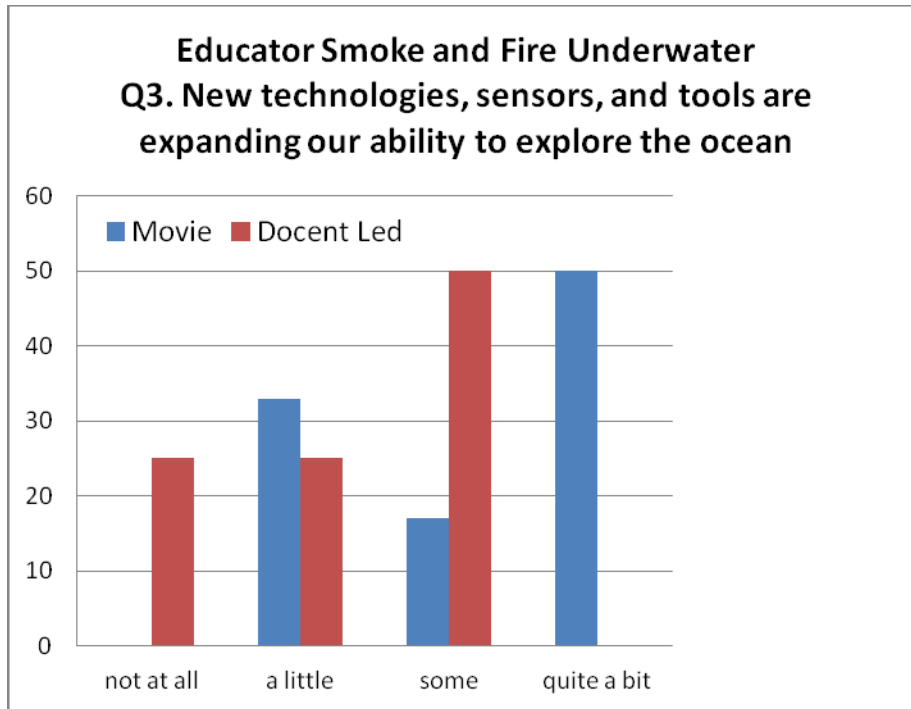
Educators who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept there are many active geologic processes occur at plate boundaries and that Plate interactions affect the locations of volcanoes and the distribution of resources and living organisms had increased: not at all (0%), a little n= 2 (33%), some n= 3 (50%), quite a bit n= 1 (17%)

Educators who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that new technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean had increased: not at all (0%), a little n= 2 (33%), some n= 1 (17%), quite a bit n= 3 (50%)

The measure of overall engagement or interest (in) the Smoke and Fire Underwater movie presentation indicated that after the presentation, The Educators rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some (0%), quite a bit n=6 (100%).

The content gains for Educators from viewing the Smoke and Fire Underwater movie and the docent-led presentation showed little variation of their content learning. In most cases with Educator survey participants, the results show that Educators are coming away from either presentation with some new learning. Increased learning was reported after both presentations. Further the results indicated that both the movie and the docent-led presentation generated much excitement, with 100% excitement being reported by those Educators who saw the Smoke and Fire Underwater movie. And no one in either presentation reported 'no' excitement at all.

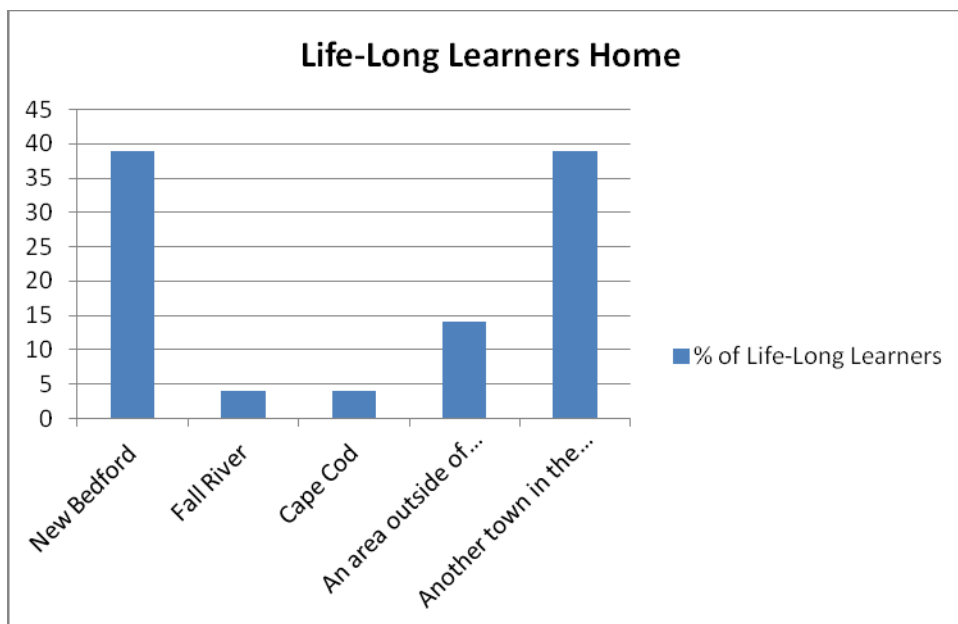




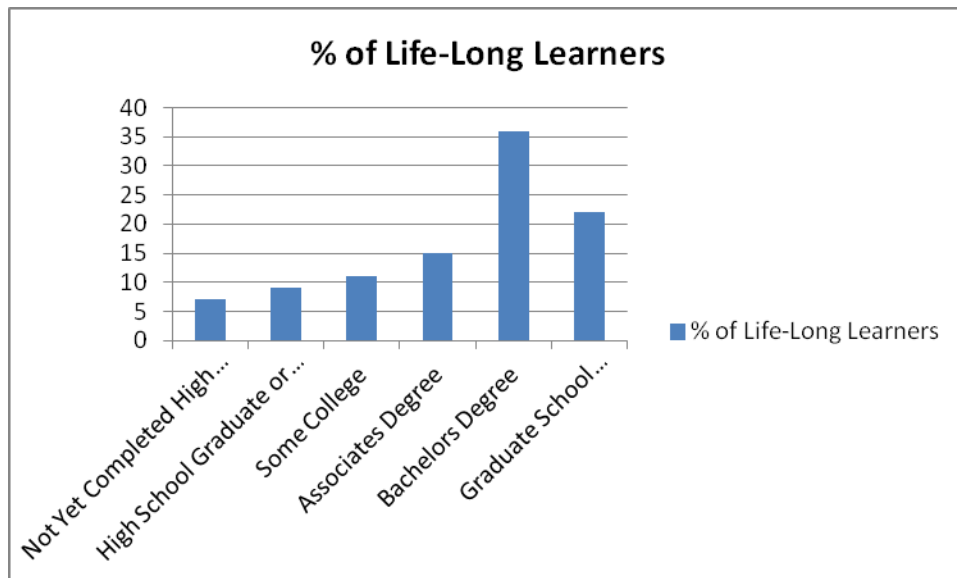
## Life-long learner Demographics

A third goal of this project was aligned with the GEO Education and Diversity Strategic Plan (2010-2015): with 1.4: *“Life-long learners have access to informal science education opportunities that utilize and/or leverage GEO research.* The new content created for the spherical display system addressed key principles of Earth Science Literacy and Ocean Literacy with the intent of connecting the public to Earth’s history and dynamic processes, linking the lithosphere, hydrosphere, and biosphere.

The self categorized Life-long learners who participated in this survey came primarily from the SouthCoast of Massachusetts cities and towns of New Bedford 18 (39%), Fall River n=2 (4%), Cape Cod n=2 (4%) a region outside of Southeastern Massachusetts n=6 (8%) and South Coast Towns n=18(39%) including Lakeville, Taunton, Rochester, Fairhaven, Dartmouth, and Mattapoisett.



The education levels of the Life-long learner survey participants represented all education categories. The graph demonstrates the large range of educational diversity in the SouthCoast.



### ***Life-long learner Results for Docent-led Life without Sunlight presentation (LWS)***

Life-long learners who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms and hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life had increased: not at all (0%), a little (11%), some (22%), quite a bit (67%)

Life-long learners who viewed the docent-led Life without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Earth is a complex system of interacting rock, water, air, and life and all Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior had increased: not at all (0%), a little (44%), some (22%), quite a bit (33%)

Life-long learners who viewed the docent-led Life Without Sunlight presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the ocean is the last and largest unexplored place on Earth, this is the great frontier for the next generation's explorers and researchers had increased: not at all (0%), a little (11%), some (56%), quite a bit (33%)

The measure of overall engagement or interest (in) the docent-led Life without Sunlight presentation indicated that after the presentation, the Life-long learners rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (11%), some (22%), quite a bit (67%).

### ***Life-long learner Results for Life without Sunlight Movie (LWS)***



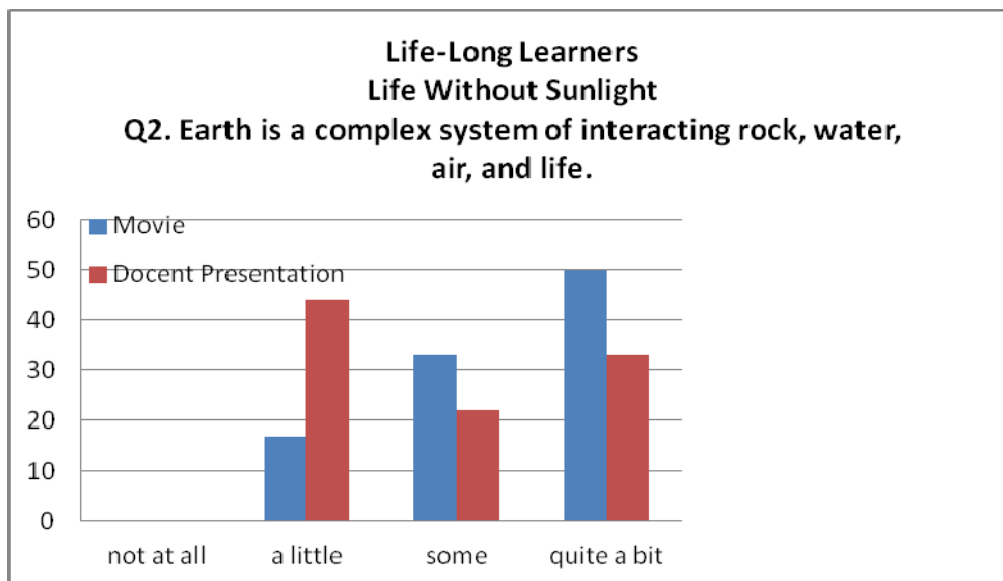
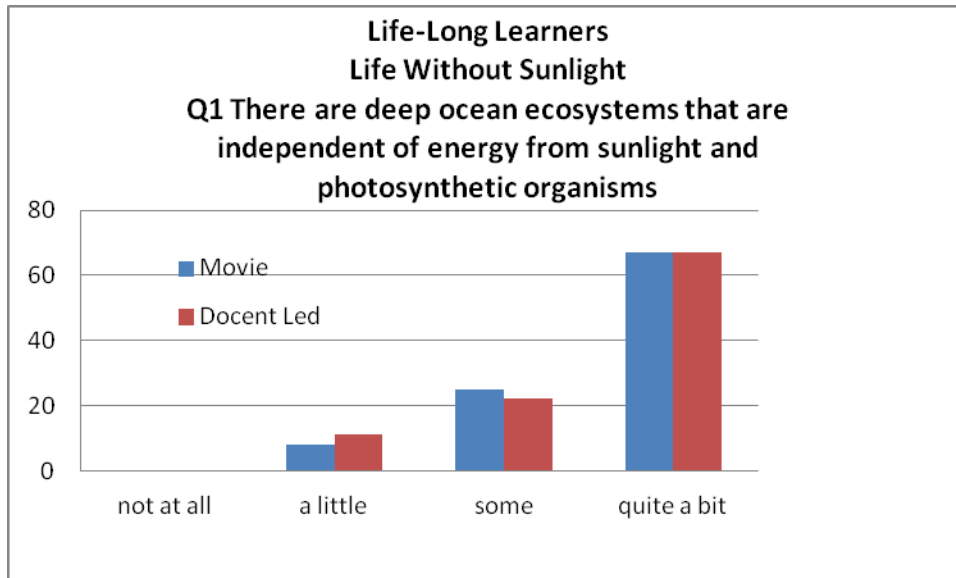
Life-long learners who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that there are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms, and hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life had increased: not at all (0%), a little n=1 (8%), some n= 3(25%), quite a bit n= 8 (67%)

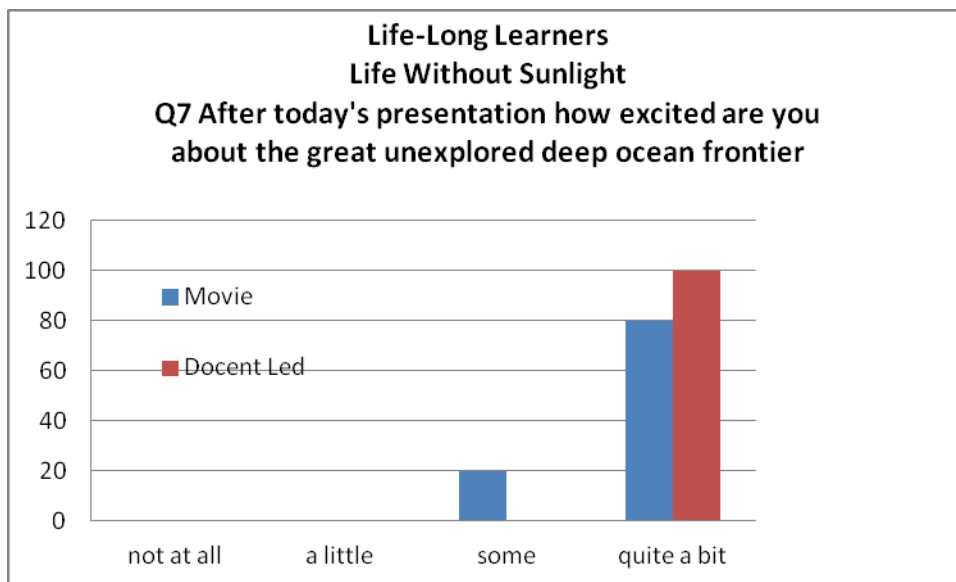
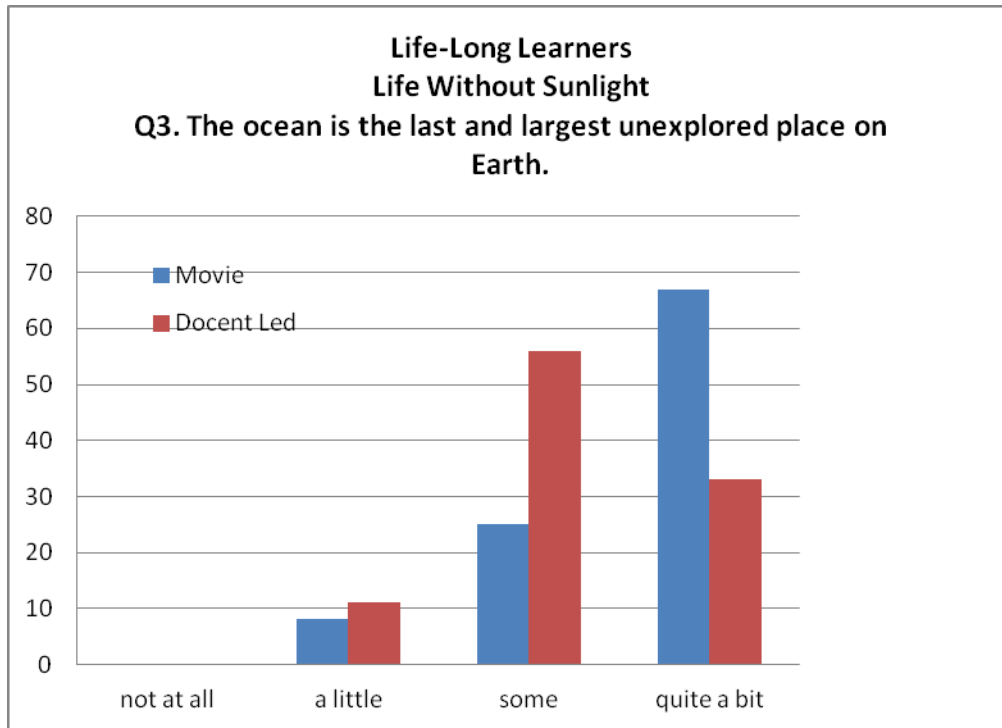
Life-long learners who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Earth is a complex system of interacting rock, water, air, and life and all Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior had increased: not at all (0%), a little n= 2 (17%), some n= 4 (33%), quite a bit n= 6 (50%)

Life-long learners who viewed the Life without Sunlight movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the ocean is the last and largest unexplored place on Earth, this is the great frontier for the next generation's explorers and researchers had increased: not at all (0%), a little n= 1 (8%), some n= 3 (25%), quite a bit n= 8 (67%)

The measure of overall engagement or interest (in) the Life without Sunlight movie presentation indicated that after the presentation, The Life-long learner respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some n= 2 (20%), quite a bit n=8 (80%).

The content gains for Life-long learners from viewing the Life without Sunlight movie and the docent-led presentation showed small variations favoring the movie presentation. In all cases with Life-long learners survey participants the results show that Life-long learners are coming away from either presentation with some new learning. While increased learning was reported after both presentations, the movie presentation Life-long learner's participants reported highest learning results. When the respondents rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents for the presentation their results indicated that the movie presentation generated highest excitement, and none of the Life-long learners reported 'no' excitement at all.





***Life-long learners Results for Docent-led Smoke and Fire Underwater Presentation (SFU)***

Life-long learners who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept Life occupies a wide range of Earth’s environments, including extreme environments at seafloor

vents where hot fluids escape from the oceanic crust life had increased: not at all (0%), a little n= 2 (22%), some n=2 (20%), quite a bit n= 5 (56%)

Life-long learners who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that many active geologic processes occur at plate boundaries and that Plate interactions affect the locations of volcanoes and the distribution of resources and living organisms had increased: not at all (0%), a little n= 1 (11%), some n= 2 (22%), quite a bit n= 6 (67%)

Life-long learners who viewed the docent-led Smoke and Fire Underwater presentation indicated that as a result of seeing the presentation, their knowledge of the concept that new technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean had increased: not at all (0%), a little n= 1 (13%), some n= 3 (37%), quite a bit n= 5(50%)

The measure of overall engagement or interest (in) the docent-led Smoke and Fire Underwater presentation indicated that after the presentation, the Life-long learners rated their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little (0%), some (0%), quite a bit n= 9 (100%).

### ***Results for Life-long learner Smoke and Fire Underwater Movie (SFU)***

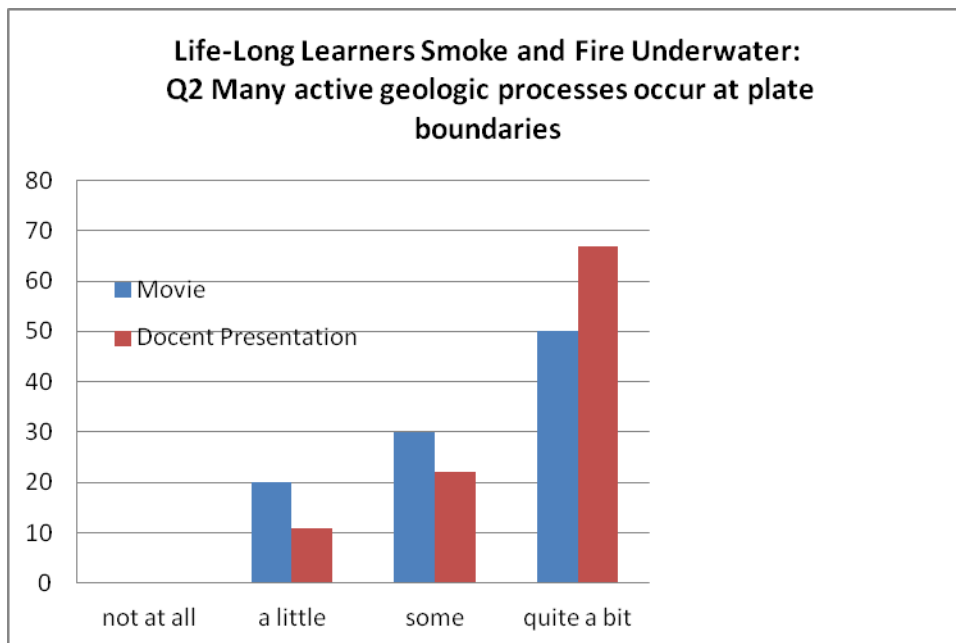
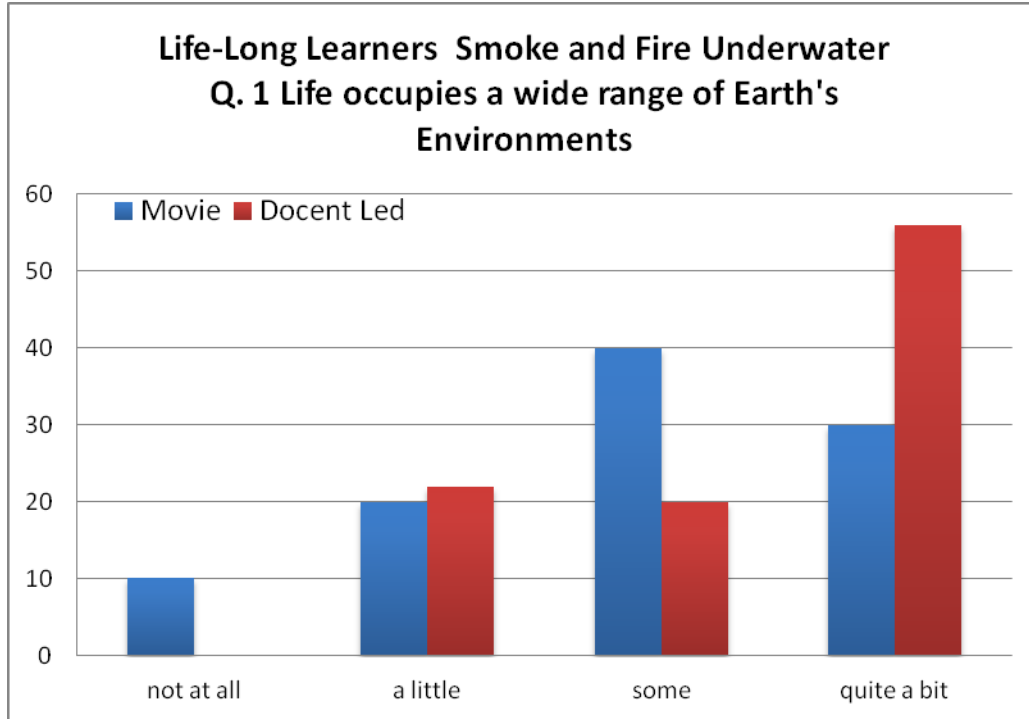
Life-long learners who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that Life occupies a wide range of Earth's environments, including extreme environments at seafloor vents where hot fluids escape from the oceanic crust life had increased: not at all n=1 (10%), a little n=2 (20%), some n=4 (40%), quite a bit n=3 (30%)

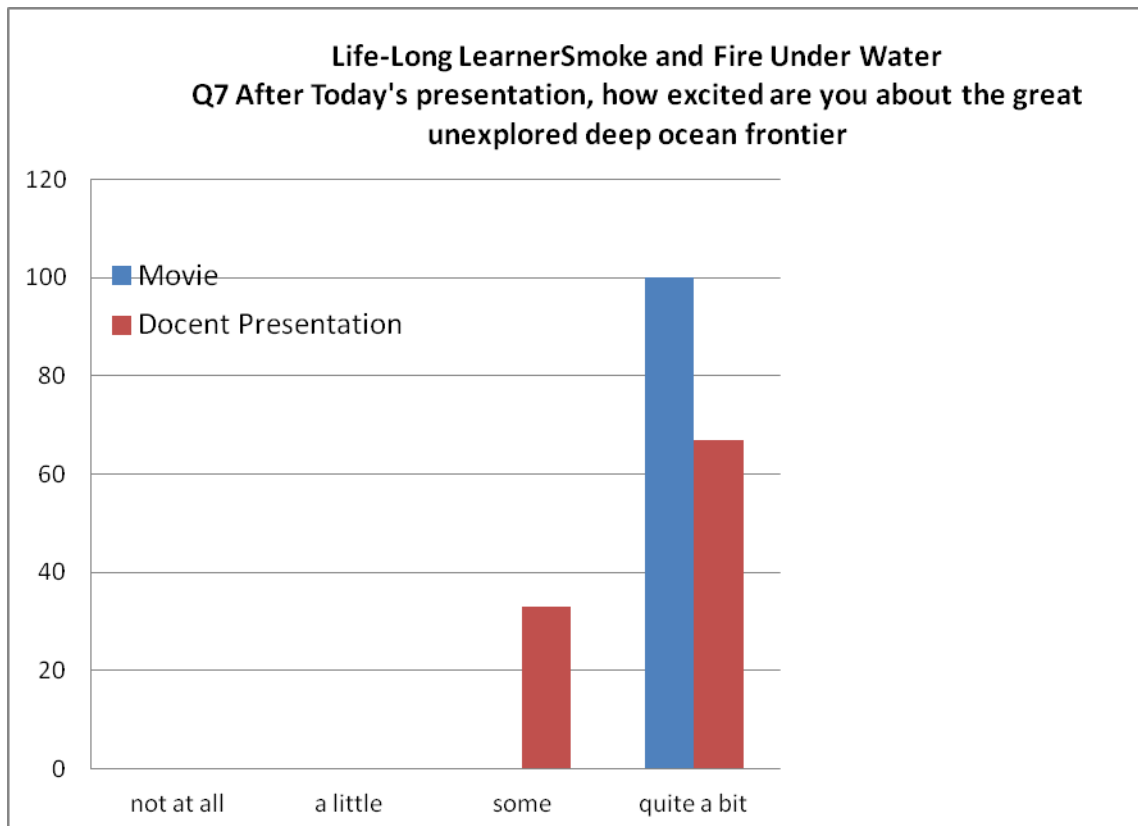
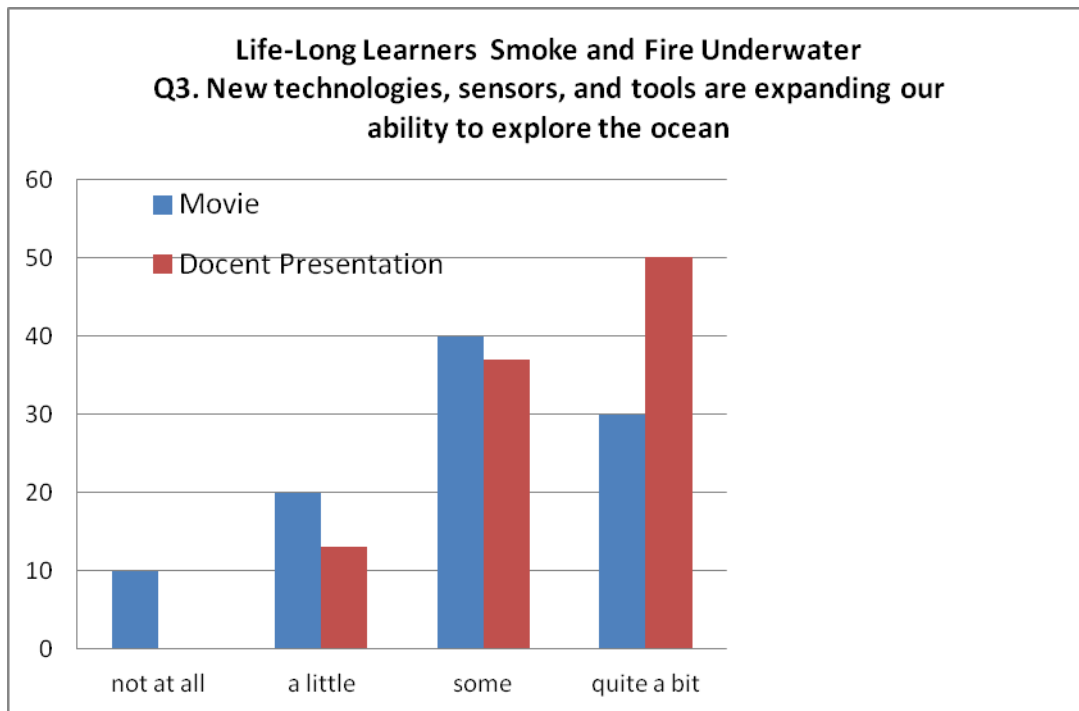
Life-long learners who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that many active geologic processes occur at plate boundaries and that Plate interactions affect the locations of volcanoes and the distribution of resources and living organisms had increased: not at all (0%), a little n= 2 (20%), some n= 3 (30%), quite a bit n=5 (50%)

Life-long learners who viewed the Smoke and Fire Underwater movie presentation indicated that as a result of seeing the presentation, their knowledge of the concept that the new technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean had increased: not at all (10%), a little (20%), some (40%), quite a bit (30%)

The measure of overall engagement or interest (in) the Smoke and Fire Underwater movie presentation indicated that after the presentation, The Life-long learner respondents rated

their level of excitement about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents as: not at all (0%), a little n= 2 (20%), some n= 1(10%), quite a bit n= 7 (70%).





The content gains for Life-long learners from viewing the Smoke and Fire Underwater movie and the docent-led presentation showed some variations in their content learning. In all cases with Life-long learner survey participants the results show that these Life-long learners are coming away from either presentation with some new knowledge. The results indicated that both the movie and the docent-led presentation generated much excitement, with 100% excitement being reported by those Life-long learners who participated in the Smoke and Fire Underwater docent-led presentation. And no one in either presentation reported no excitement at all.

These survey results demonstrate that Life-long learners felt that they had increased awareness, knowledge and or understanding (of) the learning of Earth Science and Ocean Literacy Principles presented through this new content developed for Science on a Sphere. Additionally, this new content generated increased excitement about the great unexplored deep ocean frontier and the exploration and research of deep sea vents for the Life-long learners who participated in the survey.

## CONCLUSIONS

A summative evaluation of the Global Viewport project demonstrated that the newly created content on the SOS was effective in stimulating learning and excitement. Within each group's findings showed there were mixed results for self assessed increased content learning, feeling of excitement, and the effectiveness of docent-led vs. movie presentation.

The demographic survey questions demonstrated that the participants of the four events met the criteria for under-represented / minority students, teachers, and Life-long learners from SouthCoast Massachusetts.

The Students who participated in these events fell within the criteria of under-represented minority students in that the Massachusetts SouthCoast Region includes the cities of Fall River and New Bedford and twelve surrounding towns. The majority of the Students self reported increased learning and increased excitement after viewing both the docent-led, and movie presentations for Life Without Sunlight and Smoke and Fire Underwater.

This introduction of Ocean science exploration to under-represented/minority students as a goal of this project should be considered successful because most Students felt that they had increased awareness, knowledge and or understanding (of) the learning of Earth Science and Ocean Literacy Principles presented through this new content developed for Science on a Sphere. Additionally, this new content generated increased excitement about the great unexplored deep ocean. From this self reported new learning by the Students provides evidence that this program did serve to develop the Future Geosciences' workforce for the future.

The Educator participants reported increased learning after both Life Without Sunlight and the Smoke and Fire Underwater presentations, With regard to presentation type higher number of Educators reported the most learning from the docent-led presentations.

After viewing the Life Without Sunlight presentation or the Smoke and Fire Underwater presentation all Educators reported that they had gained new knowledge that they would incorporate into their classrooms.

The Goal 1.2: *"Educators understand and use the big ideas and principles of Earth System Science literacy in formal and informal learning venues"*, was met because the survey



instrument measured the increased learning of the big ideas and principles of the Earth System Science and the intended use this learning in formal and informal learning venues.

The survey results demonstrated that Life-long learners felt that they had increased awareness, knowledge and or understanding (of) the learning of Earth Science and Ocean Literacy Principles presented through this new content developed for Science on a Sphere. Additionally, this new content generated increased excitement about the great unexplored deep ocean frontier and the exploration and research of deep sea vents for the Life-long learners who participated in the survey.

A major focus of this project was aligned with the GEO Education and Diversity Strategic Plan (2010-2015): with 1.4: *“Life-long learners have access to informal science education opportunities that utilize and/or leverage GEO research.* The new content created for the spherical display systems addressed key principles of Earth Science Literacy and Ocean Literacy with the intent of connecting the public to Earth’s history and dynamic processes, linking the lithosphere, hydrosphere, and biosphere. This goal has been met because the publication of the full package is available for download at the Woods Hole Open Access Server (Beaulieu et al., 2014, DOI: 10.1575/1912/6867, <http://hdl.handle.net/1912/6867>), and educational compilation movies were rendered for posting on YouTube (<https://www.youtube.com/playlist?list=PL1CGd4Scv4GJsaaFRzltk-btFI757bH8f>). The datasets and movies formatted specifically for the SOS are available from the NOAA SOS Data Catalog (<http://sos.noaa.gov/Datasets/index.html>).

This project was successful for *“Improving Public Earth System Science Literacy”*. The overall survey results demonstrated that Students, Life-long learners, and Educators increased their knowledge of Earth Science and Ocean Literacy. A majority of survey respondents, for both the Life Without Sunlight and the Smoke and Fire Underwater reported increased learning of the new content. However, the overall survey data showed few differences between the movie vs. the docent-led presentation for the respondents grouped as Students, Life-long learners, or Educators.

## RECOMMENDATIONS

This report of the project data leads to recommendations for additional study in the following areas:

- An evaluation of narrated movies in an unstructured environment (e.g., when a visitor chooses a movie from a kiosk).
- An Evaluation of narrated movies as value-added components of docent-led presentations.
- An Evaluation of learning from a number of docents presenting the same materials, to test for variability in docent training and style.
- An evaluation of this same content delivered on different digital globes (i.e., different sizes of digital globes).
- An evaluation of how learning can be enhanced by coupling the sphere presentation with a hands-on or other activity.

# APPENDIX I

## SURVEY INSTRUMENT

The Global Viewport Visitor Survey is a survey for the "Global Viewport to Deep-Sea Vents" project funded by the U.S. National Science Foundation. Please check a button below to indicate that you would like to participate. The survey will take only 3 minutes. All the information we collect will be kept in the strictest confidence, and used for research purposes only. It will not be possible to identify any particular individual in the results.

1. I wish to participate in the Global Viewport to Deep-Sea Vents Survey as \*

- A student under 18 yrs old (I have received parental permission to participate in this survey)
- an Educator
- Life-long learner

### 2. Demographic Information

1. I currently live in \*

- New Bedford
- Fall River
- Cape Cod
- A region outside of Southeastern Massachusetts
- Another Southeastern MA Town (Please Specify)

### 3. Educator Survey

1. Will you use what you learned today in your educational activities?

- Definitely won't
- Probably won't
- Probably will
- Definitely will

### 4. Presentation Type

1. Did you view the movie, or participate in a docent-led presentation? \*

- Movie
- Docent-led presentation

2. Which movie/presentation did you see? \*

- Life Without Sunlight (a dive to the Galapagos Rift)
- Smoke and Fire Underwater (a dive to Loihi)

### 5. Life Without Sunlight

**1. There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life.**

**As a result of seeing today's presentation, my knowledge of the above subject has increased:**

Not at all

A little

Some

Quite a bit

**2. Earth is a complex system of interacting rock, water, air, and life. All Earth processes are the result of Earth's systems, including Earth's interior.**

**As a result of seeing today's presentation, my knowledge of the above subject has increased:**

Not at all

A little

Some

Quite a bit

**3. The ocean is the last and largest unexplored place on Earth. This is the great frontier for the next generation's explorers and researchers.**

**As a result of seeing today's presentation, my knowledge of the above subject has increased:**

Not at all

A little

Some

Quite a bit

### **Smoke and Fire Underwater**

**1. Life occupies a wide range of Earth's environments, including extreme environments at seafloor vents where hot fluids escape from the oceanic crust.**

**As a result of seeing today's presentation, my knowledge of the above subject has increased:**

Not at all

A little

Some

Quite a bit

**2. Many active geologic processes occur at plate boundaries. Plate interactions affect the locations of volcanoes and living organisms.**

**As a result of seeing today's presentation, my knowledge of the above subject has increased:**

- Not at all
- A little
- Some
- Quite a bit

**3. New technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean.**

**As a result of seeing today's presentation, my knowledge of the above subject has increased:**

- Not at all
- A little
- Some
- Quite a bit

**7. Rate Presentation**

After today's presentation, how excited are you about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents?

- Not at all
- A little
- Some
- Quite a bit

# **APPENDIX II**

# **PROJECT EVENTS**



**OCEAN  
EXPLORIUM**  
at New Bedford Seaport



## **FREE FAMILY SCIENCE NIGHT**

**Thursday, March 20**

**5:30-7:30**

**Dr. Stefan Sievert**

**Associate Scientist, Biology Department  
Woods Hole Oceanographic Institution  
and**

**Rhonda Moniz**

**Ocean Explorium Resident Explorer**

**Hands-on Activities! Science on a Sphere® programs!**

**Where in the world is the  
Research Vessel *Atlantis*?**

**Join us as we make a call to the deep to find out!**

The Science on a Sphere® is generously provided by a partnership with the University of Massachusetts Dartmouth.



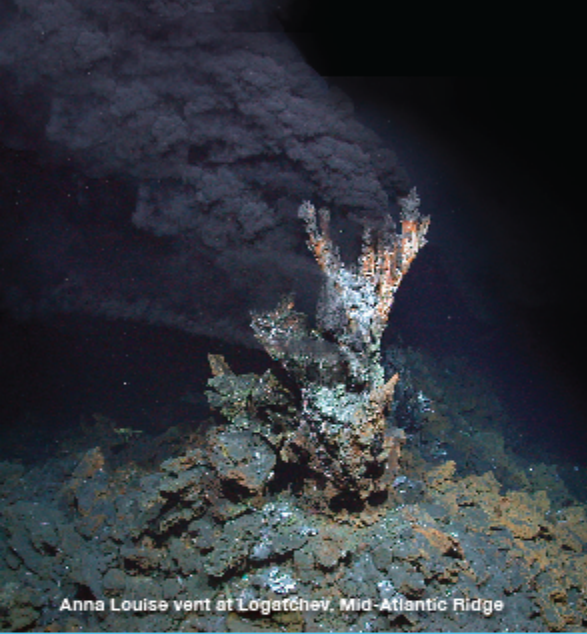
**174 Union Street  
New Bedford, MA 02740**

**tel: 508.994.5400  
www.oceanexplorium.org**



# Teacher PD Workshops for Virtual Exploration of Deep-sea Vents

Using Spherical Displays to Advance Public Literacy in Earth System Science



Anna Louise vent at Logatchev, Mid-Atlantic Ridge

## New Bedford, fall 2014:

An Ocean Academy Content Institute will be offered at the Ocean Explorium, for 3 evenings (3:30-7:00 PM) for a total of 10 PDP hours:

*Energy and Living Things, highlighting the Life Without Sunlight educational content.*

Join our Teacher PD mailing list by contacting Ellen Dion ([edion@oceanexplorium.org](mailto:edion@oceanexplorium.org)) to find out about this offering and more!

## Woods Hole, fall 2014:

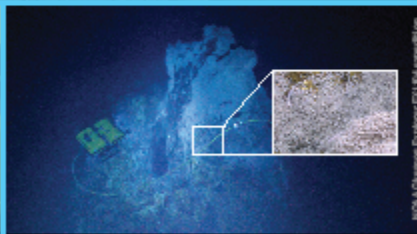
This 1-day workshop is targeted for middle school teachers and will be held at the Woods Hole Oceanographic Institution (WHOI) Exhibit Center, highlighting the Smoke and Fire Underwater educational content.

Please contact Kate Madin ([kmadin@whoi.edu](mailto:kmadin@whoi.edu)) if you are an Educator and would like to be added to our mailing list for this opportunity.

MA 02543, University of Bremen, Germany



The Magic Planet at Woods Hole Oceanographic Institution's Ocean Science Exhibit Center



ROV *Little Hercules* explores Von Damm vent at Mid-Cayman Rise, finding an abundance of shrimp (*Rimicaris* sp.) at 2300m depth.



New content for Science on a Sphere is being evaluated at the Ocean Explorium in New Bedford.

[www.divediscover.whoi.edu/sos/](http://www.divediscover.whoi.edu/sos/)




This project is a collaboration between Woods Hole Oceanographic Institution and New Bedford Ocean Explorium




Our project is funded by NSF Geoscience Education #1202977

# APPENDIX III

## PROJECT EDUCATIONAL DISPLAYS




### ED53G-0684: Partnering and teamwork to create content for spherical display systems to enhance public literacy in earth system and ocean sciences



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#### Why create content for spherical display systems?

Spherical display systems, also known as digital globes, are technologies that, in person or online, can be used to visualize global datasets and Earth system processes. Using the InterRidge Vents Database and imagery from deep-sea vehicles, we created content for spherical display systems to educate and excite the public about dynamic geophysical and biological processes and exploration in the deep ocean. The "Global Viewport for Virtual Exploration of Deep-Sea Hydrothermal Vents" is a collaboration between the Woods Hole Oceanographic Institution and the Ocean Explorium at New Bedford Seaport, hosting a Magic Planet and Science On a Sphere® (SOS).

#### New content tied to Earth Science and Ocean Literacy Principles

We produced two educational movies, each matched to a scripted, interactive, docent-led presentation – and each focusing on a different set of three literacy principles.

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#### Iterative design and development

We developed our content through a process similar to an iterative software development process, in which: "A use case is a collection of possible sequences of interactions between the system under discussion and its Users (or Actors), relating to a particular goal" (Fox and McQuinness 2008).

**Use Case:** Our Use Case was to develop a dataset and educational package for spherical display systems that would excite the public while teaching several literacy principles.

**Small team, mixed skills:** Our core team is composed of a lead scientist, educators at both institutions, graphic artists, and a professional evaluator.

**Analysis:** To scope the data and related resources, we assessed available HD imagery from deep-sea vehicles and georeferenced the imagery to hydrothermal vent fields in the InterRidge Vents Database.

**Develop model/ontology:** We adopted several Earth Science and Ocean Literacy Principles, determined by the broader geosciences & education communities as important for public scientific literacy.

**Use tools:** We used a variety of software, ranging from Matlab to GIS to video editing to online survey software.

**Science/expert review:** We involved scientific colleagues to review each site-specific movie and script.

**Adopt technology:** We worked with the NOAA SOS Technical Team to develop the content for layering and annotation in SOS Version 4.

**Leverage in infrastructure:** We integrated our new content with existing datasets available to the SOS Users Network.

**Prototype iteration:** We completed 3 cycles: Nov. 2012, April 2013, and Aug. 2013. Our front-and evaluation was completed at the end of the 1<sup>st</sup> cycle.

**Evaluate:** The most important consideration in our formative evaluation related to: "Any system behavior that is irrelevant to the Actors should not be included in the use case." Basically, all content needed to pertain to the chosen literacy principles and be presented in an engaging design that effectively used the spherical display platform.

#### "Life without sunlight"

**DLP 3.2:** Earth is a complex system of interacting rock, water, air, and life. All Earth processes are the result of energy and mass moving between Earth's systems, including Earth's interior.

**DLP 5.g:** There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents rely only on chemical energy and chemosynthetic organisms to support life.

**DLP 7.a:** The ocean is the last and largest unexplored place on Earth. This is the great frontier for the next generation's exploration and research.

Linked to public SOS presentation: "Primary Productivity" and K-12 field trip program: "Energy and living things"

#### "Smoke and fire underwater"


**DLP 4.3:** Many active geologic processes occur at plate boundaries. Plate interactions affect the locations of volcanoes and the distribution of resources and living organisms.

**DLP 6.3:** Life occupies a wide range of Earth's environments, including extreme environments at seafloor vents where hot fluids escape from the oceanic crust.

**DLP 7.d:** New technologies, sensors, and tools such as subsea observatories and unmanned submersibles are expanding our ability to explore the ocean.

Linked to public SOS presentation: "Dynamic Earth" and K-12 field trip program: "Earth Science"

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Adapted from: Fox and McQuinness (2008) "A use case is a collection of possible sequences of interactions between the system under discussion and its Users (or Actors), relating to a particular goal".

#### Evaluation of two impact categories for informal science education

Our survey questionnaire focuses on two impact categories in NSF's *Framework for Evaluating Impacts of Informal Science Education Projects*: "Awareness, knowledge or understanding" and "Engagement or interest."

Our experimental design is "Quasi-experimental Study, Post-test Only Intact Group Design" with quantitative data based on self-reporting on a Likert scale.


In addition to inquiring about knowledge gained for the literacy principles above, we ask about a standard term, "excited," on the Positive Affect Negative Affect Schedule (PANAS): "After today's presentation, how excited are you about the great unexplored deep ocean frontier and the exploration and research of deep-sea vents?"

Our data will be used to test "the contention that the public learns science in settings and situations outside of school" (Faik & Dierking 2010, *The 93 Percent Solution, Am. Sci.*). We are especially interested in comparing the results between Users who watch a stand-alone spherical display movie vs. live docent presentations with the SOS. Respondents, who remain anonymous, also provide demographic information related to age, home town, and educational attainment. For those respondents who are professional educators, we ask whether they are likely to use what they learned in their educational activities.

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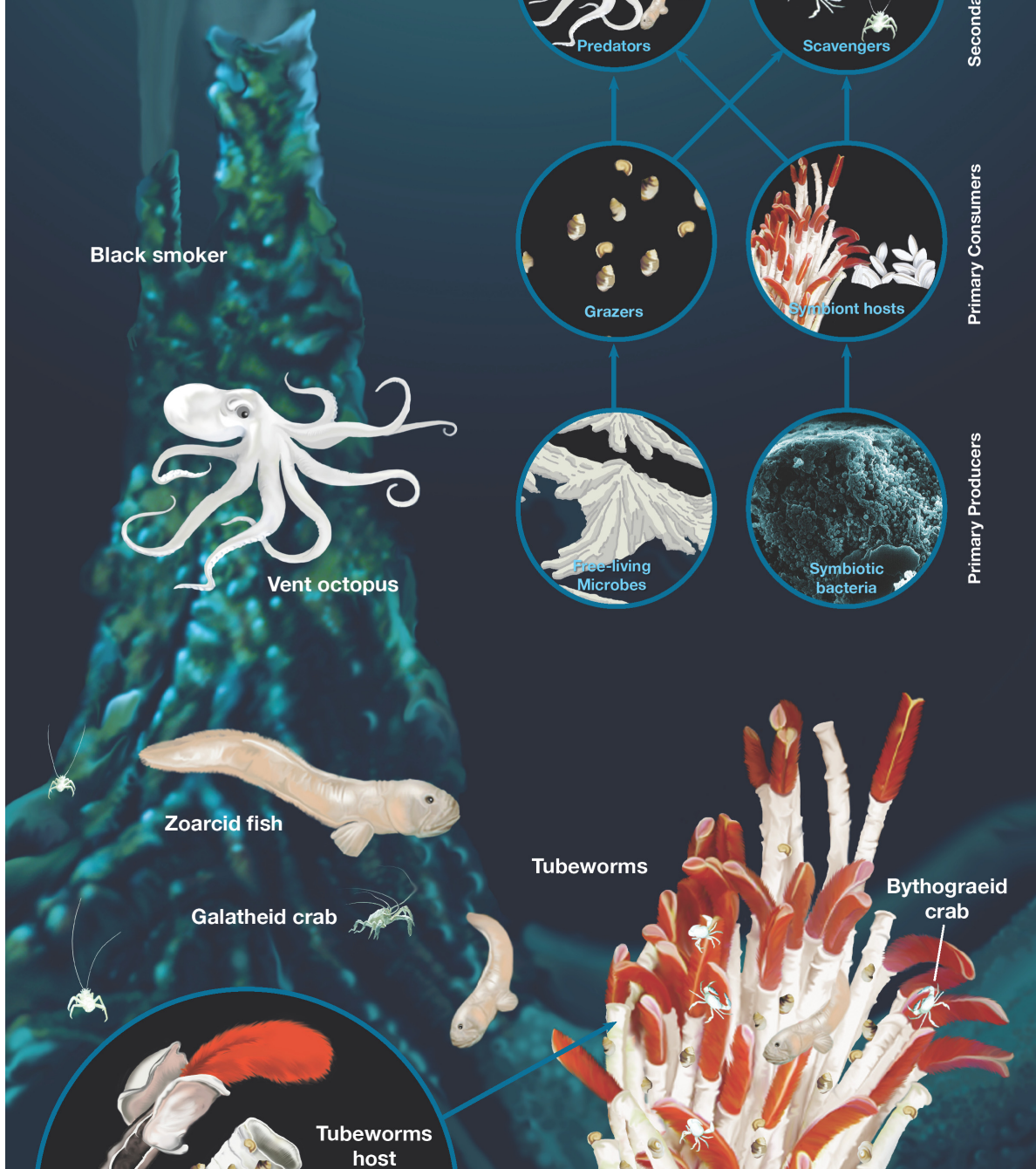
Learn more at <http://divediscover.whoi.edu/sos>

Funded by NSF GeoE-1202977

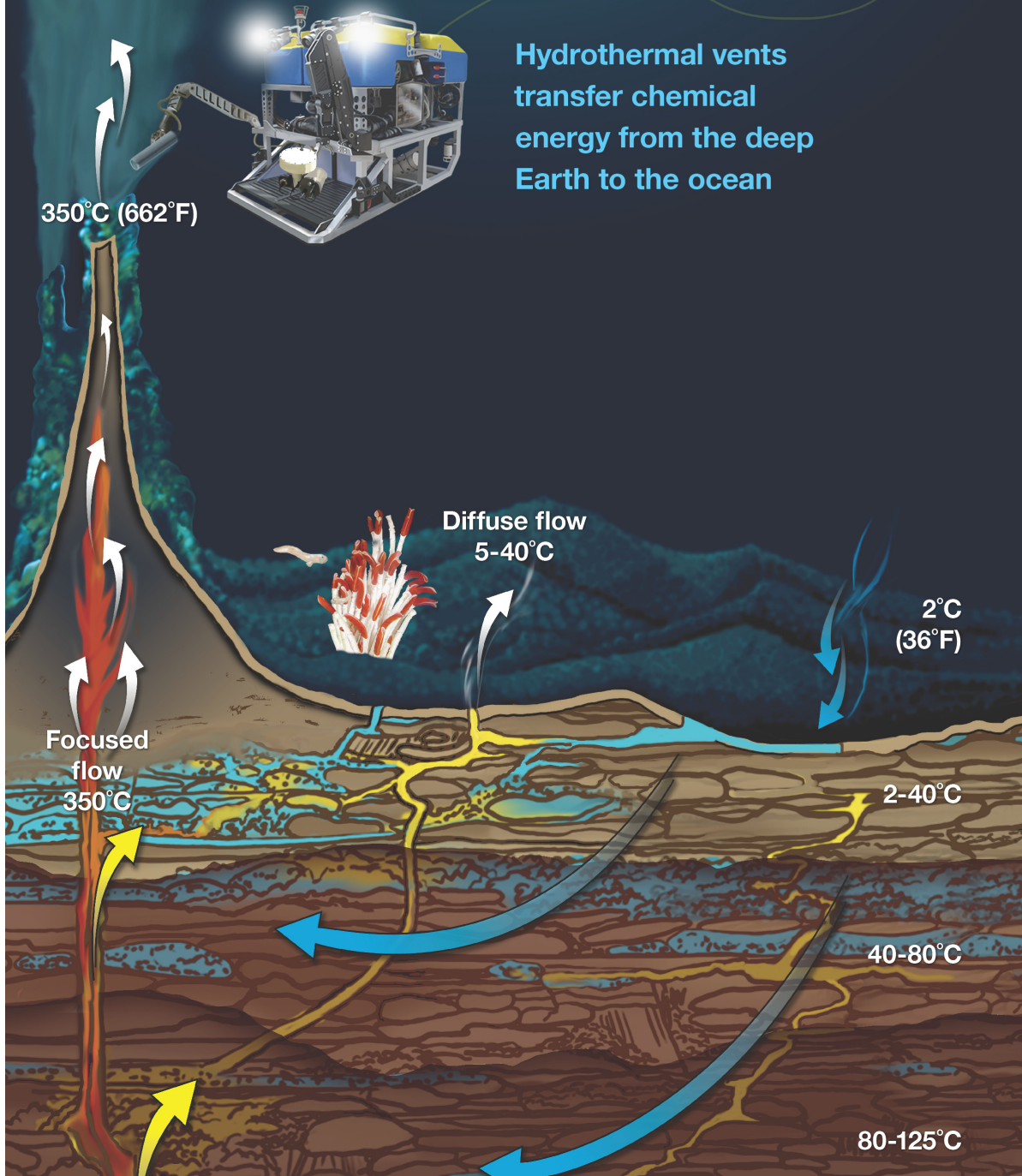


# Life without Sunlight

Chemosynthesis supports the food web at deep sea hydrothermal vents.



# Smoke & Fire under water



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