Students' Attitudes and Understandings about Science in their Field Trip to Laser Interferometer Gravitational-wave Observatory

Hyunju Lee, Allan Feldman
Secondary Education, University of South Florida, Tampa, FL
AAS 224th meeting, Boston, MA • 1-5 June 2014

1. LIGO

LIGO's mission is to directly detect gravitational waves. These waves were predicted by Einstein's General Theory of Relativity in 1916. There are two LIGO observatories in US: one is the LIGO Livingston Observatory in Livingston, Louisiana, and the other is the LIGO Hanford Observatory in Richland, Washington.

LIGO Livingston Observatory

2. LIGO Livingston Science Education Center

The LIGO Livingston Observatory Science Education Center (SEC) provides various public outreach programs to students, teachers, and the public. One of the main programs of LIGO SEC is field trips for K-12 students.

LIGO SEC Field Trip Programs
(3-4 hours) consist of:

LIGO Livingston Science Education Center

- Watching a documentary movie about Einstein and the LIGO mission (*Einstein's Messenger*)
- Touring the observatory and facilities
- Classroom hands-on activity
- Exploring interactive science exhibits

http://www.ligo-la.caltech.edu/SEC.html

LIGO Science Education Center

3. Methods

Research Question: What do students learn from the field trip to LIGO?
1) Attitudes and interests about science;
2) Understanding of basic scientific concepts relevant to LIGO science
3) Understanding of LIGO project

Participants: Approximately 1,000 students (5th -9th) who visited the LIGO as their field trip in Spring 2013

Data Collection: Pre/Post-survey

Analysis: Mixed-method (descriptive statistics, t-test, qualitative data analysis)

4. Current Findings (from 410 students)

4.1. Attitudes & Interest about Science

- The field trip to LIGO had significant positive impact on increasing the number of students who think that "science is fun" and that "they would want to be a scientist" ($p<0.05$).
- Correlation between variables (significant)

Variables	Pearson's r
Positive: (Number of previous visits to LIGO) and (Number of previous visits to Science Museums)	r=.105 p=.035
Positive: (Number of previous visits to LIGO) and (Interest to Science before this field trip)	r=.110 p=.027
Positive: (Number of previous visits to Science Museums) and (Interest to Science before this field trip)	r=.161 p=.001
Negative: (Number of previous visits to LIGO) and (Interest Gain from the field trip) * → This indicates that "the ones who were never to LIGO gained higher interest about science from this field trip."	r=-.138 p=.006

- The ones who gained higher interest to science from this field trip (higher difference between post-pre interest) showed:
  1) Gained more positive thoughts about science.

More who think that "Science is fun" (r=.347, p=.000)
Less who think that "Science is always difficult and boring." (r=-.276, p=.000)
More who think that "I would want to do science-related work in my future." (r=0.215, p=.000)
More who think that "I would like to be a scientist." (r=.162, p=.001)
More who think that "I may not make great discoveries, but working in science would be fun." (r=.228, p=.000)

* Same tendency for the number of previous visits to science museums, but not strong enough to be significant. (r=-.043, p=.388)

2) Gained better understanding about science & scientists.

More who think that "Scientific ideas can be changed." (r=.169, p=.001)
More who think that "Scientists must report exactly what they observe." (r=.171, p=.001)
Less who think that "It is useless to listen to a new idea unless everybody agrees with it." (r=-.130, p=.010)
Less who think that "If one scientist says an idea is true, all other scientists will believe it without doubt." (r=-.121, p=.017)

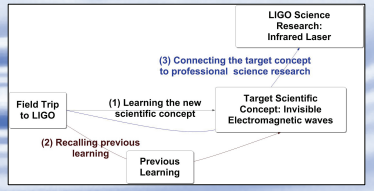
3) Gained more positive attitude about the necessity of science.

More who think that "People must understand science because it affects their lives." (r=.167, p=.001)
More who think that "It is worth to spend time and money to do science research." (r=.209, p=.000)
More who think that "It is necessary for people to understand science." (r=.176, p=.000)

4.2. Understanding of Basic Scientific Concepts relevant to LIGO Science

- No significant content gain about Gravity and Sound.
- The students had significant content gain ($p<0.05$) in understanding that invisible light exists that is not seen to human eye and naming them (such as UV and infrared).

Learning happened in three ways:

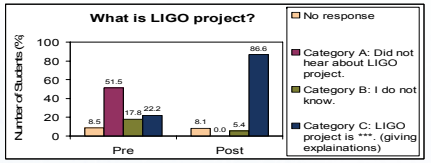


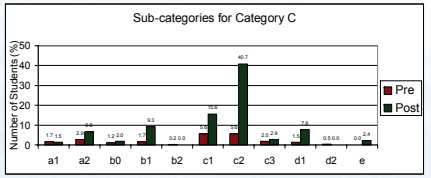
1) Learning the New Scientific Concept
(ex.) school B, S096, 6th student
pre: "Nah, I have to see it to believe it."
post: "Yeah, it's called infrared light. It's the color past red on the rainbow chart."

2) Recalling Previous Learning
(ex.) School E, S085, 6th student
pre: "Yes, but I don't remember."
post: "Yes. Gamma ray, radio waves, microwaves"

3) Connecting the target concept to professional science research.
(ex.) School E, S130, 6th student
pre: "I think there is light that we can't see. All absorbed light."
post: "I think there is light we can't see. This light is infrared light and ultraviolet light. The laser at LIGO is concentrated infrared light."

4.3. Understanding of LIGO Project





a. Education/ Attitude	a1: interest/attitude in science (ex.) *"To help kids and to make science fun"*
	a2: help people & students learn science/scientist better (ex.) *"It's to help children learn about science"*
b. Broad concept of Science	b0: no more info than "science" or "scientists" (ex.) *"A group of scientists"*
	b1: general characteristics of science research (ex.) *"To discover new things about science"*
	b2: negative attitude, or non-general characteristics of science research (ex.) *"I think it's a secret government operation trying to enslave the universe"*
c. Science Research: LIGO science	c1: provide a key concept that is related to LIGO science, but in a broad sense, or with limited description (ex.) *"To detect waves in space"*
	c2: correctly describing LIGO science research (ex.) *"It's about finding G-waves so that they can track down the source of the Big Bang", "To prove Einstein's theory of relativity"*
d: Other science research: topics that is not the main LIGO science	d1: misconception that is somewhat related to LIGO science (ex. Mostly, concepts of physics, earth science, astronomy) (ex.) *"To measure for speed of light", "To locate things like earthquakes"*
	d2: misconception that is not related to LIGO science (ex. biology, chemistry, or medical science, etc.) (ex.) *"the project I would do something about animals"*
e: others	e: response that does not fit into the above sub-categories (ex.) *"To build stuff"*

5. Summary

- The 4-hour field trip to LIGO and its education center gave the visiting students positive impacts about science and scientists.
- This field trip led the students to recognize that science can be fun and to consider science as their future career positively.
- While it was a short visit, it showed the evidence that the students could actually gain content knowledge as well from the visit to a science museum.
- This study supports public outreach programs for professional science research centers because they can lead to students broadening their view of science and helping them recognize the value of science research.

Acknowledgement: This study was funded by NSF PHY0917587. We would like to thank LIGO SEC staff members and participated students.
Authors' email: Dr. Hyunju Lee (hyunju.umass@gmail.com), Prof. Allan Feldman (afeldman@usf.edu).