The effects of S-BEL program on middle school students' awareness about scientific literacy and attitudes changes[1)]

Ji-Seon Ha* · Hyong-Jae Lee · Kee-Ju Jeong · Sang-Tae Park
Department of Physics Education, Kongju National University, Kongju 314-701

Abstract: The science museum shows the progress of science technology and its historical footsteps providing a vision of future science technology to the people living in the present society of science technology by offering them to scientific knowledge and science-related information. It is also a field of education which helps people to recognize the relationship of the society and science technology, which builds science-culture of all people. The exhibits in the Science Centers are by themselves fairly influential to science education. It is in a complementary relationship with the school subject and provides opportunities for an alternative kind of learning that cannot be easily realized in the boundaries of the schools. In order to successfully integrate the regular curriculum at school and the activities outside, it is the most effective to interrelate the regular curriculum and the outside activities in teaching the students. In consideration of the above, the purpose of this study is to find out the implication of the educational activities in the Science Centers on science education by examining the changes and awareness on science in a science-technology-societal perspective held by middle school students in a case study of S-BEL (Scientorium Based Exploration Learning) implemented by Gwacheon National Science Center , which provides a proper educational content reflecting the school curriculum and provision of information on the facility for out-of-school learning activities.

Key Word: creative experience activities, S-BEL (Scientorium Based Exploration Learning), science-technology-societal relationship, changes in the understanding and awareness on science

Corresponding author: JI-Seon Ha(physicslove0521@gmail.com)

Introduction

Due to the curriculum revision in 2009 by the Ministry of Education, Science, and Technology, newly introduced creative experience activities are in operation in all schools. The purpose of the creative experience activities is to foster the practical implementation of the knowledge and cultivation of future oriented human resources that are equiped with both sound personality and creativity. To realize this goal, it is necessary for the curriculum to allow the student form a base of sound and practical knowledge and teach them to find and utilize the necessary knowledge for themselves. Also, in order for the efficient operation of the creative experience activities, the human and physical resources in the local community should be put to use based on carefully calculated plans. (Ministry of Education, Science, and Technology, 2009) As a part of such creative experience activities, the importance of the Science Centers is being emphasized as a place where the students can have the scientific and cultural experiences in connection with the science subject. Among various physical resources outside of the schools, the Science Centers especially provide opportunities for the students to have a broader perspective on the science and have a first hand experience of the science in our daily lives. (Cho, 2003) The exhibits in the Science Centers are by themselves fairly influential to science education. It is in a complementary relationship with the school subject and provides opportunities for an alternative kind of learning that cannot be easily realized in the boundaries of the schools. (Semper, 1990) The Science Centers are also serving as the facilities in which the students can learn about the history of science, the progress it has made, and the visions of future science and society. It plays the role of cultivating the scientific creativity of the juveniles and deepen the understanding on science by the general public. (Minseon Lee, 2010)

While it is generally agreed that the learning experiences outside of the school boundary promotes the experience and the interests of the students, more attention is needed on the method by which such learning opportunities outside of the schools and the regular curriculum can be interwoven seamlessly. According to the survey, many interviewees answered that the visits to the Science Center are helpful in studying for school. But, most of them also answered that such an events were not sustained, ending up as arbitrary happenings that comes from time to time. The teachers pointed out various difficulties that obscures the visits to the Science Centers, including the semester schedules in school, difficulties in the operation of the curriculum, the work load implicated on the teachers, lack of information on the Science Centers, difficulties in guiding and leading the students as they visit

and see the facility, and lack of information on science and the education programs for that. (Jinwoong Song, et al. 2003; Sejin Jeong, 2003; Hyewon Kim, 2004) But, a good number of them were aware of the necessity of the interrelated activities between the school curriculum and the science education. And, they suggested that it is necessary to develop the science education program that can go along with the science curriculum at schools, as well as promotion thereof. (Hyewon Kim, 2004)

In order to successfully integrate the regular curriculum at school and the activities outside, it is the most effective to interrelate the regular curriculum and the outside activities in teaching the students. (Hyunsook Chang, 2005)

In consideration of the above, the purpose of this study is to find out the implication of the educational activities in the Science Centers on science education by examining the changes and awareness on science in a science-technology-societal perspective held by middle school students in a case study of S-BEL (Scientorium Based Exploration Learning) implemented by Gwacheon National Science Center , which provides a proper educational content reflecting the school curriculum and provision of information on the facility for out-of-school learning activities.

Research Samples and Method

1. Research Samples

The samples used in this study were composed of 32 middle school students who were members of science circles in public middles schools within the city with a view to analyze the changes in understanding and awareness when S-BEL program was applied to a set of the above mentioned sample students. The members of the science circles were selected in a 2-phased qualification process. The first phase was a oral test, by which 30 candidates were selected. And, 32 students were finally accepted to the science circles by evaluating the free-exploration reports which was a group project that was part of the creative experience activity program for the 1st semester. For the finally analysis, 31 of 32 survey questionaries were used, as one of them was excluded due to untrustworthy answers.

2. Measurement Tool

While the previous use of the Science Center was as the place for debates or suggestion on alternative concepts by the visitors while reviewing the ideas they got from the visits, the current objectives of the Science Centers is to suggest the science in close interrelations with various cultures by the visitors, while they engage in conversations and debates on imminent issues that affect the entire earth. (AAM, 1992) In this

study, the subject students visited four Science Centers over a period of five months to measure the changes in the students' awareness and the long term influence of the visits to the Science Centers and selected the S-BEL program of Gwacheon National Science Center which was of the highest preference by the students to examine the opinions of the students on the themes related to science-technology-society. The long term influence of the field trips to the Science Centers to the students was measured in two different aspects, of which one is examination of the changes in the understanding and awareness on science in terms of the science-technology-societal relationship, while the other was the changes in the understanding and awareness on science held by the students as a result of the implementation of the S-BEL program. The measurement tool used to measure the changes in understanding and awareness of the STS relationship by the field trips to the Science Center was the VOSTS (Views on Science-Technology-Society) questionnaires developed by Aikenhead, Ryan and Flemming (1989) to be used on students to measure the opinions held by the students on STS related topics. Science VOSTS was made in a way to allow extraction of a part of the questionnaires in accordance with the purpose of the study, only 5 questions that asked the changes in the scientific understanding and awareness in terms of the STS relationship. The questions used in this study was verified by 2 science education experts and 3 graduate students who were on their doctors and masters degrees' courses for the appropriateness of the interpretation and the answers.

The measurement of the changes in scientific understanding and awareness as a result of the field trips to the Science Centers using S-BEL program was measured by using the measurement tools developed in a preceding study by Hyunsook Chang (2005), with reviews and feedbacks from 2 science education experts and 3 graduate students who were on their doctors and masters degrees' courses for the appropriateness of the interpretation and the answers.

3. Evaluation and Analysis

VOSTS tool has the advantage of being capable of measuring the perspectives of the students rather precisely. But, it has its own difficulty in the inference statistical analysis by the comparison between the groups and verification of the effects on the students as a result of their visits to the Science Centers. So, Rubba, Schoneweg, and Harkness (1996) categorized the answers from the students in realistic opinions, opinions that has merit, and naive opinions, which were given with 3, 2, 1 points respectively.

Table 1. The Evaluation System for the Answers from the Students

Category	Points	Description
Realistic Opinion	2	Appropriate opinion on the science-technology-societal relationship
Opinion that has merit	1	Non realistic but has merits to some extent
Naive Opinion	0	Untrustworthy or inappropriate opinion

The points could be calculates by using the above mentioned method. But, each of the category is not sound enough to be regarded as an evenly distributed scale. Therefore, the comparison between the awareness levels before and after the field trips was done by Wilcoxon method, which is a kind of responsive sample t-verification which is a parametric statistical method among non-parametric method. As for the changes after the visits to the Science Centers using S-BEL programs before and after the field trips, t-test method was used to measure the trend in the changes of the understanding and awareness on science. All answers were processed using SPSS software.

Table 2. Questions extracted from VOSTS

No.	Question		Preliminary Test		After Test	
			Frequency	Percentage	Frequency	Percentage
1	The science and technology are closely connected.	Realistic Opinion	17	54.8	16	51.6
		Opinion that has merit	11	35.5	11	35.5
		Naive Opinion	3	9.7	4	12.9
2	The policy of the government influences the scientists since they are still part of the society.	Realistic Opinion	11	35.5	11	35.5
		Opinion that has merit	6	19.4	7	22.6
		Naive Opinion	14	45.2	13	41.9
3	The scientists should be responsible for the possible damages caused by their researches.	Realistic Opinion	10	32.3	10	32.3
		Opinion that has merit	9	29.0	10	32.3
		Naive Opinion	12	38.7	11	35.5

4	We have to find a way to accept the positive and negative aspects of the science and technology with a compromise between them.	Realistic Opinion	11	35.5	14	45.2
		Opinion that has merit	7	22.6	9	29.0
		Naive Opinion	13	41.9	8	25.8
5	As the technology improves, our lives will be better.	Realistic Opinion	10	32.3	7	22.6
		Opinion that has merit	18	58.1	23	74.2
		Naive Opinion	3	9.7	1	3.2

Table 3. Questions to measure the awareness of the students on the field activities outside of the school (preliminary testing)

No	Questions
1	Pervious visiting experience to the Science Centers
2	If 'yes' to question No.1, the most memorable place within the facility
3	The reason of visit
4	Preferred mode of field trips to the science centers
5	Which Science Center does the interviewee wants to visit and why
6	Is it helpful to visit the Science Centers for studying?
7	The level of interest about the field trips to the Science Center
8	The level of efficacy from the visit to the Science Center
9	The level of demand for the visits to the Science Center
10	The level of correlation between the field trip to the Science Centers and studying science
11	The scale of attitude in participating the field trip
12	The scale of efficacy from the field trip

Table 4. Questions regarding the awareness on the field trips for students (after testing)

No.	Questions
1	The most memorable science center among the places you have been visiting and why
2	The most memorable exhibitions or facilities in the places you have been visiting and why
3	The Science Center that you would like to visit again or recommend to others and why
4	The Science Center you would like to visit and why
5	Is it helpful to visit the Science Centers for studying? If so, why?
6	Any interrelated ideas on social issues among the contents of the programs you have seen at the Science Centers? If there is, what was it?

7	The preferred mode of field trips to the Science Center
8	The preferred kind of activity sheets that are give during the visits to the Science Centers
9	The level of utilization of the activity sheets
10	The level of interest on the field trips
11	The scale of efficacy from the field trips to the Science Center
12	The scale of demands for the field trips to the Science Center
13	The scale of the relationship between the field trips to the Science Center and studying Science
14	The scale of the relationship between the science and daily lives
15	The scale of attitude in participating in the field trips
16	The scale of negative impacts from the visits to the Science Center
17	The scale of the increase in the interest on the science as a result of the visits to the Science Center
18	The scale of attitude on the promotion of the Science Center
19	The scale of the intent in pursuing a career in science
20	The level of interest in the influence of the science on the society

4. Study Result

As a result of the preliminary survey to find out the level of awareness and understating on science regarding the Science-Technology-Societal relationship held by the middle school students, the student samples scored 5.46 in average out of 10. The after testing conducted after the field trip to the Science Centers showed an average score of 5.68, which showed an increase of 0.22. Based on a verification process developed by Wilcoxon, the difference turned out to be statistically significant.

Table 5. The result of Wilcoxon verification and the average testing scores for the comparison of thew awareness of the Science-Technology-Societal relationship before and after the field trips to the Science Center

Questions	Preliminary (n=31)		After (n=31)			
	Average	Standard Deviation	Average	Standard Deviation	Z	P Value
Scores	5.46	0.790	5.68	0.750	-0.50[a]	0.665*

*P <.05

a. based on the negative order

The verification result of the average scores for each questions before and after the visits to the Science Centers by Wicoxon verification process was as shown in <Table 6> below.

<Table 6> The result of Wilcoxon verification on each of the questions in order to compare the level of awareness before and after the vitis in terms of the Science-Technology-Societal relationship (n=31)

Question	Preliminary (n=31)		After (n=31)		Z	P Value
	Average	Standard Deviation	Average	Standard Deviation		
1	1.45	.675	1.39	.715	-.361[a]	.718
2	.90	.908	.94	.892	-.226[b]	.821
3	.94	.854	.97	.836	-.226[b]	.821
4	.94	.892	1.19	.833	-1.405[b]	.160
5	1.23	.617	1.19	.477	-.243[a]	.808

*P <.05

a. based on a negative order

b. based on a positive order

The preliminary testing was conducted one week before the visit, while the after test was conducted immediately after the visit to Gwacheon National Science Center, which received the highest preference for repeated visits. The comparison of the awareness before and after the visit was carried out using responsive sample t-test, which is one of the parametric statistical technique of non-parametric statistical methods. And, the test was conducted mainly on two aspects of the preference to the field trip to the Science Centers and the efficiency of the field trip activities.

Table 7. Comparison of the test answers before and after the visits to the Science Center

Category	Question	Test		Absolutely not	No	Moderate	Yes	Absolutely	Average	t-Value
Preference to the field trips	It is fun to visit the Science Centers	Before	Number (answers)	1	1	11	13	6	3.69	.284
			Percentage(%)	3.1	3.1	34.4	40.6	18.8		
		After	Number (answers)	0	4	10	12	6	3.63	
			Percentage(%)	0	12.5	31.3	37.5	18.8		
	The facility you visited and the programs there were helpful for your studying science.	Before	Number (answers)	3	4	13	9	3	3.16	-1.137
			Percentage(%)	9.4	12.5	40.6	28.1	9.4		
		After	Number (answers)	0	7	6	18	1	3.41	
			Percentage(%)	0	21.9	18.8	56.3	3.1		
	I will be glad to participate in the field trips to the Science Centers.	Before	Number (answers)	1	2	10	11	8	3.72	-.150
			Percentage(%)	3.1	6.3	31.3	34.4	25.0		
		After	Number (answers)	0	2	10	14	6	3.75	
			Percentage(%)	0	6.3	31.3	43.8	18.8		
Awareness on the efficiency of the field trip to the Science Center	It field trips are too distracting and not efficient as the classes in the school.(N)	Before	Number (answers)	5	13	9	3	2	2.50	-.107
			Percentage(%)	15.6	40.6	28.1	9.4	6.3		
		After	Number (answers)	5	15	6	2	4	2.53	
			Percentage(%)	15.6	46.9	18.8	6.3	12.5		
	It was so difficult that I cannot remember what I have learned.(N)	Before	Number (answers)	6	12	11	2	0	2.29	-.379
			Percentage(%)	18.8	37.5	34.4	6.3	0		
		After	Number (answers)	9	13	2	6	2	2.34	
			Percentage(%)	28.1	40.6	6.3	18.8	6.3		

N: Negative Questions

In answering the questions on for what aspect the field trip to the Science Centers were helpful, the answers before and after the field trips were compared. As for the preliminary test conducted before the visits, the

majority of the students answered 'it is possible to deeper the knowledges beyond what they have in the text books.' (7 answers, 21.9%) On the other hand, the majority of the student answered in the after-testing that 'it is helpful for understanding the scientific principles and studying science subject.' (11 answers, 45.8%) Most of the subjects chose 'the content of the program guidance and the activity sheets were great' as the reason for this.

Study result

In this study, we could verify that the field trips to the Science Centers with S-BEL programs in place could be a good teaching-learning process of STEAM, which is the purpose of the modern science education, including deepening the understanding on science and foster positive awareness thereof. Also, as the benefits of the visits to the Science Centers do not appear in a short term, it would be necessary to observe the students over a prolonged period. In spite of such limitations, the implication of this study would be that the field trips to the Science Centers with S-BEL programs could help deepening the understanding and positive awareness on science through increased preference and motivation for learning, indicating the necessity of such field trips in regular curriculum. It is not true that the field trips are not as efficient as the science education by regular curriculum. Also, it would be necessary to increase the efforts to use S-BEL programs more proactively in the curriculum, since it helps broadening the range of interest and positive influence. It is hoped, finally, that more proactive promotion activities are made to let the excellent programs of Gwacheon National Science Center's programs better known and foster the usage of the facility as the place to maximize the potentials the students have for learning.

References

Park, Kang, Kim, Song, Yu, Yeon, Jang, Jeong, Han. (2000). A Study on Promotion of Youth out of School activities for Science. In Korean Education Development Institude. 2000(18)

Yim, Cho, Jeong, Son, Kim, Wu, Yeon, Lee, Yim, You. (2001). A Preliminary Study for the Construction of the National Science Museum. In Korean Education Development Institude. 2001(11)

Chang, hyunsook. (2005). The Effect of Science Museum field trips on middle school students' Scientific literaracy and the awareness of field trips to science museum. A doctoral dissertation on Ewha Womans University.

Aikenhead. G. S. (1988), An analysis of four ways of assessing student beliefs about STS topic. Joural of Research in Science Teaching, 25(8), 607-629.

Aikenhead. G. S. Flemming, R. W.&

Ryan, A. G. (1987). High school graduates' beliefs about science-technology-socity I. Methods and issues in monitoring student views. Science Education, 71(2), 145-161

National Research Council (NRC)(1996). Nationalscience education standards. Washington, D.C. : National Academy Press.

Ruggiero, C. (2000). Spreading the analytical word. Chemistry & Industry,,5,,182-184.

Semper, R. J. (1990). Science museums as environments forlearning. Physics Today,3(11),50-56

Wellington, J. (1990). Formaland informal learningin science : The role of the interactive sciencecentres. Physics Education, 25, 247-252.

Wellington, J. (1991). Newpaper science, schoolscience : Friends of enemies? International Journal of Science Education, 13(4), 363-372.

Henriksen, E .K. ,& Frøoyland, M. (2000). The contribution of museums to scientific literacy : Views from audience and museum professionals. Public Understanding of Science, 9(4), 393-415.

Barstow, D. Geary, E. & Yazijan, H. (Eds). (2001). Informal Education and Outreach. Blueprint For Change: Report from the National Conference on the Revolution in Earth and Space Science Education, June 21-24. Snowmass, Colorado. Retrieved Dec 5, 2004, from http://www.earthscienceedrevolution.org/RevEarthSciEd.pdf.

Cho, S. (2003). Science Culture Centers: Its History, Concepts and Functions. Proceeding in Joint Seminar under the Japan-Korea Basic Scientific Cooperation Program. Kobe. Japan. 31-36

Choi, K. (2004). Developing Active Roleof Science Museum in Educating on Ethical Issues on Science and Technology: Four Case Studies. Journal of Korean Association for Research in Science Education, 24(1), 109-120

Cook, R. (1999). Is there a way to make controversial exhibits that work: Journal of Museum Education, 23(3), 18-20.

Falk, J. H. & Dierking, L. D. (1992). The museum experience. Washington, DC: Whalesback Books.

Henriksen, E. K. (1998). Environmental Issues in the Museum: Applying Public Perceptions in Exhibition Development. Curator, 41(2), 90-105

Hurd, P. (1958). Scientific literacy Its meaning for American schools, Educational Leadership, 16(1), 13-16&52

Lucas, A. (1983). Scientific literacy and informal education. Studies in Science education, 10, 1-36

Song, J. & Cho, S. (2004). Yet Another Paradigm Shift: From Mind-on to Heart-on. Journal of Korean Association for Research in Science Education, 24(1), 129-145