

The Study of High School Students' Environmental Literacy

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Abstract: The purpose of this study is to explore high school students' environmental literacy and from its result, to suggest ways to reform environmental education. 1047 students from Seoul and Gyeonggi province participated in the survey. The questionnaire consisted of four criteria of environmental literacy including knowledge, skill, attitude and behavior. The result was analyzed and the factors which affect high school students environmental literacy were explored. From this result, we made suggestions to improve environmental education as follows. First, environmental education in school should focus on knowledge criterion. Though school environmental education has been helpful for students to build environmental literacy in attitude and behavior criteria, its effect has not been good enough in knowledge criterion. Second, science education can enhance students' environmental literacy. Students who like science best and students who belong to science major classes were reported to possess better understanding in knowledge criterion. Also, students who like life science appeared to have a more positive attitude in environmental literacy. Third, informal education must be considered to form students' environmental literacy. In particular, the effect of mass media is inarguable. Thus, we should find a way to link formal education and informal education to improve environmental education. Fourth, high school students' interest in the environment must be encouraged since it is evident that higher interest would result in better outcome in environmental education.

Keywords: high school students, environmental literacy, environmental education, science education

Introduction

Today, we are facing an environmental crisis that has never been so serious before. To deal with various environmental issues and for our future to prosper, environmental education for the next generation is essential. Environmental education can take place in both formal and informal education contexts, and it could be taught not only in environment class, but also in all other classes (Choe et al., 1999). The ultimate purpose of environmental education is to produce environmentally literate populations (Roth, 1996). Thus, how to teach students to be environmentally literate should matter to all educators.

Environmental literacy could be defined using the following five criteria (UNESCO, 1985). The first criterion is environmental perception. An Envi-

ronmentally literate person should perceive the environment that he/she belongs and its issues. The second criterion is environmental knowledge which means that a person who is environmentally literate should understand environmental issues and related problems, both cognitively and empirically. The third criterion is attitude toward environment. Environmentally literate person will be interested in environment and also recognize its value. The fourth criterion is environmental skills. It means that environmental literacy includes the skills to deal with environmental problems. The fifth criterion is participation. A person who possesses environmental literacy will pursue opportunities to actively participate in environmental actions. These five criteria give us a more detailed perception about environmental literacy.

Since environmental issues cannot be separated from cultural, political, and economic background, environmental education should take into account various local backgrounds (UNESCO, 1980). This implies that environmental education in Korea

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should be based on its particular circumstance. In Korea, the noncompulsory subject called 'environment' was introduced in the sixth national secondary curriculum. However, school environmental education has actually been conducted through other subjects since a few schools have chosen to teach it. Among those other subjects, science is one of the most effective and closely related subject to environmental education (Bybee, 1991; Volk, 1984). Thus, we assume that school science has contributed to environmental education in Korea, and we should explore more about it for future environmental education.

Nevertheless, effective environmental education must be based on reliable information, so collecting reliable data on the current status of students' environmental literacy should take place first. Therefore we surveyed high school students' environmental literacy using four criteria such as knowledge, skill, attitude, and behavior. These four criteria were developed from Simmons's (1996) environmental literacy framework. Also, we tried to figure out what factors might largely affect high school students' environmental literacy. From the results of this survey we hope to make more effective suggestions to improve secondary environmental education in Korea.

Procedure

Development of Questionnaire

The questionnaire contains 86 items and was divided into four criteria: knowledge, skill, attitude, and behavior. These criteria were based on Simmons's (1996) framework. We surveyed many reliable instruments developed to assess various aspects of environmental literacy. Those instruments were already approved in reliability and validity. We selected the relevant items from those instruments and then screened and revised them through repeated reviews. Later, a pilot-test was administered to a group of students. Reliability and validity were reviewed again and the final revision

was conducted.

In knowledge criterion, there are 24 multiple choice items. thirteen of 24 items concern ecological and biological knowledge, while 11 of 24 items concern a broad range of environmental knowledge such as energy, pollution, climate change, expanding population. In skill criterion, the virtual story that includes an environmental issue is given and five multiple choice items are provided. Students are required to read the story carefully then answer questions. There are 27 items in attitude criterion and 28 items are in behavior criterion. These items are given in Likert scale presenting 'strongly agree' 'agree' 'disagree' 'strongly disagree'.

Sample

In April, 2003, the survey was conducted with 1047 high school students in Seoul and Kyungki province. Participants were chosen according to gender, hometown, and other background. To explore the difference between science major students and literary major students, 11th grade students were chosen. Some basic background information of participants were given in Table 1. Other background information such as students' interest, self-estimated knowledge, main resource for environmental information, favorite subjects, and influence of school education were asked of the participants in a written form at the time of survey.

Analysis

The data were statistically analyzed using SPSS 10.0 for Windows and quantitative analysis was conducted. In each criterion, a standard score was calculated and a correlation coefficient was also calculated to see correlation between each criterion. Also, the ratio of correct answers was calculated for each item in knowledge criterion and skill criterion. In attitude criterion and behavior criterion, mean and standard deviation was calculated for each item. Scores were analyzed according to

Table 1. Number (ratio, %) of participants according to gender, major, and hometown

Gender (N = 1047)		Major (N = 1047)		Hometown (N = 1037)			
Male	Female	Literacy	Science	City	Town	Country	Others
555 (53.0)	492 (47.0)	526 (50.2)	521 (49.8)	559 (53.8)	309 (29.8)	143 (13.8)	26 (2.6)

gender, hometown, parents, major, source of environmental information, experience of school environmental education, favorite subjects, favorite science contents and other variables.

Result and Discussion

High school students' score in each criterion is shown in Table 2 below. There seemed to be no significant difference among them. Each criterion appeared to be meaningfully correlated to each other and correlation coefficient between attitude criterion and behavior criterion was relatively higher. Table 3 shows the correlation coefficient in each criterion.

The result revealed that high school students' environmental literacy appeared not to be much affected by where they live. In each criterion, standard scores of students from different hometowns did not show any recognizable pattern. There was a meaningful difference between city and town, as well as town and country in knowledge criterion. However, there was no meaningful difference in attitude criterion. In behavior criterion was there a meaningful difference only between city and other area. In skill criterion, there was no meaningful difference between city and town. Students from towns obtained the highest score in all but behavior criterion; however the difference was very slight in attitude criterion and skill criterion.

Parents' influence does not affect high school

students' environmental literacy, either. Whether parents were highly educated or not, whatever parents' occupations were, they seemed not seriously affect students (See Table 4).

There was a slight gender-based difference. Female students obtained meaningfully higher scores in attitude criterion. And another slight difference was shown in knowledge criterion. Since the participants were 11th grade students, they belonged to either science-technology major classes or literacy-social studies major classes. Science major students obtained meaningfully higher scores than literacy major students did as might be expected. In attitude criterion, literacy major students outdid science major students. No other significant difference was found in gender based or in major based (See Table 5).

Meanwhile, the important results of this study can be summarized as follows. First, students' personal interests and self-estimated knowledge about the environment seemed to be the most important factor that affect their environmental literacy. Students who answered that they have a lot of interest in the environment obtained a higher score in every

Table 2. Standard score in each criterion of environmental literacy (N = 1047)

Criterion	Mean \pm SD
Knowledge	49.97 \pm 8.26
Skill	50.02 \pm 8.03
Attitude	50.16 \pm 9.12
Behavior	49.10 \pm 9.38

Table 3. Correlation coefficient in each criterion

Criterion	Knowledge	Skill	Attitude	Behavior
Knowledge	1.000 (**)	.369 (**)	.290 (**)	.097 (**)
Skill	.369 (**)	1.000 (**)	.248 (**)	.081 (*)
Attitude	.290 (**)	.248 (**)	1.000 (**)	.520 (**)
Behavior	.097 (**)	.081 (*)	.520 (**)	1.000 (**)

* $p < 0.05$ ** $p < 0.01$

Table 4. Standard scores according to parents' education level

	Knowledge			Skill			Attitude			Behavior		
	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
Father (N=1028)	College and above N=408	50.21 ± 8.42	.539	.463	49.82 ± 8.09	1.018	.313	.841	.359	49.86 ± 10.07	1.625	.203
	up to high school N=620	49.82 ± 8.20			50.33 ± 7.89			50.40 ± 8.52		48.74 ± 8.97		
Mother (N=1024)	College and above N=238	49.94 ± 8.27	.002	.964	48.49 ± 8.43	12.710	.000	3.470	.063	49.21 ± 10.20	.354	.552
	up to high school N=786	49.97 ± 8.31			50.58 ± 7.76			50.47 ± 8.82		50.06 ± 9.43		

Table 5. Standard score according to gender, major, hometown

	Knowledge			Skill			Attitude			Behavior		
	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
Gender	Male N=555	50.88 ± 8.45	.425	.831	49.97 ± 7.81	.042	.838	8.154	.004	49.40 ± 9.73	.251	.616
	Female N=492	48.94 ± 7.92			50.08 ± 8.28			51.00 ± 8.35		49.25 ± 8.65		
Major	Literacy N=526	49.07 ± 8.46	12.433	.000	50.00 ± 7.83	.012	.914	4.582	.033	50.76 ± 8.84	.102	.750
	science N=521	50.87 ± 7.97			50.05 ± 8.23			49.55 ± 9.37		49.01 ± 9.85		
Home town	City N=559	40.03 ^a ± 8.21			49.25 ^a ± 8.15			49.86 ± 9.11		49.86 ± 9.11		
	Town N=309	52.06 ^b ± 7.87			51.51 ^b ± 7.45			51.09 ± 8.97		49.23 ± 9.05		
	Country N=143	49.64 ^{ab} ± 8.42	9.812	.000	50.40 ± 8.00	5.613	.001	49.83 ± 9.15	.147	48.21 ± 9.82	3.221	.022
	Others N=26	47.85 ± 9.55			49.00 ± 7.99			48.04 ± 11.00		44.01 ^b ± 10.80		
Total N=1047	49.97 ± 8.26			50.02 ± 8.03			50.16 ± 9.12			49.10 ± 9.38		

*There is meaningful difference between a and b, b and ab.

criterion. Students who answered that they have better knowledge than others also obtained a higher score in every criterion (See Table 6).

Second, the influence of media such as TV, newspapers, magazines, and internet seemed to be huge to form high school students' environmental literacy. Seventy percent of the respondents answered they obtain environmental information mainly through media. But they did not show a meaningful difference in the score except for attitude criterion. In behavior criterion, only students who chose school and students who chose newspapers/magazines showed a meaningful difference between them. A group of students who chose newspapers/magazines gained highest score in skill and attitude criteria, while students who chose internet and/or TV did not gain a high score. It means that high school students are largely influenced by the media; however it does not help much to form positive environmental literacy at present. Nevertheless, this finding implies that informal environmental education by media could positively affect to form environmental literacy if it is well administered (See Table 7).

Third, school education appeared to positively contribute to form better attitude and better behavior. Students who had attended an environment class in school obtained higher scores in attitude criterion and behavior criterion. Also students who answered that they learned useful knowledge in school and it helped to act for environment obtained higher score in attitude criterion and behavior criterion (See Table 8).

Fourth, science education can be an effective alternative when the independent environment class is not available. Students whose favorite subject is science obtained a significantly higher score in knowledge criterion. 244 of 1047 students chose physical education as their favorite and mathematics, science, Korean were chosen respectively as favorite. But only students who chose science showed a meaningful difference in their scores. For science contents, most of students chose life sci-

ence as their favorites. And those students were shown to have a higher score in attitude criterion (See Tables 9 and 10).

In addition to the results above, we found the following characteristics in each criterion. In knowledge criterion, the ratio of correct answer was higher in ecological and biological items. And three of four items that showed lowest ratio belonged to non-biological items (See Table 11). This implies that high school students' environmental knowledge might be biased towards ecology and biology. There was no significant trend in skill criterion. Meanwhile, high school students' attitude toward the environment appeared to be mediocre. Their mean score in Likert scale was between two (disagree) and three (agree) in 17 of 27 items. But they showed a positive attitude in everyday life issues concerning pollution, waste, recycling, and future environmental problems. In behavior criterion, their mean score in the Likert scale was between two and three in 16 of 28 items, and between one and two in 10 of 28 items. It means that high school students hardly act on environmental issues. In particular, social action such as sending his/her opinion to newspapers has barely been done. The only action that they do was 'turning off the light/water'. High school students seem not be much different from elementary students in doing something for the environment.

Conclusion and Implications

From the above result, we could say that high school students' environmental literacy was not much affected by local or parental influence but by their own interests and knowledge. Also, they were shown to have biased knowledge, mediocre attitude and to be inactive. School environmental education has been partly successful; however, it seems to need some sort of reform. Finally, we assume that there are at least four factors which influence high school students' environmental literacy and these are students' own interests and

Table 6. Standard score according to students' interests and knowledge in environment

	Knowledge			Skill			Attitude			Behavior		
	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
Knowledge	Ample (N=99)	51.18 ^a ± 9.67		49.49 ^{ab} ± 7.64			53.42 ^a ± 12.85			54.74 ^a ± 10.25		
	Normal (N=101)	45.11 ^b ± 8.05	20.474	.000	47.60 ^b ± 8.29	5.939	.003	47.05 ^b ± 7.26	12.386	48.07 ^b ± 9.57	21.011	.000
	Scarce (N=839)	50.43 ^b ± 7.94		50.43 ^b ± 7.97			50.16 ^b ± 8.69			48.53 ^b ± 8.98		
Interests	Ample (N=178)	52.20 ^a ± 8.82		50.82 ^a ± 7.56			55.85 ^a ± 11.21			54.22 ^a ± 9.45		
	Normal (N=147)	46.81 ^{ab} ± 9.02	17.717	.000	47.47 ^{ab} ± 8.38	9.300	.000	45.27 ^b ± 7.65	62.987	46.05 ^b ± 10.66	39.394	.000
	Scarce (N=710)	50.03 ^b ± 7.79		50.42 ^b ± 8.02			49.75 ^b ± 8.09			48.36 ^b ± 8.52		

*There is meaningful difference between a and b, b and ab, b and c, a and c.

Table 7. Standard score according to resource of environmental information

	Knowledge			Skill			Attitude			Behavior		
	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
School (N=125)	47.90 ± 7.19	3.176	.001	48.97 ± 8.23	2.366	.016	45.70 ^a ± 7.98	6.842	.000	46.45 ^a ± 9.55	3.468	.001
Books (N=46)	49.77 ± 8.81			49.36 ± 8.71			52.27 ^b ± 10.81			52.22 ± 9.99		
Newspapers/magazines (N=116)	51.75 ± 8.11			52.59 ± 6.75			53.36 ^c ± 9.85			51.21 ^b ± 7.84		
Family (N=13)	52.50 ± 11.33			51.15 ± 9.39			50.70 ± 14.63			51.78 ± 13.07		
Field trip (N=54)	47.37 ± 9.33			48.79 ± 8.83			49.48 ± 9.57			49.10 ± 9.72		
TV (N=497)	50.45 ± 8.12			50.43 ± 7.84			50.35 ^{ab} ± 8.48			48.65 ± 9.06		
Internet (N=119)	50.72 ± 8.75			49.53 ± 7.93			51.11 ^{ca} ± 12.90			49.68 ± 9.99		
Visiting (N=6)	52.14 ± 10.26			47.14 ± 6.98			53.82 ± 12.91			53.58 ± 15.31		
Others (N=15)	46.50 ± 8.67			48.46 ± 8.30			45.53 ± 8.89			45.20 ± 12.28		
Total (N=991)	50.89 ± 8.33			50.21 ± 7.95			50.20 ± 9.21			49.01 ± 9.43		

*There is meaningful difference between a and b, a and c, b and c, b and ab, a and ca, b and ca.

Table 8. Standard score according to influence school environmental education

Question	Answer	Knowledge			Skill			Attitude			Behavior		
		Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
A	yes N=847	50.20 ± 8.07	3.627	.057	50.27 ± 7.97	3.089	.079	50.75 ± 8.92	18.252	.000	49.36 ± 9.12	4.381	.037
	no N=195	48.95 ± 9.06			49.16 ± 8.12			47.67 ± 9.63			47.81 ± 10.12		
B	yes N=669	50.26 ± 7.97	.411	.522	50.37 ± 7.90	.608	.436	51.45 ± 8.45	20.297	.000	49.92 ± 8.92	12.100	.001
	no N=176	49.83 ± 8.41			49.85 ± 8.25			48.08 ± 10.15			47.24 ± 9.60		
C	yes N=577	50.19 ± 8.01	.000	.990	50.30 ± 7.92	.005	.941	51.74 ± 8.33	23.052	.000	50.27 ± 8.82	19.009	.000
	no N=267	50.19 ± 8.14			50.25 ± 8.05			48.61 ± 9.81			47.36 ± 9.46		
D	yes N=424	49.51 ± 8.08	6.186	.013	50.05 ± 8.17	.695	.405	51.93 ± 8.67	14.916	.000	50.99 ± 9.24	27.766	.000
	no N=421	50.89 ± 8.03			50.50 ± 7.75			49.58 ± 9.04			47.73 ± 8.73		

A: Have you ever been taught an environmental lesson in school?
 B: Was school education helpful for you to learn about environment?
 C: Was school education good for you to have environmental attitude?
 D: Was school education helpful for you to do something for environment?

Table 9. Standard score according to favorite subject

Favorite subject	Knowledge			Skill			Attitude			Behavior		
	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
Korean (N=100)	48.83 ^a ± 8.95			50.17 ± 8.44			49.18 ± 10.93			48.71 ± 10.99		
Ethics (N=26)	48.01 ± 9.32			51.54 ± 7.26			53.08 ± 7.88			51.69 ± 6.84		
Math (N=190)	50.27 ± 8.20			49.90 ± 8.20			48.69 ± 8.56			48.78 ± 8.57		
Social study (N=93)	52.86 ± 7.93			50.59 ± 8.27			53.11 ± 9.22			50.59 ± 7.66		
Science (N=127)	53.56 ^b ± 7.73	5.803	.000	50.99 ± 8.27	1.058	.392	52.40 ± 9.85	4.167	.000	50.40 ± 8.71	1.641	.099
Music (N=72)	49.27 ± 9.07			50.96 ± 8.43			49.89 ± 8.76			49.55 ± 9.95		
Art (N=72)	49.00 ± 7.92			50.68 ± 7.82			50.60 ± 8.61			47.74 ± 8.57		
Physical E. (N=244)	48.77 ^{ab} ± 7.87			49.41 ± 7.71			48.81 ± 8.94			48.09 ± 9.78		
Practical E. (N=18)	48.36 ± 7.67			51.15 ± 6.11			47.81 ± 6.11			46.50 ± 7.90		
English (N=77)	48.08 ^{ab} ± 7.28			48.42 ± 8.43			52.22 ± 7.68			50.39 ± 10.74		
Total (N=1019)	50.00 ± 8.29			50.09 ± 8.02			50.21 ± 9.17			49.11 ± 9.33		

*There is meaningful difference between a and b, b and ab.

Table 10. Standard score according to favorite contents in science

	Knowledge			Skill			Attitude			Behavior		
	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P	Mean ± SD	F	P
Force and energy (N=96)	48.67 ± 8.84	1.412	.238	48.39 ± 8.66	2.257	.080	47.62 ^a ± 10.77	4.901	.002	48.90 ± 10.04	.125	.946
Substantial feature (N=210)	50.16 ± 8.38			50.08 ± 8.18			49.43 ± 8.71			48.84 ± 9.14		
Earth and universe (N=326)	50.58 ± 8.31			49.94 ± 7.65			50.40 ± 8.91			49.30 ± 9.80		
Life (N=400)	49.88 ± 7.94			50.69 ± 7.92			51.22 ^b ± 8.74			49.05 ± 8.49		
Total (N=1032)	50.04			50.12 ± 7.98			50.26 ± 9.04			49.07 ± 9.19		

*There is meaningful difference between a and b.

Table 11. Ratio of correct answer in knowledge criterion

Item no	Ratio (%)	Ecological and biological knowledge			Others		
		Contents	Item no	Ratio (%)	Contents	Item no	Ratio (%)
4	88.8	Plants' adaptation	23	75.9	Oxygen in atmosphere		
5	78.4	Role of bacteria	18	75.5	Feature of energy		
13	76.1	Environmental condition for growing of population	19	66.2	Nuclear accident		
12	73.8	Influence of pesticide	17	60.3	Formation of soil		
14	73.6	Solar energy in ecosystem	22	53.7	Green house effect		
9	72.1	Embedding of chemical substances in human body	24	48.1	Food issue		
7	70.9	Food chain	20	48.1	Nuclear plant		
3	67.7	Symbiosis among species	21	38.5	Ground water pollution		
15	61.4	Environment and extinction	8	30.8	Energy transfer		
11	54.2	Food net	16	28.1	Erosion		
10	51.1	Extinction of some kinds of whales	-	-	-		
6	47.7	Energy transfer in food chain	-	-	-		
1	40.6	Number of species	-	-	-		
2	29.0	Prey and hunter	-	-	-		

knowledge, influence from mass media, school environmental education, and science education. Thus, we suggest the following to improve environmental education. First, school environmental education should focus on knowledge criterion since it has been partly successful only in attitude and behavior criterion. And environmental knowledge beyond ecology and biology must also be taught. Second, science education could be effective to develop environmental literacy. In science education, environmentally literate attitudes should be considered as well as knowledge. Third, informal education through mass media should be recognized and a way to link informal and formal education to promote environmental education, especially a way through media, should be found. Last, it is most important to increase students' interests in the environment because high school environmental education could be a great success when students have an interest in it.

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