

# A Survey of Effects of STS Education on the University Students' Moral Development and Epistemological Beliefs : Using DIT and EBI

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## 국문초록

본 연구는 이공계 대학에서 이루어지고 있는 과학기술학 교육의 교육심리학적 효과를 측정하는데 그 목적이 있다. 과학기술학 교육은 과학기술윤리, 과학기술사, 과학기술사회학, 과학기술정책학 등을 포괄하는 학제적 학문으로서 이공계 학생들의 과학기술에 대한 사회적 인식을 함양하는데 주목적을 두고 있다. 최근 과학기술계에서 촉발된 여러 사태들로 인해 과학기술의 윤리 문제 및 교육 문제가 중요한 이슈로 떠오르고 있다. 하지만 효과적인 교육을 실시하기 위한 교육학적 탐구는 전무한 실정이다. 이에 본 연구는 도덕발달과 인식론적 신념이라는 교육심리적 관점에서 과학기술학 교육의 효과에 대한 탐색적 조사를 실시하고자 한다. 도덕발달의 측정에는 DIT(Defining Issues Test), 인식론적 신념의 측정에는 EBI(Epistemic Beliefs Inventories)가 사용된다. 결과로, 인식론적 신념 부문에서는 지식의 확실성에서 장기간-다과목 수강자군이 타 학생들에 비해 발달의 정도가 유의하게 컸고, 도덕 판단력 부문에서는 역사 맥락적-학제적-사회 이슈를 다루는 과목군의 수강생이 여타 과목군의 수강생에 비해 발달의 정도가 유의하게 컸다. 이러한 측정도구들을 통해 조사된 결과를 바탕으로 대한민국의 과학기술학 교육에 대한 개선점을 제안하고자 한다.

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주요어 : 과학기술학 교육, 과학기술윤리, 인식론적 신념, 도덕 판단력, 이공계 대학생, EBI, DIT, STS.

## I. Introduction

In these days, ethical issues related to scientific activities and engineering are being more important than 20th century; especially, since November 2005, bioethics problems are being seriously debated in Korea. Therefore, it will become more important that how to educate ethics to natural science and engineering student. Nowadays, as an educational invention to improve social perspective of science and technology student, STS(Studies of Technology and Science) education was introduced and is performed in many Korean universities; the STS includes philosophy, history, sociology, ethics, and other related humanities and social sciences of science and technology.

However, there were few studies for STS education from pedagogical view point; in fact, its educational psychological effects, curriculum, and other educational aspects have not been seriously studied. So, the purpose of this study is to explore the effect of STS education to students. This study will concentrate on following issue whether STS education affects students' moral reasoning and epistemological beliefs; moral reasoning is related to how to make moral decisions and epistemological beliefs are related to students' attitude about knowledge.

## II. Literature review

This literature review is divided into three sections. The first section describes the theory of moral development that is basis of this survey. The second section describes a summary of several theories of epistemological development, especially most current theory-component model- and its assessment -EBI(Epistemic Beliefs Inventory)-. The third and last section reviews moral educational programs for professions in USA, such as college students in medical schools, nursing schools, dental schools, etc, and its effects for students' development.

## 1. Moral Development

According to Kohlberg, the structure of the development of moral reasoning has three levels and six stages; each level has two stages. Level 1 (pre-conventional) is a perspective from which rules and social expectations are something external to the self; in the Level 2 (conventional) perspective the self is identified with or has internalized the rules and expectations of others, especially those of authorities; and the Level 3 (post-conventional) perspective differentiates the self from the rules and expectations of others and defines moral values in terms of self-chosen principles.<sup>1</sup> For this structural development, Blatt suggested that how students' moral reasoning advance; he believed that the cognitive stimulation of moral discussion, that is of children hearing themselves and others argue at different stages of moral reasoning, ought to create movement to the next stage up for the children involved.<sup>2</sup>

To assess students' moral reasoning, DIT(Defining Issues Test) will be used in this study. DIT is a multiple choice test that can be group-administered and computer-scored. In the DIT, a subject is presented with a moral dilemma, such as Heinz dilemma; and then, student chooses reasons of selected behavior.<sup>3</sup> Davison and Robbins reviewed that DIT reliable internal consistency .70 in Cronbach alpha.<sup>4</sup> And Its Korean version, that translated by Moon and et all. showed internal consistency .64 in alpha.<sup>5</sup> In this study, three stories version of DIT in Korean will be used to evaluate students' moral development during the semester.

## 2. Epistemological Development

According to Hofer and Pintrich, epistemological beliefs mean individuals' conception about the nature of knowledge and process of knowing. It is related to how individual get knowledge, think, and reasoning.<sup>6</sup> Major researchers in epistemological beliefs are Perry, Belenky, Baxter Magolda, King and Kitchener, D. Kuhn, and Schommer. Among them, Schommer established the latest theory. Schommer suggests that there are multiple components in epistemological beliefs : first, simple knowledge(SK) that

1 Jeong, C. W., *A Cross-Cultural Study of the Relationships between Epistemological Beliefs and Moral Judgement as a Psychological Foundation for Moral Education*, Ph. D. Dissertation (Athens: University of Georgia, 2003), pp. 10-11.

2 Higgins, A., "Educating for Justice and Community: Lawrence Kohlberg's Vision of Moral Education" in Kurtines, W. M. and Gewirtz, J. L. (eds.), *Moral Development : An Introduction* (Boston: Allyn and Bacon, 1995), p. 59.

3 Rest, J. R., "Background: Theory and Research" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics*(Hillsdale: Lawrence Erlbaum Associates Inc., 1994), p. 11.

4 Moon, Y. L., *A Study to Diagnose Moral Development of Korean Adolescents -Standardization Research for DIT-(Korean)* (Seoul: Seoul National University, 1994), p. 82.

5 *Ibid.*, p. 108.

6 Hofer, B. K. and Pintrich, P. R., "The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning", *Review of Educational Research*, 67, 1997.

knowledge consists of discrete facts, second, certain knowledge(CK) that knowledge is absolute, third, innate ability(IA) that learning is innate, fourth, omniscient authority(OA) that authorities have access to otherwise inaccessible knowledge, fifth and last, quick learning(QL) that learning occurs in a quick or not at all.<sup>7</sup> Similar to the theory of moral development, numerous suggestion have been made for promoting the progression described in most of the schemes reviewed, typically along the lines of challenging the existing ideas by presenting ideas one level higher to foster cognitive conflict and restructuring.<sup>8</sup>

Epistemic Beliefs Inventory(EBI) is a widely used assessment tool to assess students' epistemological beliefs. It was devised by Bendixen et al.; based on Schommer's five component model. EBI uses five scored Lickert scale(From strongly disagree(1 point) to strongly agree(5 point)) for 32 questions related to five components.<sup>9</sup> Korean version of EBI is interpreted and tested by Jeong, in his doctoral dissertation; it showed reliable internal consistency .79 in alpha<sup>10</sup>. In this survey, Korean EBI that was interpreted by Jeong will be used to evaluate the influence of STS courses to students' epistemological beliefs.

### 3. Professional Ethics Education Programs

There are several results related to educational effects of professional ethics education programs in USA. Some educational programs that were designed by educational psychologist showed significant growth in moral reasoning; Duckett and Ryden's "Education for Ethical Nursing Practice"<sup>11</sup>, Bebeau's "Influencing the Moral Dimensions of Dental Practice"<sup>12</sup>, Self and Baldwin Jr. s' "Moral Reasoning in Medicine"<sup>13</sup>, and Self, Olivarez, Baldwin Jr. s' "Moral Reasoning in Veterinary Medicine". They designed programs to promote moral development, and got results that indicate these programs were usually effective. Moreover, Tsai's research indicates that students who attended STS related instruction, especially

7 Schommer, M. "Comparisons of beliefs about the nature of knowledge and learning among postsecondary students", *Research in Higher Education*, 34, 1993.

8 Hofer, B. K. and Pintrich, P. R., *op. cit.*, p. 123.

9 Bendixen, L. D., Dunkle, M. E. and Schraw, G., "Epistemological beliefs and reflective judgment", *Psychological Reports*, 75, 1994.

10 Jeong C. W., *op. cit.*, p. 65.

11 Duckett, L. J. and Ryden, M. B., "Education for Ethical Nursing Practice" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics* (Hillsdale: Lawrence Erlbaum Associates Inc., 1994), p. 63.

12 Bebeau, M. J., "Influencing the Moral Dimensions of Dental Practice" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics* (Hillsdale: Lawrence Erlbaum Associates Inc., 1994), p. 127.

13 Self, D. J., Olivares, M. and Baldwin Jr., D. C., "Moral Reasoning in Veterinary Medicine" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics* (Hillsdale: Lawrence Erlbaum Associates Inc., 1994), pp. 159-160.

longer than 8 months, could develop higher and more integrated cognitive structure<sup>14</sup>.

In Korea, Hong designed and tested ethics education program for medical students; it's duration was a semester. There was slight growth in moral development of course-taken students, however, it was not statistically significant.<sup>15</sup>

### III. Design and Plan for Survey

Undergraduate students majoring natural sciences or engineering in three universities shown below were observed in this survey.

A University : In Province, Public Institute of Science and Technology

B University : In Seoul, Public University

C University : In Seoul, Private University

Experimental group of this survey is consisted of students who attend STS courses in 2005 fall semester, and control group is consisted of students who does not. List of subjects that are samples of this survey is shown in table.

<Table 1> Subject List

Subj. #	Group	Univ.	Subject Name
0			History of Science & Technology in Korea
1			Science Technology History
2			Science Technology and Philosophy
3	Experimental Group	A	Science, Technology and Ethics
4			Introduction to Environment
5			Science Technology and Society
6		B	Science and Technology History
7			Philosophical Understanding of Science
8			Philosophical Understanding of Science and Technology
9	Control Group	A	History of Western Civilization
10			Introduction to Programming
11		B	Astronomy
12			C

14 Tsai, "The effects of STS-oriented instruction of female tenth graders' cognitive structure outcomes and the role of student scientific epistemological beliefs", *Journal of Science Education*, Vol. 22 No. 10, 2000, p. 1111.

15 Hong, S. H., *A Study on the Development of Medical Ethics Education Program, Ed. D. Dissertation(Korean)* (Seoul: Seoul National University, 2000).

All of the courses uses lecture, debating, project, personal reports as methods of the STS education. Pre semester results were gathered in early September 2005, and post semester results were gathered in early December 2005 (during a semester, 15 weeks, 2~3 hours per a week). Sizes of each group will be shown with descriptive statistics in next section. The samples were all students in the classes; therefore, the sampling method could not be random sampling.

The main hypotheses of this study are,

1. STS education significantly affects students' epistemological beliefs.
2. STS education significantly affects students' moral development.
3. Long-term and frequently STS course taking significantly affects students' development. (derived from Hypothesis 1 and 2)
4. Interdisciplinary, Socio-History based STS courses have significantly greater effects on students' development than Single field bases STS courses and non-STS courses. (derived from Hypothesis 1 and 2)
5. There are significant differences in students' development by universities' policy on STS education.

## IV. Descriptive Statistics

### 1. Pre semester test

Table summarizes the means and standard deviations for moral development, epistemological variables, and results of the t-tests. Simple independent t-tests were used to assess the difference between experimental group and control group in all variables.

<Table 2> Descriptive Statistics of Pre-semester test

Variable	Experimental group (n=366)		Control group (n=138)		t	d	
	M	SD	M	SD			
P	41.95	14.63	43.14	15.00	-0.71	-1.19	
Epistemological Variables	SK	2.89	0.46	2.93	0.47	-0.97	-0.04
	CK	2.43	0.52	2.46	0.51	-0.66	-0.03
	QL	2.14	0.56	2.17	0.51	-0.55	-0.03
	OA	2.72	0.56	2.80	0.54	-1.46	-0.08
	IA	2.96	0.58	2.90	0.53	1.03	0.06

The results indicated that there were no significant differences between STS taking students and non taking students in all variables. It might be inferred from these results that there were no biases in students' moral development and epistemological beliefs before taking courses.

## 2. Post semester test

Table shows the means and standard deviations for P score and epistemological beliefs, and t-test results of students. Similar to Pre-semester test, simple independent t-tests were used to compare.

<Table 3> Descriptive Statistics of Post-semester test

Variable	Experimental group (n=301)		Control group (n=76)		t	d	
	M	SD	M	SD			
P	41.52	15.08	41.42	15.29	0.04	0.10	
Epistemological Variables	SK	2.95	0.43	2.98	0.41	-0.56	-0.03
	CK	2.46	0.50	2.48	0.50	-0.36	-0.02
	QL	2.28	0.62	2.28	0.52	-0.05	-0.00
	OA	2.83	0.51	2.81	0.59	0.37	0.02
	IA	2.98	0.56	2.97	0.53	0.09	0.01

The results are quite similar to pre semester's results. The P score and epistemological variables are not significantly different each other.

## 3. Pre-Post semester test

After pre and post semester tests, growths of moral reasoning and epistemological beliefs between pre semester and post semester were calculated; and then, t-tests were used to find whether there were significant difference between experimental and control group in growths of moral thinking and epistemological beliefs or not. Table summarizes the means and standard deviations for moral development growth(dP), differences in epistemological variables(dSK, dCK, dQL, dOA, dIA), and results of the t-tests.

<Table 4> Descriptive Statistics of Pre-Post semester test

Variable	Experimental group (n=257)		Control group (n=62)		t	d
	M	SD	M	SD		

dP		0.85	14.34	-1.88	15.52	1.06	2.73
Epistemological Variables	dSK	0.06	0.44	-0.04	0.43	1.63	0.10
	dCK	0.04	0.48	-0.05	0.50	1.42	0.09
	dQL	0.13	0.61	0.12	0.45	0.14	0.01
	dOA	0.11	0.52	-0.01	0.54	1.61	0.12
	dIA	0.05	0.46	0.12	0.50	1.11	-0.07

The results showed that there were no significant differences between experimental group and control group in growth of moral reasoning and epistemological beliefs . However, it is important to note that these groups includes both students, who attended STS courses before 2005 fall semester and who did not; therefore, to investigate the effects of previously taken STS courses, two groups are separated: students who experienced STS courses at least once (includes both before 2005 fall semester and 2005 fall semester), and who never experienced STS courses.

The results were summarized in Table. Similar to previous results, there were no differences between STS experienced group and non experienced group in growth of moral development and epistemological beliefs.

<Table 5> T-test between experimental group and control group

Variable	STS experienced group (n=289)		non experienced group (n=32)		t	d	
	M	SD	M	SD			
dP	0.80	14.03	-3.33	18.48	1.29	4.13	
Epistemological Variables	dSK	0.44	0.44	0.00	0.41	0.57	0.44
	dCK	0.03	0.48	-0.05	0.50	0.94	0.08
	dQL	0.12	0.59	0.14	0.47	-0.19	-0.02
	dOA	0.11	0.53	-0.08	0.49	1.91	0.19
	dIA	0.06	0.47	0.13	0.46	-0.81	-0.07

Moreover, STS experienced group and non experienced groups are separated into four groups by existences of STS experiences before 2005 fall semester; legends for four groups are given below.

<Table 6> Legends for four student groups

#	Group description
0	Students who does not attend STS courses in 2005 fall semester, and did not experience STS courses before 2005 fall semester.
1	Students who experienced STS courses before 2005 fall semester, but does not attend STS courses in 2005 fall semester.
2	Students who did not experience STS courses before 2005 fall semester, but attends STS courses in 2005 fall semester.
3	Students who attend STS courses in 2005 fall semester, and experienced STS courses before 2005 fall semester.



And then, the results according to the classification are showed in table. 'T' is studentized T value that  $T = \frac{M}{SD/\sqrt{n}}$ .

<Table 7> T-test among four student groups

Var	0 (n=32)			1 (n=30)			2 (n=222)			3 (n=37)			
	M	SD	T	M	SD	T	M	SD	T	M	SD	T	
dP	-3.33	18.48	-0.87	0.21	10.07	0.08	0.85	14.76	0.72	0.87	11.34	0.37	
Epist. beliefs	dSK	0.00	0.41	0.00	-0.08	0.45	-0.98	0.06	0.44	2.01	0.07	0.43	1.05
	dCK	-0.05	0.50	-0.58	-0.05	0.50	-0.59	0.08	0.48	2.59	-0.18	0.46	-2.44
	dQL	0.14	0.47	1.73	0.09	0.43	1.11	0.11	0.60	2.79	0.21	0.65	1.97
	dOA	-0.08	0.49	-0.94	0.07	0.58	0.63	0.12	0.54	3.30	0.06	0.46	0.79
	dIA	0.13	0.46	1.60	0.12	0.54	1.20	0.04	0.45	1.41	0.10	0.49	1.28

To see the long-term effects of STS education, four groups were re-grouped into two groups: students who never experienced STS courses or experienced STS just once (0, 1, 2), and students who experienced STS for several times and longer than a semester (3). T-test result between two groups showed that the latter's CK decrement was significantly greater than the former. (t = 2.81).

To see the details of analysis, the result of ANOVA will be showed in next section.

## V. T-test for each STS course

The table summarizes T-test results for differences pre-test and post-test of each subject including experimental group and control group. Subject numbers are showed in previous section.

<Table 8> T-test for each STS course

Group	Subj.	P		SK	CK	QL	OA	IA					
		Pre	Post										
Experimental Group	0 n=15	44.22	47.11	2.86	2.92	2.32	2.42	2.16	2.48	2.69	2.68	3.04	3.11
		t 0.99		0.77	1.22	2.49*	0.00	0.82					
	1 n=26	33.34	34.63	3.03	3.01	2.38	2.51	2.08	2.12	2.89	2.98	2.92	2.94
		0.48		-0.27	1.78	0.52	0.69	0.18					
	2 n=26	40.44	39.11	2.95	2.98	2.40	2.43	2.14	2.35	2.57	2.91	2.89	3.02
-0.48		0.31	0.33	1.41	3.04**	1.14							
3 n=43	47.53	45.80	2.79	2.83	2.34	2.42	2.04	2.00	2.73	2.80	2.79	2.91	
	-0.62		0.59	1.14	-0.35	1.19	1.67						
4 n=33	38.12	37.25	2.89	3.00	2.55	2.58	2.18	2.39	2.84	2.89	3.09	3.21	

		-0.25	1.95	0.38	2.16*	0.57	1.89						
5	n=28	40.56	40.69	2.83	2.88	2.38	2.50	2.18	2.39	2.79	2.90	3.02	2.92
		0.04		0.69		1.22		1.95		1.34		-1.11	
6	n=12	35.83	43.33	2.81	2.75	2.32	2.41	2.22	2.28	2.62	2.75	3.20	3.08
		1.72		-0.52		6.50		0.42		1.00		-0.80	
7	n=16	48.15	44.07	2.49	2.55	2.37	2.32	2.21	2.28	2.44	2.61	2.97	3.00
		-1.04		0.73		-0.35		0.52		1.23		0.19	
8	n=54	40.92	43.58	2.99	3.11	2.38	2.33	2.04	2.17	2.66	2.75	2.90	2.95
		1.12		1.71		-0.62		1.46		1.14		0.86	
9	n=21	44.36	37.69	3.09	3.03	2.69	2.58	2.30	2.46	2.90	2.86	2.97	3.16
		-1.78		-0.58		-0.99		1.46		-0.41		2.00	
10	n=2	40.00	31.67	2.93	2.50	2.50	2.63	2.30	2.40	3.20	3.10	3.07	3.14
		-1.67		-1.54		0.33		1.00		-0.14		0.14	
11	n=3	46.67	38.89	3.09	2.95	1.67	2.17	2.20	2.53	2.93	2.67	3.00	3.43
		-0.45		-1.00		2.65		1.15		-4.00		1.43	
12	n=36	45.08	47.62	3.05	3.05	2.42	2.34	2.14	2.22	2.68	2.72	2.80	2.87
		0.80		-0.01		-0.93		1.05		0.43		0.76	

\*p<.05, two-tailed, \*\*p<.01, two-tailed.

Most subjects shows no differences between pre-test and post-test in P score and epistemological beliefs; however, QL was significantly different in subject 0 and 4(p<.05), and OA was significantly different in subject 2(p<.05). Both of them showed significant increase of variables.

To analyze effects of type of course for moral development and epistemological beliefs, this data was re-tested with contrast, that means re-grouping by type of courses; differences between historical, social case related STS courses such as history of science and technology, science-technology and society, and other STS courses such as philosophy of science and technology, special topics on STS and non STS courses. The growth in moral development of historical, social case related STS courses(0, 1, 5, 6, 8) were significantly greater than other courses(2, 3, 4, 7, 9, 10, 11, 12) (t = 1.85) It can be inferred that real case based, interdisciplinary courses are more effective than specific field related courses and non STS courses to further development of post-conventional moral reasoning.

## VI. ANOVA

### 1. ANOVA for pre-test data

To investigate possible differences in pre-test variables of experimental group, ANOVA by subjects was used; moreover, to distinguish what subject shows significant difference, Duncan grouping was used

after ANOVA. The results indicate that there were significant differences in several subjects before attending STS course in 2005 fall semester; subject 7 showed significant differences in moral development, SK, OA scores. Subject 7 was a STS course offered in B University, it is freely elective course; in contrast, in other universities, A and C, STS courses are required to all students. It can be inferred that academic policies in B University made the significant differences in pre-test. Details will be discussed in discussion part.

<Table 9> ANOVA for Pre-semester test

Subj. #	P	SK	CK	QL	OA	IA
0	38.17 B	2.80 A,B	2.36 A	2.13 A	2.75 A	3.01 A
1	45.98 A,B	2.78 A,B	2.36 A	2.08 A	2.70 A,B	2.87 A
2	42.36 A,B	2.92 A	2.40 A	2.14 A	2.59 A,B	2.90 A
3	41.15 A,B	3.00 A	2.41 A	2.10 A	2.67 A,B	2.93 A
4	38.67 B	3.00 A	2.48 A	2.19 A	2.79 A,B	2.98 A
5	46.86 A,B	2.88 A	2.37 A	2.15 A	2.65 A,B	2.94 A
6	42.05 "A,B	2.84 A	2.45 A	2.14 A	2.77 A	3.02 A
7	49.45 A	2.60 B	2.46 A	2.32 A	2.44 B	2.96 A
8	41.52 A,B	2.89 A	2.54 A	2.14 A	2.86 A	3.04 A

## 2. ANOVA for differences of each variable

### 1) Change in P score

The results were presented in tables. Simple one-way ANOVA was used to analyze differences among four groups. First, growths of moral reasoning(P score) was analyzed. There were no significant difference among 0~3 groups in growth of moral development.

<Table 10> ANOVA for dP

	dF	SS	MS	F	Pr>F
Model	3	357.71	119.24	0.56	0.64
Error	215	45834.15	213.18		
Corr. Total	218	46191.88			

### 2) Change in SK

Second, Epistemological variables were also analyzed; Table shows ANOVA results for SK growth among 0~3 groups. Similar to the result of P score growth, there were no statistically significant differences among four groups.

&lt;Table 11&gt; ANOVA for dSK

	dF	SS	MS	F	Pr>F
Model	3	0.62	0.21	1.07	0.36
Error	315	60.58	0.19		
Corr. Total	318	61.2			

## 3) Change in CK

Next table shows the result of CK growth; there were significant difference among four groups.

&lt;Table 12&gt; ANOVA for dCK

	dF	SS	MS	F	Pr>F
Model	3	2.71	0.9	3.94	0.01**
Error	315	72.05	0.23		
Corr. Total	318	74.75			

To compare groups, four groups were re-grouped into two groups: students who never experienced STS courses or experienced STS just once (0, 1, 2), and students who experienced STS for several times (3). In this process, Duncan Grouping method was used. This result is similar to the result of T-test.

## 4) Change in QL

Growths of QL were also analyzed and summarized in table. Although CK showed significant difference between two groups, ANOVA results of QL growth does not show statistically significant differences among four groups.

&lt;Table 13&gt; ANOVA for dQL

	dF	SS	MS	F	Pr>F
Model	3	0.36	0.12	0.35	0.79
Error	315	107.43	0.34		
Corr. Total	318	107.78			

## 5) Change in OA

Table shows the result of ANOVA for dOA in for student groups; it implies that there were no significant differences in change of OA among groups.

<Table 14> ANOVA for dOA

	dF	SS	MS	F	Pr>F
Model	3	1.17	0.39	1.41	0.24
Error	315	87.48	0.28		
Corr. Total	318	88.66			

#### 6) Change in IA

Lastly, change in IA variable were analyzed and summarized in table; there were no significant differences among four student groups, similar to OA ANOVA result.

<Table 15> ANOVA for dIA

	dF	SS	MS	F	Pr>F
Model	3	0.38	0.13	0.58	0.63
Error	315	68.91	0.22		
Corr. Total	318	69.29			

## VII. Discussion and Conclusion

This study surveyed effects of STS education for college students' moral development and epistemological beliefs; the results show that, first, there was significant difference between growth in epistemological beliefs of students who attended STS course for semesters and who did not attend STS course at all or attended just once, second, students who attended historical-social based and interdisciplinary STS courses showed significantly grater growth in moral reasoning than students who attended non STS courses or field specified STS courses such as philosophy of science and technology, third and last, there were bias in students' moral development and epistemological beliefs among courses before taking courses.

First, students who attended STS courses in this semester and attended before showed significantly grater decrease in CK than students who did not attended STS courses once or attended just once. This result leads us to the conclusion that just a course for STS does not affect students' epistemological beliefs significantly; instead, longer and steady attendance may further significant change of students' epistemological beliefs, especially deceasing certainty of knowledge. Penn Jr.'s study in USA also did not show students' significant change by short term courses.<sup>16</sup> It means that we should develop long term and systemized STS curriculum in natural science and engineering colleges.

Second, there was significant difference in moral development among courses; STS courses related historical or social cases and interdisciplinary approaching showed statistically greater moral development than single-discipline courses and non STS courses. This study suggests that when we design STS curricular, we have to make case-based, up to date, and interdisciplinary course. Han and Park suggested that not only philosophical ethics, but also various studies of science and technology, such as sociology of science and technology, should be introduced to science and technology to improve its educational effect.<sup>17</sup>

Third and last, the result of pre-semester test showed that there was significant difference in moral reasoning and epistemological beliefs among subjects; moral reasoning and epistemological beliefs(P score, SK, OA) of free elective course's students were significantly more sophisticated than those of students who attended STS courses that were required by university policy. It can be inferred that if STS courses are elective to students, students who have already improved moral reasoning and epistemological beliefs choose STS courses; students who really need developing their moral reasoning and epistemological beliefs usually does not choose STS courses. Therefore, the curriculum in natural science and engineering colleges should be amended to make students experience more and various STS courses.

This study surveyed effects of STS education and discussed its implications for educational inventions. Since importance of science and technology is rapidly increasing in these days, and ethical problems in scientific fields also often arise, sophisticated educational inventions are should be developed to improve students' ability to cope with moral dilemmas. Consequently, following researches are necessary to improve STS education for natural science and engineering college students.

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16 Penn Jr, W. Y., "Teaching Ethics-A Direct Approach", *Journal of Moral Education*, Vol. 19 No. 2, 1990, p. 133.

17 Han, H. M. and Park, C. S., "A Study on the Application of Sociology of Science and Technology Perspective in Moral Education Curriculum", *Journal of Korean Ethics Studies(Korean)*, 60, 2005.

## Bibliography

- Bebeau, M. J., "Influencing the Moral Dimensions of Dental Practice" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics*(Hillsdale: Lawrence Erlbaum Associates Inc., 1994).
- Bendixen, L. D., Dunkle, M. E. and Schraw, G., "Epistemological beliefs and reflective judgment", *Psychological Reports*, 75, 1994.
- Duckett, L. J. and Ryden, M. B., "Education for Ethical Nursing Practice" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics*(Hillsdale: Lawrence Erlbaum Associates Inc., 1994).
- Han, H. M. and Park, C. S., "A Study on the Application of Sociology of Science and Technology Perspective in Moral Education Curriculum", *Journal of Korean Ethics Studies(Korean)*, 60, 2005.
- Higgins, A., "Educating for Justice and Community: Lawrence Kohlberg's Vision of Moral Education" in Kurtines, W. M. and Gewirtz, J. L. (eds.), *Moral Development : An Introduction* (Boston: Allyn and Bacon, 1995).
- Hofer, B. K. and Pintrich, P. R., "The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning", *Review of Educational Research*, 67, 1997.
- Hong, S. H., *A Study on the Development of Medical Ethics Education Program, Ed. D. Dissertation(Korean)* (Seoul: Seoul National University, 2000).
- Jeong, C. W., *A Cross-Cultural Study of the Relationships between Epistemological Beliefs and Moral Judgement as a Psychological Foundation for Moral Education*, Ph. D. Dissertation(Athens: University of Georgia, 2003).
- Moon, Y. L., *A Study to Diagnose Moral Development of Korean Adolescents -Standardization Research for DIT-(Korean)*(Seoul: Seoul National University, 1994).
- Penn Jr, W. Y., "Teaching Ethics-A Direct Approach", *Journal of Moral Education*, Vol. 19 No. 2, 1990.
- Rest, J. R., "Background: Theory and Research" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics*(Hillsdale: Lawrence Erlbaum Associates Inc., 1994).
- Schommer, M. "Comparisons of beliefs about the nature of knowledge and learning among postsecondary students", *Research in Higher Education*, 34, 1993.
- Self, D. J., Olivares, M. and Baldwin Jr., D. C., "Moral Reasoning in Veterinary Medicine" in Rest, J. R. and Narvaez, D. (eds.), *Moral Development in the Professions: Psychology an Applied Ethics*(Hillsdale: Lawrence Erlbaum Associates Inc., 1994).
- Tsai, "The effects of STS-oriented instruction of female tenth graders' cognitive structure outcomes and

the role of student scientific epistemological beliefs", *Journal of Science Education*, Vol. 22 No. 10, 2000.



Abstract

A Survey of Effects of STS Education on the University Students'  
Moral Development and Epistemological Beliefs: Using DIT and EBI

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The purpose of this study is to assess effects of STS(Science and Technology Studies) education in natural science colleges and engineering colleges. STS is an interdisciplinary study includes ethics, history, sociology, policy of science and technology; its main purpose is elaborating students' social perspectives on science and technology. In Korea, however, there is few studies related to STS education to improve its educational effects. Therefore, this study will do exploratory investigation effects of STS education in moral development and epistemological beliefs from view point of educational psychology; moral development will be assessed by DIT(Defining Issues Test), and epistemological beliefs will be assessed by EBI(Epistemic Beliefs Inventory). The results show that, first, there was significant difference between growth in epistemological beliefs of students who attended STS course for semesters and who did not attend STS course at all or attended just once, second, students who attended historical-social based and interdisciplinary STS courses showed significantly grater growth in moral reasoning than students who attended non STS courses or field specified STS courses such as philosophy of science and technology, From the results of investigation, this study will propose some suggestions to improve STS education in Korea.

Keyword : STS education, Ethics of science and technology, Epistemological beliefs, Moral judgement, Undergraduates in natural science and engineering colleges, EBI, DIT, STS.

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