The effect on learning achievement gotten by the teaching-learning method of STS integrated approach in technology

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Abstract

The purpose of this research is to understand the effect to students' learning-achievement gotten by the teaching-learning method of STS integrative approach in technology.

The subjects of this research were as follows:

1) Are there any differences in learning achievement between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

2) Are there any differences in cognitive domains between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

3) To the groups of high, intermediate, and low level, are there any differences in learning achievement between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

4) To the groups of high, intermediate, and low level, are there any differences in students' cognitive domains between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

The major findings of this research were as follows:

1) Students' learning-achievement gotten by the teaching-learning method of STS integrative approach in technology course is better than that of a traditional teaching-learning method.

2) In higher and lower levels of cognition, learning achievement gotten by the teaching-learning method of STS integrative approach in technology course is better than that of a traditional teaching-learning method.

3) In the groups of intermediate and low level, learning achievement gotten by the teaching-learning method of STS integrative approach in technology course is better than that of a traditional teaching-learning method.

4) In higher levels of cognition, learning achievement gotten by the teaching-learning method of STS integrative approach in technology course is effective to intermediate group and in lower levels of cognition to low level group.

I. Introduction

1. Preliminary proposal

The twentieth society is based on knowledge, knowledge as the key element of individual and of national competitive power and the source of value production. The government organization of the existing industrial society and social, economic, and school system should be changed to the paradigm of a society based on knowledge. The essential common feature of each country of the world's educational reform, under the preposition that education should satisfy the learners, is to support the citizens who can meet a diverse society actively with problem-solving ability, through 'learning the methods for studying' and through acquiring a basic concept, knowledge, information, social roles, and technology with which they adapted themselves to society self-directively.

For this, the most necessary ability will be an interdisciplinarity and overarching learning ability. Therefore, in comparison with the traditional curriculums separated into the text unit, it is desirable to integrate the curriculums and texts, which correspond to learners', needs and interests and helps learners to improve social and technological problem-solving ability.

Project 2000+ carried by ICASE(The Institute for Computer Applications in Science and Engineering) and UNESCO aims to make all of the people in the world equipped with scientific and technological literacy and asserts the integration between science, technology, and society programs as the spirit. The report, 'Science for all American' by Project 2061 team of AAAS(American Association for the Advancement of Science), also says that along with literacy education there should be integrative education of mathematics, science, and technology courses as well as of science, technology, and society courses. Integrative curriculums of science, technology, and society become needed, as the roles of science and technology increase in modern society and the negative elements come out according to it. STS arises as an alternative to satisfy this necessity. STS is a meaningful method to produce a well-equipped person with a scientific and technological literacy. It focuses on the inquiry process for getting knowledge and the problem-solving process rather than knowledge itself, and emphasizes the interrelationship of science, technology, and society connected with real life.

In the upcoming knowledge-based society, the continuous increase of new knowledge will happen first in technical engineering such as information technology, genetic engineering, environment engineering and the other new technical fields(The Federal Ministry of Education, Science, Research and Technology Delphi Germany Survey Report, 1998). As it is generally known that the possibility of development of the technology is only limited by technology field, so the STS integrative approach focusing on the technology courses should be emphasized in technology curriculums as well. In technology courses, especially, as the understanding of knowledge and problem-solving ability through manufacturing ability is emphasized, and practical attitudes and experienced activity are considerably important, application of the STS

integrative approach will be an excellent teaching-learning method and will be effective on technology education which plays an intermediate role between science and society. The study for the effect should be made first to apply the STS integrative approach to technology course teaching-learning curriculums. The purpose of this study is to determine the effectiveness of using the STS integrative approach to technology course and to discover the outcome of learners' achievements.

2. Research Question

The objectives of this research were as follows:

1) Are there any differences in learning achievement between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

2) Are there any differences in cognitive domains between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

3) To the groups of high, intermediate, and low level, are there any differences in learning achievement between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

4) To the groups of high, intermediate, and low level, are there any differences in students' cognitive domains between the teaching-learning method of STS integrative approach and a traditional teaching-learning method in technology course?

II. Literature Review

1. Definition of STS

STS means a teaching-learning strategy to solve scientific and technological problems on the basis of the interrelationship and the integration of science, technology and society. The ultimate aim of STS realized with persons' experience and practice is to produce well-equipped persons with scientific and technological literacy, to make them understand related knowledge through interaction, and to train democratic citizens to meet related values and ethical problems wisely. Therefore, various kinds of decision-making processes based on values and ethics, and technological problem-solving ability based on science and also technology is important in the STS integrative approach.

2. Interaction of technology, science, and society

1) Interaction of technology and science

Science is an inquiry act to explain natural phenomena reasonably and a process of making knowledge available. Technology is a method or an activity to apply scientific knowledge to

industry or real circumstances. The differences between science and technology are discussed in aim, conception, description, description of method, field, motive and in the qualitative side of curriculums(Sung-wook Hong 1994).

<Table 1> Difference of Science and Technology

	Technology	Science
Aim	Means, Problem solving in life	The law of nature, Pursuit of truth, Universality
Conception	Practicality, How to do	What is that? Why is the thing like?
Description	What shall we do?	What, Why
Description of method	Collect materials, Analysis, Design, Doing the suitable solutions in daily life	Observation, Experiment, Hypothesis, Verification
Motive	Practical usefulness	Intelligent curiosity
Curriculum	Specific and prescriptive, Effective design, Transformation of applied science	Reasonable understanding, Pursuit of origins, Importance of theory, Prospecting of future

Lately, however, people emphasize that science and technology is interactive rather than they separate difference. In modern society, science and knowledge become compound and interdisciplinary. In the twentieth century, it is obvious that there is a reciprocal effect between technology and science, and they have great influence on such studies of semiconductor and laser as condensed matter physics, quantum electronics, and the other new technologies. Scientific technology is used as a key element in pharmacy, medical science, and genetic engineering. Interaction between science and technology means that the various elements of science (new effects discovered in scientists research, theory and law, machinery and instruments, trainees) integrate the various elements of technology(understanding of artificial, technology law, process of design, skill, application ability). Since technology provide people with the research device and question of science, and science offers ideas to technology, they are in complementary relation.

2) Interaction of technology and society

In knowledge-based modern society, where technology as well as knowledge undergoes rapid changes, the effect of technology on society increases everyday. With society reflecting on technology and technology embodying society, technology and society are constructing and changing together. The change in technology induces not only a change in social systems like family, politics, economy, education, and religion, but also a change in the derivative social system like communicating method and process, the work and recreation, and public welfare. The interpretation of the relation of technology with society is divided between the causal point of view and the interactive point of view.

The essential meanings of interaction between technology and society are that we can live in a

technological society with a correct understanding of the influence on social and personal life according to technical renovation. Furthermore, we can develop decision-making ability that enables us to suggest an alternative on technological and social problems in various fields.

3. STS integrative approach in technology course.

1) Necessity in technology course

Current technology education demands a scientific process of, and science education also requires scientific and hands-on practical learning. Today's problems should include these related subject domains; first, technological literacy like energy and environment, the protection of nature, the understanding of interaction between technology and science, second, scientific knowledge and inquiry method, and third, the population problem, the food problem, health and disease problems at the same time. Therefore, a series of teaching-learning methods using the STS integrative teaching-learning method in technology course should be accomplished on the basis of these necessities. Some history of STS movement would be useful for the audience, especially that it was developed as a vehicle mainly for enhancing science teaching, well before technology education became a formal part of the curriculum. It would also be useful to point out, with examples, the aspects of technology curricula that emphasis the societal/environmental implications of technology, and the ways in which science can serve the needs of technology, i.e. it is regarded as another tool in the technologist’s tool kit, which assists in decision making.

The first step is to understand technology correctly in complicated and diversified society and to produce well-equipped person with technological literacy. Technology and science are made by the sensitive response to influence from the goal and value of society, and cause the social, ethical, and political censures, environmental pollution problems and so on. To understand the adverse reaction of technology and science and to overcome it, it is necessary to acknowledge the influence of technology and science on society.

The second step is to improve the larger technological literacy rather than the existing technical skill scope; that is, the decision-making and the problem-solving abilities. Today, since solving some problems become difficult and it is followed by the contrary value according to the decision, it is necessary to apply integrative knowledge and technology more deeply and largely to analyze our own sense of value and to express it. The introduction of STS in technology courses helps us to improve the multi-cultural and multi-dimensional decision-making ability and to develop the inclusive and deep technological problem-solving ability and practical flexible thinking through the integrative and systematic process.

The third step is to raise the interests on real life and local problems by regarding technology as a medium of science and society and to use this opportunity to choose jobs. The STS integrative approach in technology course enables all the learners to take advantage of the opportunity to choose their jobs and to know the characteristics and outlooks of jobs related with technology and

engineering fitting their aptitudes and interests. It also must be effective on humanization education, the environmental pollution, the moral and value education by creating interests on the local problems including real life with the application of technology and science.

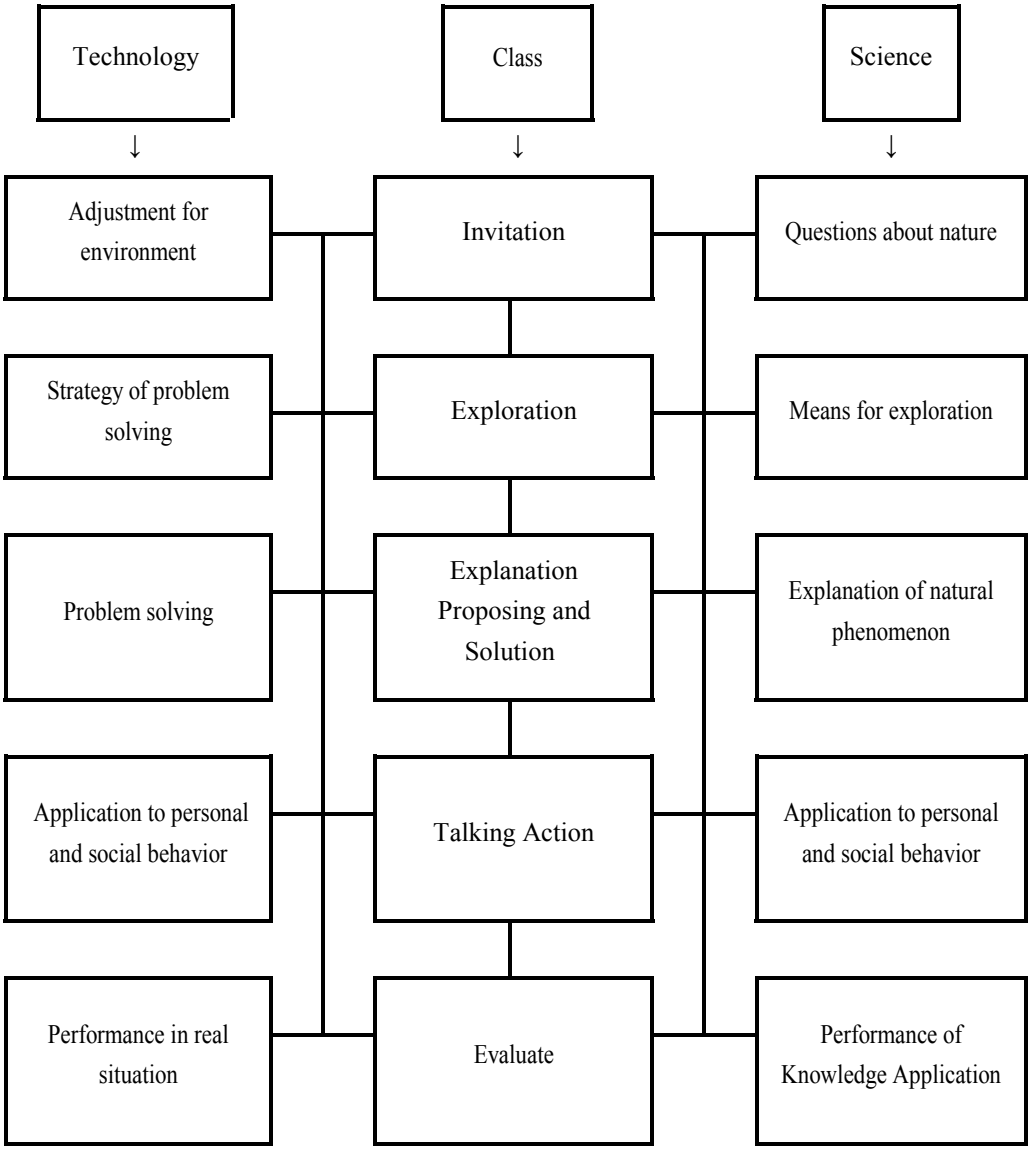
2) STS teaching-learning strategies in technology

The following is the teaching-learning strategies through the STS integrative approach in technology course.

First, active operation of instruction by learner-centered method. Second, individual and specific operation of instruction by permitting learner's diversity. Third, instruction centered on creative and direct practical experience. Forth, integration of Hands-on and Minds-on. Fifth, connection between social arguing issue and problems related in technology and science and cooperative learning. Sixth, using various teaching materials not only the textbook but also other materials. Seventh, we should centrally deal with close relationship and application with region and real life in planning teaching.

3) STS teaching-learning model

STS teaching-learning models currently used are BSCS (Biological Science Curriculum Study) and Iowa Chautauqau program developed with the support of NSTA and NSF. These models were mainly developed in the context of science education. The teaching model of the Iowa Chautauqau program emphasizes applying concept and principles to real life and using exploration and the process of problem solving in class. It was devised to provide a solution for regional problems based on scientific notion, knowledge and technological capability through comprehension and evaluation of science and technology advanced in class. The following <Figure 1> shows the STS teaching-learning model fitted in technology according to the STS teaching-learning strategies based on the model. The <Table 2> is about the activities for each level of the class.



<Figure 1> The STS teaching-learning model fitted in technology

In these two tables, or associated with them, it would be very useful to provide examples of the approach/materials used in the integrated STS course, so readers can make some realistic links to their technology teaching. It would also serve to more fully explain the investigation, which is presented at a fairly high level of abstraction.

<Table 2> Activities for each level of STS teaching-learning model fitted in technology.

steps of instruction	class activities
Invitation for Problem	Triggering learner's intellectual curiosity and presenting idea • We should trigger intellectual curiosity by the presentation of possible problems related to real life in the problem situation. • We need to propel learners to think and present their own ideas. • The teacher's role is to help learners to recognize a problem and to trigger the motivation for learning.
Exploration	Data collection and exchanging opinion for problem solving • Practice and observation, discussion, and use of audio-visual material • The inquiry of related work • Amendment and reinforcement of validity of their own idea through exchanging opinions with others • Prediction of effects related in society • The teacher summarizes the related terms and guides the direction of learning.
Explanation and presentation of answer	Amendment and elaboration of previous idea through the discussion • Explanation of problem solving method: trial to integrate technology and science • Presentation of the methods for problem solving and the teacher's complementing explanation and demonstration to comprehend problems not to be solved through a discussion
Performance	Application to problems in the real life • Integration of Hands-on and Minds-on • Emphasis on the direct experiences which is creative and practical • Application to the new situation for the learners to conform and settle down their idea • Application to the problems related in the real life as soon as possible • The conformation of a social effects on technology and science.
Evaluation	Performance test • Real and direct assessment • Process-oriented assessment • Integration of teaching and assessment • Learner's reflective self-assessment • Various assessments using portfolio, concept map, interview, computer, videotaping, and recording devices • Continuous feedback and feedforward

III. Methodology

The subjects of the research are 180 sophomores of 4 classes in the high school. We divided them into 2 experimental groups and 2 control groups. In the experimental groups, STS teaching model was applied and the traditional lecture method with audio-visual material was used in the control group. In addition, experimental groups were organized into small groups consisting of about 8 learners. Independent variables are the learning ability group that divides the learning group being applied STS teaching model and the one being applied the traditional teaching method into high, intermediate, and low level groups. We assigned learning achievement to the dependent variables. The learning achievement is divided into higher levels of cognition and lower levels of cognition.

To determine the homogeneity between groups, we made use of scores of IQ test and scores of pre-examination of learning achievement. Two weeks before the experiment was performed, the test was implemented. The result of the test proved that the scores of IQ test and learning achievement of two groups were relatively homogeneous.

Though the literature review, we abstracted the suggestions from the Iowa Chautauqau program and developed teaching-learning model that STS integrative approach suited to technology. Based on the model, the design of the instruction was made and teaching-learning process was devised. Two teachers were trained in the STS teaching-learning method by the researchers. And the other two teachers taught the other group with the traditional lecture-centered method. The researchers provided continuous feedback throughout the participation and observation. The class covered whole 6 chapters 2 hours a week; a total of 12 hours during 6 weeks.

The pre & post-test was developed by Bloom's knowledge classification system separated in higher levels of cognition and lower levels of cognition domain. In higher levels of cognition, the questions require high level problem solving ability such as application, analysis, synthesization, and evaluation. The lower levels of cognition are composed of questions using knowledge and comprehension. Educators, experts, and teachers in technology amended pre & posttest, teaching-learning model, and the teaching-learning designs twice. The distribution of a mark is 4 for each question of learning achievement test. The cronbach α of the pre-test was .879 and that of post-test was .842.

IV. Results

1. The result of research questions 1: As <Table 3> shows, the mean of the learning achievement of STS teaching-learning group is higher than that of the traditional instruction. According to t-test, there is a statistically significant.

2. The result of research questions 2: As <Table 3> indicates, the mean of STS

teaching-learning group is higher than that of the traditional class in the domain of higher levels of cognition. The result of t-test says that a significant difference. In the domain of higher levels of cognition, the result is the same as that of lower levels of cognition. And also there is a significant difference.

<Table 3> Post-achievement test Results of Learning groups

Division	Total score		higher levels of cognition score		lower levels of cognition score	
	STS group	Traditional group	STS group	Traditional group	STS group	Traditional group
n	90	90	90	90	90	90
Mean	33.31	29.62	11.61	10.16	21.70	19.46
Std. Dev	6.84	9.63	4.03	4.60	4.75	7.27
t	2.96		2.26		2.44	
p	.004		.025		.016	

Note) n.s.: P > .05: Non Significant

3. The result of research question 3: we divided the learning group into high-level (25% from the top), and low-level (25% from the bottom), and intermediate-level group (others) by classifying result of pre-achievement test to quartiles. As the <Table 4> shows, the mean of the learning achievement of STS teaching-learning group is somewhat higher than that of the traditional class in the high-level group. But there is no significant difference between them. In the intermediate and low-level groups, STS teaching-learning groups are higher than those of the traditional classes are. In two groups there is a significant difference between according to the t-test.

4. The result of research question 4: As the <Table 4> shows, the mean of the learning achievement of STS teaching-learning group is somewhat lower than that of traditional class. And the result of t-test doesn't make any statistically significant difference in high-level group of higher levels of cognition. In intermediate group, the mean of STS teaching-learning group is higher than that of the traditional class. The result of the t-test tells us significant difference. In the low-level group, though the mean of STS teaching-learning group is higher than that of the traditional class; there is no significant difference according to the result of t-test. The mean of STS group is somewhat higher and there is no significant difference in the high-level group of the lower levels of cognition. In intermediate group, the result is the same as the high-level group, and there is no significant difference. But there is a significant difference even if the mean of learning achievement by STS model is higher than that of traditional class.

<Table 4> Post-achievement test Results between learning-group and learning ability group

Division	Learning ability group	Teaching method	n	Mean	Std. Dev	t	P
Total Score	low level group	STS	24	29.57	7.98	2.86	.007
		Traditional	26	22.67	8.03		
	intermediate level group	STS	40	34.19	6.32	2.76	.007
		Traditional	40	29.26	9.21		
	high level group	STS	26	34.92	5.49	.39	.391$^{n.s}$
		traditional	24	34.09	8.93		
higher levels of cognition score	low level group	STS	24	9.91	4.33	1.93	.061$^{n.s}$
		traditional	26	7.62	3.56		
	intermediate level group	STS	40	12.00	4.05	3.10	.003
		traditional	40	9.16	4.15		
	high level group	STS	26	12.31	3.38	1.31	.158$^{n.s}$
		traditional	24	13.74	4.15		
lower levels of cognition score	low level group	STS	24	19.65	4.96	2.64	.012
		traditional	26	15.05	6.44		
	intermediate level group	STS	40	22.19	4.61	1.51	.136$^{n.s}$
		traditional	40	20.11	7.29		
	high level group	STS	26	22.62	4.52	1.40	.158$^{n.s}$
		traditional	24	20.35	6.49		

Note) n.s.: P > .05: Non Significant

V. Conclusions

The major findings of this research were as follows:

1) Students' learning-achievement gotten by the teaching-learning method of STS integrative approach in technology course is better than that of a traditional teaching-learning method.

2) In higher and lower levels of cognition, learning achievement gotten by the teaching-learning method of STS integrative approach in technology course is better than that of a traditional teaching-learning method.

3) In the groups of intermediate and low level, learning achievement gotten by the teaching-learning method of STS integrative approach in technology course is better than that of a traditional teaching-learning method.

4) In higher levels of cognition, learning achievement gotten by the teaching-learning method of STS integrative approach in technology course is effective to intermediate group and in lower levels of cognition to low level group.

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