大 韓 工 業 敎 育 學 會 誌
第 40卷 第 1號 pp. 180-200

Implementation of Student Teams Achievement Divisions (STAD) in a Robotic Technology Class for Pre-service High School Teachers

Seong Jin Kim*, Hyuksoo Kwon, Jeongyoon Jeong*****

<Abstract>

The problems current robotic technology education class has are the students with different basic background knowledge levels and the class based on the instructional teaching method. This study shows the implementation of the student teams achievement divisions (STAD) learning model into an introductory robotic technology education class to resolve the problems in the current robotic technology class. The STAD learning model focuses on the ability of each team member with different knowledge levels and make team members help each other through class activities such as assignments and a project. All members get rewarded by their performance output as a team in a course grade. The outputs of STAD learning models were measured by paired sample t-test as pre-test and post-test in terms of students's transition on basic knowledge for robotic technology, students' attitudinal transition on teaching robotic technology class, and students' competencies and self-efficacy on related subject areas. The study participants were 22 pre-service technology teachers at a university. The results show that all four measured areas were improved significantly, compared to pre-test with respect to the means scores of each measurement area. The STAD learning model could be an alternate for the current robotic technology class to deliver the better class outcomes for students under the specific circumstances.

Keywords : robotic technology, STAD, pre-service technology teachers

* Teaching Instructor, Kongju National University
** Correspondence: Assistant Professor, Kongju National University, hskwon@kongju.ac.kr
*** Student, Kongju National University

Ⅰ. Introduction

1. Background

Technological innovation plays an important role in the human society. Thus the technology education is a must for students to meet new needs and standards. The influences of technology in the society have been remarkable for years and one of its areas is robotic industry. As a highly developed information technology (IT) country, there have been tremendous efforts in robotic industry and recently have started showing positive outcomes in many related fields.

Robotic technology education mainly consists of concept, structure, control through programming of robot and most of them require science, mathematics, physics, and engineering backgrounds. Many technology education classes including robotic technology class are related to them as well. To aid secondary school students in problem solving skills, invention, and creativity through technology education, it is vital for pre-service high school teachers to have the ability to perform all the required tasks in the class(Lee, 2010). It has to be based on thorough understandings of subjects. To achieve the degree of required level of comprehensions, a well-organized program for pre-service secondary school teachers is a necessity. However, some of pre-service secondary school teachers do not meet the required skills in many areas of technology education. There are controversial issues in that matter. The root causes may come from the current secondary school educational system.

Even though it is heavily related to the subjects like mathematics, science, physics, and engineering in technology education, due to the characteristics of technology and home economics department, students without engineering, mathematics, science, and physics background or students being deficient in those backgrounds could get admitted into the department of technology and home economics. Due to a highly going-to-college oriented education system in South Korea, regardless of their backgrounds in those subjects, many of them are not ready enough to learn various fields of technology education at the university level even though many areas in technology education largely require mathematical and scientific backgrounds. Additionally, the students' attitudes and abilities towards learning get accustomed to being passive and there is no change in their attitudes toward learning in universities and therefore their efficiency of learning has not been improved(Baek & Park, 2012).

During freshmen and sophomore years in college of engineering, students could take basic courses to build knowledge foundations for the courses they learn in junior and senior years. It is systematically possible for students to fill the gap between their current ability to learn and required ability to learn later. However it is impossible to offer students in college of education basic but helpful courses like college of engineering does. Students in college of education have to fulfill requirements in education and specialization together. Due to this characteristics, there are no enough credit hours available to offer basic courses solely for their specialized areas. With respect to this situation in many courses offered by department of technology and home economics including robotic technology education, it is necessary to seek for an empirical solution through a subjective research process.

The instructional method is common in the current robotic technology education class. There are no benefits from this method due to the complexity of robot assembly and robot theories. This traditional method focuses on delivering information and it seems to make students passive in their participation in the class(Park, 2008). It blocks out student from understanding of subject and could lead to making students less interested in the subject. Under these circumstances, to improve the ability of pre-service secondary school technology teachers in robotic technology education, another method is necessary. This paper addresses implication of the student teams achievement divisions (STAD) method and its outputs in a robotic technology education class. Although there are various definitions in cooperative learning, it is basically to work together as a group to achieve academic goals/objectives(Beon, 2008). In STAD based models, there is no specific assigned role among team members and the team will be rewarded based on each member’s achievement compared to his/her objectives. During this process, team members help and complement each other in their learning process. This cooperative learning is also an alterative solution for the hierarchical, competitive based learning method(Shin, Kim, & Seo, 2001). A student with deficiency of learning could achieve objectives/goals through the group not individual. It is suitable for pre-service technology teachers who have different levels of basic knowledge, learning ability, and preparedness.

2. Research Goals

The purpose of this study is to address the quantitative and qualitative analysis of pre-service technology teachers’ influences in an introductory robotic technology education class using the STAD method originally developed by Slavin(1980). The objectives are to: 1) Show the changes of pre-service teachers' basic knowledge for the robotic technology education class; 2) Check the improvement of pre-service teachers' attitude toward the robotic technology area; 3) Test the changes of pre-service teachers' competency in the robotic technology education class; 4) Measure pre-service teachers' satisfaction in the robotic technology; and 5) Show the possibility of implementation of STAD method in the future. The literature review addressed the past and current research on professional development for technology teachers, curriculum and teaching method, and STAD method to support this paper. The methodologies used in this paper are descriptive statistics, independent *t*-test, and paired sample *t*-test. Finally, findings and recommendations will be presented in the conclusion of this study.

3 . Research Limitations

This research was implemented in a university located in the middle of South Korea. The robotic technology class was offered as a major elective class during the summer semester and had 22 class participants. This study might have a limitation of generalizing this study's findings to other educational institutes.

Ⅱ. Literature Review

1. Professional Development for Technology Teachers

Professional development is one of the basic requirements of technology teachers. It is very important to consider the technology education and its process in a different perspective as country, society, and individual(Choi, 2005). Since technology education classes are empirical-oriented, the competency of technology teachers is critical.

There are still some obstacles to achieve these objectives. With respect to the current technology education situation, more than 50 % of technology teachers in middle and high schools was non-professional or certified by taking a short term training program as a second major(Ham, 1994). Park(2007) addresses that 88 % of technology teachers needed the retraining program and the way of retraining programs could be professional development by competent technology educator and mandatory training to produce well-educated technology teachers.

To educate the technology teachers properly, the curriculum and methodology in the technology education are vital. Technology teachers ought to understand completely various fields in technology to have their students learn and be technological literacy. Technological literacy defines as the ability to use technology, manage, evaluate, and understand technology(ITEA, 2000). However there are limitations in specialization in technology education. In addition to this, the application of up-to date technology in technology education is not as fast as the short cycles of current technology innovation. Under these circumstances, it is hard to have effective outcomes in specialized enlightenment for technology educators.

The pre-service technology teachers get admitted into the technology program with very different backgrounds of knowledge foundations and deficiency of necessary basic mathematics, science, and engineering classes. At the university level, the instructional method is popular by motivating students through doing assignments, in this case, the teaching method and the role of professor are very important(Baek & Park, 2012). There is a limitation of the instructional method due to the various levels of students' ability in the class. It is necessary to provide a learner-focused teaching method considering the current problems in technology education.

2. Curriculum and Teaching Method

Technology education evolves as much as the trends of technological transition. A new paradigm in education is to consolidate the educational environments and to liberalize education activities(Kim, 2005). This paradigm is applied to the technology education at universities. Robotic technology is an example of technology education that reflects the current trends. Robotic technology gets paid attentions and is considered as the final destination of technological development. Robotic technology education class provides opportunities to increase robotic literacy through basic knowledge and structure of robots. It is offered as an elective major class but is important to meet the current and future demands.

The most common teaching method in robotic technology education class is instructional along with questions and answers and laboratory activities. If a class is mainly instructional oriented in robotic technology education, students participate in the class passively, become less interested, and it makes the quality of class lower(Hong, 2002). Students have troubles with, in a way that robotic technology is not a common subject, the complexity of robot assembly and problem solving processes. Additionally many of them cannot take any prerequisites such as mathematics and science or lack for basic knowledge in the class. There is a demand in education that solves the problems, fulfill the differences among students, and improve problem solving skills and creativity and it is a must in many university classes(Bae, 2007). Robotic technology class should be done by a learner based teaching method.

3. Students Teams Achievement Divisions(STAD)

A cooperative learning is very eccentric to the competitive-oriented education environment. Slavin(1980) asserts that a cooperative learning is a way of teaching method that all team members work together as a team and complement each other to achieve the goals by having attitudes among team members like all-for-one and one-for-all and it is necessary to avoid individual-focused and to share each member's pros and cons(feedbacks). There are various cooperative learning models. One of them is STAD and it has four to six team members in a group. A cooperative learning model developed by Slavin(1980) at Johns Hopkins University shows the positive outputs on problem solving skills by learner themselves. Robotic technology education is a class that has a certain level of difficulty in contents and a complicated robot assembly process may not appropriate for individual. Therefore robotic technology education is a suitable class applying a STAD learning model with cooperative learning environments.

The most obstacles among students in technology education departments are the different levels of backgrounds in subjects, deficiency of prerequisites for the classes. If a team is formed by the consideration of each member's ability of the subject and the abilities among teams are less different or more equal, it is expected to have the positive outcomes within a team and among teams(Kim, 2005). Since each member contributes to the team goal accordingly, it leads to having a successful experience among team members and a member with the lowest ability benefits from a member with the highest ability on a team through the cooperative learning process(Kim, 2005). The best point of this cooperative learning model is to complement each other among team members for common goals. According to Johnson and Johnson (1999), to achieve the team goals, the true nature of cooperative learning is to assign goals, to perform better on tests, to reward each team based on the rules and outcomes from each team. For team goals, team members study together by agreed upon and get rewards by the results in a way of grade. Each team member improves his/her performance through interaction among team members and it is evident that working together provides members with opportunities of increasing recognition of existence of each member on the team positively. It also gives a professor various class strategies to manage the class and learners consider other students, have their attitude towards them nicely, and improve their problem solving and decision making skills(Park, 2008). In various research and literature, it is shown that a cooperative learning model has more positive outcomes in efficacy than instructional teaching method. The goal of this study was to investigate pre-service technology teachers' transition toward their basic knowledge on robotic technology, attitude to teach robotic technology, and competency for robotic technology and its instruction.

Ⅲ. Research Method

1. Program Development

An introductory robotic technology program for pre-service technology teachers was developed in three stages: Preparation, development, and improvement. The preparation stage was started with the reviews of the previous studies and national revised curriculum. Development stage consisted of the following procedure: (1) choosing and organizing the learning contents, (2) confirming the weekly plan, and (3) establishing instructional and assessment strategies.

A complete course plan was reviewed by two in-service technology teachers. The reviewers had more than five years of teaching experience in the field of robotic technology education and emphasized the importance of pre-service technology teachers' practice or project based learning and basic understanding toward science and mathematics. Also, the reviewers participated in the process of instrument development. The developed course consisted of 70% team project and 30% lecture (3 hours × 15 sessions = 45 hours). The team project had two parts: Group hands-on project and STAD learning.

2. Participants

The developed course, an introductory robotic technology, was implemented in an institute for pre-service technology teachers. There were 22 class participants enrolled in 2014 summer semester as pre-service technology teachers. The participants did not take any prior major courses except ‘introductory biotechnology’ and ‘information and communication technology’. The participants’ preferences toward school subjects in their secondary school indicated all medium level, as presented in <Table 1>. 12 participants (54.5%) took high school physics and chemistry subjects while 10 students did not take any physics or chemistry subject in their high school.

<Table 1> Participants’ Preferences toward School Subjects

	Dislike strongly (1)	Dislike (2)	Neutral (3)	Like (4)	Like Strongly (5)	Total	Mean
Technology	0	0	11	10	1	22	3.545
Science	1	2	6	8	5	22	3.636
Mathematics	2	3	6	6	5	22	3.409

3. Instruments

The instrument in this study consisted of four parts: (1) participants’ demographic information, (2) basic Science/Mathematics knowledge for robotic technology, (3) attitudes toward robotic technology and its instruction, and (4) participants’ thoughts toward STAD learning. The first three instruments were administered twice at the first day and last day of class. The fourth part of this instrument was implemented at the last day of class. Additionally, to establish the validity and reliability of the developed instrument, we asked participants to answer their thoughts toward STAD learning by in-depth individual interview.

The participants‘ demographic information consisted of gender, science and mathematics courses taken in their high school, the preference toward technology, science, and mathematics domain in their high school. The second part of the instrument was to measure participants’ transitional knowledge toward robotic technology related to science and mathematics. Two robotic technology educators and two high school science teachers (physics and chemistry) chose key science and mathematics concepts and principles required for learning robotic technology through two sessions of discussion. They found 25 items as the basic science and mathematics concepts and principles for robotic technology and developed 20 questions. The basic knowledge test was administered in a pre-test and post-test format. The items were designed to investigate participants’ basic knowledge toward the domains such as electricity & electronics, chemistry, physics, and mathematics by asking them to write a short answer for each question.

As the third part of this instrument, this study measured technology pre-service teachers' attitude toward robotic technology and its instruction employing and modifying an instrument, 'technology teachers' motivation toward biotechnology instruction survey', developed by Kwon(2009) as presented in <Table 2>.

<Table 2> Technology Teachers' Attitude toward Robotic Technology Teaching

Survey Items	Construct
I like to teach robotic technology content.	Value
I believe that human life will be improved through robotic technology.	Value
I am interested in learning new terminologies and concepts related to robotic technology.	Value
I believe that all literate people should know robotic technology content.	Value
I can teach robotic technology in a unique method different from that of science teachers.	Expectancy
I believe that teaching robotic technology valuable, considering the developmental trends of contemporary technology innovation.	Value
I can develop hands-on activities related to robotic technology for my technology class.	Expectancy
I can implement problem-based learning in hands-on activities related to robotic technology.	Expectancy
Considering students' future life, learning robotic technology is essential.	Value
I can evaluate/assess hands-on activities for robotic technology.	Expectancy
I can manage materials, tools, equipment, and the laboratory for robotic technology hands-on activities.	Expectancy
Robotic technology is one important content that should be taught in technology class.	Value
I can employ the content or strategies of other subjects (e.g. physics, mathematics, etc).	Expectancy
Considering students' actual life, learning robotic technology is useful.	Value

The instrument was developed by a robust theory for teachers' motivation and was based on two constructs such as expectancy and value defined as 'how successful they expect to be' and 'how highly they value it' respectively by prior studies(Graham & Taylor, 2002; Wigfield, Tonks, & Eccles, 2004). The reliabilities were 0.889(expectancy) and 0.878(value) and turned out to be stable in prior study(Kwon, 2009). Even though there were 15 items in the original instrument, for this study, the instrument had to be modified with 14 items to meet the research criteria. In this study, the modified instrument indicated stable reliabilities ranging from 0.897 to 0.902. 14 items with a five points Likert scale were used in measuring pre-service technology teachers' attitude toward robotic technology and its instruction. The fourth part of this instrument measured pre-service technology teachers' competency level for robotic technology knowledge and its instruction. The question items were about key learning contents in robotics technology: Electrical circuit, electronics circuit, digital logic circuit, electrical application, mechanical elements, and mechanics. This instrument asked participants to indicate the degree of their knowledge and teaching ability toward six learning areas by a five points Likert scale.

A complete instrument set was reviewed by two pre-service technology teachers' educators and finalized as an instrument for data collection.

3. Data Collection and Analysis

This study investigated pre-service technology teachers' transitions through an introductory robotic technology class with STAD learning. To accomplish the research goal, this study employed data collection methods in both quantitative and qualitative ways. Participants' transitions toward basic science and mathematics knowledge related to robotic technology, attitude toward robotic technology and its instruction, and competency level toward robotic technology knowledge and its instruction were measured by a pre-test and post-test strategy. Pre-test was administered after the class orientation under the participants' voluntary consent of this study. Post-test was administered after their final term examination and individual in-depth interviews were conducted to investigate their perception toward STAD learning. The collected quantitative data were analyzed by descriptive statistics, independent *t*-test, and pair sample *t*-test using SPSS version 21. Also, qualitative data collected from the in-depth interviews were analyzed by theme analysis method. To establish the reliability of the qualitative analysis, this study let two raters conduct the theme analysis and make their findings consented.

Ⅳ. Findings

1. Transition on Basic Knowledge for Robotic Technology

This study measured basic knowledge toward domains such as (1) electricity ad electronics, (2) physics, (3) chemistry, (4) mathematics for robotic technology as a pre-test and post-test. The paired sample *t*-test was used to compare the pre-test and post-test in transitional knowledge for robotic technology. Pre-test and post-test have 20 questions consisting of eight questions (electricity & electronics), five questions (chemistry), four questions (physics), and three questions (mathematics) as shown in <Table 3>.

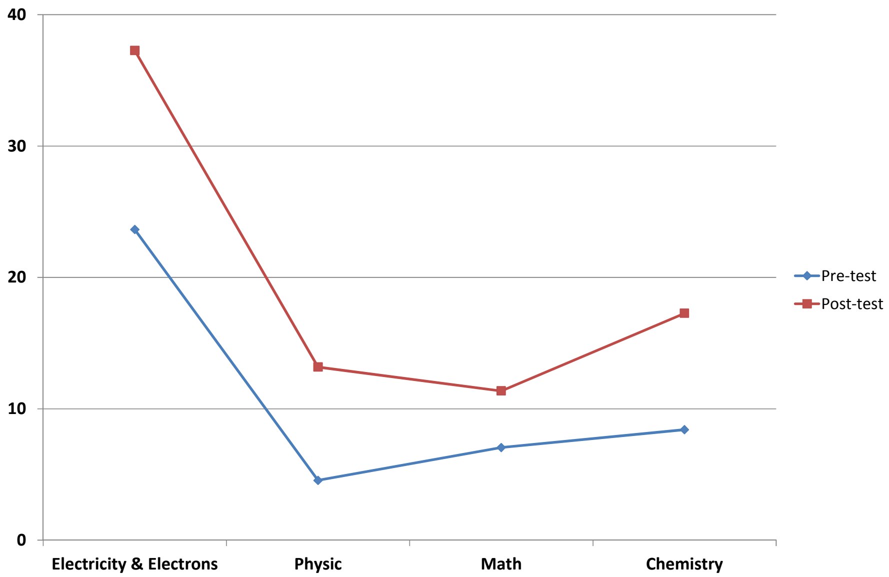
<Table 3> Paired Sample t-test Result for Basic Knowledge for Robotic Technology

Area	Items	Pre	Post	*t*
Electricity & Electronics	The unit of resistance	23.64	37.27	-9.721*
	The relationship difference between voltage and electric current			
	The direction of electron and electric current			
	The amount of electricity			
	The unit of illuminance			
	The relationship between electrical resistance and the cross-sectional area of the conductor			
	The components of calorific value			
	The Fleming's left hand rule			
Chemistry	The elements in the outermost electrons with 3 electrons	8.41	17.27	-5.291*
	The chemical bonds between Si and Ge			
	The synthetic resins			
	The most important elements to the steel			
	1 nanometer			
Physics	The unit of pressure	4.55	13.18	-8.227*
	Torque			
	The ideal gas law			
	Acceleration			
Mathematics	Values of trigonometric function	7.05	11.36	-4.091*
	Logical calculation			
	Frequency			

* : $p<0.01$

To investigate the transition of the pre-service technology teachers' basic knowledge toward robotic technology, the findings from the pre-test and post-test were analyzed by the pair sample t-test. The basic knowledge test could be analyzed by each sub-category: Electricity and electronics, chemistry, physics, and mathematics.

Considering the number of questions in each field, the highest improvement area was physics (t = -8.227, p<0.01) with –2.15 scores which was computed as the mean difference between pre-test and post-test divided by the number of questions, followed by chemistry (t = -5.291, p<0.01) with –1.77, electricity & electrons (t = -9.721, p<0.01) with –1.7, and mathematics (t = -4.091, p<0.01) with –1.4. All four basic knowledge areas showed higher improvement compared to the results of pre-tests. The null hypothesis was that there is no difference in knowledge transition after the robotic technology class. If the p value of t-test equals or is greater than 0.05, then it fails to reject the null hypothesis or vice versa. Since the p values of all four areas were less than 0.05, the null hypothesis was rejected at α = 0.05. It showed the robotic class had the positive impacts on the students' knowledge transition for the class. Also, the graphic presentation of this result is shown in [Figure 1].



[Figure 1] Graphic Presentation of Transitional Knowledge for Robotic Class

3. Attitudinal Transition on Teaching Robotic Technology

Students' attitude toward teaching robotic technology was measured with 14 questions. These 14 questions were divided into two major constructs of students' expectancy and value in terms of teaching robotic technology. There were eight questions related to value and six questions related to expectancy. Regarding the changes in attitudes toward teaching robotic technology, the paired sample *t*-test was used to measure the difference between pre-test and post-test. <Table 4> shows the results of paired sample *t*-test. Scores of two constructs (expectancy and value) were significantly improved through the class (t=-5.661, p<0.01 for expectancy, t=-7.208, p<0.01 for value). The mean scores of both constructs were increased by 4.3 and 5.5 for expectancy and value respectively. Due to the *p* value of *t*-test, the null hypothesis did not fail to be rejected. It is evident that the robotic technology class delivered the good outputs in terms of students' attitude towards the contents and showed that students in the class became more comfortable with the robotic technology field than before.

<Table 4> Transitions for Attitude toward Teaching Robotic Technology

Construct	Pre-test	Post-test	*t*
Expectancy	31.091	35.409	-5.661*
Value	18.409	23.955	-7.208*

* : p<0.01

4. Competency for Robotic Technology and its Instruction

Students' competencies of the robotic technology knowledge and teaching ability regarding key learning contents: electricity & electrons and mechanics were measured. This measurement was based on self-reported questions. Measured areas are shown in <Table 5> and <Table 6>. As shown in <Table 5>, students' competencies on key learning contents were improved significantly after taking the robotic technology class, compared to before taking it. The two most improved areas were 1) electronic circuits – electronic component, electronic circuits (t=-8.450, p<0.01) with -1.545 as the mean difference between pre-test and post test and 2) electrical application – generation of electricity, lights, heat transfer (t=-9.566, p<0.01) with –1.318. The two least improved areas were 1) electrical circuits – direct and alternating current (*t*=-6.236, *p*<0.01) with –0.909 of the mean difference and 2) mechanics – machining (*t*=-5.457, *p*<0.01) with –1.045. The null hypothesis of this test was that students' competencies on six areas are the same as before taking the robotic technology class. Since the p-value of each item was less than 0.05 at α=0.05, the null hypothesis should be rejected. So the paired sample *t*-test showed that students' competencies on six areas were significantly different with higher mean values and it might lead to influencing pre-service technology teachers' teaching ability on these areas as well.

<Table 5> Competencies for Key Learning Contents in Robotic Technology

Item	Pre-test	Post-test	*t*
Electrical circuits : Direct and alternating current circuits	3.091	4.000	-6.236*
Electronic circuits : Electronic component, electronic circuits	2.318	3.864	-8.450*
Electronic circuits – digital electronic circuits	2.909	4.136	-7.085*
Electrical application : Generation of electricity, lights, heat transfer	2.500	3.818	-9.566*
Mechanics – Mechanical components	2.636	3.818	-6.500*
Mechanics – Machining	2.955	4.000	-5.457*

* : *p*<0.01

Taking the robotic technology class had positive impacts on students' competencies on six different areas of electricity & electrons and mechanics. It is necessary to seek out for students' teaching ability on them. <Table 6> shows the results of students' self-efficacy on six different areas. Students' self-efficacy on six areas were significantly improved after taking the robotic class. In terms of mean difference between pre-test and post-test, the first three items shown in <Table 6> were tied as the most improved areas with a value of 1.5, mean difference. They were 1) electrical circuits – direct and alternating current (*t*=-13.748, *p*<0.01), 2) electronic circuits – electronic component, electronic circuits (*t*=-8.189, *p*<0.01), and 3) electronic circuits – digital electronic circuits (*t*=-8.775, *p*<0.01). Items of electrical application – generation of electricity, lights, heat transfer (*t*=-7.545, *p*<0.01) and mechanics – machining (*t*=-9.721, *p*<0.01) had the same mean difference value as –1.363. Mechanics – mechanical component (*t*=-11.451, *p*<0.01) had the mean difference value of –1.455. The *p*-value of each item was less than 0.05 at α=0.05. The null hypothesis should be rejected. It is evident that taking the robotic class aids students' teaching ability on six areas in being comfortable with the contents.

<Table 6> Competency for Teaching Key Learning Contents in Robotic Technology

Item	Pre-test	Post-test	*t*
Electrical circuits : Direct and alternating current circuits	2.456	4.046	-13.748*
Electronic circuits : Electronic component, electronic circuits	2.182	3.682	-8.189*
Electronic circuits: Digital electronic circuits	2.546	4.046	-8.775*
Electrical application – Generation of electricity, lights, heat transfer	2.318	3.682	-7.545*
Mechanics – Mechanical components	2.363	3.818	-11.451*
Mechanics – Machining	2.546	3.909	-9.721*

* : $p<0.01$

5. Perception toward STAD Learning

This study conducted individual in-depth interviews regarding class students' perception toward STAD learning. The interview contents were transcribed and analyzed by researchers. Three researchers analyzed 20 transcripts individually and finalized four themes about the STAD learning in an introductory robotic technology. The themes were responsibility, achieved goals, teaching ability, and advanced STAD learning. All participants expressed the responsibility and achieved goals as a huge benefit from the STAD learning. The STAD learning activities got participants responsible for given learning activities and finally achieved in their collaborative projects. Also, they indicated improved 'teaching ability' as an advantage of studying in a group for STAD tests. Under the diverse team members regarding their knowledge level, they had to help each other by teaching and learning collaboratively.

Hyeji (Pseudonym) Studying in a group made me more responsible for group learning activities. Usually, I gave up solving difficult calculation problems. In this STAD *learning, I had to concentrate on our team goal like 'having good scores for all the tests'. It was amazingly achieved. I mean, I could solve the problems with my team members and help others solve the problems.*

Sookhi (Pseudonym) At the end of semester, I was surprised when I retook the test that I took it earlier in the semester. I felt very comfortable on the subjects and my score was very improved compared to the first test. I fet great. The team improvement ranking among all the teams in the class kept me motivated to perform better than the others. I could find myself improved by sharing the tips and highlights for studying with other team members.

Gilsoo (Pseudonym) In this class, I had to consider other team members because my performance influenced on my team's performance. All the team members had to try their best and helped each other if necessary to achieve the team goals/objectives. It brought us good team performance outcomes at the end like I could improve myself by helping other team members. It was a great way to study on the team.

All the participants expressed positive perspectives of the STAD learning in this class. But they pointed out a challenge of advancing the STAD learning strategy. For example, good achievers expressed unsatisfied with their final score when the group members were not all the achievers. They suggested an individual compensation systems for overcoming the disadvantage of the STAD learning.

Jisoo (Pseudonym) The course grade criteria and policy should be clearly addressed. Even though we tried hard, one of team members sometimes didn't do well on the team activities. If it happened, it lowered the team's morale. In this case, there should be any other way to compensate the gap between the team's effort and individual's effort.

Based on in-depth interviews with pre-service teachers, it is evident that the STAD model has positive impacts on four themes as outcomes of the class. In general, it might mitigate the current problems addressed earlier in the technology education classes at the universities. However, it is necessary to minimize the disadvantages found in this paper for the future use.

Ⅴ. Summary, Conclusions, & Recommendation

1. Summary

The robotic industry is one of the most fast growing industries in South Korea. So it is important to have pre-service technology teachers understood the context of the field. Unfortunately, the current secondary education curriculum does not provide pre-service technology teachers with the basic knowledge for the robotic technology class. Many of pre-service teachers have different basic knowledge backgrounds and their knowledge backgrounds are not related to the robotic technology education class. Although the class is based on science, mathematics, physics, engineering, and chemistry, many of pre-service technology teachers lack of these course works before they take the robotic technology education class. The instructional teaching method cannot deliver the required learning outcomes to the students with different background knowledge levels. To fill the gap between the basic knowledge required and the basic knowledge educated for the better robotic technology education class performance from the pre-service technology perspective, the Students Teams Achievement Divisions (STAD) model was implemented into the class of an introductory robotic technology education class. The STAD model fundamentally focuses on the ability of each team member on the subject and helps team members compensate each other with respect to their familiarity of the subject through the team activities such as assignments and a project. All team members get rewarded based on their performance compared to their individual objectives as a course grade. The participants for this study were 22 pre-service technology teachers in the introductory robotic technology education class. This class was performed through the STAD learning model. The results of implementation of the STAD learning model were measured before taking the class as pre-test and after taking the class as post-test in terms of the students' attitude, efficacy, and satisfaction toward the robotic technology education class.

2. Conclusions & Recommendation

The effects of STAD learning model in the robotic technology education were measured by a modified instrument and in-depth interview. The paired sample *t*- test was used to verify the results of pre-test and post-test. The four measurements were 1) the pre-service technology teachers' transition on basic knowledge for robotic technology, 2) their attitudinal transition on teaching robotic technology, 3) their competencies on key learning contents, and 4) their competencies on teaching key learning contents. Pre-service technology teachers' transitions on basic knowledge for robotic technology were measured in terms of electricity & electronics, chemistry, physics, and mathematics. Also, there were two major constructs of students attitudinal transition on teaching robotic technology as expectancy and value. Lastly, the students competencies for key learning contents knowledge and teaching it were based on six areas related to electrical circuits, electronic circuits, electrical application, and mechanics. Due to the *p*-values of paired sample *t*-test for all four measurements that were less than 0.05, the null hypotheses were rejected at $\alpha=0.05$. All four measurement areas were improved significantly after taking the class using the STAD learning model. This result supported that the STAD learning activities helped students make a good transition in the basic knowledge for robotic technology class and in teaching robotic technology class and increase their competencies on the related fields and self-efficacy on the robotic class itself. Although the STAD model may not be a perfect solution for the current problems in the robotic technology education class, it could be a better alternative for the robotic technology education class to compensate the problems and increase the students' learning in the field regardless of their different basic knowledge levels.

Reference

Bae, Y. (2007). The Development of College Programming Instruction Model based on STAD Learning Model. *Korean Journal of Educational Studies*, 38(3), 93-115

Baek, H. & Park, J. (2012). The Study on the Effects of Applying Cooperative Learning Model, Student Teams-Achievement Division to Engineering Education. *Korean Journal of Engineering Education Research*, 15(1), 34-42

Beon, Y. (2008). Instructional supervision and instruction analysis. Seoul: Hakjisa.

Choi, Y. (2005) Study of Technology Education. Seoul: Hyungseul.

Graham, S., & Taylor, A. Z. (2002). Ethnicity, gender, and the development of achievement values. In A. Wigfield, & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 121-146). San Diego: Academic Press.

Ham, J. (1994). Study on the Direction of Technology Education. Unpublished master thesis, Catholic Kwandong University: Gangneung

Hong, H. (2002). The Effectiveness of Project Method as A Transformer from Virtual and Indirect Experience to Real and Direct Experience in Knowledge-Based Society. *Korean Journal of Curriculum Studies*, 20(1), 155-182

International Technology Education Association (2000). Standards for Technological Literacy: Content for the study of technology. Reston, VA: Author.

Johnson, D., & Johnson, R. (1999). Making cooperative learning work. *Theory into Practice,* 38*(*2), 67-73.

Kim, C. (2005). The Effects of Web based Cooperative Learning Using STAD Model in Computer Graphic Instruction. *Korean Journal of Economy and Business*, 3(2), 101-117

Kwon, H. (2009). Technology Teachers' Motivation toward Teaching Biotechnology. *Journal of Korean Industrial Education Association*, 34(1), 252-273

Lee, J. (2010). Research on in-service education of middle school technology in Pusan. Unpublished master thesis, Korea National University of Education: Cheongju-Si.

Park, J. (2007). Satisfaction levels in unit and contents of the technology education curriculum and recognition for technology teachers. Unpublished master thesis, Korea National University of Education: Cheongju-Si.

Park, S. (2008). Effects of web-based cooperative learning adopting the STAD model on the problem solving ability. Unpublished master thesis, Korean National University of Education: Cheongju-Si

Shin, D., Kim, K., & Seo, K. (2001). The Effects of STAD Cooperative Learning on Student's Cognitive and Affective Domain. Education and Forum: Chonbuk National University, 21, 1-22

Slavin, R. (1980). Cooperative learning, *Review of Educational Research, 50(*2), 315-342.

Wigfield, A., Tonks, S., & Eccles, J. S. (2004). Expectancy-value theory in cross-cultural perspective. In D. M. Mclnerney and S. Van Etten (Eds.). *Big theories revisted: Rsearch* *on sociocultural influences on motivation and learning* (pp. 165-298). Information Age Publishing.

◎ 논문접수: 2015. 2. 17 / 수정일자: 2015. 3. 21 / 게재확정: 2015. 3. 23

<국문초록>

예비기술교사를 위한 로봇기술수업에서 성취과제분담 협동학습(STAD)의 실현

김성진*, 권혁수**, 정정윤***

현재 로봇기술과 관련된 강의들은 수강생들의 다른 기초 지식 수준과 교수학습 방법에 관한 문제들을 가지고 있다 이 연구는 이러한 문제점에 고려하여 성취과제분담 협동학습(STAD)의 모형을 로봇기술 입문 강의에 적용한 사례 연구이다. 이 강의에서 STAD학습 모형을 사용하여 다른 지식 수준을 가지고 있는 팀 구성원의 능력 향상에 초점을 두고 과제와 프로젝트와 같은 수업 활동을 통하여 서로 팀 구성원들이 협력하는데 관심을 가지게 된다. 이는 모든 구성원들이 팀 성과에 따라 같은 성적을 받게 되기 때문이다. STAD 학습의 성과는 로봇기술과 관련된 기초 지식, 로봇 기술을 가르치기 위한 태도, 그리고 학습 영역에 대한 자신감과 교수 능력에 관하여 사전 평가와 사후 평가를 실시하였고 t 검정을 통하여 그 효과를 분석하였다. 이 연구의 참가자는 교사양성기관의 22명의 예비기술교사이다. 이 연구의 결과 로봇기술과 관련된 기초 지식, 로봇 기술을 가르치기 위한 태도, 그리고 학습 영역에 대한 자신감과 교수 능력에 있어 향상된 성취를 보였다. STAD 학습은 특별한 상황에서 예비교사들에게 더 나은 학습 결과를 도출하기 위한 하나의 대안적인 방법이라 할 수 있다.

주제어 : 로봇기술, STAD, 예비기술교사

* 강사, 공주대학교
** 교신저자: 공주대학교 조교수, hskwon@kongju.ac.kr
*** 공주대학교 학생