Development and Application of Robot Curriculum Based Education in Insects Robot

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ABSTRACT

Robot Curriculum based education in Insects Robot help elementary school students better understand how a robot works. This robot curriculum is aimed at elementary school students in fifth grade. This study progressed with LEGO® MINDSTORMS® NXT, departed 6 groups, reached the insect's movement, designed robot like insects. This curriculum enhanced discussion prowess and improved the ability of building robot. During this study, most of the students were attracted to the action of the robot-like insect's movement.

Keywords : Insect Robot, Competition, Programming, Robot Pedagogi

곤충형 로봇 제작에 기반한 로봇 교육과정 개발 및 적용

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요 약

곤충형 로봇을 기반으로 개발한 로봇 교육과정을 학생들에게 적용한 결과 학생들이 로봇 움직임을 쉽게 이해하고 프로그래밍 및 알고리즘을 이해하는데 큰 효과가 있었다. 초등학교 5학년 학생들을 대상으로 마인드스톰 NXT 로봇교구로 진행한 로봇학습은 개미나 바퀴벌레 등 곤충을 관찰한 후 그룹별로 곤충의 모양을 본따 로봇을 만들고 곤충의 움직임을 모방하여 프로그래밍을 하도록 하였다. 특히 그룹별 임무 수행 경기의 경쟁을 함으로써 학생들 간의 토의 능력 및 로봇 제작, 프로그래밍에 대한 흥미도를 높일 수 있었다.

키워드 : 곤충형로봇, 경쟁, 프로그래밍, 로봇교육과정

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1. Introduction

Today, robot technology is very widely used for things such as home cleaning, washing a car, medical, and space science. Not only do these robots move at the word of command, but they also move by figuring out the situation[1][4]. Most students are interested in robots and want to build robots.

In this study, students will design and build robots based on their observations of the behavior of insects. Then groups will have to create a program similar to the behavior of insects. Through the robot competition, students will be able to understand robot movements easier. The purpose of this study is as follows:

◦To analyze and understand the movement of insects, to improve robot creating abilities.

◦To design and build the insect robot using a variety of robot sensors.

◦Through group discussions and competition, enhance students' creative ability.

2. Related Works

2.1 Robot Competition

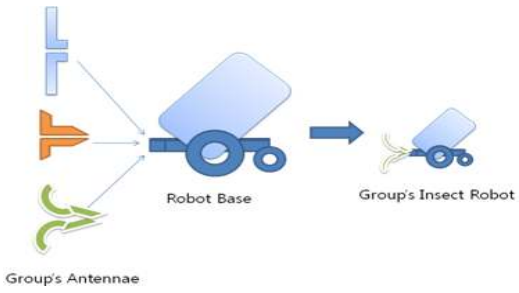
Recently, various robot training has been underway in the education field. The robot competition started from MIT; today, the robot competition has been implemented worldwide[3][5].

The robot competition is different from a typical school subject. Students offer their own ideas, as in planning, to carry out their mission. Students, who progress through the robot competition, can gain knowledge of basic electrical and mechanical self-education from the new robots.

2.2. Insect Robot

To facilitate the research interests and goals of insect inspired robotics, a robot platform has been developed and appropriately named InsectBot (insect robot). Two primary design features distinguish the InsectBot[2]. The first primary design feature is horizontal omni-directional motion. The second primary design feature is vertical motion.

In this study, first build the robot base with the LEGO® MINDSTORMS® NXT, then attach the antennae part like an insect's antennae. The insect robot concept is shown in Figure 1.



(Figure 1) Concept of Insect Robot Design

2.3 Robot Sensors

Sensors are a very critical part of any robot, whether autonomous or teleoperated. Sensors are the robot's contact with the outside world or its own inner workings. These sensors are divided into three types according to the features[6].

2.3.1 IR(infrared) Sensors

A Passive Infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. PIR sensors are often used in the construction of

PIR-based motion detectors (see below). Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall[7].

2.3.2 PSD(Position sensitive device) Sensors

PSDs can be divided into two classes which work according to different principles. In the first class, the sensors have an isotropic sensor surface that has a raster-like structure that supplies continuous position data. The second class has discrete sensors on the sensor surface that supply local discrete data[8].

2.3.3 Ultrasonic Range Sensors

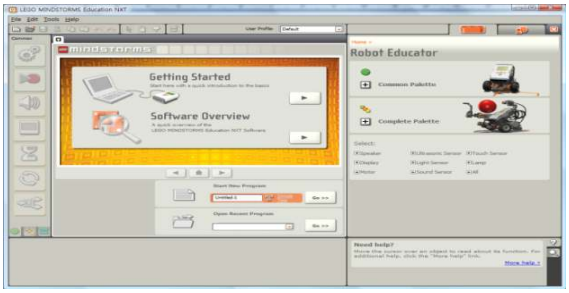
Ultrasonic sensors work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object[9].

2.4 LEGO® MINDSTORMS® NXT & NXT-G

LEGO® MINDSTORMS® NXT is a line of Lego sets combining programmable bricks with electric motors, sensors, Lego bricks, and Lego Technical pieces.

(Figure 2) LEGO MINDSTORMS 9797

NXT-G is the programming software that comes bundled with the NXT. This software is adequate for basic programming, such as driving motors, incorporating sensor inputs, doing calculations, and learning simplified programming structures and flow control.



(Figure 3) NXT-G software

LEGO® MINDSTORMS® NXT has 4 different types of sensors. These can help the students make the robot similar to an insect's sensory. <Table 1> shows the different types of NXT sensors.

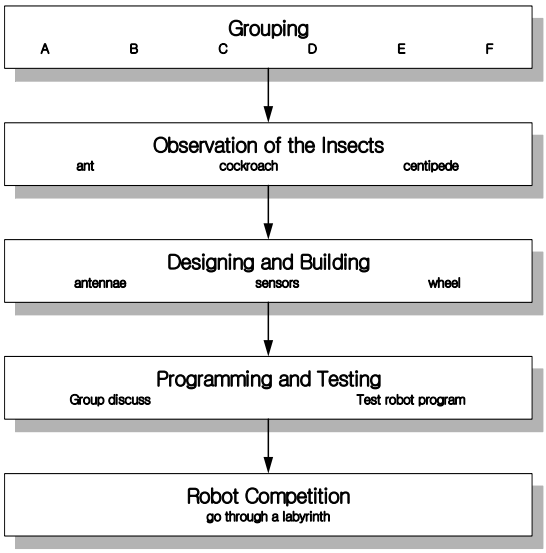
<TABLE 1> NXT Sensors

	Sonic Sensor
	Sound Sensor
	Touch Sensor
	Light Sensor

3. Insect Robot curriculum concept

3.1 Insect Robot curriculum

Insect Robot curriculum consists of five kinds of steps. Figure 4 shows the robot curriculum.



(Figure 4) Concept of Robot Curriculum

◦ Grouping: 36 students were divided into six groups. This group considered students' interest in robotics. Groups were asked to say what they thought about robots. (1 hour)

◦ Observation of the Insects: Groups observe the behavior of insects in this process. Groups discuss which insect sense organs to movement. (2 hour)

◦ Designing and Building: Groups design and build, based on characteristics of observed insects. Groups attach a creative robot tentacles to the base robot. (6 hours)

◦ Programming and Testing: Make a program (to get around obstacles) for an insect robot to move. Each group advances to test the robot's behavior.(4 hours)

◦ Robot Competition: Group Robot Competition held. Every group is given three chances. Programs and robot designs can be modified at any given time. (2 hours)

3.2 Research Target and test tools

This study was conducted in May 2009 from day 1 to 15 with 5th grade elementary school students.

<TABLE 2> Research target study period

Research target	Elementary School 5Grade Male 21, Female 15
study period	2009.05.01 ~ 2009.05.14

MINDSTORMS® sets and Notebooks that have the program to create a robot was provided.

<TABLE 3> Educational Tool

Educational Robot	LEGO® MINDSTORMS® NXT	6 set
Educational Notebook	HP EliteBook 2730p	6
	SL9300(1.6GHz), 120G, 2G	
Educational Program	NXT-G program	6

4. Process of the Robot Education

Robot class was composed of a total of 30 hours

<TABLE 4> Process of Study

Process	Lessons	Hour
Grouping	1. The concept of a robot 2. Drawing robots and Grouping	2
Observation	1. Watch the video (variety of insects) 2. Observed ants	2
Robot Design	1. NXT Guide 2. Basic robot structure 3. Drawing robot Design (by group)	5
Robot Building	1. The role of the sensor 2. Making insect robot	5
Robot Programming	1. NXT-G guide 2. Makeing sample program 3. Making insect program	10
Test and Competition	1. Program test and Robot structural changes 2. Robot Competition	5
Survey	1. Survey of lessons	1

4.1 Group

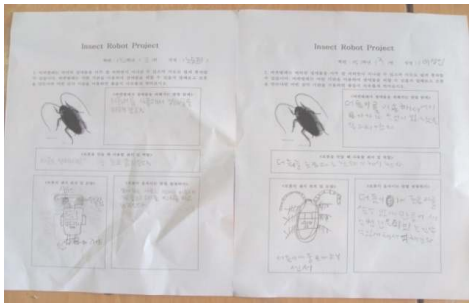
Group composition is shown in Table IV. For comparison purposes, the Robot making ability of boys and girls, A Group composed of only male, E Group composed of only female.

<TABLE 5> Composition of group

Team	Composition
Group A	Male 6
Group B	Male 3, Female 3
Group C	Male 3, Female 3
Group D	Male 4, Female 2
Group E	Female 6
Group F	Male 4, Female 2

4.2 Observation of Insects

First, they watched a video about various insects, and then had a group discussion about the movement of insects. What is the most important sense for cockroaches', centipedes', and ants' movement?
(Figure 5) shows the results of students' study of insect's behavior.

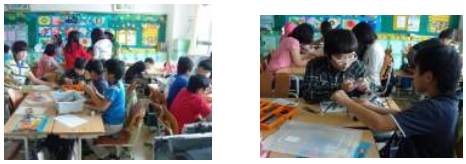


(Figure 5) Paper of Observation

All groups found the antenna to be the most important sense. They recorded: Insect's Antennae help to detect obstacles and can move.

4.3 Designing and Building

This process is about insect robot designing and building. Students had the most difficulty with this process, but they also thought the activities were very fun. This curriculum allowed students to easily see how to create a basic robot. In the process, the most important thing is to create effective robotic tentacles.



(Figure 6) Building Robot

Various insect robots were produced by the groups. Four groups created the robot's antennae with the touch sensors, and two groups used the ultra sonic sensors and touch sensors.
(Figure7) shows the insect robots created by the 6 groups.

(Figure 7) 6 Groups' Insect Robots

Creatively designed insect antennaes are very diverse. Depending on the situation, the antennaes change shape. Small wheels attach to the antennae. But the two groups with the help of the teachers were able to build a robot.


(Figure 8) 2-Touch Sensor and 1-Touch Sensor anetnnae

6 groups analyze the structure of the antenna in <Table 6>

<TABLE 6> Number,Kind of Sensors

Team	Touch Sensor	Ultra Sonic Sensor
Group A	2	0
Group B	1	1
Group C	1	1
Group D	1	0
Group E	1	0
Group F	1	0

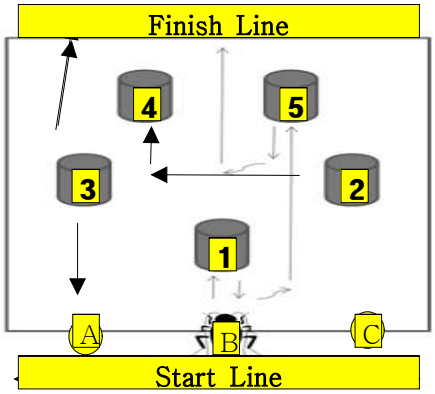
4.4 Programming and Testing

Robotic missions of the competition are given. The mission is shown in (Figure 9). The rule is the insect robot needs to avoid obstacles.

<Table 7> is The rules of Robot mission

<TABLE 7> The rules of robot missions

Division	Rules
Start	Starting line A, B, C can start anywhere
Obstacles	Go to the finish line of avoiding obstacles 1,2,3,4,5
Sensors	All NXT sensors can be used
Robot size	Size does not limit
Mission accomplished	Must pass the finish line



(Figure 9) Example of Robot mission

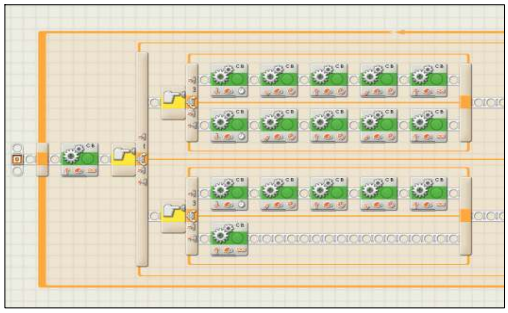
During 2 hours, training is given to students based on the robot program. Students can easily move the robot based on the programming taught to them. In addition, education has to be given on touch sensors and ultrasonic sensors. After training, students run the robot by creating their own programs.


(Figure 10) Robot Programming

6 groups perform the mission that they created with the program shown below.

4.4.1 2-Touch Sensor Insect Robot (Group A)

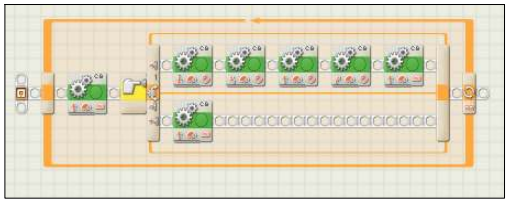
The 2-touch sensor robot by Group A was created with a program using three switch statements. A student in Group A has the ability to program.



(Figure 11) 2-Touch Sensor Switch Program

4.4.2 1-Touch Sensor Insect Robot (Groups B, D, F)

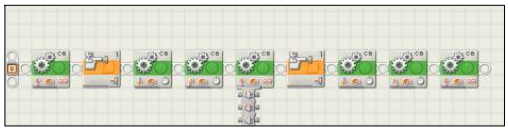
The 1-touch sensor robot by Groups B, D, F, used a program with a loop statement and a switch statement.



(Figure12) 1-Touch Sensor Program

4.4.3 1-Touch Sensor Insect Robot (Groups C,E)

The 1-touch sensor robot by Groups C and E used a very simple program. Robotic missions were in operation, but many problems followed the program.



(Figure 13) 1-Touch Sensor Simple Progran

4.5 Robot Competition

Each group is given a total of three chances to complete the mission. Groups are allowed to modify the program and fix the robot in 3 chances.

(Figure 14) Robot Competition

In this competition, the number of successful missions by the 6 groups is shown in (Table 8).

<TABLE 8> Result of Competition

Team	opportunity			Number of success
	1st	2nd	3rd	
Group A	Failure	Success	Success	2
Group B	Failure	Failure	Success	1
Group C	Failure	Failure	Failure	0
Group D	Failure	Failure	Success	1
Group E	Failure	Success	Failure	1
Group F	Failure	Failure	Failure	0

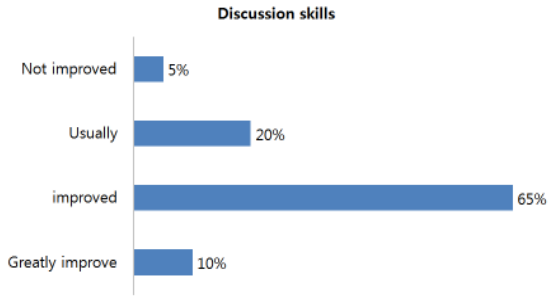
Group A (Consisting Only male) have better Robot skill than those Groups. Group A made a more perfect robots and more diverse programs.

5. Conclusion

After education, we had a survey about the Insect robot curriculum.

5.1 Discussions and programming production

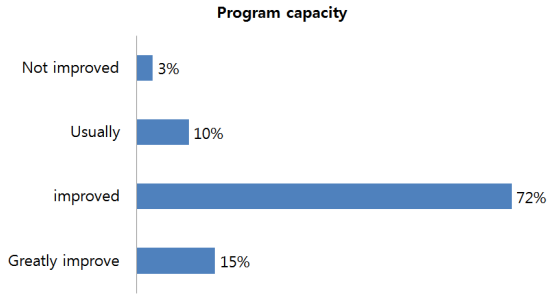
Insect robot curriculum, Each step include discussion of student. Like as discussion observed insect behavior, Creating a better robot design. So, 75% of students said this study improved their Discussion skills.



(Figure 15) Did you improved your discussion skills?

This curriculum was designed of easy to understand robot programming. Observed the behavior of insects, and based on observations, make the program. So they were able to create various robot programs themselves.

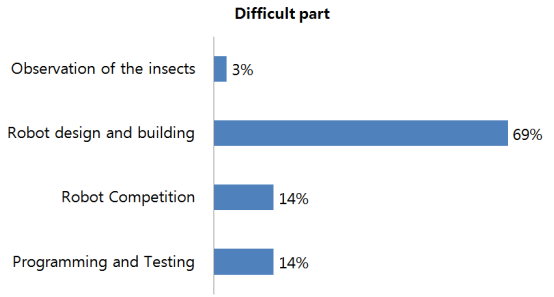
87% of students said this study improved their Program capacity.



(Figure 16) Did you improved your program capacity?

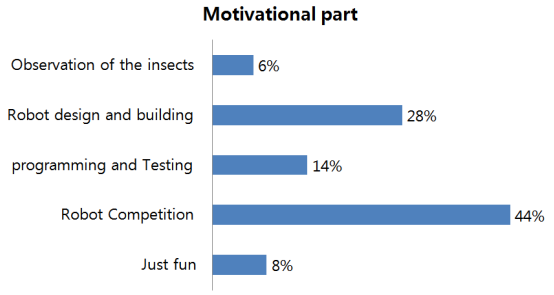
5.2 Difficult Part and Motivational Part

In this curriculum, the most difficult part was designing and building the robot, with a response of 69%. Robot programming and robot competition were equally the second most difficult, with a response of 14% each. Most students responded the research of insects was the most easy.



(Figure 17) Which of these was the toughest part?

We asked the students what the most motivational part of this curriculum was. A large number of students (44%) selected the robot competition. Notable answers from the survey: 28% of students selected robot designing and building. This part was the most difficult for the students, but they were interested in building the robot.



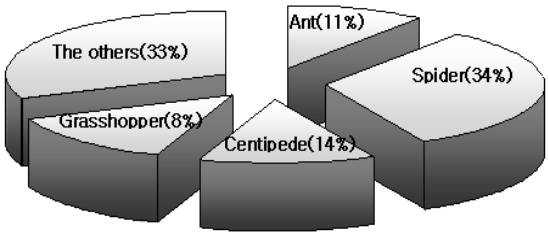
(Figure 18) Which of these is the most Motivational part?

5.3 What kind of Insect robot make

If they decide to continue with this robot curriculum, the students were asked what kind of insect robot they would want. 34% of students want to build a spider robot, 14% want to build a centipede. The other answers (33%) wanted to build flying insects, such as butterflies, dragonflies, ladybugs.

Competition Curriculum Based Education in

insect design help the students understand the robot's behavior. During education, many of the students became interested in the role of insect sensors, enjoyed group discussions and cheering during the robot competition. But most students didn't build insect robots within the given time, so they didn't experience any joy in creating robots. They had never been taught the basics of robot engineering.



(Figure 17) What kind of insect do you want to make?

This robot curriculum will include the basic robot engineering education course. Also it will develop various insect robot designs. So through this curriculum, many students will have the ability to observe insect behavior and improve the ability to create a robot program.

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