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Learning Method of WeDo+Scratch based on Programming for Non-Programing Major

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Abstract: For boosting computational thinking skills, the need of SW education has been becoming conspicuous recently and algorithm-based programing education has been conducted. However, new learners, who have never learned programing before, find difficulties understanding the basic syntax and the logic of computer languages in the process of acquiring programming techniques and also find difficulties making out algorithm and converting it into computer language code. These difficulties are due to limited time for acquisition of the techniques. In this study, an education method to draw interest from new learners into programming and develop algorithm thinking skills using the basic syntax of programing and to develop abilities to solve problems that arise in programing shall be introduced. This education makes the concept of SW education easier to approach by interlocking the concept of WeDo constructionism-based robotics built with LEGO Model blocks and scratch-based programing of more effective programing education method to learn and use the basic programing concept through prerequisite.

Key words: LEGO WeDo, scratch, robotics, constructionism, programming education

INTRODUCTION

The algorithm and programing education for improving abilities to solve problems based on SW has been conducted recently for boosting computational thinking skills (Bae *et al*., 2009). However, new learners who have never learned programing before, find difficulties understanding the basic syntax and the basic logic of computer languages in the process of acquiring program techniques. Also, there are times to acquire programing techniques. Therefore, there is a need of more effective programing education method to learn and use the basic programing concept through prerequisite fundamental learning in order to solve the difficulties learning the programing languages.

In this study, a fundamental learning method to develop abilities of new learners to have algorithm thinking skills using the basic syntax of programing and to solve many different problems made in the process of programing shall be introduced. The learning method proposed in this study allows more effective approach to the concept of programing as it makes learners have interests in basic programing by interlocking the robotics concept, built with LEGO Model blocks based on the construction of WeDo with scratch-based programing. This study proposes the way of learning by creating and combining small patterns of the basic logic with WeDo+Scratch applying 4 syntax of input, operator, decision and repeat which are the basics of programing in consideration of prerequisite programing learning of non-programing major students. The learning method is to make a student produce a programmable robotics by attaching LEGO blocks with sensors, access and control it by programing. Below is the 7-step approach which is a learning method of basic program coding proposed in this study:

- Step 1: practice code blocks of input, operator, decision and repeat using icons of WeDo
- Step 2: combine the code blocks using the practiced icons of the basic syntax in many different ways to make the robot response
- Step 3: according to the response of the robotics completed based on the WeDo code blocks, execute tests or edit the codes
- Step 4: install the plug-in to interlock WeDo with scratch then do programing with scratch for the same assignment

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- Step 5: interlock scratch with the robotics and test or modify
- Step 6: when there is a need to add animation or such functions available on scratch, add Scratch code blocks
- Step 7: interlock the added codes with the robotics on scratch, test and modify the codes

Above 7-step method helps developing basic programing skills for SW development by interlocking the concept of the robotics built with WeDo constructionism based LEGO Model blocks with scratch.

Literature review

WeDo: WeDo (Mayerova, 2012) is a product of LEGO group developed for fundamental learning of robotics and programing education. It makes users to build their models with LEGO blocks and find the ways run their models using software. Users can build basic LEGO Models connectable to computer and do programing.

The software UI of WeDo is made up of connect with pc, record voice, manu tab, file options, storage, stop button and programing code blocks as in Fig. 1. And it also has 4 sensors attachable to LEGO after assembly including a motor, a motion sensor, a tilt sensor and a LEGO USB hub.

Scratch software: The scratch is a programing language created by Lifelong Kindergarten team of MIT's media lab with Yasmn Kafai team of UCLA (Clements, 1999; Olabe *et al*., 2011; Polchow, 2014). Figure 2 shows the scratch interface. Scratch can be classified into instruction combination, instruction, sprite and result check and it is

Fig. 1: The WeDo Software interface and WeDo sensors

Fig. 2: Scratch Software interface

made to resolve mistakes or problems that beginners often make when practicing programing languages. The errors of incorrect spelling or inconsistency do not occur on scratch. Unlike programing languages that are to enter commands to prevent syntax errors, scratch is to drag programing blocks interconnect them. In result, users can easily control the way that the commands interact and do not need to fear of failing programing due to negative feedback with syntax errors. Also, the blocks get assembled only when it corresponds to the logical flow of computer and they are classified in different colors so, it makes a lot easier to construct instructions that are relevant to special functions the blocks have.

MATERIALS AND METHODS

The WeDo+scratch-based learning way of programing for non-programing major

The software education model using WeDo and scratch: The learning way proposed in this study plans problems in many different situations to achieve assignments and based on the process of resolution of the problems, the education models are created using LEGO robot assembly, WeDo Software or scratch and it is as in Fig. 3.

In the order of the education models in Fig. 3, the plans to understand the learning goals of each curriculum are made and the robot is assembled using the block assembly drawing. Then users practice WeDo+scratch to control their robotics and execute the assignments. And they conduct intuitional tests, edit the codes and share and present their ideas and resolutions.

The curriculums using WeDo and scratch: The curriculums of the WeDo+scratch based basic learning method of programing for new learners are as in Table 1. In the first step, they look over the components as they try WeDo for the first time and they create their works. In the second step they install the WeDo program and scratch to understand and use the USB hub and the sensor of WeDo. In the third and the fourth try, they learn the condition-control using the sensor. Especially in the third step they assemble the "Moving Bird", complete the robotics, compose the same content on scratch using the WeDo Software and complete their assignments. Through this process they learn and practice operator and repeat which are the basic syntax of programing using the change and tilt sensor upon their input. In the fourth step, they complete the "Hungry Alligator" in the same manner as the "Moving Bird" in the third step. In the fourth step they control the robotics by using the programing logic such as input, operator, decision and repeat using the motor and the infrared sensor.

It helps to have repeated learning of the basic syntax of programing by interlocked-execution of the blocks made on WeDo with scratch. Also, by adding media such as images and effects available on scratch, it helps better understanding of the concept of programing and in this process of making a program, the learners experience spiral-creative thinking (Resnick, 2008) such as 'imagine', 'create', 'execute', 'share', 'look back' and 're-imagine'. And they have their creative thinking abilities improved while they design their scratch project and gain more confidence as they learn to overcome difficulties and

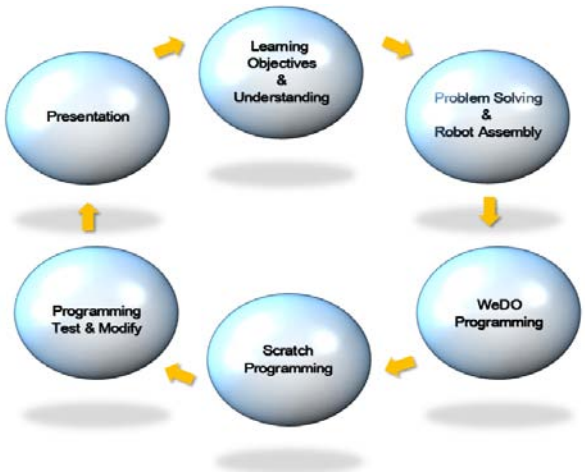


Fig. 3: Educational model using WeDo with scratch

Table 1: Curriculum based on WeDo with scratch

Education contents	Programming grammar exercise
First learn WeDo and scratch	
Products navigation	WeDo: setting exercise
Learn the role of each WeDo product	Scratch: setting exercise
Create free creations with parts	
Scratch item navigation	
Learn the role of each scratch item	
WeDo programming getting ready	
Learn about usb hub	WeDo: setting exercise
Installation of WeDo program	Scratch: setting exercise
Computer connection with WeDo	
Block assembly diagram and block classification	
Interlocking with scratch	
Moving bird: learning example 1	
Block assembly	Condition control using sensors
Controlled via WeDo Software	Change sound: change input value
Control processing according to WeDo dedicated sensor value	Use of tilt sensor: input
Controlled through scratch programming	Repeat control: loops
Challenge tilt sensor sounds through water	
Hungry crocodiles: learning example 2	
Block assembly	Condition using air sensor
Controlled via WeDo Software	Infrared sensor utilization: input
Control processing according to sensor value	Infrared sensor utilization: input
Controlled through scratch programming	Infrared sensor utilization: input
Challenge: controlling the gear through the motor and infrared sensor	Show the number of food feeds: operator
	Open the mouth of a crocodile: a loop

resolve problems during the project. Consequently, they obtain expansive thinking ability as they practice not only computing thinking but also creative thinking systematic inference and cooperation.

Combination of programing language syntax and WeDo icons: In this study, the basic logic of the programing syntax such as input, decision, operator and repeat shall be applied with WeDo icons in consideration of prerequisite programing learning. Learners anticipate operation of the robotics when using certain icons with the basic logic and apply what they learned and they conduct a test and edit the programing so that their understanding in the syntax expands. Table 2 proposes combinations of the basic programing syntax proposed in this thesis with WeDo icons. First of all, the icons in Table 2 are input and "Icon 1~7" are the conditions that are attached on the bottom of the blocks and the icon is small and convex on the top. "Icon 1~3" are input letters, input numbers and input random value and "Icon 4~6" are input of motion sensor, tilt sensor and sound sensor each and "Icon 7" is display input. Secondly they are decision icons and "Icon 11~12" are to set up conditions to run or stop the motor. Thirdly, "Icon 13~16" are operators which users can select for the four fundamental arithmetic operations and can set up or adjust the changeable width by entering number like "Icon 2" at the bottom. And lastly, "Icon 17"

Table 2: Programming basic syntax and WeDo icon matching

Programming basic process	WeDo icon	WeDo icon description
Input		Icon 1: text input Icon 2: number input Icon 3: random input Icon 4: motion sensor input Icon 5: tilt sensor input Icon 6: sound sensor input Icon 7: display input Icon 8: start block Icon 9: start on key press block Icon 10: display input
Branch		Icon 11: motor on for block Icon 12: motor off block (Bottom Icon no combination)
Operator		Icon 13: add to Display block Icon 14: subtract from display block Icon 15: multiply by display block Icon 16: divide by display block
Loop		Icon 17: Repeat block (loop counting)

is to set up repeat and users can enter a number to set up the number to repeat and if none, it does endless looping (Kazakoff *et al*., 2013; Maloney *et al*., 2008).

RESULTS AND DISCUSSION

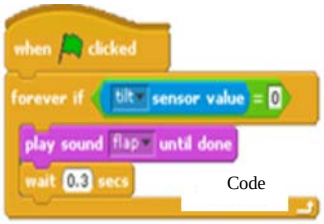
Combination of WeDo icons with scratch: Scratch provides plug-in to interlock with WeDo. Users can control what they learned on WeDo software with the blocks using scratch. It is able to program the same codes which control the robotics on WeDo, on scratch and it also allows testing and editing the programing by applying the same plan for problem resolution. Through this, users learn the same syntax on WeDo and practice with scratch does so they understand the syntax easily and have stronger practical ability of programing. Also, it enhances understanding in programing since it can interlock as it shows images on a computer screen through scratch which WeDo could not do and the robot works correspondingly. Table 3 shows the same result programming based on WeDo with scratch.

Application examples: In this study, WeDo 1.2 and scratch 2 offline editor are used to test the proposed learning method. Scratch requires Adobe Air for its use and the offline editor is used which is available both online and offline. To interlock with WeDo on scratch, it needs to install the plug-in first. In scripts tab on scratch, click more blocks-add an extension and select LEGO WeDo 1.0. When connecting the USB of WeDo after installation of the plug-in, the grey block that controls the motor is added at the bottom. The programing is done by combining the WeDo assembly sensors with scratch code blocks. In Fig. 4 is to add WeDo blocks step by step. In the first step, apply the icons with sound to change the set-up and in the next step, practice to repeat the bird sound. In the third step, adjust the angle with the tilt sensor value and set up to turn on the bird sound when it tilts. After this, change the set up to turn on the sound only when the bird picks up the feed with its head down in the fourth step. In the fifth step, set up to turn on the sound every time the bird bows down its head. And lastly in the sixth step, set up to turn on the bird sound and increase the number by one every time the bird bows down its head, display the number on the screen and add repetition. Then set up again to repeat displaying the numbers of picking up the feed and the bird sound afterwards. Practice using the icons and add them, then test the robot moving by creating patterns with the basic syntax in small ranges. In Fig. 5 is a converted code from WeDo into scratch. It executes when the start button is clicked, the 'parrot-b' images that were pre-selected in 'costume' change and the bird sound is on when the value of the tilt sensor is 0. In sequence, 'costumes' appears and it waits 0.3 sec. When the value of the tilt sensor is 0, it repeats in a cycle.

Fig. 4: WeDo additional programming step-by-step

Fig. 5: Programming based on scratch with robotics: application example

Table 3: Same result programming based on WeDo with scratch

WeDo icon	Scratch code	Descriptions
 Combination 3	 Code 1	Keyboard press start (input) Motor strength setting Motor rotation Motor standby time standby (branch) Play selected sound
 Combination 2	 Code	Start button press start (input) Depending on the tilt sensor value, Play sound selection. Sound can be changed (variable) Waiting time setting (variable) Repeat all infinite (repeat)

CONCLUSION

This study proposes the learning method to develop problem solving skills by creating and combining small patterns with the basic syntax on WeDo of LEGO and scratch as a prerequisite programing learning method for new learners who have never learned programing before. And this method has its intention to make the learners produce programmable robotics on their own by attaching the LEGO blocks with the sensors and understand the concept of SW programing using the software called Scratch. It allows more efficient programing education as the learners obtain knowledge of programing, create, evaluate and make practical use through WeDo+scratch and their cognitive structure changes through understanding. Also, it is able to check the process and the result of production in real time as the robotics and the programing are interconnected, so the learners clearly understand the content of the integral SW education. Additionally they are able to understand the linguistic characteristics and the similarities of the basic syntax of computer languages such as JAVA and C through the interconnected process of the same assignment on WeDo and scratch. The WeDo+scratch learning method is based on the curriculums that can help learners with none of programing experiences understand the basic logic effectively and do SW programing easily. However, this method is insufficient for learning the algorithm in intermediate or higher levels since it uses only the basic logic. Therefore, there is a need of further research to learn the algorithm such as SW programing and data structure in intermediate or higher levels with the WeDo+Scratch programing learning method.

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