Configurable Tangible Programming Based on Event Programming

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Abstract

Coding will be an important skill in the future, since the robot will come to replace human workforce. Nevertheless, many users did not have a programming skill. Tangible programming is an alternative way to enhance this learning skill. The previous research shows that tangible programming is easily to learn more than the traditional computer programming. In this study, two methods of tangible programming will be examined. The method of the sequential block was compared with the event block. Subjects who are novice users were recruited to test both types of programming. The result from the experiment shows that the event block is more flexible and more practical under the same conditions and instructions. Moreover, participants understood how does it works even the event block is more complex than sequential block.

Keywords: Tangible Programming, Event programming, Creativity

1. Introduction

'Children should learn to code' is a simply message that many countries start with this campaign. UK educational policy makers created the new computing in the national curriculum on September 2014 [1].When children learn how to code, the possibilities of jobs opens. If they learn how to code when they are young, they are able to develop their logical thinking. It means that they are able to tell as story in exact particular order. From a theoretical perspective, Piagetian theory addressed four stages of child development. At earlier stage, their capacity for logic and abstract thought is non existent (age 3-7). At age 7-11, they operates on the physical objects [2]. Howland et al., addressed that the role of concrete experience in tangible forms of interaction [3]. Several tangible programming tools started developed like an electronic building blocks [4], AlgoBlocks [5] and Wagon [6]. LittleBits is one of commercial product in the market made by a startup company [7]. It consists of small circuit boards with specific functions built to snap together with magnets without soldering or programming. Each bit has its own specific functions such as buttons, LED light and sound. One of the problem in LittleBits is about the structure of programming. Since each piece of module connects as a series circuit, it has limitation in term of programming. The logic of programming will follow like the command line of building blocks(linearity) that cannot be customized for the advanced programming. For example, children cannot blink the light automatically.

Event-handling concept is another choice from the series programming. TanPro kit was an example that used to teach children about the event handling concept [8]. There are three kinds of programming blocks: power blocks, sensor blocks, and action blocks. The rules can be regards as "When..Do..". When the value detected by sensor, the result will do the action programmed. The action blocks contains the behavior such as moving objects, lightening LED and playing music. One of the problem in event-handling is the specific behavior that may not flexible for different types of output devices. The action blocks should be flexible enough to be used for different kinds of behaviors, for example, dimming the light or accelerate the music volume. The aim of this research is to compare the difference between Series and Event-handler programming. The investigation is on how event programming enables students to build a project creatively with a group collaboration.

2. Design and Implementation

C-TAN is configurable tangible programming with the event-handler concept. It consists of 2 main parts : Device hub and Command block (see Figure 1). The device hub is a station for plug-in the input and output modules such as LED, speaker, button, motion sensor and light sensor. The command block contains the action modules that can control the behavior of output, for example, controlling the smoothness, brightness and time duration of LED light.

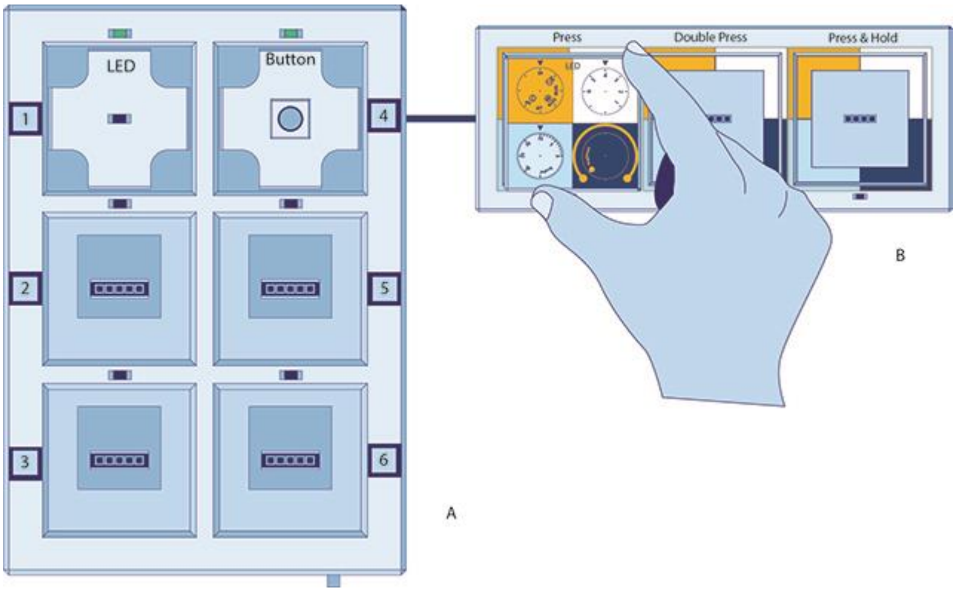

Figure 1. C-TAN with a) Device hub and b) Command block

3. Method

Three groups of grade 11 students who never programming before participated in the study. One group has three members. They were randomly tested either LittleBits or C-TAN. Participants spent time 10 minutes to review each product. Then they were assigned to design a device used in plantation (see Fig.2). Additional materials such as paper, tape and wood strips for model making. The maximum time of the project is 15 minutes. After finished the project, they were requested to present their works. The teacher rates the students' projects by using the rubrics from one to four scales (see Table 1). After finishing the experiment both teacher and students were interviewed.

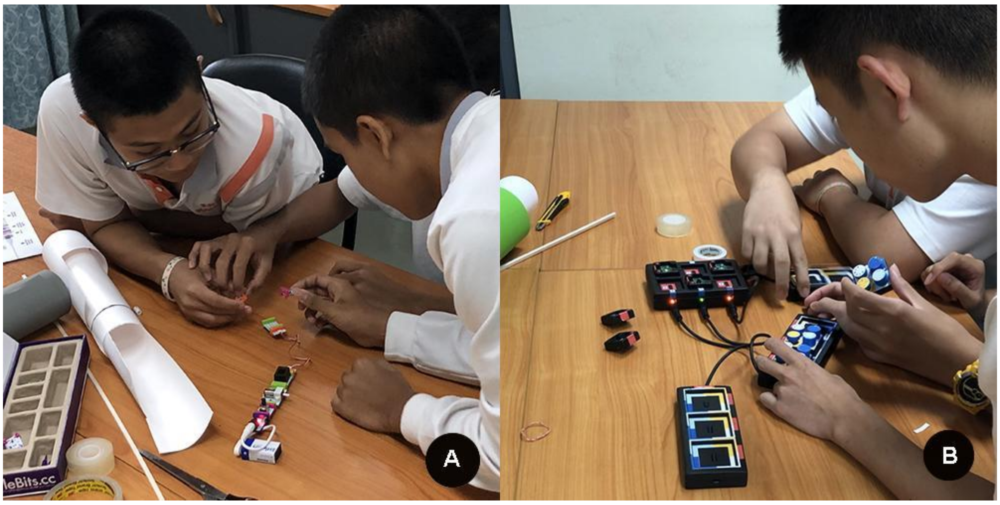

Figure 2. Co-creation on a) LittleBits and b) C-TAN

	Level 1	Level 2	Level 3	Level 4
Creativity	Students cannot make the device function.	Students can make the device function according to the given components.	Students can make the device function perfectly and differentiate from the given components.	Students design the device with new functions. They can recommend other possibilities outside the scope of given components.
System thinking	Cannot explain the procedure of programming clearly and achieve the goal of project.	Can explain the procedure of programming but lack of details.	Can explain the procedure of programming clearly.	Can explain the procedure of programming clearly and recommend how to do the further development.
Problem solving	Team members are lack of enthusiasm in solving problem. If they met the difficulty, they are avoid the problem.	Team members are partly of enthusiasm but they ask for assistant when facing the problem without solving the problem by themselves.	Team members are full of enthusiasm but they spent too much time on finding solutions. They need some advice to solve problem.	Team members use their skill to find out the procedure. They can ask the experts' opinion no more than 3 times or 3 people.
Presentation	The presentation cannot explain procedure of devices.	The presentation is still vague and cannot see how the device works.	The presentation is clear objectives and procedures.	The presentation is clear and highlight the issue. They understand the procedures clearly.
Productivity	Team members cannot accomplish the project.	Device works in some part but not all of them. The team cannot finish the project on-time.	The team works effectively. Some module effectively works. Just only the minor part that cannot function.	The team manages the time effectively. They can finish the project as their expectation.

Table 1. Rubric for project assessment

4. Results

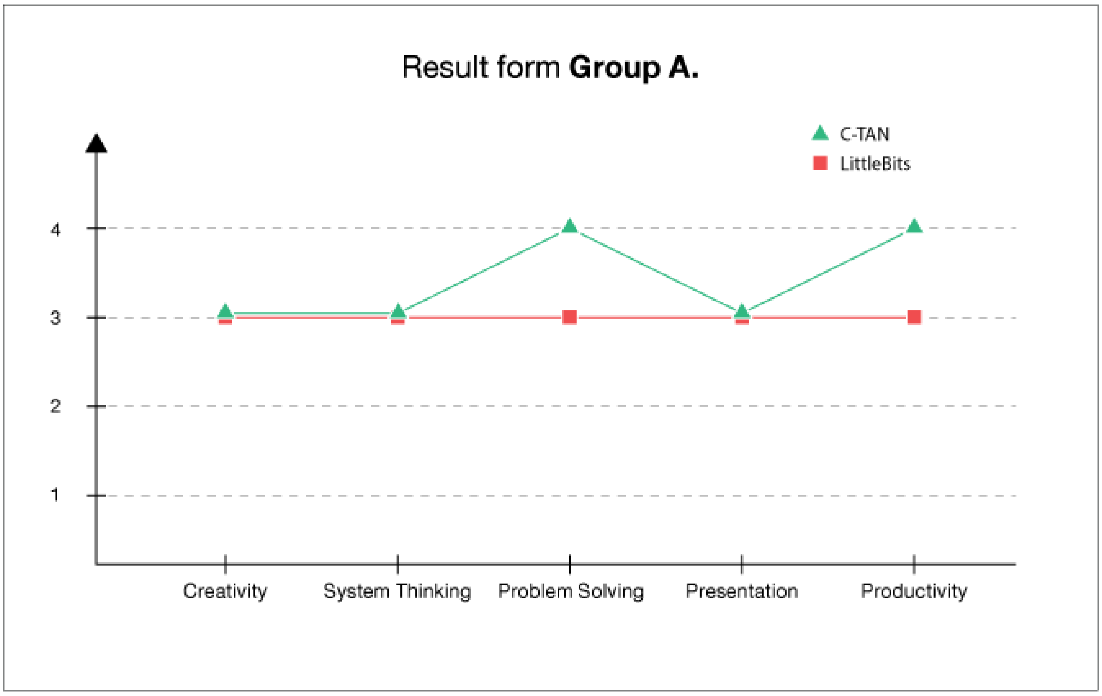

Figure 3. Comparison of C-TAN and LittleBits in Group A

The first group designed with 3 modules for water plants, robbery prevention and alarm signal with LittleBits. They started to plan the project roughly and try to explore littleBits first. The problem that happens is that participants cannot separate the module of water plants and robbery prevention. This is a reason why students cannot integrate many sensors together to make their projects more sophisticated. They used the potentiometer to control the motor for water plants. They used the button to control buzzer alarm and LED light for robbery prevention. As a result, they must turn the potentiometer for the maximum range in order to use the switch button for robbery prevention. On the other hand, this group designed three modules as well for C-TAN. Participants separated each three modules easily and they can operate one without interrupt another module. Figure 3 shows that teacher rated the problem solving and productivity of C-TAN higher than LittleBits. The group performs their teamwork quite well when they met the C-TAN first time.

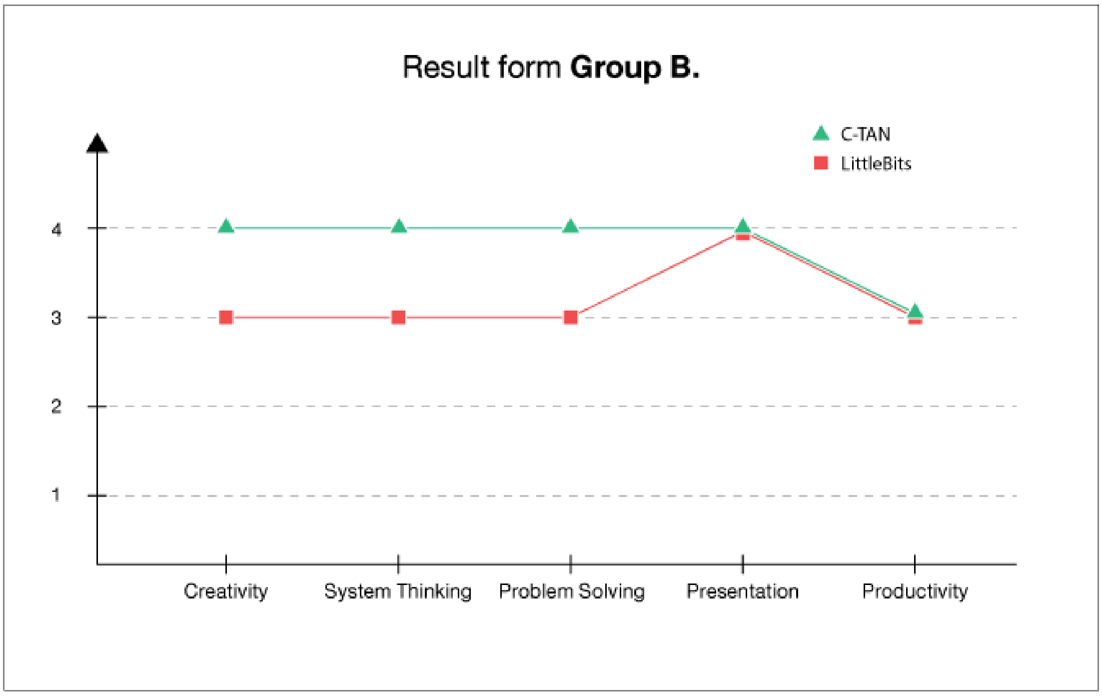

Figure 4. Comparison of C-TAN and LittleBits in Group B

For the second group, there are difference in two aspects. First, participants designed only two modules with LittleBits. As a result, the limitation of features reduce the opportunity to create things. Second, participants preferred to use advanced functions than the basic function. For example, they used different types of five melody from C-TAN over the piezo sound. Moreover, they are eager to try more features of C-TAN to explore new experiments for their projects. The melody sound leads them to think about the aesthetic of music. This is quite interesting that the sound affects the functions. If the sound looks like piezo sound, many subjects think about the alarm. For this group, teacher rated three skills of creativity, thinking process and problem solving of C-TAN higher than LittleBits (see Fig.4). This group said that they did not perform well when they played C-TAN before LittleBits. The limitation of functions in LittleBits makes them perform lower in term of creativity.

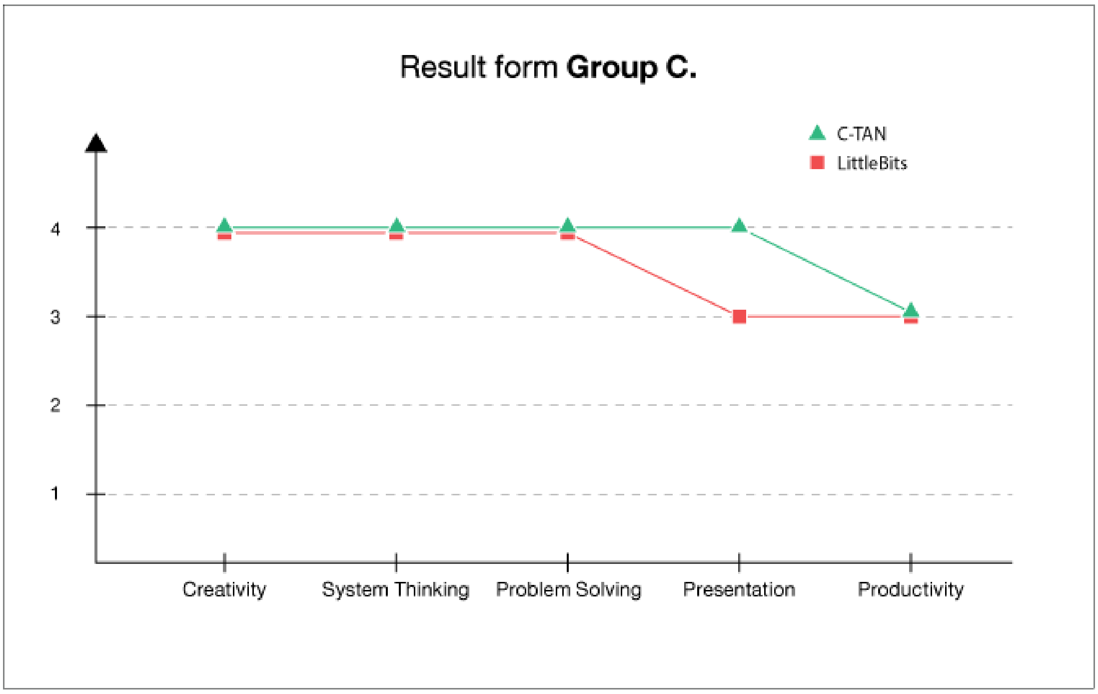

Figure 5. Comparison of C-TAN and LittleBits in Group B

For the third group, participants designed for three modules but they faced the problem similar to the first group. They cannot operate the third module if they did not operate the second modules. On the other hand, this group used the functions on C-TAN in term of presentation as can be seen in Figure 5. The presentation is clear and highlight the issue. They understand the procedure clearly.

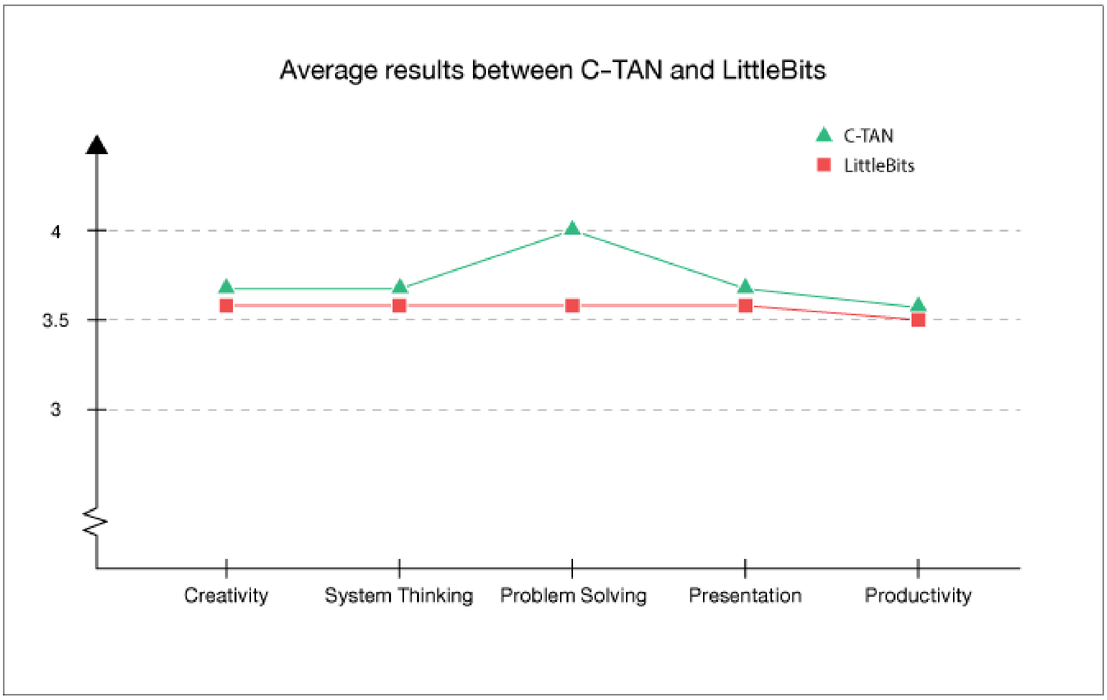

Figure 6. Average results between C-TAN and LittleBits.

The result from the average score shows that C-TAN has a significant difference in the problem solving (see Fig. 6). The less is slightly higher than LittleBits but not so much difference in creativity, thinking process, presentation and productivity. The result leads us conclude that C-TAN can assist participants in term of solving problem.

5. Discussion

From the interview with subjects, one group prefers the LittleBits than C-TAN because of the ease of assembly and it prevents the short circuit by using the magnetic connection. Nevertheless, it has a limitation because the button in series circuit must be pressed in order to activate other blocks. If the first block does not work, the less cannot function. This is similar to the finding like the work from Guldenpfenning [9]. They implement more on the complex sequences of interactions in a straightforward fashion without no prior technology experience or computer needed.

Another two groups preferred C-TAN than LittleBits. They said that C-TAN is more complex but it opens an opportunity for many applications. It has several functions that LittleBits cannot do also and all functions had been treated separately. One of the problem is the wrong circuit connection between modules. It does not have a mechanic that prevents the short circuit like LittleBits. Participants suggest that the shape of modules should not be a rectangular because it cannot prevent the wrong connection. C-TAN might need to be developed in term of stability of system and less bug. It should not have a delay feedback. Teacher prefers C-TAN than LittleBits. The system could be used to train students the process of thinking in classroom. The manual and connection socket may need to improvement.

Event-handler programming has an advantage over the series programming, since participants can program separately in each module and it is easy to separate tasks for group collaboration. One insight thing that found in the experiment is that participants can solve the problem easily when many features integrated into the device.

In this work-in-progress paper, the researcher demonstrated early results from C-TAN, an experimental approach to programming an event-handling concept. While an implemented an interactive prototype early in the design process is used to clear questions around the learning ability of product among different types of program structure. There are many open questions regarding the interaction design of C-TAN. What kinds of graphic user interface on the action modules that make participants understand across different types of sensors? How can we prevent the short circuit without using the magnetic connector? How many knobs in action module that does not make participants confused? How can users understanding how to debug the program in physical environment? Having completed that, we will develop the design of product to increase the usability and reduce the error of wiring circuit.

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