Design and Evaluation of Computer Programming Education Strategy using Arduino

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Abstract. Arduino, physical computing platform, provides learner heuristic environment to achieve core values of SW/HW knowledge. This research design teaching and learning model for programming education with Arduino platform. This model supports multi component of various techniques, which are based on core knowledge from design, computer science and electronic engineering. In this environment, learners try to make prototype with low fidelity design method such as brainstorming and sketching. After then students will approach more sophisticated method with programming techniques, which include shaping, and forming knowledge from those of who attend Arduino project. To do this we designed teaching and learning model for Arduino-based programming education and then applied it to education field for 5 weeks with 26 students at Incheon education district. We develop the 'bling-bling art design' curriculum which is composed 10 chapters with LED artworks. We found that our approaches could more provide strength such as problem solving ability, creation techniques, flow of learning compare than traditional programming education approaches.

Keywords: Computer Programming Education, Arduino, EPL, Design, Prototype

1   Introduction

Information skills are core competencies in order to develop human resources in the knowledge-based society[2][3]. There was a lot of research in order to improve more information skills[8]. In this study, we paid attention to Arduino open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino can be great educational materials also. Because It can link to Scratch[5], S4A[11] and Modkit[10] like Educational Programming Language (EPL)[7] with ease. The purpose of this study is developed and applied to computer programming education using Arduino. To achieve this purpose Arduino model, teaching-learning lesson plan and e-Textbook were developed. This teaching-learning lesson plan was applied in the actual elementary school 6th grade classroom teaching for 10 class-hours in the fall semester 2014. The data from the questionnaires were analyzed by

SPSS/WIN 17.0. The result of this study showed that computer programming education using Arduino is possible in the regular elementary school curriculum as a STEAM[1][4][6][9] and in the Creative Experiential Activity with e-Textbook. It also showed the developed computer programming education using Arduino have positive possibilities in Learning attitude, Problem-solving, Academic interest and Flow of learning. Finally this study introduces a new way to educate computer programming using Arduino.

In this paper, we propose Arduino model in Section 2 and evaluate it in Section 3. Then, we conclude in Section 4.

2 Design and Implementation for Programming Education with Arduino platform

We developed 'Arduino Education Model' as shown in Figure 1 and it has several basic concepts of educational strategies. First it should apply the design process which includes design research method to reify from their initial ideas to creative output. In this research we selected LED Art Activity with programing to control the LED and sensor I/O that could well applied K1-6 level. Second, curriculum can be composed with compulsory subjects such as Science, Art and also applied additional subjects as like Educational programming Language, UX design.

To implement the Arduino model, modkit, S4A, Ardublock[12] was used. Those platform provides scratch based programming interface in which even novice student easily learn the programming techniques.
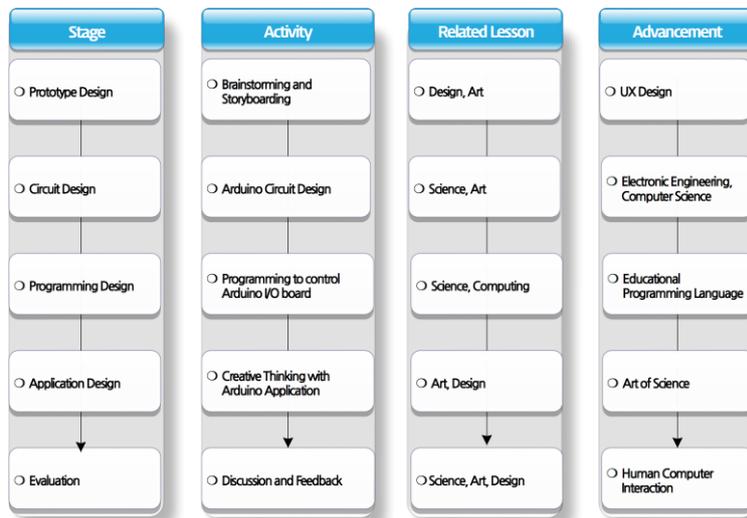

Figure 1. The Proposed Arduino Education Model

The figure 2 shows activity of Arduino model; students designed circuit to control the Arduino board with several sensor part such as LED, light (left). Students designed scenarios LED Art with Scratch programming to control sensor board I/O (right).

Fig. 2. The Proposed Arduino Education Model

3   Evaluation

In this test, we applied proposed Arduino model to verify educational effect for 26 students of K-6 at Incheon district.

A design of experiment is shown in Table 1. First, a pre-test was given to the participants of experimental group (i.e., EG) and control group (i.e., CG) to evaluate the possibility of learning attitude, problem-solving. basic knowledge of the target material. After the test, we did post-test to verity the difference of learning attitude and problem-solving between EG and CG. We developed the questionnaire tool to examine learning attitude which partially modified from previous researches. And also we used Problem Solving Inventory[8] that is modified of questionnaire to fit level of elementary students.

Table 1. Design of Experiment

EG	E_1	X	E_2
CG	C_1	Y	C_2

$E_1, C_1,$: Pre-test (learning attitude, problem-solving)
X : Class with Arduino model
Y : Class with traditional programming education
$E_2, C_2,$: Post-test(learning attitude, problem-solving)

Table 2. Educational effect of Arduino model from experiment group

Test		Mean	SD	t	p
Learning attitude	Pre-test	3.34	0.52	-.915	0.369
	Post-test	3.37	0.73		
Problem Solving	Pre-test	13.80	1.94	-6.34	0.000
	Post-test	18.63	2.79		

Table 3. Results of educational effect using traditional programming education model

Test		Mean	SD	t	p
Learning attitude	Pre-test	3.72	0.72	0.393	0.698
	Post-test	3.67	0.77		
Problem Solving	Pre-test	3.25	0.44	1.059	0.301
	Post-test	3.18	0.37		

We found that there are significant differences between EG and CG related learning attitude and problem solving in table 2 and table 3. The EG shows progressive possibility of learning attitude and problem solving that gets more data 0.13, 0.01 respectively as show in table 1.

4   Conclusion

The purpose of this study is developed and applied to computer programming education using Arduino. To achieve this purpose Arduino model, teaching-learning lesson plan and e-Textbook were developed. This teaching-learning lesson plan was applied in the actual elementary school 6th grade classroom teaching for 10 class-hours in the fall semester 2014. Our results show that computer programming education using Arduino is possible in the regular elementary school curriculum as a STEAM and in the Creative Experiential Activity with e-Textbook. It also showed the developed computer programming education using Arduino have positive possibilities in Learning attitude, Problem-solving, Academic interest and Flow of learning. Finally this study introduces a new way to educate computer programming using Arduino.

References

1. John, T, STEM to STEAM - recognizing the value of creative skills in the competitive debate, http://www.huffingtonpost.com/john-tarnoff/stem-to-steamrecognizing_b_756519.html, 2010
2. Ministry of Education, Science and Technology, "Revised National Curriculum in 2007", 2007.
3. Ministry of Education, Science and Technology, "Revised National Curriculum in 2009", 2009.
4. Ostler, E., 21st century STEM education: A tactical model for long-range success. International Journal of Applied Science and Technology, 2(1), 28-33, 2012
5. Resnick, M. et al., Scratch: Programming for All. Communication Of The ACM, 52-11, 60-67, 2009
6. Sanders, M., IntegrativeSTEM(Science, Technology, Engineering, and Mathematics) Education: Contemporary Trends and Issues, 59(3), 729-762, 2011
7. Tony Jenkins, On the difficulty of Learning to Program, 3rd annual LTSN-ICS Conference, 2012
8. VanLengen, Craig A, Does instruction in computer programming improve problem solving ability? Journal of information systems education 12/90, 1990
9. Yakman, G., STΣ@M Education: anoverview of creating a model of integrative education, PATT, 2008
10. Modkit, http://www.modkit.com, 2014
11. S4A, http://s4a.cat, 2014
12. Ardublock, http://blog.ardublock.com, 2014