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AN IMPACT STUDY ON THE ARDUINO PROGRAMMING TRAINING FOR BEGINNERS

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ABSTRACT

This study reports an impact assessment of the basic Arduino programming training conducted among select Junior High School Students in a National High School in Cagayan De Oro City. The Focus Group Discussion sessions and survey questionnaires via goggle form complemented the content of the impact study table. The researchers aimed to determine the impact of the training towards the perception of the trainees in programming, skills development and learning gain. Furthermore, the training program used was evaluated by both trainers and trainees in terms of content, strategies and activities used. Research results showed the respondents' negative perception on Arduino programming yet manifested positive views on the training for programming skills development and enhancement of learning. The training material was rated high ranging from format to organization and content.

KEYWORDS

Assessment, Arduino Programming, Training.

1. INTRODUCTION

Song Seng (2019) posits that student competence is a vital factor for achieving educational excellence. Emphasis has been placed on academic training. This is to ensure that students become more accountable and extra knowledgeable about the courses they take. As the core component in any educational system, these students need training to assure learning efficiency. Thus, educational institutions should be driven by the need to achieve efficiency, effectiveness and equity. This highlights the importance of training students, supplementary to the lessons they receive in classes.

Recently, Alam (2020) found a considerable surge among industries to attract skillful people. The significant development in technologies, working skills, and learning method increased the competition level. Hence, the academe needs to enhance student competence by providing trainings; thus addressing the students' needs to keep abreast with technological changes.

However, involving students in various trainings is not an end in itself. To further assess whether they really had enhanced their competences, the primacy of conducting an assessment is indeed high. In her study, Organtini (2018) concludes that an after training evaluation provides information whether a program has achieved or failed its objectives. Moreover, she adds that analyzing the training event by using appropriate evaluation tools can improve the outcome of future trainings to a considerable extent.

In 2019, this University conducted an extension program among select Junior High School students of Lapasan National High School. The training offered an introduction to Arduino programming, working with analog and digital sensors and building Arduino project leading to Robotics. To measure the impact of the implemented training, the researchers proposed for the conduct of this study. Specifically, the study scrutinized and described the skills developed among the respondents, including the motivation and focus which aided their programming performance. These are founded from Basarmak's (2021) study which recommends that training should help in updating skills and increase confidence level which strengthens the students' competitiveness.

Furthermore, the researchers administered this impact study to determine one important factor, change. For formative purposes, this impact evaluation was undertaken to analyze the given training intervention and gauged whether to continue, replicate or scale it up by examining the piloted training content.

2. BODY OF PAPER

2.1 Research Design and Instruments

This paper employed both descriptive and diagnostic research designs. In the research process, the researchers gathered data from both trainers and trainees. The training material/program were evaluated by both trainers and trainees; with emphasis on content, strategies and activities. Furthermore, this impact assessment took a process that included four basic components: 1) described training improvement over time, 2) motivated students to evaluate the training process, 3) evaluated the training materials and 4) ranked the trainees and trainers' evaluation of the entire training process.

2.2 The Instruments

This research made use of the prepared focus group discussion prompts modified from Sparks (2016), questionnaire and Ong's (2017) evaluation tool for assessing the training material used. These validation instruments served as basis for further recommendation on the training material enhancement.

2.3 The Respondents

The participants of the study were the USTP trainers involved in the 2019 Arduino programming for beginners' training. This was also inclusive of the thirty-six Graders who served as respondents in the training from Lapasan National High School. As the study was conducted during the COVID-19 pandemic, they were reached out via Facebook, group chats and zoom video conferencing.

2.4 Data Gathering Procedure

The researchers of this study conducted separate focus group discussion sessions among the trainers and trainees of the 2019 Arduino training program conducted at Lapasan National High School. The modified FGD prompts was utilized. These respondents likewise answered via google form, an adopted questionnaire which focused on the assessment of the training areas. An impact assessment table was likewise completed in this regard.

This qualitative research, which is based on the impact method; examined the impact of the conducted training in terms of the respondents' perception on programming, development of their programming skills and learning gain. Their ideas on how to enhance the training program used were likewise sought. An evaluation tool was modified which served as baseline instrument for the assessment.

3. RESULTS AND DISCUSSION

Table 1 shows that out of 36 respondents, majority perceived programming negatively or difficult. This data was taken through the focus group discussion and survey questionnaire. Similarly, results from the study of Arslan & Tanel (2021) manifested the same outcome. The paper presented a new approach to teaching programming to undergraduate computer science students. A dedicated Arduino board along with custom application programming interface (API) was introduced into programming classes with a view to strengthen students' engagement and improving the attractiveness of the course. The students were presented with basic functionalities of the board, which gave them a possibility to accomplish their own projects, typically video games; without any background in electronics. The level of engagement of the participants was observed by

the tutors during classes and also reviewed based on questionnaires filled by 347 first, second, and third year undergraduates. The results indicated that the proposed approach was well received by nearly 80%, while nearly 75% of the participants expressed a wish to continue their Computer Science education using Arduino. Hence, the negative perception did not affect the students' ability to learn programming in this study.

Table 1. Respondents' Perception of Programming

Perception on Programming	Frequency	Percentage	Rank
Easy to understand			
Negative	35	97.2	1
Positive	1	2.7	2
Interesting to Learn			
Negative	2	5.5	2
Positive	34	94.4	1
Needed in higher g-level			
Negative	5	13.8	2
Positive	31	86.1	1
Needed formal training			
Negative	0	0	2
Positive	36	100	1

Another study of Perenc et. al (2019) aimed to examine the effect of robotic design with Arduino on students' attitudes towards programming and on their perceptions of self-efficacy in programming. The study group consisted of 25 sophomore students attending the Department of Computer Education and Instructional Technologies in a state university located in the south of Turkey. The study lasted 12 weeks and the participants performed robotic design activities with Arduino throughout the process. Firstly, participants prepared a prototype and then programmed it for 8 weeks, and they created their own designs in the remaining 4 weeks. The Computer Programming Attitude Scale and Computer Programming Self-Efficacy Scale were utilized as the data collection tools in this pretest-posttest experimental study. The findings revealed that robotic design activities with Arduino significantly improved the participants' attitudes towards programming and programming self-efficacy. In addition, according to the participants' views, the factors that cause this improvement can be listed as activities' being enjoyable, facilitating and concretizing the process, being interesting and practical. Moreover, these robotic design activities were found to contribute to students' understanding of finding bugs and the logic of programming.

Table 2. Respondents' Perception of the Training Impact on the Development of their Skills

Development of Skills	Frequency	Percentage	Rank
Programming for beginners			
Negative	0	0	2
Positive	36	100	1
Basic Electronics			
Negative	1	2.7	2
Positive	35	97.2	1

The researchers looked into these two areas in the development of programming skills: programming for beginners and basic electronics. When the respondents were asked about their views as to whether Arduino training will develop their programming and basic electronics skills; majority of them were on the positive side. They believe that indeed, when they receive the training, they will be able to develop such skills.

The study of Darmawan (2017) proves that Arduino programming develops both basic programming and electronics skills. Accordingly, electronic devices have become a part of human life today that cannot be ignored. The Community Service Program conducted by Prodi Electrical Engineering, Maranatha Christian University aimed to increase knowledge, increase interest, form the ability of cooperation, improve creativity and improve the fighting power of high school students on the operation of electronic devices, in the form of Arduino programming training. Arduino was referred to as an open source electronic kit specifically designed as a controller that regulates the working process of electronic circuits. The method used in this PKM was Participatory Action Research (PAR) in the form of lecture method to describe the material that had been prepared by PKM team, the method of practice in the form of Arduino programming and assembling the electronic component connected with Arduino, the method of mentoring when the students do the programming and stringing electronic components, and discussion methods in the form of inter-group cooperation to solve the case given. The results of this training became a provision for high school students in the form of programming skills, the ability to assemble electronic components, the ability to work with groups to solve existing problems, and increase confidence in designing and operating electronic devices.

Table 3. Respondents' Perception of the Training Impact on Learning Gain

	A Lot	Quite	Some	A Little	Nothing
Did you learn in the Arduino lectures and training?	95%	5%	0%	0%	0%
Did you find the Arduino lectures interesting?	95%	5%	0%	0%	0%
Did you learn in the activities you performed?	100%	0%	0%	0%	0%
Did you find the series of Arduino activities interesting?	100%	0%	0%	0%	0%

Table 3 manifests that the trainees were able to learn a lot from the training conducted. They found the activities and the lectures interesting too. Enjoyment was manifested when they shared that they found the activities on lighting up bulbs and circuits among others fun. This is supported by Rubio's (2013) study which found that the training modules they developed enhanced the students learning. Seventy-four percent of the students attained a good programming level, a 32% increase compared to the traditional learning. Attitudes improved also: sixty four percent of the class felt confident programming by themselves, a 21% gain. Only 55% that received the traditional approach asserted their satisfaction with programming. The Arduino platform was received well by the students. Over 95% of student found the laboratory sessions interesting and over 85% enjoyed the lecture demonstrations.

Albatish's (2018) paper aimed at helping trainees to overcome the difficulties they face when dealing with Arduino platform by describing the design of a desktop based intelligent tutoring system. The main idea of this system is a systematic introduction into the concept of Arduino platform. The system shows the circuit boards of Arduino that can be purchased at low cost or assembled from freely-available plans; and an open-source development environment and library for writing code to control the board topic of Arduino platform. The system is adaptive with the trainee's individual progress. The system functions as a special tutor who deals with trainees according to their levels and skills. Evaluation of the system has been applied on professional and unprofessional trainees in this field and the results were good.

Table 4. The Trainers' Evaluation of the Training Activities

Areas	Large Extent	Some Extent	Not at All
Correlated with the skills developed	4	0	0
Practical and Feasible	4	0	0
Encourage active involvement	4	0	0
Logically arranged	4	0	0
Suitable to the grade level	4	0	0

All of the four trainers evaluated the training activities positively. They rated large extent the five areas identified as basis of the evaluation which are: correlation of the activities with the skills developed, practicality and feasibility, encourage active involvement, logically arranged and suitable to the grade level. Similarly, using the same evaluation tool, the trainees gave a positive rating. This is presented in the table that follows.

Table 5. The Trainees' Evaluation of the Training Activities

Areas	Large Extent	Some Extent	Not at All
Correlated with the skills developed	34	2	0
Practical and Feasible	35	1	0
Encourage active involvement	36	0	0
Logically arranged	36	0	0
Suitable to the grade level	36	0	0

Majority of the trainees believe that the training activities manifest a large extent on these five areas: correlation of the activities with the skills developed, practicality and feasibility, encourage active involvement, logically arranged and suitable to the grade level. Only two out of thirty-six ticked some extent for the area correlation of the activities with the skills developed while one chose some extent for the activities' practicality and feasibility.

In a study conducted by Garcia et al (2019), it was cited that several countries have usually adopted several priorities for developing ICT competences from kindergarten to secondary education. Most of them were focused on the development of key competences and/or coding skills. It was suggested that although coding may be very attractive for young students and a very good practice or experience, it could be more interesting to develop students' logical thinking skills and problem-solving skills throughout programming approaches or computational thinking. The paper presented a very exciting challenge with lots of possibilities regarding coding, robots, mobiles devices, Arduino-based application, game-based learning and so on. Thus it is very important discuss the experiences that are being developed worldwide in specialized for a with researchers that are working on this field, such as for example European Union TACCLE 3 - Coding project. This track is devoted to identify, share and valorize best practices and experiences (including technological and methodological issues) that focused on the development of computational thinking and related skills in any level of pre-university education.

4. CONCLUSION

In conclusion, the researchers found a strong positive impact between the trainee-respondents' perception on programming, the development of their programming skills, and the learning gain from the conducted training. All trainees agreed that the training had a huge effect on their perception on basic Arduino programming. The training significantly improved their competency and abilities to perform excellently in programming related activities.

The trainers developed an introductory Arduino programming teaching resource that enhances students learning. These modules composed of topics on programming codes, IDE, analog sensors, digital sensors and Arduino project application. The results obtained from the respondents show that when using these modules more students learn to program and more students enjoy programming.

Although teaching computer programming to Junior High School and Elementary students is a challenge, the respondents found the subject related to their core interests and felt comfortable during the course of the training conduct. The application of the physical computing paradigm engaged students more effectively and enhanced their learning. These are reasons why the evaluation of the training program was positively skewed.

REFERENCES

Alam, M. (2020). Arduino for Chemical Engineering Students via Game-based Learning. *ASEAN Journal of Engineering Education*, *4*(1).

Albatish, I., Mosa, M. J., & Abu-Naser, S. S. (2018). *ARDUINO Tutor*: An Intelligent Tutoring System for Training on ARDUINO.

Arslan, K., & Tanel, Z. (2021). *Analyzing the effects of Arduino applications on students' opinions, attitude and self-efficacy in programming class*. Education and Information Technologies, 26(1), 1143-1163.

Basarmak, U. (2021). Views of Pre-service Teachers in Different Disciplines about Coding with Arduino. *Malaysian Online Journal of Educational Technology*, *9*(2), 1-14.

Darmawan, A., Ratnadewi, R., Sartika, E. M., Pasaribu, N. T. B., & Arlando, R. (2017). Basic Arduino Programming Training for High School Students. *The Spirit of Society Journal*, *1*(1).

García-Peñalvo, F. J., & Cruz-Benito, J. (2016). *Computational thinking in pre-university education*. In Proceedings of the Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality (pp. 13-17).

Ong, C. G. (2017). *College Communicative Teaching and E-Learning: A Training Scheme*. International Association for Development of the Information Society.

Organtini, G. (2018). *Arduino as a tool for physics experiments*. In Journal of Physics: Conference Series (Vol. 1076, No. 1, p. 012026). IOP Publishing.

Perenc, I., Jaworski, T., & Duch, P. (2019). Teaching programming using dedicated Arduino educational board. *Computer Applications in Engineering Education*, *27*(4), 943-954.

Rubio, M. A., Hierro, C. M., & Pablo, A. P. D. M. (2013). *Using arduino to enhance computer programming courses in science and engineering*. In Proceedings of EDULEARN13 conference (pp. 1-3). IATED Barcelona, Spain.

Sparks, G. M. (2016). The effectiveness of alternative training activities in changing teaching practices. *American educational research journal*, 23(2), 217-225.