Scratchtopia Challenge: From Science Experiment to Coding in Upper Primary School

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Abstract

Purpose and/or Research Question - The purpose of this paper is to integrate the Scratchtopia programming into the Science experiment in an attempt to meet the needs of the Science curriculum, whereby students are given the opportunities to control over their learning in Science experiment.

Methodology – A prototype called "Scratchtopia Challenge: From Science experiment to coding" has been designed and implemented among the students of upper primary school in Johor Bahru..

Findings – The study revealed the impacts of Scratchtopia programming towards students' learning in Science experiment.

Significance and Contribution in Line with Philosophy of LSM Journal - The impacts of Scratchtopia programming into science experiment were elaborated with illustration of exemplary prototype designed to provide students the opportunities to control over their learning in Science experiment.

Keywords: Scratch programming; Science experiment; Upper primary school students

Introduction

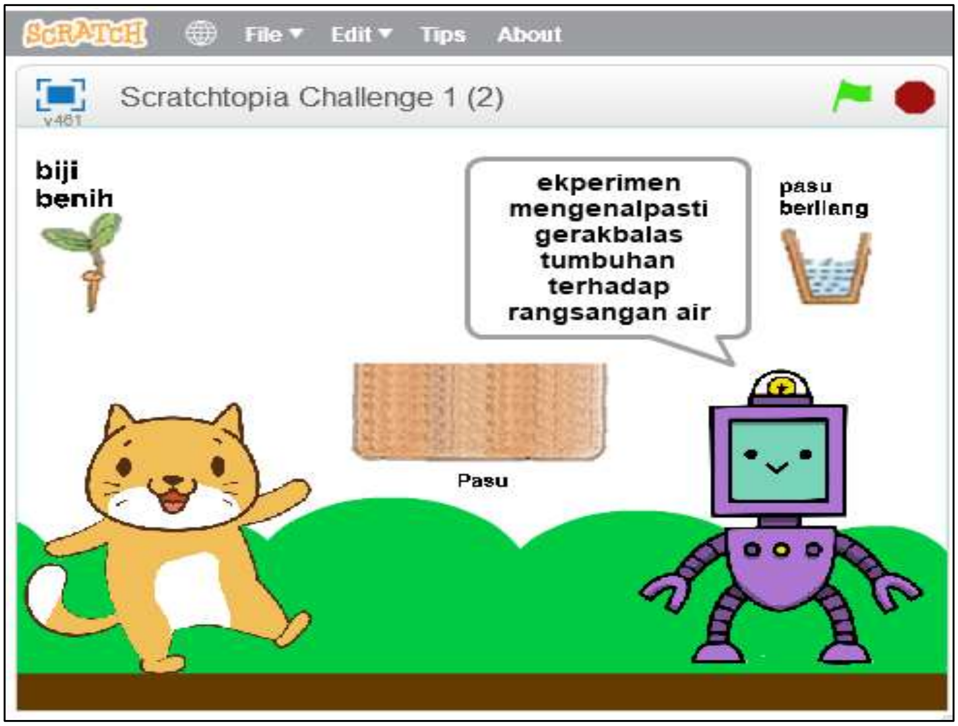
The current global spread of the Covid-19 virus has caused many teachers to look for alternative approaches in conducting their teaching lessons. Many sets of recommendations were proposed in order to support the teaching lesson yet the suggestion may not necessarily be able to cover all the topics of the subject. Taking science experiment as an example, it is part of the teaching activities that is compulsory to be included in science education (Millar, 2010). Yet, teachers faced limitations in terms of time management, model, apparatus and resources (Toplis, 2012) when the lessons were to be taught online or from home. Although digital video guidelines are now available to facilitate the teachers in experimental teaching (Croker, Andersson, Lush, Prince, & Gomez, 2010), teachers who do not have the data internet access may struggle to teach while students may also face a similar situation. As a result, the students eventually would lose the science process skills when they did not practise the practical skills consistently. In view of these points, this research aims to develop an E-module with a Scratch application that combines Science experiment and programming application in order to provide an alternative approach for teachers to teach science experiments at home even though the materials and apparatus are not available while engaging students to learn independently for science experiment.

Problem Statement

Technology has been recognized as an integral component of the Primary Science Standard Curriculum (KSSR) as well as a new component called ‘Elements Across the Curriculum’ (EMK) that will help improve the quality of KSSR implementation (Kementerian Pendidikan Malaysia, 2016). A technology tool, for example, could be used to make science learning more interesting and effective in such a way that makes an abstract or difficult concept easier to learn. Yet little discussion has been made on how the technology could be integrated into a science experiment in the KSSR. Experiment or practical work is one of the science teaching methods used to discover specific concepts and principles. Ideally, students should have control over their learning by designing the experiment, drafting the experimental method, measuring the data, and analyzing it (Kementerian Pendidikan Malaysia, 2016). Teachers' control, however, largely limited these practices (Osborne, 2015). To achieve these idealistic practices, the researchers intend to design a technology tool to be integrated into the science experiment. By using Scratch programming, a prototype has been created titled "Scratchtopia Challenge: From Science experiment to coding" (see Figure 1and 2). Overall, 15 science experiments were developed that cover the science experiment for Standard 4, 5 and 6.

Figure 1 Module of Scratchtopia Challenge

Figure 2 Printscreen of Scratchtopia Challenge



Research Objectives

It is envisioned that this Scratchtopia Challenge would be able to facilitate and increase the interest of students in learning science experiments. Therefore, this paper aims to integrate the Scratchtopia programming into the science experiments that are aligned with the objectives of the science experiment based on the Primary Science Standard Curriculum (KSSR) while meeting up the needs of the science curriculum.

Literature Review

Science Experiment

Several studies have provided insight into the difficulty teachers and students encounter when teaching science experiments (Millar, 2010; Osborne, 2015). Due to a lack of materials and apparatus in the laboratory, some science experiments could not be conducted as planned (Ouahbi, Kaddari, Darhmaoui, Elachqar, & Lahmine, 2015; Redfern, Burdass, & Verran, 2013), whereas some schools raised concerns about financial issues, safety concerns, technical support, practical skills (Redfern et al., 2013), and time constraints (Muhtasib, 2019; Redfern et al., 2013).

In terms of teaching practices, a report has been published on how the science experiment was taught. Rather than allowing students to take control of their learning, the students were taught using a procedural and traditional approach in which students must follow the teacher's instructions closely (Shamsia, 2014). The students were taught to replicate procedures so as to achieve the expected results or to answer questions based on the examination setting, rather than being given the opportunity to take control of their learning.

In the new science curriculum, there has been an emphasis on integrating technology and ICT, yet little discussion has been made about how to integrate them. Many suggestions were made, including digital video guides (Croker et al., 2010) and game-based learning (Ouahbi et al., 2015), but none of them demonstrated if they could enable students to learn independently.

Additionally, Science experiments are being taught with a different focus. The concept of "dry laboratory" was introduced, for example. The "dry laboratory" teaching used Crocodile Mathematics, ICT, Chemistry, and Physics computer software. Since this form of teaching is still new, researchers have been interested in identifying or discovering its effectiveness. According to Muhtasib (2019), there have been significant differences between the teaching of science experiments in dry laboratories and those in actual laboratories. Kobsiripat (2015) and Muhtasib (2019) cite Scratch as one of the most popular visual two-dimensional programming tools in education today.

Scratch

Students who have used Scratch programming in the past have shown significant improvements in their learning (Kobsiripat, 2015). The students were in general self-disciplined, independent, and capable of controlling their learning pace (Meerbaum-Salant, Armoni, & Ben-Ari, 2010). Additionally, Scratch encourages problem-solving and collaborative learning (Kordaki, 2012), while some researchers (Kobsiripat, 2015) believe Scratch is a new teaching approach that promotes higher-order thinking while functioning as a new approach to teaching. The interface of Scratch was simple and easy to use, which made it ideal for use in teaching and learning materials (Meerbaum-Salant et al., 2010).

Research Methodology

As part of a questionnaire in the pre-test and post-test, students were asked to provide information about their demographic characteristics, their experiences with science experiments, their opinions regarding the instructional approach for Scratchtopia Challenge: From Science Experiment to Coding, as well as their opinions regarding the activities in Scratchtopia Challenge: Science Experiment to Coding. The data collected from the questionnaire were entered into SPSS. Findings based on positive impacts, frequency of students wanting to do science experiments, students' perceptions and benefits of the Scratchtopia Challenge were presented in this paper. Descriptive statistics were computed using mode, mean score and standard deviation as measures of findings.

During the study, the researcher adopts the concept of ADDIE to design a module named "Scratchtopia Challenge: From Science Experiment to Coding". This module would serve as an alternative method of teaching science experiments. A total of four phases were involved in the design of this model.

Phase One: Developmental

During this phase, the researcher developed the E-module (first version) in terms of its content and structure. Based on the concepts of the science experiments, the module was developed to align with the KSSR objectives.

Phase two: Evaluation

In this phase, the developed E-module was verified by experts in the field and school researchers. A revised version of this E-module (second version) would then be created after it was validated by technical and market experts. In order to develop the final version of the E-module, the data of the validation would be analyzed for reliability followed by the second step of validation based on technical and market expectations.

Phase three: Instrument and data analysis

This phase involved implementing the E-module and Scratchtopia Challenge program in selected schools. A teacher and students from three different upper primary levels (Primary 4, 5 and 6) participated in the pilot test. Students and teachers were surveyed quantitatively on the Scratchtopia Challenge. To obtain descriptive statistics, the collected data were analyzed using the Statistical Packages for the Social Sciences (SPSS) software.

Phase four: Production Phase

A final version of the E-module would then be packaged and refined by the professional before being released to the local and international markets.

Findings

As shown in Table 1, there has been a positive change in the students' interest in learning science experiments. For instance, the mean scores for items 9b and 9c in the pretest decreased correspondingly in the posttest, which indicates a decreasing feeling of boredom in conducting science experiments and forgetfulness of what has been learnt. Thus, the students are able to focus more on the learning, and this contention is supported by the increasing of the posttest mean score for Item 9r. Meanwhile, the mean scores for items 9g and 9I in the pretest increased correspondingly in the posttest, suggesting that students were more knowledgeable in science experiment and confident in answering questions in science experiment. Through gaining knowledge and confidence in science experiments, the students were able to acquire a better understanding of, and a higher confidence in carrying out the procedure in the experiment. As a consequence, their mean scores in the posttest for items 9p, 9q, and 9n increased.

Table 1 Comparison of the Students' Mean Score in the Pre- and Post-Test with Positive Impacts

Factors	Before		After	
	Mode	Mean ± SD	Mode	Mean ± SD
9b I feel boring to conduct science experiment	2	1.86 ±0.86	1	1.62±0.79

9c I often forget the learning in science experiment	2	2.36±0.84	2	2.31±0.86
9g I feel confident to answer the questions in science experiment	3	3.21±0.70	3	3.31±0.63
9l I am very knowledgeable in science experiment	3	2.79±0.70	3	2.93±0.73
9m I can study science experiment on my own	2	2.21±0.73	2	2.43±0.56
9n I prefer to control my own learning in science experiment	3	2.79±0.80	3	3.08±0.64
9p I understand the procedure in the science experiment	3	3.00±0.39	3	3.14±0.54
9q I see the importance of learning science experiment	3	3.14±0.66	3	3.29±0.61
9r I am focus when I learn science experiment	3	3.07±0.48	3	3.21±0.58

1= strongly disagree; 2= disagree; 3= agree; 4= strongly agree

As a result, the descriptive mean scores for Table 1 are used to analyze the frequency distribution of the pre-test and post-test among students who want to do science experiments (see Table 2). There has been an increase in the number of students asking for more science experiment lessons even though they would not choose to have the experiment in almost every lesson. 42.9% of the students indicated that they preferred to have science experiments at least once a week or once a month.

Table 2 Frequency of Students Wanting to do Science Experiment

	Before		After	
	N	Percentage (%)	N	Percentage (%)
Once a week	5	35.7%	6	42.9%
Once a month	4	28.6%	6	42.9%

Every two weeks	1	7.1%	2	14.3%
Once a term	0	-	0	-
About every lesson	4	28.6%	0	-
Others	0	-	0	-

Although there is no significant increase in the interest of students towards the learning the science experiment (see Table 1)), a total of 71.4% of students have been engaged in the learning activities since it incorporates coding as part of its learning element, embedded in the Scratchtopia Challenge. In addition, 92.8% of students said they would use the Scratchtopia Challenge in the future, indicating that this module had a positive impact on students' overall learning. Given as "factors" in Table 3, students provided reasons to support their view of the Scratchtopia Challenge.

Table 3 Students' Perception and benefits on Scratchtopia Challenge

Factors	Strongly disagree	Disagree	Agree	Strongly agree	Mode	Mean ± SD
12b It was easy to use	7.1%	14.3%	57.1%	21.4%	3	2.93 ± 0.829
12d It helped me to understand actual hands-on experiment in science	0	14.3%	42.9%	42.9%	3[a]	3.29 ± 0.726
12h It can be used to enhance my learning in science experiment	0	14.3%	57.1%	28.6%	3	3.14 ± 0.663
	7.1%	14.3%	42.9%	35.7%	3	3.07 ± 0.917
12k I felt more control for my learning in science experiment	0	21.4%	57.1%	21.4%	3	3.00 ± 0.679
12m It allowed me to study science experiment	0	14.3%	57.1%	28.6%	3	3.14 ± 0.663

Factors	Strongly disagree	Disagree	Agree	Strongly agree	Mode	Mean ± SD
regardless where I am located						
12n It allowed me to study science experiment at the time convenient to me	0	0	78.6%	21.4%	3	3.21 ± 0.426
12s I could concentrate more when learning it	7.1%	14.3%	57.1%	21.4%	3	2.93 ± 0.829
12p I tried to relate it to the real-life situation as if like I am doing the Science experiment		21.4%	64.3%	14.3%	3	2.93 ± 0.616
12q I learned to apply principles of coding to other subject learning		7.1%	64.3%	28.6%	3	3.21 ± 0.579
13h I was able to relate the content to my actual learning in science experiment	0	14.3%	64.3%	21.4%	3	3.07 ± 0.616
13j I was able to think critically and analytically after learning it	0	21.4%	50.0%	28.6%	3	3.07 ± 0.730

1= strongly disagree; 2= disagree; 3= agree; 4= strongly agree

a. Multiple modes exist. The smallest value is shown

Academically, Scratchtopia Challenge helps students to connect to real-life situations and apply the principles of coding to other learning subjects. In general, students were able to think critically and analytically after learning the principles of coding. However, more research is needed to understand how coding enables students to think logically, critically, and analytically in science experiments.

Conclusion

As a result, Scratchtopia Challenge is potentially useful for increasing students' interest in learning science or as an alternative approach for teachers to teach science experiments regardless of location, time, or limited materials. As suggested by the students, Scratchtopia can be used alongside the actual hands-on experience in science, although further research is needed to determine whether it can fully replace the hands-on experience.

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