Effectiveness of 5E-Flipped Classroom in Facilitating Higher Order Thinking Skills in *Reka Bentuk dan Teknologi* (RBT) subject among Year 4 Students

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Abstract
Previous studies and government documents made it abundantly evident that Malaysian students lacked High Order Thinking Skills (HOTS). In line with that, the aim of this research is to study the effectiveness of 5E-Flipped Classroom approach on the tendency of students to acquire HOTS as outlined in Taxonomy Bloom. The basis of theoretical foundation of the study is based on Constructivist Theory by Vygotsky views. It is a quantitative study, data collection was obtained through questionnaires, which were distributed randomly to 92 students selected from three schools in Bangsar zone. The data obtained from the research were analyzed using descriptive and inferential statistics. The outcome of this study is the 5E-Flipped Classroom enhanced students' HOTS in the dimensions of problem solving, critical thinking and creative thinking. Implementing mixed method which are quantitative and qualitative data collection methods and teachers` perspectives should be the focus of future research. The result implication shows students engaged in HOTS. The items measured in the questionnaire are evidence that the 5E-Flipped Classroom strategy impacted students to use the technology, proclivity to adopt active learning communicate and cooperate with peers, contributing to students' HOTS. Therefore, this study concluded that students can acquire HOTS by integrating an appropriate pedagogical approach.

Keywords: 5E-Flipped Classroom, Engagement, High Order Thinking Skills, Scratch, Reka Bentuk dan Teknologi.

Introduction

An intellectual nation is developed through the strong role of education. The 21stcentury learning is garnering attention as it is about successful learning in the classroom which leads to ability to produce a generation that is able to globally be productive economically and competitive in the fast-moving world (ASEANstats, 2019). Realizing the present education highlights the importance of developing students' 21stcentury skills. Therefore, the Partnership 21 (P21`s) developed standards for 21st Century Learning in 2002 (Zain, 2017) to allow students to embed 21st century skills to navigate our education through the development of technology and globalization to ensure students are competent and skillful (Amanisa & Maftuh, 2021). In line with this, The Ministry of Education in Malaysia (MOE) established *Pelan Pembangunan Pendidikan Malaysia* (PPPM) (KPM, 2013) or also known as

Malaysian Education Blueprint 2013-2035 (MEB) to outline strategies for an educational transformation for Malaysian students to take up the opportunities and challenges to develop the skills needed, pace up with the technology advancement and underpin the holistic education to align with the 21st century needs (UNESCO, 2021).

Problem Statement

Development of HOTS has been the central demand of education goal for the past few decades (Ahmad & Hussin, 2017; KPM, 2013; Mitani, 2021; Zohar & Dori, 2003). However, previous studies have indicated the challenges in the acquisition of HOTS among students (Uyub et al., 2021; Widiyawati et al., 2021). This is proven through the result of the Primary School Achievement Test (UPSR) 2019 result analysis reported in *Pelaporan Pentaksiran Sekolah Rendah* (PPSR) 2019 which shows only 9.76 % of 431,635 students acquired problem solving skills in all situations in Science subject (KPM, 2019). Despite Malaysia striving to be in the top three countries in PISA and TIMMS assessments (KPM, 2013) and track record showing Malaysian students' are unable to reach the upper quartile (level 3) and still lagging behind the international average level observed in the PISA 2018 and TIMSS 2019 (KPM, 2020).

In a recent study, one of the factors identified and contributed to the lack of HOTS among students is weakness in the learning process, where it appears that an active learning process that practices thinking skills comprising of thinking skills of critical and creative, problem solving skills and collaboration are not implemented (Bahri et al., 2021). Subsequently, studies are shown that pedagogical methods used in many lessons in classrooms are usually carried out by teachers through teachers' direct instructions and students' passive listening, thus contributing to didactic lectures and concept attainment (Tsai, 2019) which resulting in the domination of teachers and lack of student' active learning (Bahri et al., 2021; Gao & Hew, 2021). The limitation in traditional classroom teaching methods results in only a surface level of understanding of the content knowledge (Strelan et al., 2020). Most teachers also adopt lecture teaching styles and have not encouraged students to employ problem solving in their learning as they are concerned that their students will not understand the content knowledge (Kwangmuang et al., 2021). According to UNESCO review (2021) referring to Malaysian education, although the actual curriculum mandates active, participatory and child-centered pedagogy learning during implementation, it's either ignored or the implementation is not carried out effectively where teachers' dominant methodology of " talk and chalk" is still applied (UNESCO, 2021).

Thus, despite the government highlighted the importance of fostering students for HOTS (KPM, 2013), there is a gap among primary school students. Parallel to that, In Malaysia, 5E-Flipped Classroom approach still remains scarce in the development of HOTS. Thus, the following were addressed in this study:

Research Objectives

To evaluate students' HOTS in 5E-Flipped Classroom through project-based learning of Scratch programming lesson.

Research Question

What are the students' HOTS level in 5E-Flipped Classroom using Project-based learning of Scratch programming lesson?

Research Hypothesis

There is no significant difference between students who undergo 5E-Flipped Classroom and students in Traditional Classroom in terms of HOTS applied to create a new artifact during their project-based learning.

Methodology

Research Design

This study is about identifying the effectiveness of 5E-Flipped Classroom in facilitating HOTS among year 4 students through Scratch project-based learning in the RBT subject. In this research, it employs a quasi-experimental quantitative methodology approach. Relevant data is collected through pre-test and post-test questionnaires handed out to experimental-control groups. Thus, it created a cause-effect relationship between the independent variable, which is the "The instructional approach referring to 5E-Flipped Classroom or Traditional classroom" with the dependent variable which refers to "The High Order Thinking skills" of the students.

Figure 1 below clearly defines how the research will be carried out by dividing the students into two classes. Traditional classroom pedagogy is applied to the control group whereas the 5E-Flipped Classroom method is applied to the teaching and learning of the treatment group.

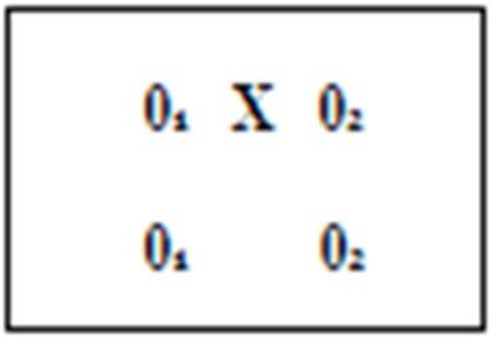

Figure 1: Non-equivalent Control Group for Pre-test and Post-test

Note. The figure above illustrates the research design using the notation system provided by Campbell and Stanley (1963), where the symbol X represents the intervention, *0* represents observation that is recorded (Stanley, 1963). The top row represents the 5E-Flipped Classroom approach where 0_1 represents the pre-test and 0_2 represents the post-test. The second row represents the traditional Classroom approach. This will ensure the validity of the research.

Research Procedure

This research took place at the Bangsar zone in Klang Valley. The researcher used a National Type Tamil Primary School (NTTPS) also known as *Sekolah Jenis Kebangsaan Tamil* (SJKT) as a setting to get the data. The curriculum used in SJKT was developed and coordinated by the National Education Curriculum. The medium of language used for instruction is Malay, English and Tamil. The particular schools chosen had been set up with a computer lab and required facilities.

Teachers implemented Scratch programming lessons under the topic '*Pembangunan Kod Arahan'* or 'Development of Instruction' (KPM, 2018b) in the syllabus of the RBT subject. Teachers carried out the lessons once per week and students took 3 weeks to complete the lessons. The treatment group that adopted the 5E-Flipped Classroom approach with a checklist to validate lesson plans and guidelines for the execution of 5E-Flipped Classroom based on each stage. Students in the treatment group are involved in the two stages of learning, which are pre-classroom and in-class sessions. In the pre-classroom session, students learned through pedagogical videos provided by the teacher. The videos were prepared by the researcher as there were no available resources narrated in Tamil language and provided to the schools that undergo 5E-Flipped Classroom to ensure all three schools' students viewed the same video. The videos were uploaded 1 week earlier before the lesson to ensure the students had adequate time to watch and comprehend the content knowledge. The length of the video is 10 minutes and has been arranged in line with the artifact created in the physical classroom session. The videos are uploaded to the Youtube channel due to limited video sizes and to enable students to rewatch again if necessary. The content of the video is then shared with the students through Google Classroom according to the weekly schedule. Followed by watching videos, students answered quizzes. The time frame for the pre-classroom session is 20 minutes. Before sharing the video with students, the pre-test questionnaire will be administered to students in the first week. Both pre-test and post-test questionnaires feature 32 questions modified from other relevant research and adapted to meet the research objectives and served as an instrument tool to collect required data from respondents.

The pre-classroom lesson adopts 4 phases, which is Engagement, Exploration, Explanation and Evaluation. Students watched the video and the content of the video provoked students' learning interests and activated their prior knowledge when familiar examples were shared (Engagement phase). The video provided by the teacher, along with additional resources independently sought by the students, served as tools for exploring and understanding the underlying concepts, this followed by the completion of the online quizzes reinforces their learning through immediate feedback given (Exploration phase). The video plays the role of a teacher, to give a brief definition of the new concept and help the students to consolidate their conceptual understanding (Explanation phase). Lastly, students conducted a self-check based on computerized feedback while the teacher observed students' responses to quiz questions (Evaluation phase). This process ensured students' commitment to watch the pedagogical video and gain the content knowledge.

Then, it is followed by an in-class session involving 4 phases, namely, 'Engagement', 'Explanation', 'Elaboration' and 'Evaluation'. The teacher will conduct activities that can catch students' attention like games related to the underlying concepts learned in the pre-classroom (Engagement phase). The purpose of this phase is to activate students` prior knowledge. Next, students involved in group discussions to discuss the quiz questions and eliminate their misconceptions (Explanation phase). This phase allowed teachers to give clarifications and clear students' doubts. Students then participated in the problem-solving activities, two students in a team, to develop their artifact (Elaboration phase) based on the content knowledge they have learned in pre-classroom. Students discussed and worked in a

team with their peers without teachers` involvement except for issues related to technical in the elaboration phase. After completion of pre-classroom and face to face session, students applied the 5E-Flip classroom learning, comprising the phases of Engagement, Exploration, Explanation, Elaboration, and Evaluation.

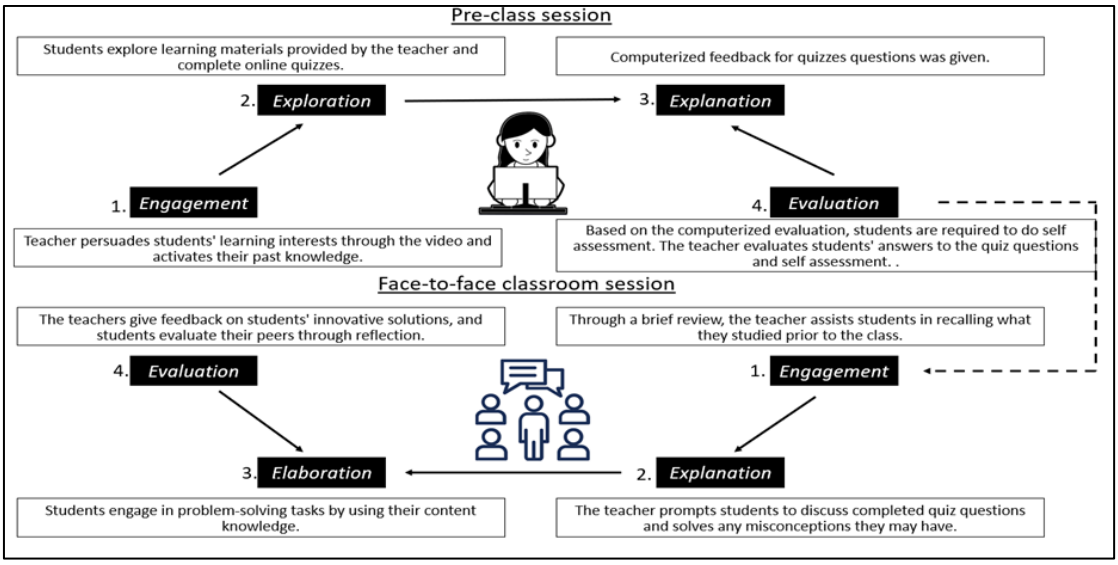

Figure 2: The Portrayal Representation of 5E-Flipped Classroom Modified from Gao & Hew (2021)

Finally, students presented their artifacts and the teacher will carry out the assessment using the artifact assessment score rubric to identify whether the students gain mastery of the content knowledge and apply the content knowledge learned to create new artifacts (evaluation phase). The artifact creation is measured based on a few dimensions in the rubric such as originality, attractiveness, needs, fulfillment and study based on the table below (Tugun et al., 2017). To encourage the involvement of students and draw their interest in the learning activities, announcements were made that the three best artifacts will be chosen by the researcher for each school and be rewarded with prizes along with e-certificates and other students who were involved actively will be given e-certificates. Finally, in the 3rd week, the same questionnaire will be administered to them.

Population and Sample Selection

The study was conducted in the four National Tamil primary schools in Bangsar Zone of Kuala Lumpur. One of the schools, SJK(T) A with an enrolment of 10 students, will be excluded from the research and involved as the pilot test school. The estimated sampling size of respondents in the study yielded based on a simple random sampling technique (Krejcie & Morgan,1970). Stratified random sampling was applied in the process of selecting the sample. Stratified random sampling is a process where the students in the population are divided into non-overlapping and separate strata and the sample is randomly chosen from each stratum (Gerow, 2012; Mills & Gay, 2019). According to Darusalam (2018), it is suitable to be applied for research that are based on zone, state, section and area or selection of sample based on category. Thus, in this research, two SJKT schools, C and D in zone Bangsar chosen to apply the proportionate stratified random sampling.

The minimum number of students (respondents) required for each school is identified based on the stratified sum of students in a specified school divided by the sum of Year 4 students in all the SJKT schools in the Bangsar zone. The value is then times by the size of the sample respondents identified for this research based on Krejcie and Morgan (1970), which is 92 students. The 35 students of SJK(T) B students served as reserve respondents for the treatment group as the school has only one class, thus the students could not be divided to carry out traditional and 5E-Flipped Classroom and will be taken in as respondents in case the existing respondents took part in the research could not further contribute to the research.

$$\text{The Sub-sample size required for each school} = \frac{\text{Sub-population size}}{\text{Population size}} \text{ X n}$$

Figure 4: Formula to Identify The Number of Samples Required for Each School (Piaw, 2020a)

Figure 4 shows the formula used to identify the sample required for each school (Piaw, 2020a) and Table 1 shows an example of a calculation carried out. In the formula, "n" represents sample size.

Table 1: The Calculation Carried Out to Identify Number of Samples for SJK(T) C Using The Formula to Identify The Number of Samples Required for Each School (Piaw, 2020a)

$$The\ number\ of\ students\ required\ for\ SJK(T)\ \ C = \frac{59}{117} \times 92$$

$$= 46$$

The 10 students each from SJK(T) C and SJK (T) D will be placed in the reserve category which bring to a total of 55 students. Thus, based on this calculation, the minimum number of samples required for each SJK(T) C and SJK(T) D in Bangsar zone is identified as shown in Table 2 below.

Table 2: The Total Number of Respondents That Involved in Research

Schools participating	Name of class	Number of students according to class	Total number of year 4 students in the school	Minimum students required	Total students that will be involved in this research
SJK(T) B	4 Yaazh	35	35	-	35
SJK (T) C	4Mahakavi 4 Nayanaal	30 29	59	46	46 + 10 (reserve)= 56

Schools participating	Name of class	Number of students according to class	Total number of year 4 students in the school	Minimum students required	Total students that will be involved in this research
SJK (T) D	4 Valluvar 4 Barathi	27 31	58	46	46 + 10 (reserve)=56
Total students involved in research	-	162	162	92	147

Next, suitable random sampling for the 147 students is chosen from the options that are available such as tossing dice, flipping coins, and spinning wheels using computer programs to identify target students who will be involved in the research (Darulsalam, 2018) Thus, spinning wheels using computer programs is applied and the participants were not informed whether they belong to experimental or control group to ensure the feasibility of what being tested.

Research Instrument

In this research, the researcher modified the questionnaire from different sources to achieve the objective of the research and answer the research questions. The questionnaire is segmented into two sections namely: Section A (Demographics) and Section B (HOTS) as shown in Table 3 below:

Table 3: Guidelines on the Instruments that have been Used

No	Instrument	Instrument producer	No of item taken	Reference / Original source
1.	Section A Demographics	-	-	-
2.	Section B HOTS	(Hwang et al., 2018)	10	Hwang, G. J., Lai, C. L., Liang, J. C., Chu, H. C., & Tsai, C. C. (2018). A long-term experiment to investigate the relationships between high school students' Perceptions of mobile learning and peer interaction and higher-order thinking tendencies. *Educational Technology Research and Development*, *66*(1), 75-93.

Profile demographics in section A gather the basic information's on the respondents' background such as gender, age, race, previous knowledge of Scratch, and experience of attending Scratch class. The instrument in section B is to explore students' HOTS adapted from Hwang et al. (2018) where it has been validated through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) and the dependability shows the result of Cronbach`s alpha achieved 0.86 acceptable reliability coefficient (Hwang et al., 2018). The item in this section measures the dimension of problem solving, the ability of creative thinking and critical thinking.

Data Collection

Data collection is employed through a pre-test which served as a preliminary evaluations. The pre-test was given to identify the students' prior knowledge (Eryılmaz & Ahmed, 2017). Whereas, the post-test was given after the intervention. The questionnaire adopted 10 items to access students' HOTS. Even though questionnaire is a common type of data collection, Year 4 students who were still lack of vocabulary knowledge, might find it hard to understand the context questioned in the survey form. Therefore, the teacher assisted students to read the questions and explain to them. Respondents will fill up the survey questions together after teacher explains each question to ensure the respondents understand the questions and uncover students' misconceptions before answering them. Tamil language is applied as students learn using their mother tongue throughout the lesson. Thus, questionnaires given in Tamil language are understandable by them. Finally, in the 3rd week, the same questionnaires were administered to them. The contrast between the pre-test and post-test enabled the researcher to analyze to what extent is the HOTS of students. Data from the pre-test and the post-test were collected, compared and analyzed accordingly as shown in Figure 5 below:

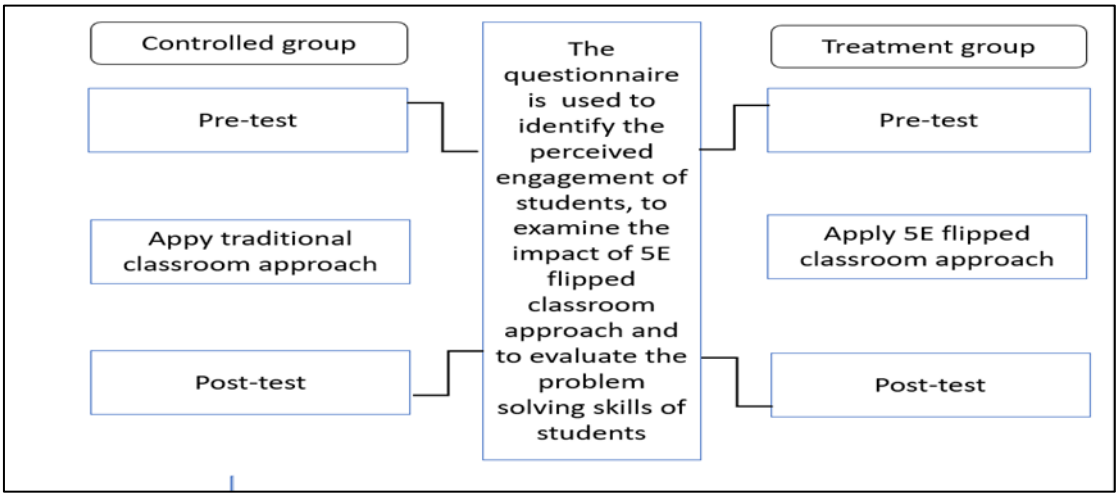

Figure 5: Study Compared the Pre-Test and Post-Test Designs Conducted for Controlled Group and Treatment Group

Data Analysis

The researcher analyzed the raw data obtained from this research using descriptive statistics and inferential statistics (Piaw, 2020a) by applying the Statistical Package for the Social Sciences Software version 23 (SPSS).

Quantitative data in the form of numerical in the inferential statistics gives insight about the relationship between variables to answer research questions and to determine whether the hypothesis is significant or not (Creswell & Creswell, 2017). Thus, as a first step, hypotheses were formed and identified the suitability of the type of statistical test to analyze data by identifying the terminologies used in the research hypothesis (Piaw, 2020b). Thus, in this research independent-sample t-test is selected as a method to analyze data as the terminologies used in the research hypothesis.

The SPSS Software will also be used to analyze the mode, mean, median, standard deviation, range, normal distribution and Z score to describe the characteristics of a variable and make a conclusion about a variable in descriptive statistic (Piaw, 2020b). Descriptive analysis and inferential statistics were done for the questionnaire Thus, descriptive statistics were used to ascertain whether there is a large discrepancy between the outcomes of the subjects. Box plot was utilized to look at how the values of the data are spread out between 5E-Flipped Classroom and Traditional Classroom. The data obtained from the findings were interpreted and justified using the literature review and theories.

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Results and Discussions

Descriptive Analysis of Demographics

The demographics variables were presented by the researcher to understand the diversity and generalize the findings between the Traditional Classroom and the 5E Flipped Classroom.

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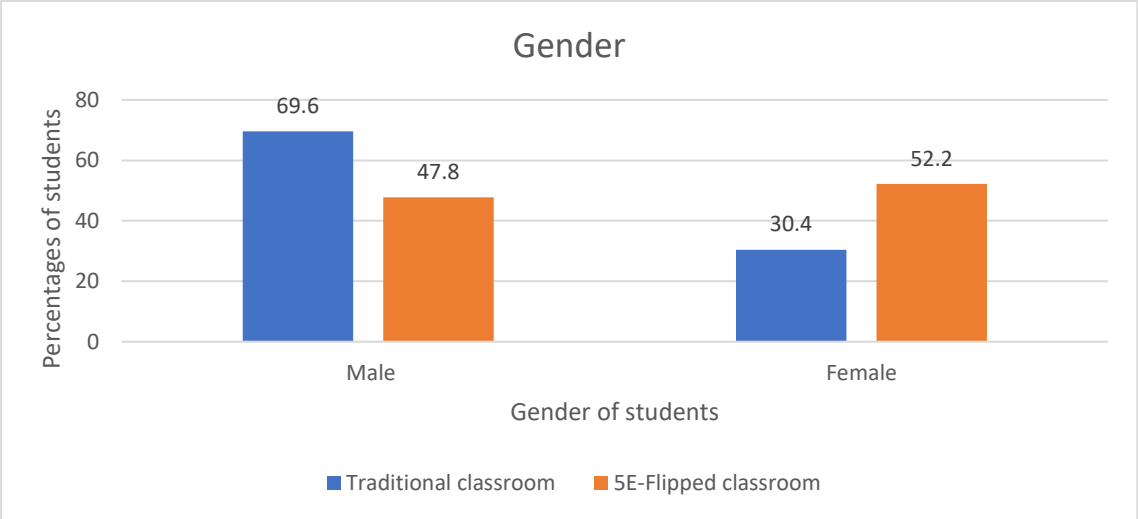

Figure 6: The Breakdown of Data Based on Gender Both in Traditional Classroom and 5E-Flipped Classroom

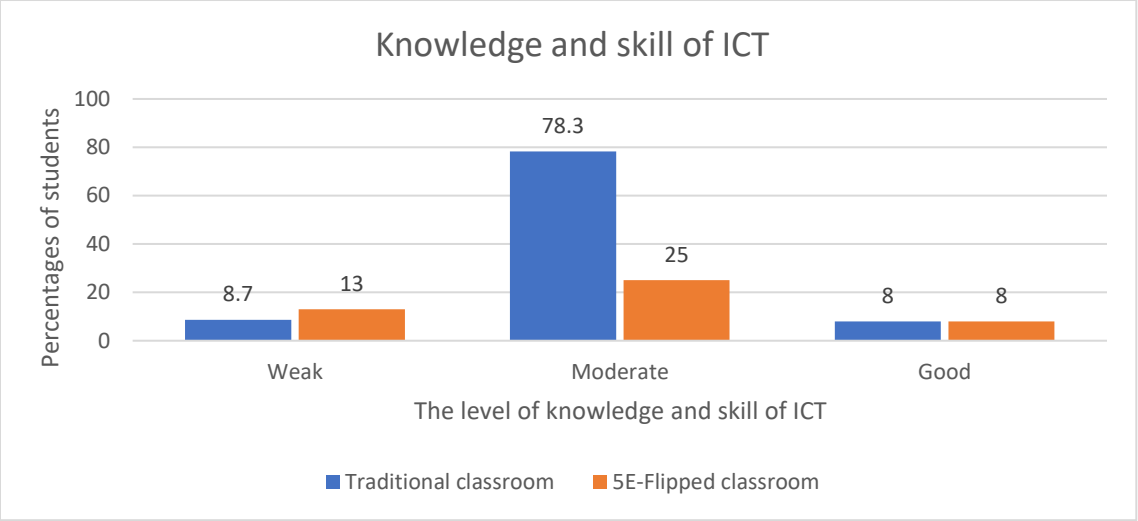

Figure 7: The Breakdown of Data Based on Knowledge and Skills of ICT in Traditional Classroom and 5E-Flipped Classroom

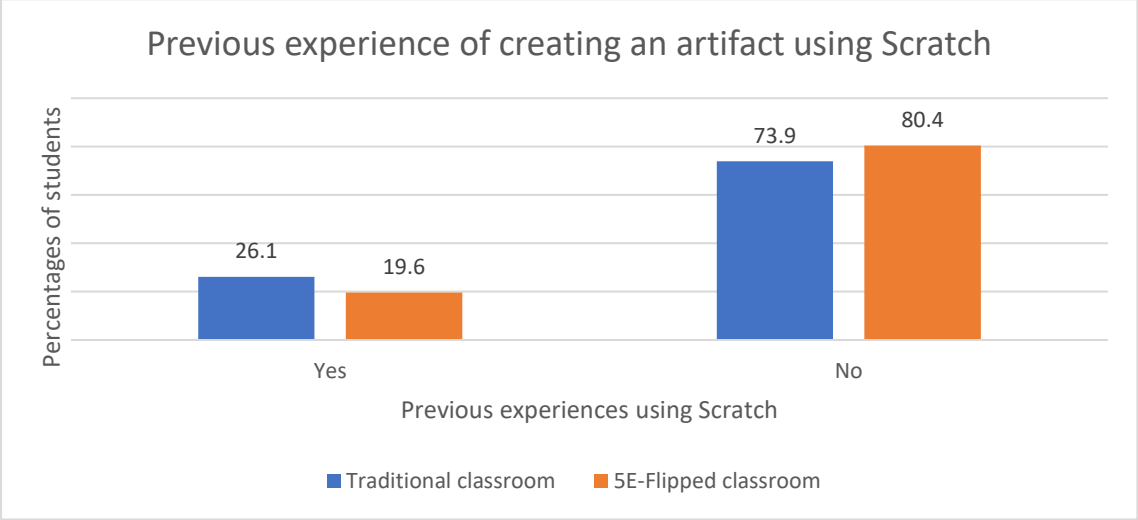

Figure 8: Bar Graph Analysis between Traditional Classroom and Flipped Classroom for Previous Experience of Creating an Artifact Using Scratch

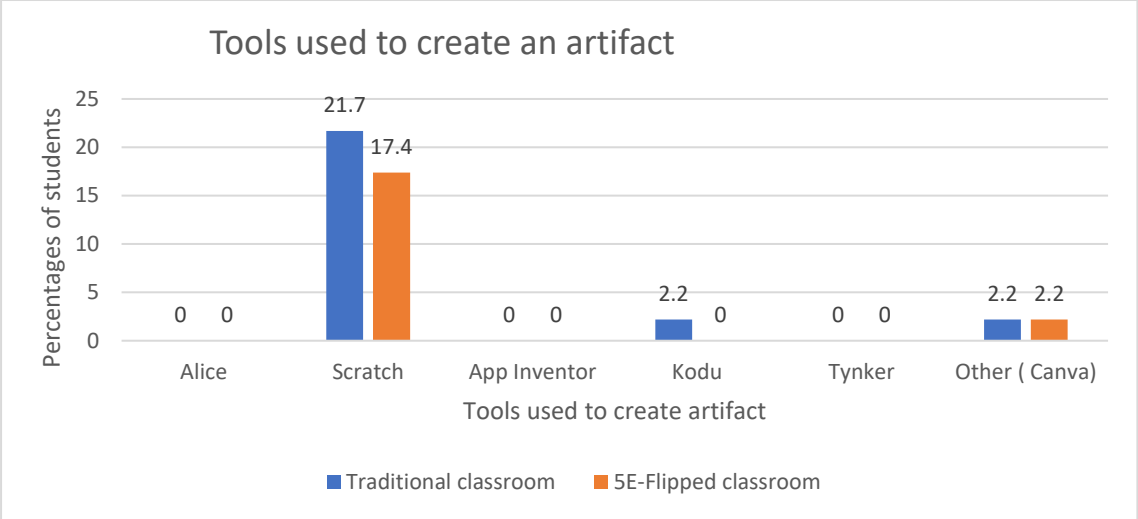

Figure 9: Bar Graph Analysis between Traditional Classroom and 5E-Flipped Classroom for Type of Tools Used to Create an Artifact

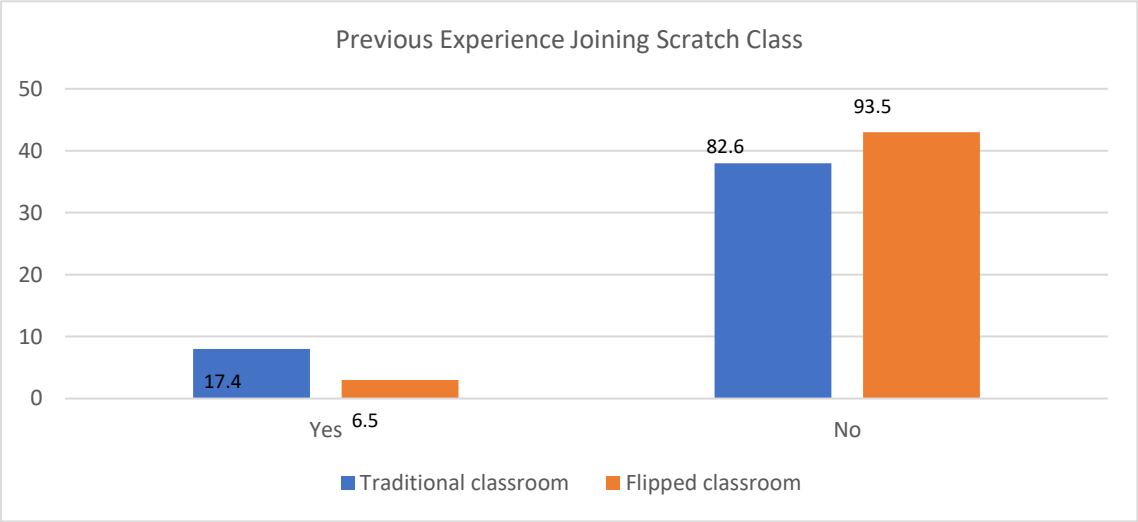

Figure 10: Bar Graph Analysis between Traditional Classroom and 5E-Flipped Classroom for Previous Experiences Joining any Class Outside School

Descriptive statistics between Control Group and Treatment Group for HOTS

From the study, descriptive statistics were collected to identify if the students in the 5E- Flipped Classroom received higher scores compared to the Traditional Classroom in terms of students' HOTS. The HOTS domain is distinguished into 3 dimensions, which are, Problem solving, Critical thinking, and Creative thinking.

Table 5: The Difference in Calculated Value of Mean for HOTS and Its Percentage for Traditional Classroom and 5E-Flipped Classroom

	Mean score on 4-point scale, μ			
	TRADITIONAL CLASSROOM (A)		FLIPPED CLASSROOM (B)	
	Differences $\mu_2 - \mu_1$	Percentage %	Differences $\mu_2 - \mu_1$	Percentage %
C3Q1. When facing problems, I believe I have the ability to solve them	0.848	21	2.174	54
C3Q2. I ask myself periodically if I am meeting my goals	0.935	23	2.522	63
C3Q3. I like to observe something I haven't seen before and understand it in detail	0.76	19	1.652	41
C3Q4. I believe I can put effort into solving problems	0.739	18	2.087	52
C3Q5. I consider several alternatives to a problem before I answer	0.521	13	2.087	52
C3Q6. I like to try something new	1.022	26	1.587	40
C3Q7. I can solve problems that I have met before	0.761	19	2.217	55
C3Q8. I find myself pausing regularly to check my comprehension	0.478	12	2.267	57
C3Q9. I like to do something by myself	1.152	29	-0.755	-19
C3Q10. I am willing to face problems and make an effort to solve them	0.891	22	2.254	56

The comparison of percentages from pre-test and post-test were observed in both instructional approach in terms of HOTS of students. The differences in mean percentages showed higher values in the 5E-Flipped Classroom than in the Traditional Classroom for all the items except item number nine. For item number nine, the Traditional Classroom mean percentage outnumbered 5E-Flipped Classroom.

In the dimension of problem solving of item 1,4, 7 and 10, the outcome signifies that 5E-Flipped Classroom approach assisted them in solving their learning problems effectively in contrast to the Traditional Classroom approach. The approach in the pre-classroom adopts active learning that enables students to explore and master the content knowledge, which further prepares students for problem solving tasks that help them understand the concepts more deeply. Parallel to this, according to Papavlasopoulou et al. (2019), meaningful activities that are connected to real-world contexts contribute students to spark interest in their learning, become more engaged cognitively and give them a chance to apply problem-solving to create an artifact. In an effort to meet the aim of this study, item 2,5 and 8 measured critical thinking. The critical thinking ability of students in the 5E-Flipped Classroom is higher than those in a Traditional Classroom because they can collaborate with their peers to weigh multiple options before making any judgments.

Next, despite demographic results showing most students in both approaches do not possess any previous experience of creating an artifact, items 3 and 6 which measure creativity show students in 5E-Flipped Classroom approach can showcase their creativity by creating new artifacts compared to Traditional Classroom students. There is also evidence showing younger students are drawn to the visuals and the switch of students' screen time used for entertainment to educational purposes contributes to better creative thinking (Zamin et al., 2018). However, item 9 which also assesses creativity reveals that 5E-Flipped Classroom students dislike doing something on their own. Apparently, the 5E-Flipped Classroom approach is preferred as it enable students to brainstorm their ideas through social interaction with peers, thus, from the students' point of view, the collaboration enables them to share their strengths to develop their creativity. Thus, the results answered the research objective of accessing the students' HOTS in both approaches.

Next, the 5E-Flipped Classroom was compared with Traditional Classroom in order to comprehend its impact on research objective (evaluate the HOTS of students in the 5E-Flipped Classroom through Project-based learning of Scratch programming lesson).

Table 6: Descriptive Statistics of Pre-test and Post-Test between Treatment Group and Control Group in High Order Thinking Skill (N= 92)

Teaching Methods		Pre-test	Post-test
Traditional Classroom	N	46	46
	Mean	1.370	2.180
	Median	1.200	1.900
	Range	1.500	2.800
	Std. Deviation	0.415	0.842
	Minimum	1.000	1.100
	Maximum	2.500	3.900
	Q1	1.000	1.500
	Q3	1.725	2.925
5E-Flipped Classroom	N	46	46
	Mean	1.572	3.378
	Median	1.500	3.400
	Range	1.700	1.500
	Std. Deviation	0.373	0.357
	Minimum	1.000	2.500
	Maximum	2.700	4.000
	Q1	1.300	3.100
	Q3	1.700	3.700

From table 6, the analysis of pre-test for Traditional Classroom in HOTS was (*m*=1.370, *median* =1.200, *r* = 1.500, *SD* = 0.415). The average percentage of pre-test for 5E-Flipped Classroom in HOTS was at an average level which has a record of 34.25 %. The analysis of post-test for 5E-Flipped Classroom in HOTS was (*m=2.180*, *median* =1.900, *r* = 2.800, *SD* = 0.842). The average percentage of post-test for 5E-Flipped Classroom in HOTS was at an average level with a record of 54.5%. The students in Traditional Classroom had improved by 20.25 % in the post-test analysis for HOTS.

The pre-test analysis for 5E-Flipped Classroom in HOTS was (*m*=1.572, *median* =1.500, *r* = 1.700, *SD* = 0.373). The average percentage of pre-test for 5E-Flipped Classroom in HOTS was at an average level which has a record of 39.3 %. The analysis of post-test for 5E-Flipped Classroom in HOTS was (*m*=3.378, *median* =3.400, *r* = 1.500, *SD* = 0.373). The average percentage of post-test for 5E-Flipped Classroom in HOTS was at an average level with a record of 84.45%. The students in 5E-Flipped Classroom had improved by 45.15% in the post-test in HOTS.
Thus, the findings resulted in discrepancy between Traditional Classroom (20.25%) and 5E-Flipped Classroom (45.15%) and it is concluded that the 5E-Flipped Classroom students had shown more HOTS skills compared to students in Traditional Classroom.

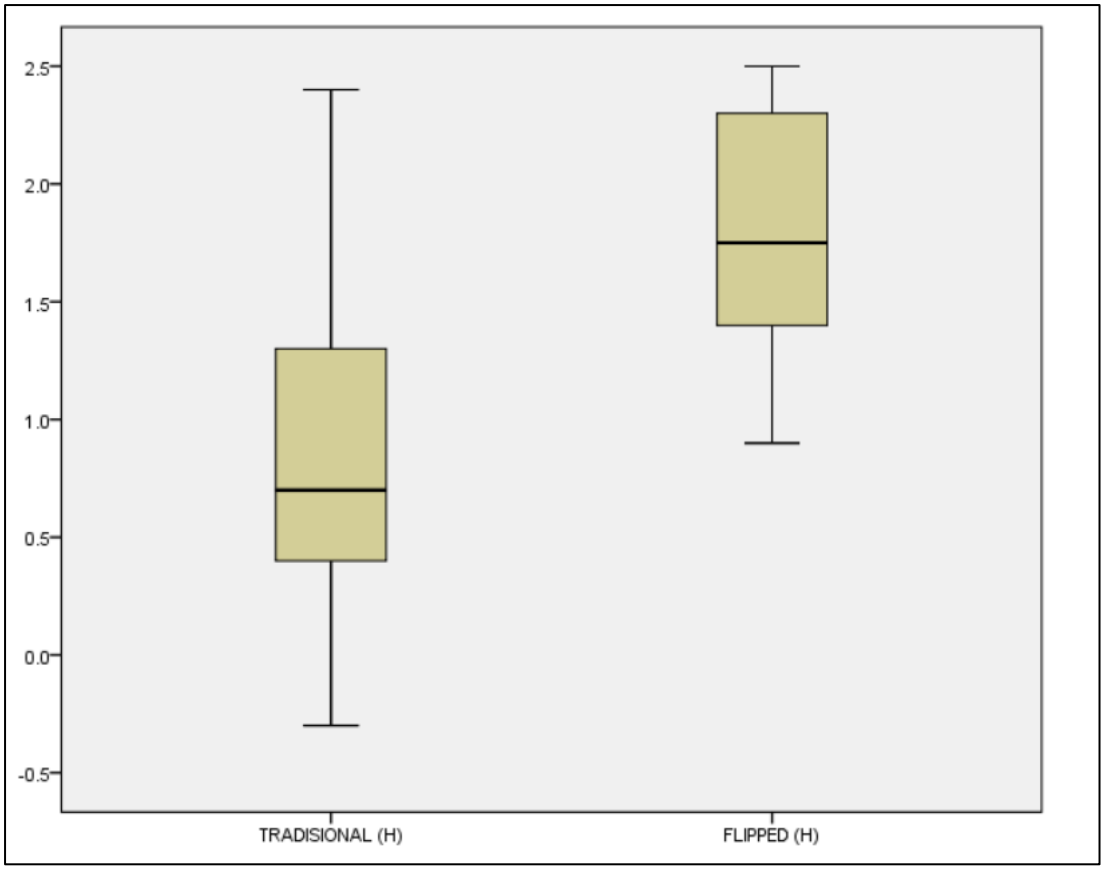

Figure 11: Box Plot Analysis between Traditional Classroom and Flipped Classroom in Higher Order Thinking Skills

The box plot analysis of Traditional Classroom in HOTS was (*m*=0.811, min = - .300, *median* =0.700, *max* = 2.400, *Q1*= .350, Q3=1.325). The box plot analysis of 5E-Flipped Classroom in HOTS was (*m*=1.807, min =0.900, *median* =1.750, *max* = 2.500, *Q1*= 1.400, Q3=2.300). In figure 11, the median score results show that 5E-Flipped Classroom students (Med-1.750) obtained scores significantly exceeding the Traditional Classroom (Med=0.700), indicating the 5E-Flipped Classroom had encouraged students to collaborate and communicate, which further impacted their tendency to engage in HOTS. The minimum score of the Traditional Classroom lesser than zero indicating a negative difference which results shown by students in Traditional Classroom may have deteriorated. In conclusion, the box plot suggests that the 5E-Flipped Classroom stimulated students to engage in HOTS.

Inferential Statistics for HOTS

The research hypothesis for HOTS based on the objective is derived. An Independent sample T-test is carried out to test the significance of the hypothesis.

Research Hypothesis 1:

Null Hypothesis, H_0 : There is no significant difference between students who undergo 5E- Flipped Classroom and students in Traditional Classroom in terms of HOTS applied to create a new artifact during their Project-based learning

$H_0: \mu = \mu$

Alternate Hypothesis, H_1 : There is significant difference between students who undergo 5E- Flipped Classroom and students in Traditional Classroom in terms of HOTS applied to create a new artifact during their Project-based learning

$H_{0:} \mu > \mu$

Dependent variable, X: The HOTS of students
Independent variable, Y: The Learning approach (Traditional Classroom and 5E-Flipped Classroom)

Table 8: Data Analysis between Traditional Group and Treatment Group in HOTS (N=96)

Variable	Teaching method	N	Mean	Std. Deviation
HOTS	Traditional Classroom	46	.811	.656
	5E- Flipped classroom	46	1.807	.443

Note. Table 8 shows the different marks of pre-test and post-test were taken as data for treatment (5E-Flipped classroom) and control groups (Traditional Classrooms) in HOTS

The analysis of different scores for Traditional Classroom in HOTS was (m = 0.811, SD = .656). The analysis for 5E-Flipped Classroom in HOTS was (m = 1.807, SD = .443) The difference in mean score value between 5E-Flipped Classroom and Traditional Classroom is -0.995. Therefore, students in the 5E-Flipped Classroom agree that group discussions and collaboration are crucial for fostering critical thinking and creativity in students learning thus they do not prefer to learn individually.

The Independent sample T-test also displays Levene`s test, which was used to assess the equity of variances and the equality of means between the Traditional Classroom and 5E-Flipped Classroom to determine if there is a significant difference in HOTS between both groups. Figure 12 below shows findings from Levene`s test.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
High order thinking skills	Equal variances assumed	6.235	.014	-8.535	90	.000	-0.995	.117	-1.227	-.764
	Equal variances not assumed			-8.535	78.993	.000	-0.995	.117	-1.227	-.763

Figure 12: Data Analysis of Levene`s test for HOTS (N=96)

The Levene`s test examines if the variances for HOTS of students in Traditional Classroom and 5E-Flipped Classroom are equal. In this analysis, the null hypothesis of this test is that the variances of the two groups are equal. Based on the first row of the table, Levene`s test is significant at ($F=6.235$, $p < .05$). As the significant value of Levene`s test for Perception is .014 and is less than the significance level of .05, it indicates that the assumption of equal variances has been violated thus null hypothesis for HOTS is rejected. Therefore, the second row of the t-test table (equal variances not assumed) was selected to interpret the results.

The second row shows that the t-value is stated as t=- 8.535 with 78.993 degrees of freedom indicating a significant difference between the two groups ($p< .05$). The mean difference is -0.995, which means that the Traditional Classroom students had a lower mean in HOTS level than the 5E-Flipped Classroom students. The standard error difference is .117 which measures the amount of variability in the mean difference. The 95% confidence interval of the difference ranges from -1.227 to -7.63 shows that it can be 95% confident that the true difference in HOTS of students between both groups lies between these two values. Thus, a significant difference can be concluded between students who undergo 5E-Flipped Classroom learning approach and Traditional Classroom in terms HOTS applied to create a new artifact during their Project-based learning.

Conclusion

The result indicated that the student-centred 5E-Flipped Classroom has increased and contributed to the students' HOTS. The research reflected the importance of HOTS for students as an effort to uplift Malaysia's education system to the level of top-tier worldwide. Thus, integration of the appropriate instructional approach that prioritizes HOTS incoherence with Bloom`s Taxonomy Bloom as a pedagogical tool and taking advantage of technological advancements is vital to be implemented by the Ministry of Education to further catalyze the effort.

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