



Evaluating Contribution of Flipped Learning on Secondary Students' Critical Thinking Skills Toward Learning Physics in Palestine

Zaher Atwa¹, Rosseni Din², Nabilah Othman³ & Muhammad Hussin⁴

¹Instructional Media and IT, Ministry of Education and Higher Education, Ramallah, Palestine

^{2,3}Center for Science, Technology, Engineering & Mathematics Enculturation, Faculty of Education, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

⁴Center for Educational Leadership & Policy, Faculty of Education, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

*Corresponding author E-mail: rosseni@ukm.edu.my

Abstract

The aim of this study is to examine the effects of Flipped Learning on Palestinian secondary school students' critical thinking skills. Flipped Learning is a new approach in ICT to improve teaching and learning process and create learning opportunity in a very limited time for high school students in a country at war like Palestine. Physics is too difficult for most students and this leads to poor academic performance and achievements. There is a need to improve learning physics with critical thinking skills for secondary school students in order to enable their advancement for higher education. The application of flipped learning is interesting, interactive and attractive for students. There is no research on Palestinian secondary schools concerning the effects of flipped learning on critical learning skills. In order to comply with the set objectives, the researcher developed video lessons by utilizing technology in Physics topics for students to view the lessons through Facebook groups outside school hours. Quasi-experimental method was used. 108 grade 11 students were selected purposively. California Critical Thinking Skills Test was adopted and administered for the students after pretest and posttest. Descriptive and inferential statistics was used to analyze the data with T-tests and ANCOVA test. The pretest and posttest scores were not statistically significant for both groups. It is found that the added value between the pretest and posttest for the flipped learning students is 20.0% which is higher than that of the conventional students at 6.5%. This approach suggests that there were positive effects of the students' critical thinking skills when using flipped learning method.

Keywords: Flipped Learning, ICT Integration, Physics Education, Smart Learning, Critical Thinking Skills

1. Introduction

Teaching and learning process (T&LP) is affected by the new opportunities offered by the usage of educational technologies. According to Din [1] e-learning is a combination of educational element and technology which focuses not only on learning processes using electronic media but also using electronic media to facilitate knowledge management to achieve meaningful learning. Thus, teachers have to challenge the changes by utilizing various tools in presenting the content to students in a better, smarter and faster way to motivate students [2] via superior learning objective, content, delivery, structure and services [3][4][5].

Flipped Learning (FL) is a technology-enabled teaching technique, that is growing continuously as the technology integration in T&LP is increasing [6]. It is considered as the latest technology that inverted teachers' task that it offered more control of material and more face-to-face (f2f) time with students [7]. FL is a new trend in T&LP to change the traditional methods; this kind of change is favored by the students and teachers [8]. It is one form of blended learning [9] [10] [8]. For a war-thorn country like Palestine where this study is carried out, it is a blessing most needed. Students who are kept out of school, able to access

Internet every in many places surprisingly, share a device to get latest information, learning materials and education for the future prosperity of their beloved country and family.

Flipped learning or inverted classroom use technology to increase the learning activities and maximize the interaction time inside the f2f session between the teacher and students [11] [12]. Active learning strategies can be used inside the class to provide opportunities for greater teacher-to-student mentoring, peer-to-peer collaboration and cross-disciplinary engagement. This will challenge and engage today's students in the "flipped classroom" model [13]. Sams and Bergmann [14] illustrated that flipping classrooms is, instead of listening to the teacher's lecture inside the classroom and going home for homework to practice what they learned, students watch the lecture at home and come to class for homework to practice what they have learned.

Many scholars agreed and asserted that FL enabled teachers to shift the T&LP from teacher-centered approach to students-centered approach to maximize time usage [9] [15] [16]. Classroom time of f2f sessions can be utilized for the application of online materials and to be used for deep understanding, problem solving and developing skills of the subject matter. FL attracts the attention of Bill Gates who is the main backer of the famous Khan Academy [7]. Khan Academy website <https://www.khanacademy.org> includes more than 2,400 video



lessons of various subjects for free. Students can prepare their lessons online by viewing selected lessons on Khan Academy, and come ready to classroom for applications and higher order thinking skills; this caused Bill Gates to say "I had been looking for something like this - it is so important" [17]. It is worthy to mention that Salman Khan who is the founder of Khan Academy did a great contribution to flipped learning model.

The innovative aspect of this method is that the flipped classroom adopts the technology of the audio-visual option in preparing videos lessons [14]. Bathker [18] and Wolff & Chan [19] looks to FL as it moves the majority of lectures out of the class by recording video lessons and uploading them to the Internet in order to have more time for interactive activities inside the classes. Some educators think about flipped classroom as creating videos by teachers to be watched at home by students. Although it is an essential ingredient, the most important part of the flipped classroom is the best use of time with students inside the classroom [14].

There are many benefits resulting from the use of FL. It is suitable for all learners because it has positive effects and can focus on all of the students [14]. Better questions and deep thinking from students are the results of using FL as the year progressed [20]. Green [21] listed some benefits of using FL such as: increasing student's engagement time in doing homework inside the class, enabling them to learn in a safe atmosphere, getting immediate feedback, increasing collaboration, increasing access to the necessary technology and more parents' engagement and support in the T&LP. Flipped learning can be considered as a good example for personalizing learning.

Palestine participated in the "Trends in International Mathematics and Science Study" (TIMSS) of grade 8 for the first time in year 2003, and then continued to the subsequent years 2007 and 2011. The TIMSS scores provide data about national and international trends in science and mathematics achievement. It gives the decision makers the opportunities to know their level and status in mathematics and science teaching scores compared to other participating countries in order to take the suitable decisions for the educational improvements. The Palestinian results were behind and under the international average scores for both mathematics and science. The international average score for the science and mathematics test is 500. The following Table 1 illustrates the Palestinian TIMSS results for science and mathematics as compared to the International and Arabic countries and the International standard [22]. Within the second goal for developing the student-based T&LP, the Palestinian Ministry of Education (MOE) will conduct a comprehensive reform for the school curricula, and the assessment and evaluation system to equip all students with the 21st century skills and enable them to employ technology to support teaching practice [23].

Table 1. Palestinian TIMSS Scores for years 2003, 2007 and 2011

Subject	2003 Score	2007 Score	2011 Score	International Ranking out of 45 in Year 2011	Arabic Ranking out of 11 in Year 2011
Mathematic	390	367	404	36	7
Science	435	404	420	34	7

1.1. ICT Integration in Education

The integration of ICT in education is one of the twenty-first (21st) century skills, which are very important in our life. They contain the ICT skills, which can help teachers and students to acquire and understand other skills. The ICT integration in education is an innovation that had revolutionized the educational system [24]. Moreover, many researches indicate that when using ICT by well-trained teachers, it will enhance education by improving learners' motivation [25]. Malaysia utilized ICT in education system in order to enhance the T&LP [26]. In addition

to that, Singapore effectively implemented ICT integration in education in order to enhance the student-centered approach, to equip students with creative thinking and communication skills in order to prepare them for the future workplace and easily use ICT to enhance their own learning [27].

1.2. Critical Thinking Skills

In this rapid changing world, the secondary students need to be exposed to practice the critical thinking skills (CTS), analysis and problem solving strategies. In order to enhance the students' active participation in learning Physics, teacher has to use the student-centered instructional strategies approach such as inquiry method, discussion and simulation in their T&LP [28]. ICT tools can be used for developing CTS by enabling the students to represent and express what they know. When students use ICT tools, an intellectual partnership between them is established and the computer amplifies their thinking. In addition to that, cognitive tools are designed to make them think harder about the content being studied [29]. Thus, critical thinking is fundamental to Physics learning which is clearly stated in the objectives of the Palestinian curricula and textbook [30] same as other countries. The critical thinking activities must be infused into Physics activities in an explicit and intentional way because the relation between pupils' performance in Physics and critical thinking is bidirectional [31]. Marshall and DeCapua [32] and Embi [33] stated that using FL increase the comprehension, interaction and the critical thinking for the students. Better questions and deep thinking from students are the results of using the FL as the year progressed [20] and they may improve high level of thinking skills [13].

2. Methodology

The various ICT educational researches are complementary to each other and they follow a multidisciplinary and multi method natural procedure; i.e. there is no single method of inquiry used in educational research [3]. This study uses quasi experiment because students could not be randomly assigned. [34] [35]. The quantitative data was collected directly before and after the implementation. To understand the findings better, qualitative data was collected after the implementation. This is to elaborate and support the quantitative research results. The quasi-experimental research design is used and it is suitable for answering research questions for this study [35] [36]. The pretest – posttest design is used to experiment the effect of FL on the students' critical thinking skills. The pretest is administered prior to an experimental and control groups; while the posttest is administered following both groups to determine the effectiveness of the intervention [37].

The students of the experimental groups were given learning experience within the FL treatment. This requires that students prepare their lessons at home and utilize the classroom time for active learning activities. Physics teachers were trained to implement the FL, and the students were oriented and prepared. Individual meetings were held with the two Physics teachers to discuss and clarify the FL in order to be used in the experimental groups. In addition to that, the researcher, physics teacher and the school principal held one session of 40 minutes for the students of each experimental group. In that session, the flipped learning concepts, the methodology, the required procedures and the orientations were discussed and clarified. A pamphlet of two pages was given to each student in order to let his/her parents know about this new method and to obtain consent for participation.

Students of the control group were given learning experience within the conventional method. The Static Electricity unit 4 from the Palestinian Physics textbook was selected. It consists of the

following subtopics: Static Charge, Coulomb Law, Electric Field, Potential Field, Capacitance and Capacitors. This topic was chosen for the students to learn during the research implementation period of the FL within the 2nd semester of year 2014/2015, exactly during the period of March, April, through Mid-May of 2015. This will not affect or alter the T&LP inside the school. It will not be extra load for students or Physics teachers in the school.

Quasi-experiment is an experimental design that random assignment is not used for selecting individuals in the categories [34] [38]. So, this design may be affected by some extraneous factors. The threats to validity need to be identified, minimized and overcome to be sure that the research results are the effects of the treatment and not of other reasons. Therefore, in this quasi-experimental design, the potential main threats to the internal validity, external validity and the ways of minimizing and overcoming them are identified in order not to affect this research results. The internal validity threats are the factors that may occur during the treatment that affect the results. According to Trochim [39] and Creswell [34], the internal validity threats can be the following or some of them: history and maturation, regression, selection, mortality, diffusion, compensatory and resentful demoralization, compensatory rivalry, testing and instruments. While the external validity threat is the factors that may limit the researcher's ability to apply the research finding to other populations or locations. According to Trochim [39] and Creswell [34], the common or standard threats of the external validity are the following: selection-treatment interaction, setting-treatment interaction, and history-treatment interaction.

3. Analysis and Findings

Students of both groups took the California Critical Thinking Skills Test (CCTST) twice: pretest before the FL implementation and posttest after the FL implementation. Quantitative data were collected using the CCTST tool which subsequently were grouped and analyzed. The Statistical Package for Social Science (SPSS) package version 20 was used for the quantitative data analysis [40]. The descriptive and inferential statistics were used in this research to determine the differences between the groups. The normality distribution of scores and results was analyzed by the inspection of the histogram, indices of skewness and indices of kurtosis. The accepted values for both of skewness and kurtosis are between -1 to +1. It is found that all variables demonstrated acceptable normality because the skewness ranges from -0.70 to 0.89, and the kurtosis ranges from -0.73 to 0.40. The homogeneity of the sample population for both control and experimental groups was checked. Referring to Table 2, it is found that there were no statistically significant differences at the level of significance ($\alpha < 0.05$) in CCTST between both experimental and control groups in the pretest by using independent sample t-test. This suggests the homogeneity of both groups before the treatment took place.

Table 2. CCTST Pretest results between Experimental & Control Groups

Item	Treatment	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
CCTST	Experimental	54	0.30	0.079	-	108	0.515
	Control	56	.31	0.084	0.653		

The researcher tests the differences between the two groups in posttest by using independent samples T-test to answer the research question: *What are the effects of flipped learning in Physics education on the Palestinian students' critical thinking skills?* The descriptive results (mean and standard deviation) for the pretest and posttest scores of the CCTST are shown in Table 3. Score and added value were calculated. It can be drawn from Table 3 that both groups of the pretest CCTST scores are almost

the same (0.31 & 0.30). Also, it is clear that there are differences between the means of the experimental and control groups concerning the posttest scores. In addition to that, the scores gain and the added value of the experimental between the pretest and posttest of the CCTST scores (0.06; 20.00%) is greater than that of the control group (0.02; 6.45%). This suggests that students using FL performed better than the students using the normal teaching model.

Table 3. Mean and standard deviation for the experimental and control groups of the pre-test and post-test of CCTST

Variables	Treatment	Pre-		Post		Gain Scores	Added Value
		Mean	SD	Mean	SD		
Critical Thinking (CCTST)	Cont.	0.31	0.084	0.33	0.123	0.02	6.45
	Exp.	0.30	0.079	0.39	0.088	0.06	20.00

Results in Table 4 shows that there were however, no statistically significant differences at the level of significance ($\alpha < 0.05$) in critical thinking skills between both groups which indicates that FL is not significant for the students' CTS, although the added value for the experimental group is 20.0% that is more than that of the control group at 6.45%. This means that FL only partially affected the students' CTS positively.

Further inquiries were done to understand these findings. Some of the explanations which does not fully shown from the quantitative data were explained. Both Physics teachers agree about advantages of FL implementation in Palestine as follows: (i) FL induced students to ask questions, answer questions, discuss with their peers, present their result and share ideas without hesitation or shying; (ii) F2F time was utilized to enrich the knowledge, ideas and issues of high order thinking skill. Also, (iii) FL encouraged students to think critically and present suggestions for improving their performance. This result reached an agreement with the findings in the literature that showed teachers opinions about positive environment of FL [41] [21] [6]. The challenges that encountered teachers in implementing FL are time and effort consuming for preparing the video lessons. Results of this study showed no significant difference between the FL and the conventional teaching method concerning CTS while teaching Physics topics for 11th scientific grade. This result is in agreement with a similar study for high school math students [42]. However, it can be inferred that students in the flipped learning model performed a little better in CTS than that using the conventional teaching method.

Table 4. Results for CCTST experimental & control groups of the post test.

Treatment	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Exp.	53	2.63	0.675	2.281	107	0.130
Cont.	56	2.35	0.612			

This result is not in agreement with [32] which stated that FL increase the CTS for the students. Also, it contradicts the study of [31] because they considered the relation between pupils' performance in Physics and critical thinking is bidirectional; while in this research, the case is different that it was significant for the academic Physics achievement [43] and partially for the CTS. As a conclusion, the result showed that FL partially affected students' CTS positively. Nevertheless, FL is still a useful tool to improve Physics achievement although no different was found in term of using FL or conventional method to increase CTS. The critical thinking skill is one of the important skills for the 21st century skills. Specifically, it is important for the Palestinian students because the Palestinian MOEHE is in the process of integrating such skills in the secondary students' curriculum to equip all students with such skills [23]. The CTS students' results being not significant was in agreement with the Palestinian MOEHE [23]

that “the current Palestinian curriculum fails to support higher order thinking skills (such as critical thinking and research skills)”.

5. Conclusion and Recommendations

The results of this research showed that the FL was effective compared to the conventional method, with respect to the students' CTS. It was found that the gain scores and the added value of the experimental group between the pretest and posttest CCTST scores (0.06; 20.00%) is greater than that of the control group (0.02; 6.45%). The two Physics teachers reported that FL improves students' research and self-learning skills which cause to the improvement of the CTS. Moreover, FL makes the T&LP enjoyable, interactive and fun. This research will be an added value to the existing flipped learning researches. It will fill a gap in the effectiveness of FL on high school students' CTS. In FL, students have more degrees of freedom of diversity for learning concerning time, place and Internet devices while viewing video lessons. Time is the first degree of freedom that they can view video lessons at any time they want whether it is outside the classroom, during the day, night or early morning.

Second degree of freedom is the place that they can view video lessons whether it is in their homes, in the garden, park, beach or any other favorite place; whether they were sitting on chairs, laying on bed, even walking, or doing their fitness. The third degree of freedom is using the Internet device, so they can use PC, laptop, tablet, or smartphone for viewing video lessons. Therefore, the implications are as follows: ICT Integration in teaching Physics maximizes students' learning opportunities, so, implementing FL can be a channel for integration of ICT in education. The developed video lessons can be used by Physics teachers for flipping their classrooms. FL can improve and promote the image about learning Physics.

Palestinian MOEHE was raising and implementing the slogan of “Digitization of Education” in the academic year 2015/2016, since utilizing FL requires integration of ICT, so FL will support this slogan. This study is considered to be the first one in Palestinian scientific secondary schools that examines the effectiveness of ICT integration in Physics education for FL. Implementing FL in Palestinian schools can help decision makers to make students active participant in the T&LP and improve their CTS. Students need more orientation on FL, and teachers need training for implementing FL on ICT integration, developing and editing video lessons and on using related Web 2.0 applications and social media. The FL needs more research generalizations in order to disseminate to other schools and other academic subjects. To implement the FL in other schools or universities, this study recommended additional researches on the effects of FL on other subjects, locations, grades and higher education specializations. Moreover, conducting researches are needed on examining the effectiveness of FL on other variable such as students' satisfaction, misconception, conceptual change, attitudes, communication skills, and personalized learning. In addition to that, more effort should be taken to identify the best suitable teaching method for students. Different method can be explored to determine effectiveness of FL for CTS since descriptive statistics have shown increase in achievement. Other recent proven more accurate method should be explored such as the second generation statistical analysis to determine effectiveness.

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