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The Impact of Integrating Flipped Learning and Information and Communication Technology on the Secondary School Students' Academic Achievement and Their Attitudes Towards It

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Abstract

The purpose of the study was to investigate the impact of integrating flipped learning and information and communication technology on secondary school students' academic achievement and attitudes. The study was based on a quasi-experimental approach where the sample of the study consisted of 40 students from Mashrek International School in Amman, Jordan, who were randomly assigned into either an experimental group (20 students) or control group (20 students). An academic achievement test was used with both groups as a pre-test and post-test, and an attitude scale was implemented only on the experimental group. The validity and reliability of the study were ensured. The findings revealed the effectiveness of the flipped learning approach, statically significant differences were found between the experimental and control group in terms of the students' academic achievement. As for the experimental group the students' attitudes towards peers, teacher, environment and learning process were positive.

Keywords: flipped learning, education, computer science course, data abstraction

1. Introduction

The rapid growth of educational technologies requires researchers to investigate and implement modern active learning strategies and integrate the Information and Communication Technology (ICT) tools into the educational pedagogy which have a major impact in education and favorable outcomes in terms of students' learning (Semich & Copper, 2018; Chu & Yang, 2017; Bart, 2016; Geist, Larimore, Rawiszer, & Sager, 2015; Thompson & Mombourquette, 2014). In the last decades the student-centered learning strategies shown a significant learning gain (Douglas et al., 2018; Chu & Yang, 2017; Bart, 2016; Geist et al., 2015; Thompson & Mombourquette, 2014; Marshall & Marshall, 2003), such as Flipped Learning (FL) which is an instructional and learning model that consists of two parts: interactive group learning activities inside the classroom, and a direct computer-based individual instruction (Bishop & Verleger, 2013). The FL model is an instructional strategy and a form of student-centered learning that deliver the instructional content, resources outside of classroom where students gain the first exposure to lessons, usually via reading or watching lecture videos, virtual laboratories, while applying the concepts in the classroom by using collaboration, co-operative group learning and other strategies to increase the interaction between teacher and students. Most studies on FL implement group-based interactive learning activities inside the classroom, referring to student-centered learning theories based on the works of Piaget (1967) and Vygotsky (1980). The FL model also called flipped teaching or inverted classroom (Nwosisi, Ferreira, Rosenberg, & Walsh, 2016), that enhances the process of learning and its outcomes as it helps to differentiate the learning on the individual bases to develop students' skills based on their self-paced. Implementing the FL model with the ICT tools in the traditional classroom is fully aligned with the digital age and meets the twenty-first century required skills. The FL model has been implemented in various disciplines, such as Economics, Mathematics, Pharmacy, Nursing, Computer Studies, Business, Physics, Engineering and Chemistry (Tainter, Wong, Cudemus-Deseda, & Bittner, 2017; Pence, 2016; Ryan & Reid, 2015; Thompson & Mombourquette, 2014; Missildine, Fountain, Summers, & Gosselin, 2013), and across all the educational levels: Elementary School, Secondary School and Universities (Shyr & Chen, 2018).

Computing in the K-12 academic field has been expanding in recent years (Tierney, Corwin, & Ochsner, 2018) and the Abstract Data Type (ADT) computing module is included in all different computing curriculum, which contains an essential concepts and skills for all students who studying computer science class and a fundamental principle in computer science problem-solving and software development (Denning et al., 1989). It requires students to perform problem-solving, conceptualization, modelling, abstract thinking, and analysis while students tend to find distributed algorithms very difficult, and they do not appreciate the utility of modeling, as they find it difficult to identify what is important in a problem and produce convoluted solutions that replicate the problem complexities (Wing, 2006).

1.1 Statement of the Problem

The study examines the impact of implementing the FL model in computer discipline. Regarding the experience of researchers in the field of teaching the course, they recognized that high school computer classrooms often deserve the commonly held notion of a boring, inflexible learning environment where the teacher lectures and the students frequently practice problems towards mastering the required skills. The main challenges face teachers are that: a) the practicing time is not enough to master the skills. b) students encountered difficulties in effectively utilizing procedural abstraction techniques to solve problems (Haberman, 2002, 2004). c) the topic requires conceptual deep understanding, quantitative technical background, mental imagination skills, and different technical data structure internal representation, which need several exercises to understand with limited classroom period allocated to execute the curricula, which is inadequate to cover it.

1.2 Purpose and Questions of the Study

This study will introduce a new pedagogy for secondary school students in ADT to overcomes these challenges by integrating the FL model with different ICT tools and employing the curricula in the proposed pedagogical design to shift the content outside the classroom time and provide a better time allocation for in-class activities which may use for practices, increase interaction between students and teacher, increase students' engagement and facilitate the understanding of the curricula. This study will attempt to answer the following questions:

Are there statistically significant differences at the significance level of ($\alpha < 0.05$) in academic achievements among secondary school students in computer discipline attributed to teaching strategies variable?

What are the attitudes of secondary school students in computer discipline toward the FL model?

1.3 Significance of the Study

The importance of implementing the FL model has long been recognized by several researchers (Tainter et al., 2017; Ryan & Reid, 2015). It provides opportunities for the students to develop 21st-century skills such as critical thinking, problem-solving, and communication skills by moving content delivery outside the classroom. There is a grab in the literature with relatively little research carried out to date in the field of implementing the FL model in Arabian school especially in computer discipline, since the FL model needs much attention on the field of researcher to support the educational system as well as utilizing the ICT tools, the theoretical importance of the study is related to the lack of the study that integrating the FL model with different ICT tools in secondary school students in Jordan and this study conducted to be the first of its kind that implemented on ADT computing module In Jordan to overcome the challenges in teaching the essential ADT computing module which is required to prepare the students with digital age skills. Also, this study provides a new scale to measure the learning attitude towards the FL model and provide an up-to-date study of the FL model in computer science that proposed a new pedagogy for ADT computing module in computer science discipline for secondary school and identify its impact on the students' learning process and their attitudes towards it. While the practical significance represented by its findings which used to insure the impact of integration the FL model and ICT tools on the traditional secondary school students that provide a guideline to computer discipline teachers on how to successfully implement the FL model and integrate it with different ICT tools, as well as, it will provide information for instructional designer, instructors, and researchers about the impact of integrating the FL model and ICT tools in the different educational systems.

1.4 Literature Review

Several studies in the literate addressed the challenges that encountered the implementation of the FL model such as student resistance (Amresh, Carberry, & Femiani, 2013), technical issues (Tague & Baker, 2014), and uninteresting online material (Semich & Copper, 2018). Other studies identified some factors to implement a successful FL model which were: a) structured monitoring system which may include weekly quizzes, online discussion boards, an open communication channel between instructor and learner, monitoring learner progress. b) changing learning behavior outside the classroom. C) motivational environments which may include preparation

group discussion topics that require a critical thinking ability rather than a specific knowledge. d) format and length of pre-recorded lectures e) increase the interaction with students during in-class activities. f) ensure learning experience by carefully planned instructional design utilize the technology (Tainter et al., 2017; Bart, 2016; Choi et al., 2015).

The FL model demonstrate several advantages including improve students' learning (Li, Gao, Liu, & Sun, 2018), prompted the student's self-efficacy (Hwang & Lai, 2017), enhanced learning experience and improved academic performance (Choi et al., 2015), improve critical thinking (Kong, 2015), facilitate students' motivation, increased student engagement, better classroom time usage, discussion with peers, access to instruction at anytime, anywhere (Fulton, 2012), engaging instruction (Milman, 2012), customized learning environment (Enfield, 2013).

On the other hands, a lot of studies were conducted to compare flipped and traditional classroom methods in terms of student's knowledge gain and perceptions such as (Chao, Chen & Chuang, 2015), explored the impact of the FL model on high school females' students registered in Computer Aided Design (CAD) course. The results showed that the FL model enhanced students' achievements, learning attitudes, motivation and self-evaluation and this aligned with (Geist, et al., 2015), study on baccalaureate nursing students at The State University in Tennessee. Where the results revealed that the flipped classroom approach performed better on the three-unit exams and the students have positive perceptions of the flipped classroom method. Moreover, (Choi et al., 2015), implemented the FL model in human beings and health course in Korea where students accepted and favored the FL model that enhanced their understanding, motivation and outcomes. Moreover, Love, Hodge, Grandgenett, and Swift (2014) implemented the FL model on linear algebra module in computer science and the result showed that students had a positive attitude about their experience in the course and improved their academic achievement and this aligned with Missildine et al. (2013), and Amresh et al. (2013) results' who they found that the FL model enhanced student's achievements. Also, Pierce, Fox, and Dunn (2012) showed that the FL model improved student performance and built a positive attitude on students of renal pharmacotherapy course at Shenandoah University in the USA.

Several studies had proofed the effectiveness of the FL model on improving the knowledge, skills of confidence, perceived usefulness, increasing student engagement, better use of classroom time, enhancing the students understanding, learning, and their critical thinking, Chu and Yang (2017) who combined the FL portfolio management system and an interactive assessment platform in computer course which indicated a well-structured the FL model will help the students engage and showed that students need at least three weeks to cultivate to benefit from the FL model. Also, Chen-Hsieh, Wu, and Marek (2017) explored the impact of the FL model for learners of English as a Foreign Language and found that it is successfully achieved the instructional goals of the class. Also, (Hanson, 2016) conducted a study on undergraduate nursing at southern Queensland University in Australia the results showed that FL model increased the student understanding and enhanced their critical thinking skills which are aligned with Pence (2016) results' who found that the FL model was enhanced student's learning. Also, the students had a positive attitude toward the FL model. As well as Gehringer and Peddycord (2013) reported experience in using the FL model in computer architecture discipline were the results showed that Students exhibited high levels of engagement.

While other studies did not demonstrate a difference between traditional method and the FL model such as Harrington, Bosch, Schoofs, Beel-Bates, and Anderson (2015), who examined the impact of the FL model on nursing student at The Public University in the USA were the results did not demonstrate statistically significant differences between the two methods in terms of outcomes. As well as Larson and Yamamoto (2013) conducted a study in Excel class on students' academic achievements were the results indicated that there is no statistically significant difference in mean scores between the two groups. As well as Harrington et al. (2015) found the same results. On the other hand, limited studies explained the implementation of the FL model and the preparation of pre-class and in-class activities and material. Tainter et al. (2017), and Chao, Chen, and Chuang (2015) mentioned their designed have consisted of a series of modules that includes several videos, assignments, quizzes, as well as Campbell, Horton, Craig, and Gries (2014), provide a case study explores an inverted classroom for an introductory programming course which consists of short lecture videos and quiz questions to prepare the student for the class, while during class, the students worked through exercises with the support of the instructor. but several studies did not show their FL designs and implementation.

Also, it is recognized that many Colleges and Universities have implemented the FL model as it provides opportunities for increased peer interaction and deeper engagement with the material and benefited from other advantages of the FL model (Gehringer & Peddycord, 2013). This Model has grown in higher education and become popular while still very limited across the K-12 schools. As well as there has been limited researches implemented the FL model in the ADT computing module in the computer discipline curricula, therefore we

must investigate a new pedagogy in computer science discipline especially in ADT to enhance students learning. As recommended by Haberman (2004) teachers should present concrete examples into their problem-solving activities, but the time for examples and practice is inadequate, therefore, using the FL model will give them the time to do it.

2. Methodology

2.1 Research Design

This study uses a quasi-experimental pretest-posttest design to study the impact of integrating the FL model and different ICT tools on the secondary school students' academic achievement and compare with the traditional method in term of students' scores on an academic achievement test (AAT) that was created by the researchers, and students attitude scale (SAS) of the experimental group (EG). Students randomly assigned into two equal groups, where control group (CG) taught using a traditional method while the EG taught using the FL model. The AAT implemented on both groups at a pretest and posttest points, while the SAS implemented on the EG. The research design is symbolized as:

O1	X1	O1	O2	(EG)
O1	X2	O1		(CG)

Where O1, O2, X1, X2 represent the AAT, SAS, instruction using the FL model and instruction using traditional method respectively. The dependent variables of the study are students' academic achievement and their attitudes while the independent variables are the teaching strategies. Descriptive and inferential data analysis were used in this study, where the collected data from pretest-posttest AAT for both groups, and SAS for EG used to analyze the data using ANCOVA, Mean, standard deviations and adjusted means to demonstrate the impact of the FL model on student's academic achievements and their attitude to answer the research questions.

2.2 Participants

The population of the study consists of all high school students, who registered in the computer discipline at Mashrek International School in the scholastic year (2018/2019). The sample of the study consisted of (N=40) students, who were randomly assigned into an EG (N=20) students (14 male, 6 female) their mean age is 16.5 and CG (N=20) students (12 male, 8 female) their mean age is 16.3. The pilot sample consisted of (N=20) students (13 male, 7 female) their mean age is 16.7, that were randomly selected from the population and outside of the study sample.

2.3 Procedures

The material for the ADT computing module was prepared and analyzed. Then, the instruments of the study were created, and their psychometric properties were examined in terms of validity and reliability. After that, the participants were randomly assigned to their groups. Prior to start teaching the AAT pre-test was implemented on both groups. Then, the teaching of the ADT computing module was started, the instructional time to complete the ADT computing module for both the EG and CG were (9 weeks – 30 hours). At the end of the ADT computing module, the AAT post-test was applied to both groups to measure the student's academic achievement while the SAS post-test was implemented on the EG to measures their attitude. Finally, the collected data were analyzed using the SPSS software.

2.4 Material and the Flipped Classroom Model

The researchers designed the content of the electronic materials and prepared the e-resources of the ADT computing module according to the Computer Science curricula of the International Baccalaureate Organization (IBO) diploma educational system and to be compatible and aligned with the FL model. The developed ADT computing module e-material consisted of different facts, concepts, activities, assignments, handout, videos, and quizzes that were stored and organized in the used ICT tools that allow the implementation of the FL model and these ICT tools were Microsoft online SharePoint (MOSP), Quizlet and Nearpod (Figure 1), which have many features such as facilitate the synchronous and asynchronous access of the ADT computing module e-contents outside and inside the classroom for the students and the teacher, activate the collaborative group works for students and allow the teacher to creates groups and assigned the students to them, follow up on the students' progress, assess and give feedback to the students.

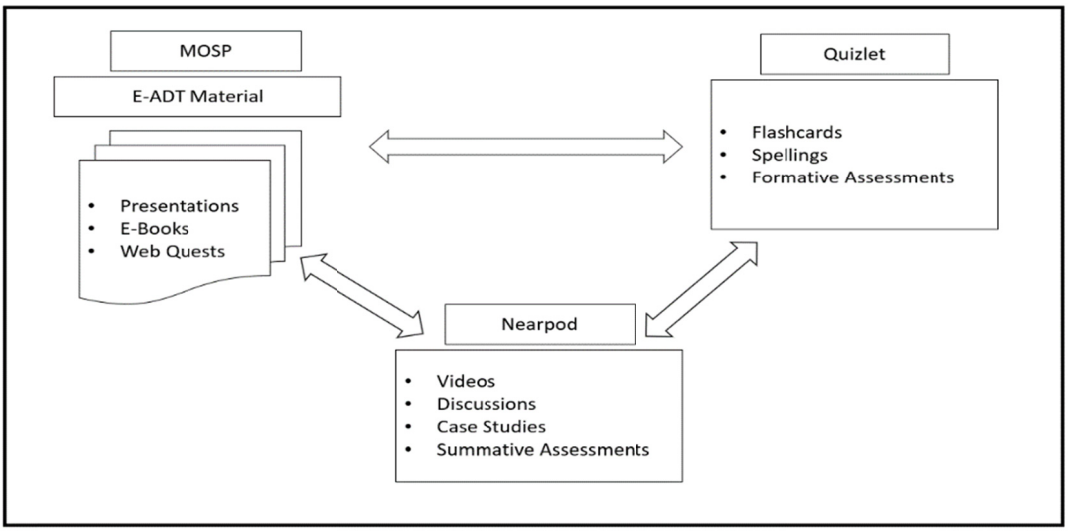

Figure 1. FL Model with ICT

2.5 Instruments

Two instruments were created and their psychometric properties determined by conducted a pilot study on a pilot sample to ensure the construct validity and reliability for each instrument, while the content and face validity for instruments were reviewed and approved by panel of (10) experts: who experiencing and specializing in measurement and evaluation, educational technology, curriculum analysis at school of educational sciences in The University of Jordan, and some computer science teachers and supervisors who teach computer science discipline in the IBO educational system.

2.5.1 Abstract Data Type Academic Achievement Test (ADTAAT)

The ADTAAT created based on the computer science IBO curriculum objectives and it is consisted of four types of questions: Knowledge, Comprehension, Application and Analysis questions, disturbed into six bulk questions (the first question is a 5 true and false statement, the second question is 5 multiple choice sub-questions, the third question is a compare question, the fourth question is a construct an algorithm question, the fifth question is drawing an abstract data type question, and the sixth question is a coding algorithm tracing question). The face validity of the exam was examined by creating the table of test specification and reviewing it by a panel of 10 experts.

2.5.2 Students Attitude Scale (SAS)

The scale created based on relevant theoretical frameworks (Ajlouni, Seitan, & Aljarrah, 2018; Tainter et al., 2017; Choi et al., 2015). It consisted of 24 items incorporated into four dimensions: 1) Peers 2) Teacher 3) ICT Tools 4) Learning Process (Motivation). The rate of the questionnaire items based on five-point Likert scheme (1: strongly disagree, 2: disagree, 3: neutral, 4: agree, 5: strongly agree). The highest values indicated positive attitudes. The face validity of these items was confirmed by a panel of (10) experts. To ensure the internal validity a test-retest in (3) weeks was implemented on the pilot sample where the Pearson correlation coefficients between each sub-scale score and the total score were P: 0.77, 0.79, 0.8, 0.76 and 0.86 respectively. Also, Cronbach Alpha (α) internal consistency coefficient calculated (0.82), and all values are statistically sufficient, and this means that SAS is valid, reliable and accepted to implement the research.

3. Results

To answer the first question: Are there statistically significant differences at the significance level of ($\alpha < 0.05$) in academic achievement among secondary school students in computer discipline attributed to teaching strategies variable? Means, standard deviations, and modified means of AAT were calculated as shown in Table 1.

Table 1. Means and standard deviations of AAT

		Pre-Test		Post-Test	
Groups	N	M	SD	M	SD
CG	20	11.90	2.693	69.50	7.316
EG	20	12.15	3.100	82.90	8.366

Note. M: Mean; SD: Standard Deviation.

It observed from Table 1 that the mean of the pretest for the CG is 11.90 and the standard deviation is 2.693. In addition, the mean of the pretest for the EG is 12.15, and the standard deviation is 3.100. Further, the mean of posttest in the CG is 69.50 and the standard deviation is 7.316. Furthermore, the mean of the posttest for the EG is 82.90, and the standard deviation is 8.366. Table 1 reveals that there are clear differences in means of an academic achievement test, the mean for CG is 69.50, while the mean for the EG is 82.90. To investigate this difference statistically, ANCOVA was carried out on the dependent variables (traditional method, the FL model). The results of this analysis are presented in Table 2.

Table 2. The results of ANCOVA of comparing scores of AAT in EG and CG

Source of variation	Sum square	Df	Mean square	F	Sig	ŋ2
Pre-test	341.384	1	341.384	6.299	0.017	0.145
Group	1861.798	1	1861.798	34.350	0.000	0.481
Error	2005.416					
The corrected total	4142.400					

Note. ŋ2 Partial Eta squared, Sig Significant, Df Degree of Freedom, F F-test.

Table 2 showed that F for the FL model was 34.350 at Sig 0.000 which is statistically significant, and the Partial Eta squared was 0.481. To decide which independent variable was affected, the covariance the Corrected Means were calculated, and results showed in the Table 3.

Table 3. Corrected means

Group	M	SD Error
CG	69.371	1.647
EG	83.029	1.647

The corrected mean for the EG was 83.029 and SD was 1.647 which greater than the corrected mean for the CG which was 69.371 and SD was 1.647. that means 48% of the covariance relate to the FL module. To answer the second research question: What are the attitudes of secondary school students in computer discipline toward the FL model? Means and Standard Deviations for SAS items, dimensions, and the overall scale were calculated, and the results are shown in Table 4. The overall mean for students towards FL was 4.4313 and SD=0.2091, which showed positive students' attitudes. For attitudes towards peers the mean was 4.2583 and SD=0.22605, as well as the mean for attitudes towards teacher was 4.4583 and SD=0.25291, as well as the mean for attitudes towards motivation was 4.3500 and SD=0.28562, as well as the mean for attitudes towards software was 4.6583 and SD=0.24468 which was the highest one.

Table 4. Means, standard deviations, for SAS dimensions

Dimension	Items	M	SD
First Dimension: Peers	Helps me to build a positive relationship with my peers.	4.60	0.503
	Increases my collaboration with my peers.	4.40	0.503
	Increases my teamwork skills with my peers.	4.30	0.470
	Increases my social interaction with my peers.	4.25	0.444
	Helps me to share different perspectives with my peers.	4.10	0.553
	Allows me to help my peers.	3.90	0.553
	Sub-Total	4.26	0.226
Second Dimension: Teacher	Allows my teacher to monitor my progress during the ADT module.	4.65	0.489
	Allows me to ask my teacher for help in an easy and faster way.	4.65	0.489
	Helps me to create a positive relationship with my teacher.	4.60	0.503
	Allows me to communicate with my teacher in an easy way.	4.60	0.503
	Allows my teacher to be a facilitator of our learning.	4.40	0.503
	Allows me to collaborate with my teacher in an easy way.	3.85	0.366
	Sub-Total	4.46	0.253
Third Dimension: ICT Tools	Allows the students to study based on their pace.	5.00	0.000
	Allows the students to access the e-material anytime anywhere.	5.00	0.000
	Allows the students to access the e-material in an easy way.	4.75	0.444
	Allows the teacher to differentiate the material based on students learning preferences.	4.70	0.470
	Allows the students to share their different ideas.	4.35	0.489
	Allows the students to organize their learning schedule.	4.15	0.671
	Sub-Total	4.66	0.245
The Fourth Dimension: Motivation	Helps students to do their HomeWorks in an easier way.	4.60	0.503
	Increases the positive collaboration towards the ADT module.	4.55	0.510
	Encourage the students to study more.	4.40	0.503
	Makes the ADT module more enjoyable.	4.20	0.410
	Helps students to understand the challenging ADT module.	4.20	0.696
	Helps the students with low ability to learn better.	4.15	0.366
	Sub-Total	4.35	0.286
Total overall SAS		4.43	0.209

Note. M: Mean; SD: Standard Deviation.

4. Discussion

The findings show that the integration of the FL model and the ICT tools that used to teach the ADT computing module were positively significantly affected the students' academic achievements, the ANCOVA results showed that a 48% of the covariance effect where $F(1, 2005.416)=34.350$, $Sig<0.05$, $\eta 2=0.481$, and the corrected means of the EG was 83.029 which is greater than the corrected mean of the CG which was 69.371, so we can conclude that the FL model had significantly large effect on the academic achievement on the secondary students computer discipline. These findings are consistent with others in the works of literature that showed the effectiveness of the FL model (Choi, Kim, Bang, Park, Lee, & Kim, 2015; Love, Hodge, Grandgenett, & Swift, 2014; Amresh et al., 2013; Missildine et al., 2013; Pierce, Fox, & Dunn, 2012), which justified according to the different benefits of the FL model (Gehringer & Peddycord, 2013), such as the flexibility in time and place, support the student-centered approach, differentiate the learning experience, self-paced study, the diversity of resources, enjoyable environment, self-assessment, giving the students more time to study and prepare their own questions when they enter the class to start applying what they studied out of the classroom, which help students perform problem-solving, critical thinking, analyzing the conceptualization of the ADT computing module that students find it difficult and mentioned benefits overcome the boring inflexible learning environment and fix the main challenges that students had to master the skills due to limited classroom period time allocated to execute the curricula which gave the students a chance to practice several exercises to understand the complicated concepts of ADT computing module. And over all the findings of this research aligned with the previous studies.

On the other hands, the students accepted the FL Model and the findings indicate a positive attitude in the four dimensions (Peers, Teacher, ICT Tools, and Motivation) due to increasing of social interaction, collaboration, the positive relationship, teamwork skills and share different perspectives with peers. As well as the increase of

communication, collaboration, with the teacher. As well as the ease of use of the software, access the ADT computing module e-material in an easy way, anytime, anywhere, self-paced study, and differentiate the material based on students learning preferences. As well as increasing the students' motivation by understands the challenging ADT computing module, do the Homework's in an easier way, increases the positive collaboration towards the ADT computing module, makes the ADT computing module more enjoyable, helps the students with low ability to learn better, and encourage the students to study more. Which justified according to the different benefits of the ICT tools (MOSP, Quizlet and Nearpod) used during the implementation of the FL model, and these findings are aligned with many works of literature (Hwang & Lai, 2017; Choi et al., 2015; Kong, 2015; Enfield, 2013; Milman, 2012).

5. Conclusion

This study reveals that the integrating of the FL Model and the ICT tools enhance the academic achievement of the secondary students who studying the computer discipline and create a positive attitude towards the Peers, Teacher, ICT Tools, and Motivation. The implementation of the FL model with the several benefits allows the students to work on the ADT computing material before the class time, prepare themselves, study on their own pace anytime, anywhere towards mastering all required skills in the ADT computing module. Thus, these findings can encourage the teachers to implement the FL model with their students to increase their academic achievement levels and performance, meanwhile this study was implemented at the secondary students at Mashrek International school for (9 weeks, 30 hours) despite this limitation this study will be consider as an indicator of the effectiveness of integration the FL model and ICT tools and provide a guideline and framework for teachers on how to successfully implement the FL model and integrate it with ICT tools, as well as, it will provide information for instructional designer, instructors, and researchers about the impact of integrating the FL model and ICT in different educational systems. A future study might be designed on different populations, samples, disciplines, and different ICT tools that could be used on the FL Model.

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