

Peer Instruction in a Flipped Learning Environment: Investigating ESL Students' Critical Thinking Performance in Argumentative Essay Writing

Amreet Kaur Jageer Singh, Raja Nor Safinas Raja Harun

Sultan Idris Education University, Malaysia

Email: nor.safinas@fbk.upsi.edu.my

Abstract: Research shows that peer instruction and flipped learning help ESL/EFL students compensate for their shortcomings in their language, support the language learning process, and facilitate social interactions and collaboration between teachers and students in the class. Despite this, there has been little research into whether upper-intermediate ESL students can benefit from the use of peer instruction in a flipped learning environment in enhancing critical thinking performance in argumentative essay writing. This current study tests this hypothesis. A total of 120 English Proficiency 4 (EP4) students from a teacher education university in Malaysia were equally divided into two experimental groups (pair work and group work) and a control group (conventional teaching method). The experimental groups' activities included a focus on different modes of peer instruction (pair work/group work) and flipped learning, while the control groups did not. Two research instruments were employed in this study: pre- and post-tests and a holistic scoring rubric. The critical thinking aspect was adapted from Stapleton and Wu (2015) and Toulmin's model of argumentation (2003). Descriptive and inferential statistics, namely, one-way analysis of variance (ANOVA) was computed using IBM SPSS Statistics 26. Overall, compared to the control group, both experimental groups (pair work and group work) performed better in mean scores for critical thinking in the posttest. The result of the study suggests that the use of peer instruction in a flipped learning environment can be an alternative teaching method to enhance the students' critical thinking in argumentative essay writing and offer implications for ESL students, language instructors, and researchers.

Keywords: Peer instruction; flipped learning environment; critical thinking performance; argumentative writing; ESL students

1. INTRODUCTION

The rapid development of the Malaysian higher education system has focused on the creation of flexible and futuristic learning spaces, promoted transformative learning and teaching delivery, and emphasised the importance of 21st century skills and

higher-order thinking skills (Ministry of Education Malaysia, 2015; Ministry of Higher Education Malaysia, 2018). Consequently, the field of English language teaching (ELT) has also undergone tremendous changes over the years in terms of emerging trends and teaching methodologies,

namely, from a traditional method (teacher-centred approach) to a modern, technology-based, and interactive method (student-centred approach) (Badjadi, 2020; Jacobs & Renandya, 2016). This so-called paradigm shift and pedagogical transformation aim to increase and encourage active participation of students in the teaching and learning of English language. In relation to that, both flipped learning approach and peer instruction technique are growing rapidly in the teaching and learning process of English language. This is in line with the development of 21st century lifelong learning that emphasises the diversity of teaching and learning methods leading to fostering four essential skills: critical thinking, creativity, collaboration, and communication to meet the country's aspirations to produce students who can compete on the world stage (Ministry of Higher Education Malaysia, 2018; Trilling & Fadel, 2009).

It is found that issues related to ESL students' poor performance in writing, especially argumentative essay writing and lack of critical thinking skills have been raised lately. Based on the previous studies, both ESL and EFL learners at the tertiary level often encounter problems in composing argumentative writing (Ariyanti & Rinda Fitriana, 2017; Maleerat Ka-kan-dee & Sarjit Kaur, 2015; Peloghitis, 2017). This problem is closely related to the lack of interesting and innovative pedagogy to learn writing. Students perceive argumentative essay writing as a rhetorically difficult, complex, and boring task due to the ineffective writing activities and modules used in the writing course and the method of instructions used in class (Botley, 2014; Vyncke, 2012). Nevertheless, in such a situation, students

become apprehensive, disinterested in writing, and feel less compelled to put much effort into being critical when presented with an argumentative essay writing task. It has also been acknowledged by Yunus et al. (2006) and Chiew et al. (2016) that there is a lack of critical thinking skills among undergraduates in English language classrooms. This is further supported by Nabila Nejmaoui (2019) and Lu and Xie (2019) that there is a lack of empirical evidence regarding critical thinking in second language education. Thus, investigating ESL students' critical thinking performance in argumentative essay writing is considered crucial as the logical content consists of facts and solid information that requires students to generate their thoughts more critically to create new ideas and solutions related to argumentative topics. It is undeniable that flipped learning approach has gained popularity among educators and its positive impacts on the students' learning process have created a space for researchers to explore the effectiveness of its implementation with the combination of peer instruction technique in argumentative essay writing. Thus, this study investigates the effect of peer instruction in a flipped learning environment on ESL students' argumentative essay writing. Specifically, the research question for this study is: Is there any significant difference in mean scores for critical thinking in the posttest between the experimental groups (pair work, group work) and control group?

2. LITERATURE REVIEW

In general, the reviews are divided into three subsections: peer instruction in English language

classrooms, flipped learning, and critical thinking cultivation in ESL/EFL writing.

2.1 Peer Instruction in English Language Classrooms

Crouch and Mazur (2001) have introduced a constructivist teaching method known as the peer instruction (PI) technique that focuses on interactive engagement. PI technique was invented by Harvard Physics Professor Eric Mazur in the early 1990s as a student-centred approach to enhance collaborative learning that can help students avoid misconceptions and misunderstandings during class (Mazur, 1997). PI is an active learning technique that allows students to articulate knowledge in their own terms and check their understanding by discussing it with other peers (Mazur, 2013; Schell & Butler, 2018; Zhang, Ding & Mazur, 2017). In addition, PI allows students to evaluate their thinking as well as exchange feedback from student-to-student, teacher-to-student, and student-to-teacher (Goodwin & Miller, 2013; Schell & Butler, 2018).

Plenty of studies have revealed the positive effects of peer instruction in language learning in that it can lead to more profound learning and improved performance through discussions and negotiations on the development of various language skills (Lee, 2017; Newton, 2013; Swain, 2005). For instance, Al-Hebaishi (2017) found that class discussion through the peer instruction method was effective in enhancing conceptual comprehension. García-Sánchez (2016) found that collaborative interactions with video role-plays promote students' development of fluency, vocabulary, content, grammar, pronunciation, and intonation. Similarly, Zheng,

Young, Wagner, and Brewer (2009) also found that collaborative interactions can promote students' language learning in terms of pragmatics, syntax, semantics, and discourse practices. Ahmed and Khaled Abdel-Jaleel (2016) also observed students' writing abilities upon discussions via an online forum. Moreover, Carter and McCarthy (2014) argued that discussions and negotiations can foster vocabulary acquisition. Despite having conducted numerous researches, the positive effects of peer instruction in an ESL writing context, particularly argumentative essay writing, remain relatively scarce. It is for this reason that this current study was therefore formed.

Nevertheless, in the context of peer instruction in a flipped classroom, studies examining the effectiveness of such a learning environment on students' language skills reveal positive outcomes. Results and findings from the previous studies have proven that the effects of flipped learning with peer instruction can enhance ESL/EFL students' engagement and reading comprehension skills (Hani Alhasani, Fauzy Mohd Wan and Mona Masood, 2017; Lasni, 2017), encourage interaction during in-class activities (Hung, 2017) and promote the development of students' writing skills, motivation, and tendency of critical thinking (Zou & Xie, 2018). These aforementioned findings of the previous studies, therefore, tend to indicate that peer instruction in a flipped learning environment is likely to be effective.

2.2 Flipped Learning

According to Mohamad Amin, Supyan Hussin and Ebrahim Panah (2014), flipped learning can be defined as a pedagogical approach that replaces

lectures with learning concepts, contents, and new information based on the materials supplied by the instructors before class. In a typical traditional classroom, the instructor delivers lectures and provides study materials to the students while students mainly listen to lectures and take notes (Soltanpour, 2018). The students are also assigned homework that needs to be completed after class. The flipped classroom inverts the traditional teaching methods, whereby the 'content delivery' of the lessons may take various forms. The basic idea of flipped learning is that the students acquire foundational knowledge before the class by watching video lectures and reading materials (Luo, O'Steen & Brown, 2020). During class time, students deepen their understanding through collaborative and active learning (Birgili, Seggie & Oguz, 2021). In addition, Gerstein (2012) has defined the flipped classroom as a place where deep learning occurs by solving problems, exploring advanced concepts, and encouraging collaborative learning that combines interactive engagement, just-in-time teaching, peer instruction technique, and integration of information content.

2.3 Critical Thinking Cultivation in ESL/ EFL Writing

Critical thinking is a crucial element for students to excel academically and be equipped professionally to meet the future workforce. Over the years, the development of critical thinking skills in the education circles in Malaysia has changed and evolved along with the emerging trends in teaching and learning. Although much effort is being placed on developing the critical thinking of English as a second language (ESL) students

and its implication on the practice of teaching and learning, researchers have only conducted studies related to critical thinking involving ESL secondary school students. For instance, Azam, Fadhil and Yunus (2019) conducted action research of quasi-experimental design to investigate the effectiveness of using proverbs via a game-based learning platform (Kahoot) and an online forum learning platform (PinUp) in improving students' writing skills. Hemadevi Sovakandan, Paramaswari Jaganathan and Fauziah Husain (2017) reported on the qualitative interview data on the use of i-Think Maps in the low proficiency students' writing classrooms. Nurshila Umar Baki, Shameem Rafik-Galea and Vahid Nimehchisalem (2016) conducted a case study to analyse the critical thinking literacy level of 20 ESL students of a rural secondary school in Malaysia. Another study carried out by Gandimathi and Nafiseh (2017) is the only research focused on postgraduate students in Selangor, Malaysia. This study investigated the use of critical thinking in language learning and how it enhanced the English language among ESL learners.

However, as there are limited studies in the ESL setting, the literature review has been expanded to the EFL setting as well. In the EFL setting, experts and scholars on critical thinking skills of tertiary level students concentrated on the aspects such as the effects of various teaching strategies and techniques on students' critical thinking ability, correlations between critical thinking and EFL academic writing performance and both teachers' and students' perceptions of critical thinking (Ali Odeh Hammoud Alidmat & Mohamed Ayed Ayassrah, 2017; Hassan Soodmand Afshar, Hossein Movassagh & Hassan Radi Arbabi, 2017; Lu & Xie,

2019; Nabila Nejmaoui, 2019; Pei, Zheng, Zhang & Liu, 2017; Tuzlukova, Al Busaidi & Burns, 2017; Veliz & Veliz, 2019; Zhang, 2018).

Designing and implementing critical thinking teaching strategies is not an easy task even for very experienced educators in colleges and universities (Ali Odeh Hammoud Alidmat & Mohamed Ayed Ayassrah, 2017; *Saeed Rezaei, Ali Derakhshan & Marzieh Bagherkazemi*, 2011; Saman Ebadi & Masoud Rahimi, 2018; Tuzlukova, Al Busaidi & Burns, 2017; Veliz & Veliz, 2019). With the rapid changes in today's world, there is a need to revisit the traditional conception and explore new ways to redesign learning for students to practice critical thinking effectively, especially in higher education institutions. Recent studies in the EFL classroom content reveal that different strategies and techniques as interventions in instruction and learning could have positive effects on students' critical thinking. For example, McKinley (2013) which emphasises non-linguistic teaching strategies, suggested that argument-based writing was an optimal way to train Japanese university students' critical thinking as it helped them analyse and evaluate different types of evidence and project authorial stances. Similar to this study, Liu and Stapleton (2014) also revealed that Chinese college students who were taught counterargument enhanced critical thinking skills in analysing and evaluating different opinions in argumentative writing.

Furthermore, Yang and Gamble (2013) conducted an experimental design with participants from two freshman EFL classes at a language university in Taiwan. While experimental group

learners engaged in critical thinking (CT)-enhanced activities such as debates and peer critiques, control group learners engaged in non-CT-enhanced EFL activities such as group presentations and process writing. Research results derived from the study revealed that experimental group learners demonstrated a significant improvement in English proficiency, specifically, writing argumentative essays in comparison to the control group. In the same vein, Tous, Tahriri and Haghighi (2015) also studied the effect of debate in EFL reading instruction, and the findings revealed that the instruction through debate is an effective intervention to develop students' reading comprehension and critical thinking. These two studies prove that debating is a useful tool that can help to promote critical thinking skills in both reading and writing lessons.

Apart from the debating technique, Fahim and Mizraii (2014) conducted an experimental study to examine the effect of dialogic CT instruction on Iranian EFL students' argumentative writing. The experimental results showed that the ability to write argumentative essay critically depends on EFL/ESL learners' being equipped with an intellectual capacity for thinking critically. Gao, Gao, and Yang (2017) proposed a cognition-based interactive teaching method in academic English reading and found the method effective in improving critical thinking and reading skills. Saman Ebadi and Masoud Rahimi (2018) explored the impact of WebQuest-based classroom on EFL learners' critical thinking and argumentative writing skills by collecting and analysing the data through a sequential explanatory mixed-methods approach. The results indicated that both the WebQuest-based and the face-to-

face classrooms developed the learners' critical thinking and argumentative skills, while the former outperformed the latter both in post and delayed post-tests.

Lu and Xie (2019) studied the effects of critical thinking oriented instructional pattern in a tertiary EFL argumentative writing course. The quantitative data revealed that students who received the instructional treatment outperformed the students in the control group in terms of overall critical thinking skills and skills of identifying and evaluating the elements of thoughts. Meanwhile, the treatment group also performed better with regard to overall writing ability, organisation, and coherence. In the same line of inquiry, Nabila Nejmaoui (2019) explored the effect of integrating critical thinking on learners' use of critical thinking skills in argumentative writing. An experimental study involving 36 Moroccan EFL learners from the department of English were divided evenly into an experimental group and a control group. The results suggested that the experimental group significantly outperformed the control group. Even though the students' ability to use more credible source or veracious evidence, address alternative arguments, support conclusions and maintain the logical flow of ideas in their essays did not reach a mastery level in the posttest, yet the average level they reached is reassuring in view of the short time of the training they had.

All of these positive results of the studies mentioned above reflect the social context of second or foreign language acquisition and critical thinking. According to Yang and Gamble (2013),

learning takes place within a social context through collaboration, social interaction, co-construction of meaning, authenticity, and relevance to learners' life experiences. Social practice is one of the essential elements of critical thinking. This statement is further supported by Handoyo Puji Widodo (2012), who stated that critical thinking should be seen as a socio-cognitive activity that involves a thinking process (mind) and interpersonal interaction. In other words, students can enhance critical thinking skills by expressing their opinions, exchanging critiques and ideas of others, discussing, and collaborating for solution to a provided problem (Hussin, Harun & Shukor, 2019).

Overall, it can be concluded that the importance of critical thinking and its implementation in Malaysian higher education institutions need to be put in place for maximum benefits. Students with stronger critical thinking skills will excel in their writing than those demonstrating weak critical thinking (Pei, Zheng, Zhang & Liu, 2017). Thus, critical thinking should be considered as part of any instructional practice in higher institutions. However, Saman Ebadi and Masoud Rahimi (2018) pointed out that there are academic settings that put too much emphasis on 'what to think' instead of 'how to think'. It is the reality that we are very keen on transmitting the content of what we teach to our students but often fail to teach them how to think critically and evaluate effectively. Saman Ebadi and Masoud Rahimi (2018) also argued that teaching students how to think rather than what to think can help them pay attention to the context in which their actions and ideas are generated. Teachers must train students to think critically in language

classrooms by innovating their teaching methods. Pei, Zheng, Zhang, and Liu (2017) have suggested various strategies to facilitate learners' use of critical thinking skills so that they may incorporate them into writing for academic success and lifelong learning endeavours. Despite having various strategies, Nabila Nejmaoui (2019) and Lu and Xie (2019) have stated that the number of studies that experiments different approaches and techniques to facilitate critical thinking in the second language (L2) education is limited. More studies are required in this field.

Therefore, to fill the literature gap, this study aims to investigate whether peer instruction in a flipped learning environment enhances ESL students' critical thinking scores in argumentative essay writing compared to the traditional method. The following hypotheses have been generated to see the differences in terms of mean scores of the pre-test and post-test among the students of English proficiency course:

Ho : There is no significant difference in mean scores for critical thinking in the post-test between the experimental groups (pair work, group work) and control group.

Ha : There is a significant difference in mean scores for critical thinking in the post-test between the experimental groups (pair work, group work) and control group.

3. METHOD

The quasi-experimental research design, specifically the matching-only pre-test post-test control group design was used for this study. This research design was chosen because it enables

researchers to carry out experiments that are close to true experimental designs and that may allow the data to be interpretable albeit more cautiously and that generalisation is certainly a limitation. Thus, this research design is more feasible as it often does not have the time and logistical constraints associated with many true experimental designs (Best & Kahn, 2014). A total of 120 English Proficiency 4 (EP4) students from a teacher education university in Malaysia were chosen as the sample of this study for seven weeks. The selection of the sample for this study was made using convenience sampling. The instruments used in this study are pre- and post-tests and a holistic scoring rubric. The pre-test served as an equivalence test and basis for matching the three means (pair work, group work and conventional teaching method). The participants of the study were required to write an argumentative essay on whether they agree or disagree with the following statement "The media is an educational tool". This topic was selected from MUET-Writing 800/4 July 2015 examination paper, set by the Malaysian Examinations Council. As for post-test, only the word 'media' was changed to 'Internet'. Holistic scoring rubric was adapted from the assessment guide designed by the Malaysian Examination Council (MEC). The rubric was chosen due to its simplicity and clarity. At the initial stage, the rubric covered the range of scores for five aspects: accuracy, appropriacy, coherence and cohesion, use of language functions, and task fulfilment. Later, the critical thinking aspect was also added to the holistic rubric. The critical thinking aspect was adapted from Stapleton and Wu's (2015) integrated Analytic Scoring Rubric for Argumentative Writing (ASRAW) and Toulmin's

Model of Argumentation (2003). The test scores for pre- and post-tests were analysed and presented using descriptive and inferential statistics. Specifically, one-way ANOVA was performed to examine the differences between independent variables on one dependent variable at a time by using IBM SPSS Statistics 26 software. Therefore, students in the experimental groups received the treatments or interventions (peer instruction in a flipped learning environment), while students in the control group received the regular instruction (conventional teaching method).

4. RESULT

The research question set was, 'Is there any significant difference in mean scores for critical thinking in the posttest between the experimental groups (pair work, group work) and control group?' In testing the null hypothesis that corresponds to the research question in this study, data consisting of critical thinking scores of pretest and posttest from experimental and control groups were obtained. As the design employed was quasi-experimental with non-randomised samples, data were analysed using the analysis of variance (ANOVA) to explore the difference between the groups (and to test the null hypothesis). The pretest and posttest of the students' critical thinking scores was the dependent variable while the type of peer instruction (individual, pair work, and group work) was the independent variables. Normality tests were conducted to determine if the data set was modelled for normal distribution.

A. Normality Assumption (Students' Critical Thinking Scores on Pretest)

In Table 1, the skewness and kurtosis statistics show the data distribution pattern. According to Cronk (2018) and Morgan, Barrett, Leech and Gloeckner (2020), a sample of data is considered normally distributed when the skewness and kurtosis values are in the range of -2.00 to +2.00. In this case, the distribution of data for students' critical thinking scores on pretest was reported normal because both skewness (.104) and kurtosis (-.593) values were within the normal distribution range.

For the Shapiro-Wilk test, Table 2 below shows that the results of the critical thinking scores on pretest here were insignificant ($p > .05$) and thus the data was normally distributed.

For the histogram (see Figure 1), the distribution frequency shows that data was normally distributed because it displayed a high distribution in the middle and a low distribution at both the left and right end. The stem-and-leaf distribution pattern in Figure 2 follows the histogram. The stem represents the leading digit of each of the values of the pretest score. The leaf consists of the final digit of each of the values with the leading digit specified by the stem value. In this display, the data appear to be centered somewhere around 7 which is close to the mean value of around 7.57 and the median value of 7.50. Since both the mean and median values are very close to each other, this confirmed a normal distribution pattern.

Table 1. Descriptive Results of the Normality Test for Students' Critical Thinking Scores on Pretest

Descriptives				
		Statistic	Std. Error	
Pretest	Mean	7.57	.236	
	95% Confidence Interval for Mean	Lower Bound	7.10	
		Upper Bound	8.03	
	5% Trimmed Mean	7.55		
	Median	7.50		
	Variance	6.668		
	Std. Deviation	2.582		
	Minimum	2		
	Maximum	14		
	Range	12		
	Interquartile Range	4		
	Skewness	.104	.221	
	Kurtosis	-.593	.438	

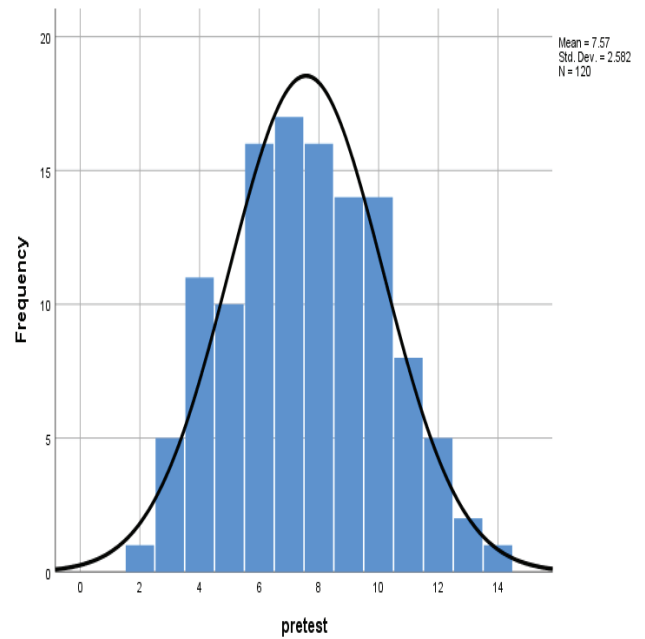


Figure 1. Frequency Distributed Histogram of Students' Critical Thinking Scores on Pretest

Table 2. Results of Shapiro-Wilk Tests for Students' Critical Thinking Scores on Pretest

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.087	120	.027	.979	120	.054

a. Lilliefors Significance Correction

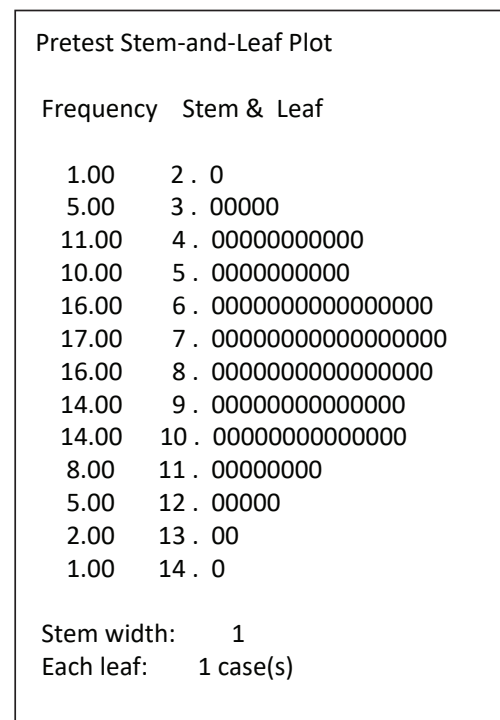


Figure 2. Stem-and-Leaf Distribution Pattern of Students' Critical Thinking Scores on Pretest

Overall, the statistical analysis results showed that the data was normally distributed for the students' critical thinking scores on the pretest, thus parametric statistics technique, particularly, one-way analysis of variance (ANOVA) was used to compare means of two or more samples.

B. Normality Assumption (Students' Critical Thinking Scores on Posttest)

The descriptive statistics table (see Table 3) shows that the distribution of data for students' critical thinking scores on posttest was normal because both skewness (.051) and kurtosis (-.467) values were within the normal distribution range.

Table 3. Descriptive Results of the Normality Test for Students' Critical Thinking Scores on Posttest

Descriptives				
		Statistic	Std. Error	
Posttest	Mean	13.63	.356	
	95% Confidence Interval for Mean	Lower Bound	12.93	
		Upper Bound	14.34	
	5% Trimmed Mean	13.64		
	Median	14.00		
	Variance	15.192		
	Std. Deviation	3.898		
	Minimum	6		
	Maximum	23		
	Range	17		
	Interquartile Range	5		
	Skewness	.051	.221	
	Kurtosis	-.467	.438	

For the histogram (see Figure 3), the distribution frequency showed that data was normally distributed because it displayed values clustering around the central peak with fewer instances further away. The stem-and-leaf distribution pattern in Figure 4 also clearly shows how the data was spread and that the distribution pattern was normal.

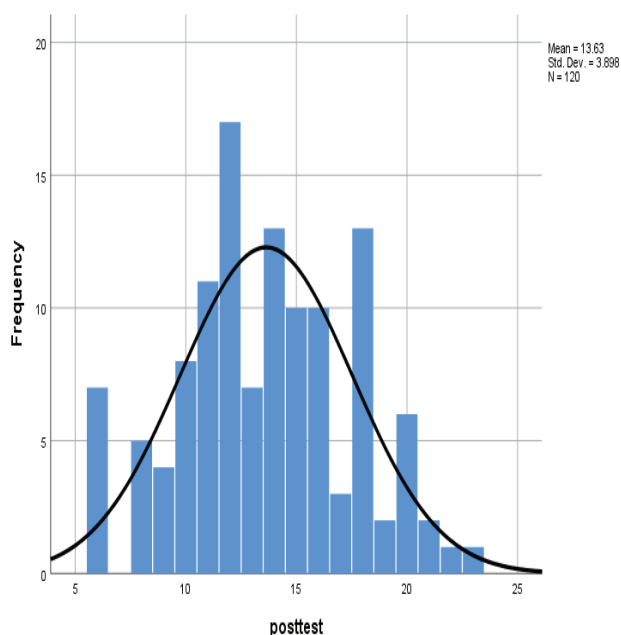


Figure 3. Frequency Distributed Histogram of Students' Critical Thinking Scores on Posttest

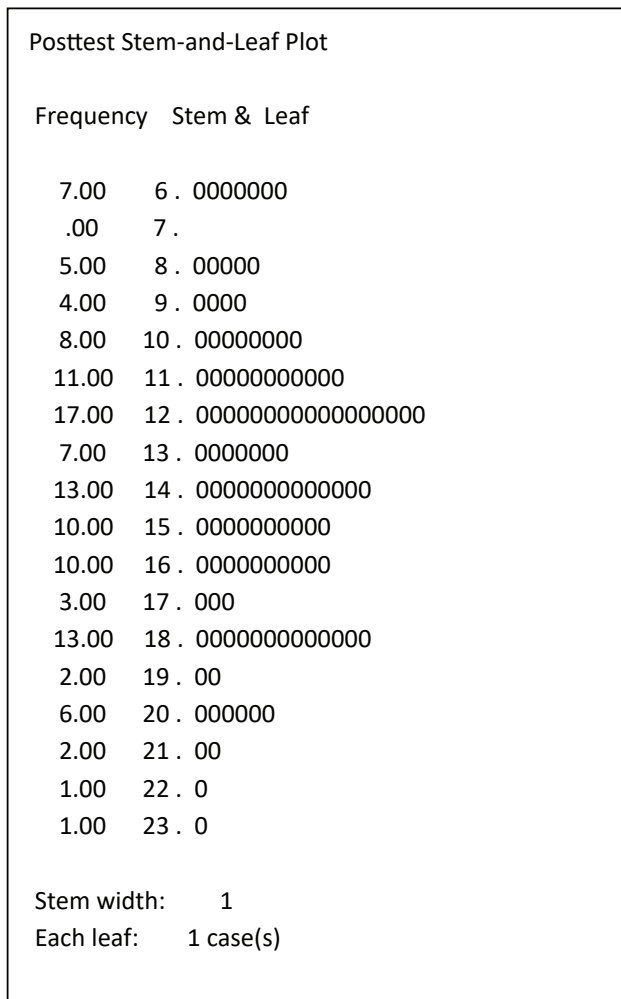


Figure 4. Stem-and-Leaf Distribution Pattern of Students' Critical Thinking Scores on Posttest

In short, the statistical results indicated that the posttest scores were normally distributed. Thus, this allowed the researcher to use one-way ANOVA to determine whether there were any statistically significant differences between the means of two or more samples.

C. Equal Variance Checking and ANOVA Test (Students' Critical Thinking Scores on Pretest)

Table 4 displays a range of summary statistics for the variable pretest score. As indicated in the table, the experimental (group work) recorded the highest mean score ($M = 7.65$) while experimental (pair work) and control group recorded a bit lower but same mean scores ($M. = 7.53$). A total number of 40 students participated in each group.

Table 4. Descriptive Statistics for Experimental and Control Groups at Pretest - Critical Thinking Scores

Descriptives								
Pretest								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Experimental_Pair work	40	7.53	2.219	.351	6.82	8.23	2	12
Experimental_Group work	40	7.65	2.806	.444	6.75	8.55	3	13
Control	40	7.53	2.746	.434	6.65	8.40	3	14
Total	120	7.57	2.582	.236	7.10	8.03	2	14

In order to check the assumption whether the variance in pretest scores is the same for each of the three groups, a test of homogeneity of variances was carried out. Table 5 shows that the significance value for Levene's test was $F(2, 117) = 2.493, p = .087$ thus, this indicated that the assumption of homogeneity of variance had not been violated for this sample. In

other words, the equal variance assumption had been met and the null hypothesis was accepted. There was no significant difference between the groups for pretest scores. This was further confirmed with the ANOVA test results, as shown in Table 6. From the ANOVA results, it is noted that the $F(2, 117) = .031, p = .970, ns$, was not statistically significant at the .05 alpha level. Hence, it can be concluded that a one-way ANOVA showed that there was no significant difference between the three groups.

Table 5. Test of Homogeneity of Variances (Pretest-Critical Thinking Scores)

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	2.505	2	117	.086
	Based on Median	2.339	2	117	.101
	Based on Median and with adjusted df	2.339	2	116.680	.101
	Based on trimmed mean	2.493	2	117	.087

Table 6. ANOVA Test for Pretest-Critical Thinking Scores

ANOVA					
Pretest					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.417	2	.208	.031	.970
Within Groups	793.050	117	6.778		
Total	793.467	119			

D. Equal Variance Checking and ANOVA Test (Students' Critical Thinking Scores on Posttest)

The descriptive table (see Table 7) shows the means and standard deviations of scores for each treatment. Among the three treatment groups, the experimental (group work) reported having the highest mean score ($M = 16.05$) followed by experimental (pair work) ($M = 14.33$) and control group ($M = 10.53$).

Table 7. Descriptive Statistics for Experimental and Control Groups at Posttest - Critical Thinking Scores

Descriptives								
Posttest								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Experimental_Pair work	40	14.33	3.230	.511	13.29	15.36	6	23
Experimental_Group work	40	16.05	3.587	.567	14.90	17.20	8	21
Control	40	10.53	2.582	.408	9.70	11.35	6	16
Total	120	13.63	3.898	.356	12.93	14.34	6	23

In Table 8, the results of the Levene's test that is $F(2, 117) = 2.217$, $p = .114$ indicated that it is not significant. The null hypothesis was rejected at the 0.605 level since the value of the Levene test statistic was greater than the critical value. This indicated that there was sufficient evidence to claim that the variances of the dependent variables in each group of respondents were unequal. Therefore, it can be concluded that the assumption was not violated and the data complied with the ANOVA test conditions. One-way ANOVA test was carried out and the results are shown on the following pages.

The one-way ANOVA test results, as shown in Table 9 indicated that the value of $F(2, 117) = 31.998$, $p = .000$ was statistically significant. The null hypothesis was thus rejected and hence, the results showed there was a significant difference in mean scores for critical thinking in the posttest between the experimental groups (pair work, group work) and control group. As for effect size between groups, the eta squared of 0.353 was deemed by Cohen's (1988) guidelines as a 'large' effect size. It also means that 35.3% of the variance was caused by the independent variable (treatment).

Table 8. Test of Homogeneity of Variances (Posttest – Critical Thinking Scores)

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Postt est	Based on Mean	2.217	2	117	.113
	Based on Median	2.298	2	117	.105
	Based on Median and with adjusted df	2.298	2	113.226	.105

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
	Based on trimmed mean	2.216	2	117	.114

Table 9. ANOVA Test for Posttest – Critical Thinking Scores

ANOVA					
Posttest					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	639.217	2	319.608	31.998	.000
Within Groups	1168.650	117	9.988		
Total	1807.867	119			

Post-hoc pairwise multiple comparisons using the Bonferroni's test as in Table 10 indicated that there was a statistically significant difference between experimental (pair work) and control group (mean difference = 3.800, $p < .05$) as well as experimental (group work) and control group (mean difference = 5.525, $p < .05$). This indicated that the difference between these two pairs caused the overall difference. Comparisons between students' critical thinking scores in experimental (pair work) and the experimental (group work) were not statistically significant at $p < 0.05$. In Table 11, univariate tests confirmed the results in the pairwise comparisons table that two pairs of comparisons yield significant results.

Table 10. Bonferroni's Post Hoc Pairwise Comparisons Test Results

Pairwise Comparisons						
Dependent Variable: posttest						
Bonferroni						
(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval	
					Lower Bound	Upper Bound
Experimental_Pair work	Experimental_Group work	-1.725*	.707	.048	-3.44	-.01
	Control	3.800*	.707	.000	2.08	5.52
Experimental_Group work	Experimental_Pair work	1.725*	.707	.048	.01	3.44
	Control	5.525*	.707	.000	3.81	7.24
Control	Experimental_Pair work	-3.800*	.707	.000	-5.52	-2.08
	Experimental_Group work	-5.525*	.707	.000	-7.24	-3.81

Based on estimated marginal means
 *. The mean difference is significant at the 0.05 level.
 b. Adjustment for multiple comparisons: Bonferroni.

Table 11. Univariate Tests

Univariate Tests					
Dependent Variable: Posttest					
	Sum of Squares	df	Mean Square	F	Sig.
Contrast	639.217	2	319.608	31.998	.000
Error	1168.650	117	9.988		

The F tests the effect of groups. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Based on the results of the analysis, it can be concluded that the use of peer instruction in pair work and group work had enhanced students' critical thinking scores in argumentative essay writing. In other words, the traditional method (control

group) used by the instructors in the university was not effective when compared to the other two instructional strategies.

5. DISCUSSION

The output of the ANOVA analysis showed significant differences in mean scores for critical thinking in the posttest between the experimental groups (pair work, group work) and the control group. In other words, the experimental groups significantly outperformed the control group. The

eta squared of 0.353 between groups was deemed by Cohen's (1988) guidelines as a 'large' effect size. It also means that 35.3% of the variance was caused by the independent variable (treatment). The result of the test analysis is consistent with the findings of previous studies related to the effect of the flipped classroom on English language students' critical thinking (Alsowat, 2016; Karagöl & Esen, 2019; Mervat Abd Elfatah Ali Said Ahmed, 2016; Sung, 2015; Zeynep Turan & Akday-Cimen, 2019; Webb, 2016). Besides, it also corroborates the cultivation of critical thinking in ESL/EFL writing (Bradford-

Watts, 2011; Hani Alhasani, Fauzy Mohd Wan & Mona Masood, 2017; Makoe & McKinney, 2009; Nabishah Mohamad, 2012; Nurhidayah Mohd Sharif et al., 2013; Yang & Lin, 2015; Zou & Xie, 2018). Hence, the null hypothesis is rejected and the alternative hypothesis is accepted.

This successful implementation could be attributed to the well-planned tasks related to argumentative essay writing which allowed the students to think critically under teacher guidance and with peer support (Lee & Wallace, 2017; Zainuddin & Perera, 2019). For instance, the five-week intervention period involved argumentative writing tasks which required students to exercise critical thinking through questioning, reasoning,

connecting, summarising and synthesising viewpoints (Barahal, 2008; Beaumont, 2010). Apart from the in-class activities, critical thinking was also promoted through the flipped classroom before entering the class as students had to pause videos to think about the learning content and then summarise the main points in the lesson study logs (Hamdan et al., 2013; Herreid & Schiller, 2013). Through the present study, it is confirmed that argument-based writing is an optimal way to train university students' critical thinking as it helped them analyse and evaluate different types of evidence and stances (Fahim & Mizraii, 2014; Gao, Gao & Yang, 2017; Liu & Stapleton, 2014; Lu & Xie, 2019; McKinley, 2013; Rohmani, 2017, Saman Ebadi & Masoud Rahimi, 2018; Tous, Tahriri & Haghighi, 2015; Yang & Gamble, 2013).

Furthermore, the finding also proves that cognitivism has significant contributions to integrating peer instruction (pair work and group work) in a flipped learning environment. In line with Piaget's emphasis on knowledge construction by learners based on their existing cognitive structures (Piaget, 1952), students in this study were trained not about what they could do but instead what they know and how they came to learn that information. For instance, students engaged themselves in class discussions related to argumentative essay topics and tasks whereby they had to provide opinions based on their prior knowledge, exchange their ideas with other group members and organise their thoughts logically. Apart from that, providing the right environment and task requirements is also considered as the key importance in developing students' critical thinking such as making claims, counterclaims, and rebuttals,

as well as using clear reasons and evidence to both substantiate and refute the opposing argument. Therefore, through the process of peer instruction in a flipped classroom environment, students were able to immerse themselves in a fun, challenging (argumentative essay writing) and safe learning environment.

Despite a significant result in the ANOVA, post-hoc pairwise multiple comparisons using the Bonferroni's test revealed that comparisons between students' critical thinking scores in experimental (pair work) and the experimental (group work) were not statistically significant. This could be due to the fact that students in both groups experienced similar procedures in learning the primary course content outside of the class and spending class time working in pairs or groups to apply that content. In short, the empirical result of this present study strongly suggests that the peer instruction in a flipped learning environment involving pair work and group work modes should be considered as a combination of two pedagogical approaches in enhancing ESL students' critical thinking scores in argumentative essay writing.

6. CONCLUSION

The result of this study showed that the use of peer instruction in a flipped learning environment (pair work and group work) has effectively enhanced the ESL students' critical thinking performance in argumentative essay writing. This positive effect implies that English language instructors have a potentially useful instructional strategy in guiding ESL students to be critical thinkers when practicing

the language by making cases in argumentative essay writing.

Thus, it is suggested that teachers should consider applying this combination of instructional strategy and teaching approach as an additional option for enhancing writing instruction and also add to their repertoire of current teaching strategies that cater to argumentative writing. The English teachers need to plan, manage, support, and assist the students' learning process by engaging them in various learning activities and boosting their critical thinking skills. In other words, English teachers need to make the necessary changes to the teaching and learning process of argumentative essay writing. Indeed, applying various teaching methods and techniques can increase the students' ability to think critically.

REFERENCES

- Ahmed, A. A. R., & Khaled Abdel-Jaleel, D. (2016). The influence of English teaching forums on improving eleventh graders' writing skills in Habla secondary school for girls. *International Journal of English Language Teaching*, 4(9), 69-85.
- Al-Hebaishi, S. M. (2017). The effect of peer instruction method on preservice teachers' conceptual comprehension of methodology course. *Journal of Education and Learning*, 6(3), 70-82.
- Ali Odeh Hammoud Alidmat & Mohamed Ayed Ayassrah. (2017). Development of critical thinking skills through writing tasks: Challenges facing maritime English students at Aqaba College, AlBalqa Applied University, Jordon. *International Journal of Higher Education*, 6(3), 82-90.
- Alsowat, H. (2016). An EFL flipped classroom teaching model: Effects on English language higher-order thinking skills, student engagement and satisfaction. *Journal of Education and Practice*, 7(9), 108-121.

- Ariyanti, A., & Rinda Fitriana.** (2017). EFL students' difficulties and needs in essay writing. *Advances in Social Science, Education and Humanities Research (ASSEHR)*, 158, 111-121.
- Azam, F. K. K., Fadhil, F., & Yunus, M. M.** (2019). Enhancing ESL learners' writing skills via ProWrit. *International Journal of Academic Research in Business and Social Sciences*, 9(1), 660-669.
- Badjadi, N. E. I.** (2020). Learner-centered English language teaching: Premises, practices and prospects. *IAFOR Journal of Education: Language Learning in Education*, 8(1), 7-27.
- Barahal, S.** (2008). Thinking about thinking: Preservice teachers strengthen their thinking artfully. *Phi Delta Kappan*, 90(4), 298-302.
- Beaumont, J.** (2010). A sequence of critical thinking tasks. *TESOL Journal*, 1(4), 1-22.
- Best, J. W., & Kahn, J. V.** (2014). *Research in education* (10th ed.). Boston: Allyn and Bacon.
- Birgili, B., Seggie, F.N. & Oğuz, E.** (2021). The trends and outcomes of flipped learning research between 2012 and 2018: A descriptive content analysis. *Journal of Computers in Education*, 8(2). <https://doi.org/10.1007/s40692-021-00183-y>
- Botley, S. P.** (2014). Argument structure in learner writing: A corpus-based analysis using argumentative mapping. *Kajian Malaysia*, 32(1), 45-77.
- Bradford-Watts, K.** (2011). Students teaching students? Peer teaching in the EFL classroom in Japan. *The Language Teacher*, 35(5), 31-35.
- Carter, R., & McCarthy, M.** (2014). *Vocabulary and language teaching*. London: Routledge. Chiew, D. Y., Elizabeth M, A., Berhannudin Mohd
- Salleh, Robijah Kamarulzaman, Zulida Abd Kadir.** (2016). Creating thinking classrooms: Perceptions and teaching practices of ESP practitioners. *Procedia - Social and Behavioral Sciences*, 232(), 631-639. doi:10.1016/j.sbspro.2016.10.087
- Cohen J.** (1988). *Statistical power analysis for the behavioral sciences*. New York, NY: Routledge Academic.
- Cronk, B. C.** (2018). *How to use SPSS: A step-by-step guide to analysis and interpretation*. New York: Routledge.
- Crouch, C. H., & Mazur, E.** (2001). Peer instruction; Ten years of experience. *American Association of Physics Teachers*, 69(9), 970-975.
- Fahim, M., & Mizraii, M.** (2014). Improving EFL argumentative writing: A dialogic critical thinking approach. *International Journal of Research Studies in Language Learning*, 3(1), 3-20.
- Gandimathi, A., & Nafiseh, Z.** (2018). The impact of critical thinking on learning English language. *Asian Journal of Social Science Research*, 1(2), 1-10.
- Gao, Z., Gao, S., & Yang, Q.** (2017). Cognition-based interactive phases and strategies in teaching academic reading. *Journal of Electronic Science and Technology*, 15(1), 33-40.
- García-Sánchez, S.** (2016). Encouraging collaborative interaction in EFL learners with video role-plays. *ENSAYOS, Revista de la Facultad de Educación de Albacete*, 31(1), 149-164.
- Gerstein, J.** (2012) *The flipped classroom: The full picture based on an experiential model of learning*. Amazon Digital Services, Incorporated.
- Goodwin, B & Miller, K.** (2013). Evidence on flipped classrooms is still coming in. *Educational Leadership*, 70(6), 78-80. Hamdan, N., McKnight, P., McKnight, K., &
- Arfstrom, K.** (2013). *A review of flipped learning*. Retrieved from <http://www.flippedlearning.org/> review
- Handoyo Puji Widodo.** (2012). Pedagogical tasks for shaping EFL college student writers' critical thinking and self-voicing. *International Journal of Innovation in English Language Teaching*, 1(1), 87-99.
- Hani Alhasani, Fauzy Mohd Wan & Mona Masood.** (2017). A flipped learning design with peer instruction to engage ESL students. *Turkish Online*

Journal of Educational Technology, Special Issue for IETC 2017, 9-19.

Hassan Soodmand Afshar, Hossein Movassagh & Hassan Radi Arbabi. (2017). The interrelationship among critical thinking, writing an argumentative essay in an L2 and their subskills. *The Language Learning Journal*, 45(4), 419-433.

Hemadevi Sovakandan, Paramaswari Jaganathan & Fauzilah Husain. (2017). Investigating low proficiency ESL students' perception of the use of i-Think maps in writing practices. *Malaysian Journal of ELT Research (MaJER)*, 14(2), 1-13.

Herreid, C., & Schiller, N. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching*, 42, 62-66.

Hung, H. T. (2017). The integration of a student response system in flipped classrooms. *Language Learning & Technology*, 21(1), 16-27.

Hussin, W. N. T. W., Harun, J., & Shukor, N. A. (2019). Online interaction in social learning environment towards critical thinking skill: A framework. *Journal of Technology and Science Education*, 9(1), 4-12.

Jacobs G. M., Renandya W. A. (2016). Student-centred learning in ELT (in) Renandya W. A., Widodo H. (eds.), *English language teaching today: Linking theory and practice*. Switzerland: Springer, pp. 13-24.

Karagöl, I., & Esen, E. (2019). The effect of flipped learning approach on academic achievement: A meta-analysis study. *H. U. Journal of Education*, 34(3), 708-727.

Lasni, B. J. (2017). Flipped learning and peer instruction: An attempt to use two pedagogical approaches to improve comprehension skills. In M. Froggett & S. Herath, *Action research in Sri Lanka: A route to inclusion and social cohesion* (pp. 63-66). Sri Lanka, British Council.

Lee, G., & Wallace, A. (2017). Flipped learning in the English as a foreign language classroom: Outcomes and perceptions. *TESOL Quarterly*, 1-23.

Lee, L. (2017). Rethinking discussion sections with peer instruction: A case study. *Asian Journal of the Scholarship of Teaching and Learning*, 7(2), 11-29.

Liu, F., & Stapleton, P. (2014). Counter argumentation and the cultivation of critical thinking in argumentative writing: Investigating washback from a high-stakes test. *System*, 45, 117-128.

Lu, D., & Xie, Y. (2019). The effects of a critical thinking oriented instructional pattern in a tertiary EFL argumentative writing course. *Higher Education Research & Development*, 38(5), 969-984.

Luo, Z., O'Steen, B. & Brown, C. (2020). Flipped learning wheel (FLW): a framework and process design for flipped L2 writing classes. *Smart Learning Environments*, 7(10), 1-21. <https://doi.org/10.1186/s40561-020-00121-y>

Makoe, P., & McKinney, C. (2009). Hybrid discursive practices in a South African multilingual primary classroom: A case study. *English Teaching Practice and Critique*, 8(2), 80-95.

Maleerat Ka-kan-dee & Sarjit Kaur. (2015). Teaching strategies used by Thai EFL lecturers to teach argumentative writing. *Procedia – Social and Behavioral Sciences*, 208 (2015), 143-156.

Mazur, E. (1997). *Peer instruction: A user's manual*. Series in Educational Innovation. NJ: Prentice-Hall.

Mazur, E. (2013). *Peer instruction: A user's manual*. UK: Pearson Education.

McKinley, J. (2013). Displaying critical thinking in EFL academic writing: A discussion of Japanese to English Contrastive Rhetoric, *RELC Journal*, 44(2), 195-208.

Mervat Abd Elfatah Ali Said Ahmed. (2016). The effect of a flipping classroom on writing skill in English as a foreign language and students' attitude towards flipping. *US-China Foreign Language*, 14(2), 98-114.

Ministry of Education Malaysia. (2015). *Malaysia education blueprint 2015-2025 (higher education)*. Putrajaya, Malaysia: Ministry of Education Malaysia.

Ministry of Higher Education Malaysia. (2018). *Framing Malaysian higher education 4.0: Future-*

prooftalents. Putrajaya, Malaysia: Ministry of Higher Education Malaysia.

- Mohamed Amin Embi, Supyan Hussin & Ebrahim Panah.** (2014). Flipped learning readiness among graduate and postgraduate students in UKM. In Mohamed Amin Embi (Ed.), *Blended & flipped learning: Case studies in Malaysian HEIs* (pp. 210-2923). Selangor, Malaysia: Centre for Teaching & Learning Technologies, Universiti Kebangsaan Malaysia Department of Higher Education, Ministry of Education Malaysia.
- Morgan, G. A., Barrett, K. C., Leech, N. L., & Gloeckner, G. W.** (2020). *IBM SPSS for introductory statistics: Use and interpretation* (6th ed.). New York, NY: Routledge.
- Nabila Nejmmaoui.** (2019). Improving EFL learners' critical thinking skills in argumentative writing. *English Language Teaching*, 12(1), 98-109.
- Nabishah Mohamad, Nurulain Abu Bakar, Shafawati Mohd Zulkifli, Norfaezah Lasman, Tan Wei Hao & Sia Siaw Khing.** (2012). Implementation of peer teaching among medical students. *Procedia - Social and Behavioral Sciences*, 60, 529-533.
- Newton, J.** (2013). Incidental vocabulary learning in classroom communication tasks. *Language Teaching Research*, 17(2), 164-187.
- Nurhidayah Mohd Sharif, Mohamad Hassan Zakaria, Wan Fara Adlina Wan Mansor, Norul Alima Nordin, Ng Siew Fong & Hema Rosheny Mustafa.** (2012). Peer tutoring and tertiary ESL learners. *Procedia-Social and Behavioral Sciences*, 66(2012), 441-447.
- Pei, Z., Zheng, C., Zhang, M., Liu, F.** (2017). Critical thinking and argumentative writing: Inspecting the association among EFL learners in China. *English Language Teaching*, 10(10), 31-42.
- Peloghitis, J.** (2017). Difficulties and strategies in argumentative writing: A qualitative analysis. In P. Clements, A. Krause, & H. Brown (Eds.), *Transformation in language education*. Tokyo: JALT.
- Piaget, J.** (1952). *The origin of intelligence in children*. New York: International University Press, Inc.
- Rohmani, N. I.** (2017). Critical thinking, writing performance and topic familiarity of Indonesia EFL learners. *Journal of Language Teaching and Research*, 8(2), 229-236.
- Saeed Rezaei, Ali Derakhshan & Marzieh Bagherkazemi.** (2011). Critical thinking in language education. *Journal of Language Teaching and Research*, 2(4), 769-777.
- Saman Ebadi & Masoud Rahimi.** (2018). An exploration into the impact of WebQuest-based classroom on EFL learners' critical thinking and academic writing skills: A mixed-methods study. *Computer Assisted Language Learning*, 31(5-6), 617-651.
- Schell, J. A., & Butler, A. C.** (2018). Insights from the science of learning can inform evidence-based implementation of peer instruction. *Frontiers in Education*, 3, 1-13. doi:10.3389/educ.2018.00033
- Soltanpour, F., & Valizadeh, M.** (2018). A flipped writing classroom: Effects on EFL learners' argumentative essays. *Advances in Language and Literary Studies*, 9(1), 5-13.
- Stapleton, P., & Wu, Y.** (2015). Assessing the quality of arguments in students' persuasive writing: A case study analyzing the relationship between surface structure and substance. *Journal of English for Academic Purposes*, 17, 12-23.
- Sung, K.** (2015). A case study on a flipped classroom in an EFL content course. *Multimedia-Assisted Language Learning*, 18(2), 159-187.
- Swain, M.** (2005). The output hypothesis: Theory and research. In E. Hinkel, *Handbook of research in second language teaching and learning*. Mahwah, NJ: Lawrence Erlbaum.
- Toulmin, S.** (2003). *The uses of argument (updated edition)*. Cambridge MA: Cambridge University Press.
- Tous, D. M., Tahriri, A., & Haghghi, S.** (2015). The effect of instructing critical thinking through debate on the EFL learners' reading comprehension. *Journal of the Scholarship of Teaching and Learning*, 15(4), 21-40.

- Trilling, B., & Fadel, C.** (2009). *21st century skills: Learning for life in our times*. San Francisco: John Wiley & Sons, Inc.
- Tuzlukova, V., Al Busaidi, S., & Burns, S. L.** (2017). Critical thinking in the language classroom: Teacher beliefs and methods. *Pertanika Journal of Social Sciences and Humanities*, 25(2), 615-634.
- Umar Baki, Shameem Rafik Galea & Vahid Nimehchisalem.** (2016). Malaysian rural ESL students critical thinking literacy level: A case study. *International Journal of Education & Literacy Studies*, 4(4), 71-80.
- Veliz, L., & Veliz, M.** (2019). An interrogation of the role of critical thinking in English language pedagogy in Chile. *Teaching in Higher Education*, 24(1), 47-62.
- Vyncke, M.** (2012). *The concept and practice of critical thinking in academic writing: An investigation of international students' perceptions and writing experiences*. King's College London: Department of Education and Professional Studies.
- Webb, M., & Doman, E.** (2016). Does the flipped classroom lead to increased gains on learning outcomes in ESL/EFL contexts? *The CATESOL Journal*, 28(1), 39-67.
- Yang, Y. F., & Lin, Y. Y.** (2015). Online collaborative note-taking strategies to foster EFL beginners' literacy development. *System*, 52(2015), 127-138.
- Yang, Y. T. C., & Gamble, J.** (2013). Effective and practical critical thinking-enhanced EFL instruction. *ELT Journal*, 67(4), 398-412.
- Yunus, A. S. M., Hamzah, R., Tarmizi, R. A., Abu, R., Nor, S. M., Ismail, H., & Bakar, K. A.** (2006). Problem solving abilities of Malaysian university students. *International Journal of Teaching and Learning in Higher Education*, 17(2), 86-96.
- Zainuddin, Z., & Perera, C. J.** (2019). Exploring students' competence, autonomy and relatedness in the flipped classroom pedagogical model. *Journal of Further and Higher Education*, 43(1), 115-126.
- Zeynep Turan, & Akdag-Cimen, B.** (2019). Flipped classroom in English language teaching: A systematic review. *Computer Assisted Language Learning*, 1-17.
- Zhang, P., Ding, L., & Mazur, E.** (2017). Peer instruction in introductory physics: A method to bring about positive changes in students' attitudes and beliefs. *Physical Review Physics Education Research*, 113(1), 1-9.
- Zhang, X.** (2018). Developing college EFL writers' critical thinking skills through online resources: A case study. *SAGE Open*, 8(4), 1-12.
- Zheng, D., Young, M. F., Wagner, M., & Brewer, R. A.** (2009). Negotiation for action: English language learning in game-based virtual worlds. *The Modern Language Journal*, 93(4), 489-511.
- Zou, D., & Xie, H.** (2018). Flipping an English writing class with technology-enhanced just-in-time teaching and peer instruction. *Interactive Learning Environments*, 26, 1-16.