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Effect Of Flipped Classroom On Developing Fluency And Flexibility Through Divergent Thinking Strategies

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Abstract: *This study examined the effect of flipped classroom design on developing fluency and flexibility through divergent thinking strategies. True experimental design, pre-test post-test control group design was used with two intact groups of students in the elementary education program at the Master's level. The experimental group was taught through flipped classroom design i.e. pre-class learning, in-class divergent thinking activities, and post-class learning. Torrance Test for Creative Thinking Skills (TTCTS) with nine subtasks on divergent thinking was adapted to measure fluency and flexibility. Independent sample t-test and paired sample t-test were used to compare mean scores. The findings showed a significant difference between the mean scores of the experimental group in pre-test and post-test scores on fluency and flexibility. A significant difference was found between the mean scores of students in the post-test of the control and experimental group. The findings will help to improve the implication of flipped classrooms along with divergent thinking strategies for teaching creativity to students at a higher level.*

Key Words: Creative Thinking Skills, Divergent Thinking, Flipped classroom.

Introduction

Flipped classrooms, as a pedagogical approach provide an opportunity for students to direct their learning towards the development of basic competencies. By identifying the 21st-century learning competencies and innovative learning processes, students at higher level institutions are expected to have creativity competencies to perform the challenges of the modern era (Abeysekera & Dawson, 2015). Practicing divergent thinking has effective results in improving creativity in terms of creative problem-solving skills, fluency in generating ideas, exploring unexpected connections, flexibility in imagination, and shifting thoughts on multiple views (Burnett Keller-Mathers, 2017, Khanova et al. 2015). Although the education system is facing a COVID-19 pandemic situation and shifting from face-to-face to online system, the students are struggling with their active learning. Students' active involvement in the flipped classes creates a conducive environment to learn, engages them in thought-provoking activities, helps them to communicate with their peers, and encourages them to respond to problem-solving situations for the development of lifelong learning abilities (Latorre-Cosculluela et al., 2021; Lestari, Effendi-Hasibuan, & Muhammad, 2020; Papadakis et al., 2019).

In a flipped classroom, the traditional classroom flips by moving lower-order thinking

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as pre-class learning and practicing higher-order thinking such as creative thinking skills in classroom activities. Flipped classroom refers to some active learning outside the classroom and some direct instructions in the classroom. International Bureau of Education by UNESCO declared divergent thinking as a key to future competency (Griffin & Gallagher, 2017). Divergent thinking is often associated with creativity as well as a desirable skill for student learning in all disciplines at a highe-level. Divergent thinking can be considered an essential cognitive process for generating, selecting, evaluating, and implementing unique and creative ideas. Divergent thinking is the ability to generate or produce multiple solutions from available information. Generally, divergent thinking is linked with multiple responses and alternative solutions (Mumford, Medeiros, & Partlow, 2012). Divergent thinking can be examined with task-oriented studies. Similarly, the two dimensions of creative thinking skills, such as fluency and flexibility, can be practiced through training by divergent thinking strategies. According to Torrance (2002) and Guilford (1959), the process of Fluency is to generate a number of ideas, alternatives, or solutions regarding available information. The process leading to Flexibility refers to generating varied ideas or generating many ideas in different categories. Fluency and flexibility can be practiced through divergent thinking tasks in which students can generate ideas in responses to verbal and figural tasks (Goff & Torrance, 2002; Kim, 2011; Mednick, 1967; Runco, 2008; Sternberg & Lubart, 1995; Urban; 2004; Wallach & Kogan, 1965).

Fluency And Flexibility Development Through Flipped Classroom On Divergent Thinking Training

Current practices in traditional classrooms provide less opportunity and space to practice skills because of rigid timetables and the transformation of conceptual knowledge. The flipped classroom design, in this study, is based on three approaches i.e. (a) readiness (pre-class learning), (b) creativity engagement (in-class learning), and extended learning (post-class learning). The flipped classroom activities on divergent thinking can improve fluency and flexibility, among university students. Divergent thinking refers to a process of manipulating existing knowledge to illiterate ideas by associating and combining that knowledge (Antink & Lederman; 2015; Marron & Faust, 2018).

Carefully designed activities through flipped classrooms can promote higher-order thinking skills such as creativity (Bergman & Sams, 2012; Syaroni et al., 2020). Relevant strategies introduced in the flipped classroom for divergent thinking, such as brainstorming and associations, might be effective for training the skills (Priyaadharshini & Sundaram, 2018; Rodrigues, et al., 2019). The brainstorming strategy by Osborn (1938) aims to generate many ideas without evaluating them, breaking down old ideas, making new links and extending the limited knowledge to create a unique idea (AlMutairi, 2015). Similarly, creating associations with unrelated stimuli, concepts, objects, or situations might lead to creating unique ideas and solutions (Scott, Lertiz, & Mumford, 2004; Mednick, 1962). Practicing mental activities for retrieving seemingly unrelated associations enhanced the creative ideas abilities. Habitually training unrelated associations can enhance the ability to create new links and relationships among irrelevant connections (Marron & Faust, 2018; Kim, 2011, Runco & Acar, 2012).

In this study, practicing creative thinking skills was in the general domain rather than domain-specific. The subject content was used as a carrier which provided an opportunity to practice divergent thinking activities. Although, divergent thinking is not creativity itself. The activities have been designed by carrying the content. A divergent thinking approach has been adopted to develop fluency and flexibility among participants through the flipped classroom to enhance the ability to think in different perspectives in the given situations (Nida et al., 2020; Yustina, Syafi, & Vebrianto, 2020). Flipped classroom approach was direct practicing divergent thinking in a variety of

tasks to arouse thoughts for productive thinking (Syaroni et al., 2020; Meng Sun, Wang, Wegerif, (2020)

The main objective of the study was to compare the effect of flipped classroom environments on students' fluency and flexibility between experimental and control groups.

The following research questions were investigated in the present study:

$H_0$1: There is no significant difference in pre-test post-test task wise mean scores on student's fluency in the control group

$H_0$2: There is no significant difference in pre-test post-test task wise mean scores on student's fluency in the control group

$H_0$3: There is no significant difference in pre-test post-test task wise mean scores on student's fluency in the experimental group

$H_0$4: There is no significant difference in pre-test post-test task wise mean scores on student's flexibility in the experimental group

$H_0$5: No significant difference was found in the pre-test mean score on student's fluency and flexibility in the control group and experimental group

$H_0$6: No significant difference was found in the post-test mean score on student's fluency and flexibility in the control group and experimental group.

Method

The experiment period for this study was four months, in which two classes per week and 90 to 100 minutes were fixed. For flipped classroom intervention and the instructional plan was designed and implemented based on divergent thinking activities. The flipped classroom consisted of (a) preclass learning, (b) in-class divergent thinking activities, and (c) post-class extended learning.

Participants

The participants were 105 students in the elementary education program for the Master's degree program from a public university. Two intact groups were randomly assigned for experimental and control conditions. The traditional lecture method was adopted for the control group (n=50) without any training. Similarly, the experimental group (n=53) trained through divergent thinking in flipped classroom design. Participants had no experience with this type of training before now.

Instrument

Creative performance: Students' fluency and flexibility in the creative dimension were measured in the pre-test at the start and through the post-test. Both pre-test and post-test consisted of two sets of open-ended questions such as creativity with words and creativity with figures. Creativity with words contains five tasks such as asking questions from available information, guessing the associations among unrelated things, what if situations, product modification, and listing unusual uses. Similarly, creativity with figures consisted of four tasks named use, combine, complete, and construction of the figure. Basically, the test adapted from Torrance Test for Creative Thinking Skills (TTCTS) developed by Torrance (2006), which is used for measuring creative thinking skills through divergent thinking tasks and scores on two major components of divergent thinking fluency and flexibility.

Pre-test and post-test constructed on the same format but different in task content and stimulus. For example, the pre-test task includes a question regarding listing unusual uses "Kindly think of as many unique and unusual uses of a piece of stone as you think that no one can." The post-test include different stimulus for the task e.g. "Please think of as many unique and unusual uses of a tin can as you think that no one can." The pre-test task consisted of the same task question but the stimulus "piece of stone" was switched by "tin can." Individual's responses to each task were measured in terms of fluency i.e. the number of generated ideas and flexibility i.e. the quantity of different categories between ideas.

Fluency scores were collected by counting the individual's relevant and unrepeated answers and flexibility scores were collected on the number of separate categories found an individual's responses and the shifting of idea category in the answer. All the scores were based on tasks scores of creativity with words and creativity with figures. Two experts blindly scored students' responses on both tests. The interrater reliability was calculated by using a two-way random single measure intraclass correlation coefficient ICC analysis. The analysis exposed the consistency for both tests were significant i.e. $ICC_{pretest} = .87$, $p<0.01$; $ICC_{posttest}=0.84$, $p>0.01$.

Procedure

In the first phase of the study, the presence of fluency and flexibility was assessed with The Test for Creative Thinking Skills for both the control and experimental group. The test included nine activities and scored on two divergent thinking components on fluency and flexibility to measure characteristics of mental characteristics of students' through responses. After that, flipped classroom sixteen days intervention was given to the experimental group based on the flipped classroom design.

A second phase intervention consisted of three types of learning such as (a) pre-class learning, which requires some degree of knowledge in order to understand the relationships between pieces of information for generating creative ideas. Multiple means were provided before the class which included assigned lessons, quizzes, and tasks to complete. (b) class-room learning includes face to face sessions fostering the creative expressions for both verbal and non-verbal, which include divergent thinking activities i.e. brainstorming, producing and considering many alternatives, combining and synthesis, tolerating the ambiguity, putting ideas into context, getting a glimpse of the future etc. (c) post-class learning aims to extend the learning by providing students opportunity for feedback on activities, their reflections for connecting what they have learned with their possible future. After that, a post-test was conducted to assess the difference in fluency and flexibility skills for the evidence of the effectiveness of the given intervention.

Table 1. Experiment agenda for flipped classroom design

S. No	Intervention Activities	Description of Flipped Classroom Design
1	Pre-Class Learning	Provide learning material before the start; create triggering events through auditory, visual presentations of content knowledge, quiz, and pre-activity tasks.
2	In-Class Activities	During class discussions and divergent thinking, activities to attain the creativity goals by practicing Finding the problem, being original, keeping open, being aware of the emotion, combining and synthesizing, imagining richly and colorfully, enjoying and using fantasy, look at it another way, highlight the essence, manipulate ideas into context, get a glimpse of the future, produce and consider many alternatives, be flexible, breakthrough extend the boundaries, let the humor flow and use it, visualize the inside
3	Post-Class Learning	Extended learning through feedback, reflections on exercises, activities constructed by students

Table 1 describes the intervention agenda designed for the flipped classroom. There were three approaches as intervention activities. Pre-class learning fulfilled the purpose of arousing curiosity. During class, designed activities were performed. The traditional method of teaching was adopted for the control group, which was based on the lecture method with whiteboard instructions, one major presentation, surprise quizzes, midterm, and final exam within the

classroom settings. The learning material was provided as the classes proceeded day to day in preparation for the midterm and final exams. The traditional outline was provided with a one-day orientation. The control group was taught with a teacher-centered approach and with a traditional lecture method in a controlled environment. There were no creative thinking practices and activities were designed for the control group.

Data Collection And Analysis

In week sixteen of the semester course, the researcher administered the post-test from the control and experimental group. The Test for Creative Thinking Skills (TCTS) assessed the presence of creative thinking skills of students in two components fluency and flexibility for the purposes of obtaining information if the flipped classroom intervention was effective for the development of these skills. The pre-test and post-test were the same tests but the tasks were shuffled and tasks were designed by different but same complexity level stimulus.

The score of fluency was collected by counting the individual's relevant answers in every task which were not repeated (quantity of the answers). Flexibility scores were collected by counting the number of separate categories found in an individual's responses and the shift of one category to another (shifting of idea category in the answers). For example, the *Task-Unusual Uses of Tin Can* contained three categories for flexibility named as *Ornamental-Household, Container-Holder, Scientific-Mechanical* each category scored one number and if an individual answered within all categories, it was scored three. If an individual presented ten ideas for the uses of a tin can within three categories but two categories in a row were scored as one and immediately shift to a separate category it was scored again.

Table 2. Example Scoring Procedure for Task-Unusual Uses

Ideas	Fluency	Flexibility	
	No. of answers	Categories	
Milk Jug	1	Container-Holder	
Moneybox	2	Container-Holder	1
Saucepan	3	Container-Holder	
Warship for my armor collection box	4	Scientific-Mechanical	1
Jewelry box	5	Container-Holder	1
Plant stand	6	Ornamental-Household	
Flowerpot	7	Ornamental-Household	1
Total	7		4

Table 2 explains the scoring procedure for Task-Unusual Uses. In this task, fluency =7, flexibility = 4. The total score for the above task was 11. Firstly, pre-test post-test data were collected from the control group (n=50) and the experimental group n=53. For analysis, all raw scores of 9 tasks were counted; frequencies were collected to calculate the mean and standard deviation. For further, task-wise t-test analyses were run for pre-test and post-test of the control group and experimental scores. Secondly, a t-test was run for pre-test post-test of group comparison of the control group and experimental group.

Results

$H_0 1$: There is no significant difference in pretest-posttest task-wise mean score on student's fluency in the control group.

Table 3. Control Group-Task wise-Mean Difference in Fluency

S. No	Task	Pre-test		Posttest		t	Sig.
		Mean	SD	Mean	SD		
1	Asking questions	1.88	.942	1.97	.821	-2.341	0.072
2	Guess associations	6.70	1.482	6.34	1.206	-1.504	0.073
3	What if situations	8.51	1.492	9.62	2.357	1.006	0.055
4	Product modification	3.77	1.202	4.16	1.360	1.405	0.086
5	Unusual uses	10.91	1.082	11.75	1.021	-1.332	0.060
6	Use of figures	4.02	1.871	4.57	0.962	1.032	0.068
7	Combine the figure	4.28	1.762	4.37	1.406	1.205	0.058
8	Complete the figure	2.62	1.872	2.85	1.220	-1.014	0.065
9	Construct the figure	1.01	1.923	1.07	0.88	-1.950	0.072

Above table 3 described task wise mean difference on fluency in control group. The paired sample t-test results indicated mean difference between pretest asking questions (M=1.88, SD=.942) and post-test (M=1.97, SD=.821) with t(-2.341), p(0.072), pretest task guess associations (M=6.70, SD=1.482) and posttest (M=6.34, SD=1.206), with t(-1.504), p(0.073), what if situations pretest (M=8.51, SD=1.492) and posttest (M=9.62, SD=2.357), with t(1.006), p(0.055), product modification pretest (M=3.77, SD1.202=) and posttest (M=4.16, SD=1.360), with t(1.405), p(0.086), pretest unusual uses (M=10.91,SD=1.082) and posttest unusual uses (M=11.75, SD=1.021), with t(-1.332), p(0.060), pretest task use of figure (M=4.02, SD=1.872) and its posttest indicated (M=4.57, SD=0.962), with t(1.032), p(0.068), pretest task combine the figure (M=4.28, SD=1.762) and its posttest showed (M=4.37, SD=1.406), with t(1.205), p(0.058), complete the figure pretest (M=2.62, SD=1.872) and its posttest showed (M=2.85, SD=1.220), with t(-1.014), p(0.065), construct the figure pretest (M=1.01, SD=1.923) and (M=1.07, SD=0.88) was posttest, with t(-1.950), p(0.072) showed no statistical significant difference among pretest and posttest tasks. Consequently, it explained that student's fluency did not significantly improve in traditional learning classroom setting.

$H_0$2: There is no significant difference in pre-test post-test task wise mean score on student's fluency in control group.

Table 4. Control Group-Task wise-Mean Difference on Flexibility

S. No	Task	Pre-test		Posttest		t	Sig.
		Mean	SD	Mean	SD		
1	Asking questions	0.45	.353	0.51	.346	1.233	1.069
2	Guess the associations	0.94	1.783	1.65	1.745	-0.203	1.024
3	What if situations	2.37	1.263	2.80	2.804	1.864	0.090
4	Product modification	1.25	1.542	1.55	1.743	1.640	0.062
5	Unusual uses	1.48	1.822	1.86	1.241	1.328	0.064
6	Use of figures	3.65	1.756	4.74	1.028	1.305	0.073
7	Combine the figure	1.57	1.870	1.74	1.204	0.805	0.054
8	Complete the figure	1.64	1.703	1.74	1.506	-1.204	0.073
9	Figure construction	4.62	1.78	4.95	1.45	-1.024	0.066

Above table 4 described task wise mean difference on flexibility in control group. The paired sample t-test results showed the mean difference between pretest asking questions (M=0.45, SD=.353) and post-test (M=0.51, SD=.346) with t(1.233), p(1.069), task guess associations (M=0.94, SD=1.783) and posttest (M=1.65, SD=1.745), with t(-0.203), p(1.024), what if situations pretest (M=2.37, SD=1.263) and posttest (M=2.80, SD=2.804), with t(1.864), p(0.090), product modification pretest (M=1.25, SD=1.542=) and posttest (M=1.55, SD=1.743), with t(1.640), p(0.062), pretest tasks unusual uses (M=1.48, SD=1.822) and posttest (M=1.86, SD=1.241), with t(1.328), p(0.064), pretest task in complete the figure (M=3.65, SD=1.756) and posttest (M=4.74, SD=1.028), with t(1.305), p(0.073), combine the figure pretest (M=,1.57, SD= 1.870) and posttest(M=1.74, SD=1.204), with t(0.805), p(0.054), complete the figure pretest (M=1.64, SD= 1.703) and posttest (M=1.74, SD=1.506), with t(-1.204), p(0.073), pretest task construct the figure calculated (M=4.62,SD=1.78), and posttest showed (M=4.95, SD=1.45), with t(-1.024), p(0.066), were not statistically significant. The results explained that student's flexibility did not significantly improve in traditional learning classroom setting.

$H_0$3: There is no significant difference in pre-test post-test task wise mean score on student's fluency in experimental group.

Table 5. Experimental Group-Task Wise-Mean Differences in Fluency

S. No	Task	Pre-test		Posttest		t	Sig.
		Mean	SD	Mean	SD		
1	Asking questions	1.89	1.544	3.87	2.113	1.230	0.00
2	Guess associations	6.21	2.392	11.17	4.632	-1.930	0.00
3	What if situations	8.70	3.261	11.85	3.761	1.320	0.00
4	Product modification	3.68	1.508	6.11	2..69	-1.345	0.00
5	Unusual uses	11.38	2.127	15.34	24.554	3.029	0.00
6	Use of figures	9.11	3.362	15.62	3.546	2.345	0.00
7	Combine the figure	4.12	2.077	7.92	2.789	4.356	0.00
8	Complete the figure	4.16	2.075	7.92	2.787	4.342	0.00
9	Figure construction	1.03	1.823	3.07	1.89	4.421	0.02

Above table 5 described task wise mean difference on fluency in experimental group. The paired sample t-test results showed the mean difference between pretest asking questions pretest (M=1.89, SD=1.544) and posttest (M=3.87, SD=2.113), with t(1.230), p(0.00), task guess associations, pretest(M=6.21, SD=2.392), and posttest(M=11.17,SD=4.632),with t(-1.930), p(0.00), what if situations pretest(M=8.70,SD=3.261),and posttest(M=11.85, SD=3.761),with t(1.320), p(0.00), product modification pretest (M=3.68,SD=1.508),and posttest(M=6.11, SD=2..69),with t(-1.345), p(0.00), unusual uses pretest (M=11.38, SD=2.127), and posttest (M=15.34, SD=24.554), with t(3.029), p(0.00), use of figure pretest(M=4.12,SD=2.077), and posttest(M=7.92, SD=2.789), with t(4.356), p(0.00), combine the figure pretest (M=4.16, SD=2.075), and posttest(M=7.92,SD=2.787), with t(4.342), p(0.00), complete the figure pretest(M=1.03, SD=1.823), and posttest(M=3.07, SD=1.89), with t(4.421), p(0.02), pretest task construct the figure indicated (M=4.62,SD=1.78), and its posttest showed (M=4.95, SD=1.45), with t(-1.024), p(0.066), were not statistically significant. The results explained that student's flexibility did not significantly improve in traditional learning classroom setting.

$H_0$4: There is no significant difference in pre-test post-test task wise mean score on student's flexibility in experimental group.

Table 6. Experimental Group-Task Wise-Mean Differences in Flexibility

S.No	Task	Pre-test		Posttest		t	Sig.
		Mean	SD	Mean	SD		
1	Asking questions	0.45	0.994	1.66	1.353	1.283	0.00
2	Guess associations	1.04	0.963	2.53	1.138	1.028	0.00
3	What if situations	2.68	1.082	3.85	1.114	1.028	0.00
4	Product modification	1.23	1.797	1.72	1.630	1.940	0.00
5	Unusual uses	1.91	2.509	2.45	1.633	2.062	0.00
6	Use of figures	3.62	1.883	7.20	2.033	4.072	0.00
7	Combine the figure	1.96	0.894	4.77	1.854	3.581	0.00
8	Complete the figure	1.96	1.894	4.77	1.857	3.490	0.00
9	Figure construction	4.42	1.79	3.65	3.13	2.846	0.00

Above table 6 described task wise mean difference on flexibility in experimental group. The paired sample t-test results showed the mean difference between pretest asking questions Asking question pretest (M=0.45, SD=0.994), and posttest (M=1.66, SD=1.353), with *t* (1.283), *p* (0.00), pretest task Guess the associations indicated (M=1.04, SD=0.963), posttest showed (M=2.53, SD=1.138), *t* (1.028), *p* (0.00), pretest task what if situations showed (M=2.68, SD=1.082), posttest (M=3.85, SD=1.114), *t*(1.028), *p*(0.00), pretest task product modification described (M=1.23, SD=1.797), and its posttest showed (M=1.72, SD=1.630), *t*(1.940), *p*(0.00), Unusual uses pretest (M=1.91, SD=2.509), and posttest (M=2.45, SD=1.633), *t*(2.062), *p*(0.00), Use of figure (M=3.62, SD=1.883), and posttest (M=7.20, SD=2.033), *t*(4.072), *p*=(0.00), Combine the figure (M=1.96, SD=0.894), and posttest indicated (M=4.77, SD=1.854), *t*(3.581), *p*(0.00), Complete the figure pretest (M= 1.96, SD=.894), and posttest (M= 4.77, SD=1.857), t(3.490), p(0.00), Construct the figure pretest (M=4.42, SD=1.79), and posttest (M=3.65, SD=3.13), *t*(2.846), *p*(0.00) were not statistically significant. The results explained that student's flexibility did not significantly improve in traditional learning classroom setting.

$H_0$5: No significant difference was found between pre-test mean score on student's fluency and flexibility in control group and experimental group.

Table 7. The t-test for Independent Samples: Control and Experimental Group Comparison on Pretest

S. No	Variable	Control Group		Experimental Group		T	Sig.
		Mean	SD	Mean	SD		
1	Fluency	40.57	4.261	41.10	3.448	1.234	0.24
2	Flexibility	15.67	3.672	16.55	3.882	-1.271	0.45

The t-test for independent samples was used to compare the pre-test mean score of students on two creative thinking skills i.e., fluency, flexibility. According to table 7, no statistically significant differences were found between the control group and experimental group. On fluency (M=40.57, SD=4.261), and experimental group (M=41.10, SD=3.448) *t*(2)=1.234, p=.24. Similarly, on flexibility with the control group (M=15.67, SD=3.672) and experimental group scores (M=16.55, SD=3.88). It means that the creative thinking

skills of students in terms of fluency and flexibility in the control group and experimental group were similar in the pre-test.

$H_0$6: No significant difference was found between the post-test mean scores on students' fluency and flexibility in the control group and experimental group.

Table 8. The t-test for Independent Samples: Control & Experimental Group Comparison on Posttest

S. No	Variable	Control Group		Experimental Group		t	Sig.
		Mean	SD	Mean	SD		
1	Fluency	42.55	3.456	94.24	3.906	1.547	0.00
2	Flexibility	17.87	3.935	38.10	3.552	1.330	0.00

The t-test for independent samples was used to compare the post-test mean score of students on two creative thinking skills i.e., fluency and flexibility. According to Table 8 statistically significant differences were found between control group and experimental group on fluency with control group (M=42.55, SD=3.456), and experimental group (M=94.24, SD=3.906), t (2)=1.547, p=.00, on flexibility with control group (M=17.87, SD=3.935) and experimental group (M=38.10, SD=3.552, t(2)=1.330, p=.00. It means that the creative thinking skills of students in terms of fluency and flexibility in the experimental group were better and higher than the scores of students in the control group in the post-test, showing the impact of a flipped classroom intervention on two components of divergent thinking named as fluency and flexibility of the participants in the experimental group.

Discussion

This study examined the effectiveness of flipped classrooms in developing students' fluency and flexibility, which can be improved through divergent thinking. Flipped classroom design has the capacity to promote divergent thinking skills due to its schedule flexibility and interactive learning environment (Bergman & Sams, 2004; Papadakis et al., 2019); Latorre-Cosculluela et al., (2021); Yurniwati & Utomo, (2020). The overall results suggested a positive impact of the flipped classroom in developing fluency and flexibility of ideas among students. Flipped classroom activities provide the opportunity to practice *fluency* in generating ideas through identification of the problem and suggesting solutions by performing brainstorming tasks such as relating ideas with topics in a similar context or situations, practicing *flexibility* to explore different options by shifting their thoughts, explaining the different point of view sometimes original ideas into a more complex problem and situations, and making connections, adding details in new or previous ideas. The study of Rodrigues, Diez, Perez, Banos, Carrio (2019), and Priyaadharshini and Sundaram (2018) also suggested that complex skills such as fluency and flexibility, can be improved and trained through flipped classroom design (Latorre-Cosculluela et al., 2021; Lestari, Effendi-Hasibuan, & Muhammad, 2020), and divergent thinking strategies (Ozyaprak, 2016).

Next, the pre-test scores on fluency and flexibility, showed fewer scores of students in the control and experimental groups. Fluency and flexibility, are developed by generating and creating ideas by exploring possible solutions and students develop these skills in the traditional classrooms over an extended period of time (Papadakis et al., 2019). For example, note-taking, practicing imagining and daydreaming, and focusing on the ideas improve divergent thinking of students; since students are not typically trained to develop these skills in a traditional classroom, they do not develop these skills frequently while solving the problems (Beghetto, 2010). The scores of both groups in the pre-test of this study endorse this finding that students were not much trained in using creating thinking skills in the classroom; they performed low scores in the pre-test and did not statically significantly differ in their mean score on fluency and flexibility.

To examine the effectiveness of flipped classrooms in developing students' *fluency*. The experimental group demonstrated a significantly higher mean score on fluency as compared to the control group. Fluency, as an essential component of divergent thinking, can be practiced through flipped classroom activities. Producing and selecting as many substitutions in ideas as possible was defined as fluency. In intervention, divergent activities were based on generating own problems and their solutions by asking questions, making unrelated connections, generating many alternatives among multiple ideas, thinking beyond the boundaries, adjusting ideas in another context, and imagining things that do not exist, giving situations and ideas of the history, making connections between things, recognizing verbal and nonverbal cues, and training the creative thinking competence in students. Al-Zahrani, (2015), Berki, (2016), Kampylis et al., (2015); Sya'Roni, et al., (2020) and Amanisa and Maftuh (2021) found similar results that flipped classroom learning environment improved students' skills in fluency, and their frequency of using questioning, guessing association, and generating ideas increased significantly under flipped classroom learning environment. The students think deliberately to use brainstorming techniques that open alternative options of solutions in their minds, as described by Torrance (1977) and Osborn (2013) may motivate them to use creative thinking skills more fluently. As the student-teacher interaction increases and students complete different activities using guided directors of the teachers, they focus particularly on different options and use their imagination to find the solutions. Further, studies might be conducted on finding possible reasons for increasing fluency skills in students in the flipped classroom learning environments.

The next finding was related to measuring the effectiveness of divergent thinking activities in the flipped classroom for enhancing *flexibility* provided significant differences before and after the intervention in developing flexibility. According to Millar (2010); Torrance and Safter (1999) recommended practices to encourage flexibility component, provide an opportunity for producing a variety of ideas, select diverse categories and perspectives, play with imagination and fantasy, arouse curiosity, wondering and exploring the alternatives and possibilities that do not exist yet. This finding was aligned with the study of Amanisa and Maftuh (2021), Al-Zahrani, (2015), and Priyaadharshini and Sundaram (2018) as they developed flexible thinking by practicing flipped classroom activities in their classrooms. In the flipped classroom learning environment, the teacher performed the role of facilitator and helped students in generating new ideas, guided them on how to direct their attention towards different categories, and explored different perspectives which led the students to think divergently and think flexibly around different options towards problem-solving.

Finally, combining the results of all factors, the students in the experimental group showed significantly higher mean scores both in fluency and flexibility. It was found that students improved their divergent thinking as a result of intervention in the result of flipped classroom learning experiences. The overall integration of pre-class and in-class activities emerged the knowledge and provided extra time for classroom activities, for instance, based group interaction, inquiry, and problem-solving facilitate creative thinking skills (O'Flaherty, & Phillips, 2015; Yurniwati & Utomo, (2020). Divergent thinking is a process of sensing the gaps in information towards a problem and then identifying the difficulties which lead to the solutions. This process based on trial-and-error practices and formulating hypotheses for the solution of the addressed problem helped students develop creative thinking skills. The overall findings of this study are aligned with previous research conducted by Rodrigues, et al., (2019), Graham & Burke, 2014, Sya'Roni et al., (2020) that students improve creative thinking through flipped classrooms and prefer flipped classroom approaches to traditional classroom learning.

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