Online Learning as a Panacea?

An Empirical Study to Discuss Problem-Based Cooperative Learning in Taiwan

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Abstract—Due to the coronavirus pandemic (COVID-19), many schools and universities have closed worldwide, however, the UNESCO recommended the use of distance learning to reach learners remotely and limit the disruption of education. this is an empirical study to discuss if the role of online learning really helps learners to learn programming design better on problem-based cooperative learning. This study adopted a quasi-experimental and nonequivalent control-group design, and it carried out a 7-week experimental instruction by applying online and face-to-face cooperative learning methods. The programming design learning achievement pretest and posttest were used to collect the data from the participants. And it shown that the different cooperative learning methods had significant differences in their achievement, learning online was helpful, but face-to-face learning was superior significantly than online learning in this study.

Keywords—Problem-based cooperative learning, programming design, learning achievement, quasi-experimental design.

1 Introduction

2020, it is a dramatic year, full of changes and tough challenges, the coronavirus pandemic (COVID-19) not only affected our life safety, but also the financial development and the global situation, more importantly, our educational system and the students' right to education have been influenced. So far, there are only 6 countries that their schools are still open, including Australia, Singapore, Sweden, Cuba, Tajikistan, and Taiwan [1]. In other words, there have be more than 1.5 billion students across the planet are affected. Face-to-face learning has been stopped in many schools, and lots of classes have been disrupted without a clear deadline. For some schools that are still open, online learning seems to be a solution to solve this impact. However, not every student has internet access or a computer at home [2]. Therefore, virus forced schools using online learning, but many students didn't follow it [3].

People who were born after 1980 are called digital natives, and they have grown up in the digital age, and generally they have the ability of technological use [4, 5]. Ac-

cording to the widespread of the internet and the technology, learners of this generation have different learning patterns than the generations before [4, 6, 7], furthermore, they have a fundamental change: communicate, socialise, create and learn [8]. Not to mention the learners of this generation have more opportunities to use this resource, but a family's socioeconomic status leads different outputs influentially.

To programming design learners, some researches shown that the digital natives had positive learning attitudes, and they participated actively during the problem-solving process [9, 10]. They liked to learn programming design and they wanted to improve their programming [11]. Therefore, in order to learn programming better, lots of practice is needed [12], and the learners need to be adequately motivated in order to learn programming in an effective manner, or the learning cannot last for a long time [13, 14]. Some studies have shown that the problem-based cooperative learning did help learners to learn better [15, 16, 17, 18, 19]. That is to say, in order to inspire the learners' motivation and to learn programming better, and to combine the issue of distance learning due to the coronavirus pandemic, this study used problem-based cooperative learning to discuss the differences between the traditional discussion method and the online method.

2 Methodology

In order to achieve the goals of this study and fit the class sizes, this study adopted a quasi-experimental, nonequivalent control-group design, and carried out 7 weeks (Each week contained 4 hours) of experimental instruction. In this study, randomly chose Class A to use face-to-fact discussion method, and Class B was chosen to use online discussion method. In order to reduce the differences between the control variables, these two classes were from the same university in Taiwan, department and grade, they had the same teaching material and class contents, and they had the same teacher. The participants from these two classes were all freshmen, and they all took programming design as a compulsory course. Moreover, both of the two classes used problem-based cooperative learning method to learn programming design, and the only different part was in the methods of discussion. Before and after the experiment, the programming learning achievement pretest and posttest were used to collect the data from the participants. The tests were designed according to the problem-based cooperative learning teaching material on programming design [20].

Furthermore, this study used heterogeneous grouping on purpose just to exchange different point of views, skills and knowledge, and hopefully the learners who had better comprehension on programming design could lead their partners to a better way, and eventually they could learn better. The scores of the programming learning achievement pretest was used on heterogeneous grouping as well. Originally the total numbers of the participants were 95, after eliminating the absentees, the valid sample number was 88 (Class A had 46 persons, and Class B had 42 persons). The course was scheduled as Table 1. After the experimental instruction, the data were analyzed by using paired-samples t test and analysis of covariance (ANCOVA).

Table 1. Course Schedule

Week	Course Content
1	Pretest & Course Introduction
2	Introduction to C++; Data type & Identifier; Constant & Variable; Input & Output.
3	Operator & Expression
4	Logic decision; Relational Operator
5	If statement
6	Nested condition statement
7	for loop; while loop
8	do while loop; nested loop
9	Posttest

3 Result and Discussion

3.1 Result

Paired-samples to test: This study compared the scores of the pretest and posttest with paired-samples *t* test, and the results were showed in Table 2. According to Table 2, after the 7-week learning, the learning achievement was statistically significant except Unit 3 (Flow control).

Table 2. The Paired-Samples *t* Test of All Participants

Units	Tests	Mean	t-test	95% Confidence Level	
Overall	Posttest	10.830	11.480***	[3.824,	5.426]
	Pretest	6.205	p<.000		
Unit 1 (Basics of C++)	Posttest	2.023	2.328*	[0.057,	0.716]
	Pretest	1.636	p=.022		
Unit 2 (Expression)	Posttest	3.989	9.300***	[1.510,	2.331]
	Pretest	2.068	p<.000		
Unit 3 (Flow control)	Posttest	1.852	6.357	[0.609,	1.164]
	Pretest	0.966	p=.569		
Unit 4 (Repeat flow control)	Posttest	2.966	6.901***	[1.019,	1.844]
	Pretest	1.534	p<.000		

***p<.000, ** p<.01, * p<.05

Table 3 shows the results of the paired-samples t test in different classes. The entire learning achievement was statistically significant in the face-to-face discussion class (A), but in the online discussion class (B) the learning achievement was statistically significant except Unit 1 (Basics of C++).

Table 3. The Paired-Samples *t* Test of the 2 Classes

Learning Methods	Units	Tests	Mean	*t*-test	95% Confidence Level	
Class A (Face-to-face)	Overall	Posttest	11.619	10.782***	[4.586,	6.700]
		Pretest	5.976	*p*<.000		
	Unit 1	Posttest	2.119	2.101*	[0.018,	0.934]
		Pretest	1.643	*p*=.042		
	Unit 2	Posttest	3.810	6.202***	[1.268,	2.493]
		Pretest	1.929	*p*<.000		
	Unit 3	Posttest	2.333	6.951***	[0.963,	1.751]
		Pretest	0.976	*p*<.000		
	Unit 4	Posttest	3.357	6.019***	[1.281,	2.576]
		Pretest	1.429	*p*<.000		
Class B (Online)	Overall	Posttest	10.109	6.412***	[2.535,	4.857]
		Pretest	6.413	*p*<.000		
	Unit 1	Posttest	1.935	1.255	[-0.184,	0.793]
		Pretest	1.630	*p*=.216		
	Unit 2	Posttest	4.152	6.870***	[1.383,	2.530]
		Pretest	2.196	*p*<.000		
	Unit 3	Posttest	1.413	2.568*	[0.098,	0.815]
		Pretest	0.957	*p*=.014		
	Unit 4	Posttest	2.609	3.860***	[0.468,	1.489]
		Pretest	1.630	*p*<.000		

****p*<.000, ** *p*<.01, * *p*<.05

Analysis of covariance: Since there were differences of sample sizes, this study adopted analysis of covariance to investigate the influences of discussion methods on experimental results. The scores of the pretest was the covariance to verify the differences between these two classes.

1. The test of homogeneity of within-group regression coefficient

Table 4 shows the summary of the homogeneity of within-group regression coefficient. The Wilks' Lambda value is 16.504, and the F value is 1.443 (p=.233>.05). in other words, the regression slopes within groups are the same, therefore, it fit the assumption of the homogeneity.

Table 4. The sammary of the homogeneity of within-group regression coefficient

Source	SS	df	MS	F
Within-group* covariance	16.504	1	16.504	1.443 (*p*=.233)
Error	961.031	84	11.441	

2. Levene's test

This study used Levene's test to analyze the homogeneity of variance and the results show that the F value is .112 (p=.738>0.05), satisfying the assumption of the homogeneity of variance.

3. ANCOVA analysis

After eliminating the pretest effects may cause to the posttest, the treatment effect was statistically significant. The F value is 5.385 (p=.023<.05), it means that the score of the posttest was different significantly according to the treatment (face-to-face or online). Even eliminating the pretest effect, the scores between these two classes were still different significantly. The results were shown in Table 5.

Table 5. ANCOVA summary

Source	SS	df	MS	F	Partial η2	Post hoc comparison
Covariance (pretest)	82.827	1	82.827	7.202** （*p*=.009）	.078	A>B
Between-group	61.927	1	61.927	5.385* （*p*=.023）	.060	
Within-group (Error)	977.534	85	11.500			

*p<.05 **p<.01

According to Table 6, Class A's adjusted mean is 11.711, and Class B's adjusted mean is 10.025 (A>B). It means that using face-to-face discussion method was more effective to enhance the learners' problem-based cooperative learning achievement in programming design.

Table 6. Descriptive statistics of the posttest between-group

Class	N	Mean	SD	Adjusted means
Face-to-face (A)	42	11.62	3.540	11.711
Online (B)	46	10.11	3.485	10.025

3.2 Discussion

Programming design learners can describe the results accurately through cooperative learning [21], and this study made a further research about different kinds of cooperative learning methods to discuss the learning achievement. As the results, this study found that the different cooperative learning methods had significant differences. in other words, different cooperative learning methods lead into different results. Therefore, face-to-face and online cooperative learning have different levels of learning achievement in programming design. In this study, face-to-face cooperative learning enhanced learners' achievement better than online did, and a previous research had the same conclusion [22]. In Pechenkina & Aeschliman's study [23], learners preferred to work with their partners face-to-face. However, some studies indicated that combine face-to-face and online can enhance learning achievement even better [24, 25, 26, 27, 28, 29], and it fits the result of the meta-analysis from 1999-2011, online cooperative learning was good for learning [30]. Other research indicated that size of the group participating in the online discussions has an influence on their performance [31].

In the past, the interactions between learners are face-to-face, but in the digital era, they communicate with each other in a digital way. And with different learning technologies, students' learning achievement were different [32]. By contrast, when digital

is applied on learning, it should be more carefully with the characters of the subjects. In this study, with face-to-face discussion, learners could reflect and response their learning problems, so they could solve their problems immediately. When it comes to the online discussion, not all the group members were fully focus on learning discussion, this fits the results of the studies [33, 34]. In the meta-analysis of face-to-face cooperative learning [35], the method of cooperative learning has a positive effect to learning achievement, and face-to-face can increase the relationships and interactions between the learners, moreover, the immediately feedback was quite important.

With the results, the digital-native learners were grown up with the high-tech products, but not all the learners can learn well through those products [36]. In other words, some modern learners tend to use the high-tech, but they still prefer to interact with others in real-life

4 Conclusion

The results showed that the different problem-based cooperative learning methods had significant differences in programming design learning. Overall, the posttest scores of the learning achievement are better than the pretest ones. This study found that the learners had learning difficulties to explain and express what they really wanted to say by using online discussion to learn programming design. By the way, timing was an important key factor as well, sometimes group members could not response and provide feedbacks immediately, and the learners could not have the answers right away while they got confused. And this situation caused more learning difficulties and problems.

At this time, people are suffering from the coronavirus pandemic, and in order to prevent anyone from being infected, online cooperative learning was helpful. And it really is a good solution to continue learning. Apparently, online learning is the antidote for learners during the period of the coronavirus pandemic (COVID-19). Then again, the traditional learning method, face-to-face, was even more efficient on learning programming design on problem-based cooperative learning, and this method would not be replaced by the online method on problem-based cooperative learning.

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