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Original Research Paper

Reciprocity Effect between Cognitive Style and Mixed Learning Method on Computer Programming Skill

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Abstract: Many universities undertake mixed learning to meet the required needs. Mixed learning is a blend of F2F classroom education and online learning education. The strength of mixed learning is that it supports student cognitive styles more than non-mixed learning. The right blend of mixed learning provides more constructive and conducive learning. Meanwhile, the programming language is the primary skill that students must master to create computer application programs. The question is: Is there an effect on student cognitive style and learning methods on mixed material 30% F2F and 70% asynchronous online on student programming skills? Therefore, this study aims to determine the effect of reciprocal interaction between cognitive st[15] and mixed learning methods on programming skill achievement. This research method is experimental research. The study found that: although there is no difference in the achievement of student learning skills based on tests on mixed learning methods, further test on student cognitive styles found that there are differences in the achievement of student learning skills in mixed learning methods; students with auditory and visual cognitive style who learn with mixed learning-2 have better programming skill achievement than students with auditory cognitive style who learn with mixed learning-2; students with kinesthetic and visual cognitive styles who learn with mixed learning-2 have superior programming skill achievement compared to students with kinesthetic cognitive styles who learn with mixed learning-1. The research novelty is: there has been no previous research on the reciprocal effect of cognitive styles and mixed learning methods with a mixture of 30% F2F and 70% online and vice versa.

Keywords: Cognitive Style, Mixed Learning, Computer Programming, Learning Method

Introduction

The rapid advancement of ICT (information and communication technology) makes it easier to realize multimedia in learning to support student cognitive styles. Besides that, the use of ICT also has a positive impact on the learning process as well as realizing learning efficiency (Aljuboori, Fashakh and Bayat, 2020). However, the rapid development of ICT has increased pressure for universities to include greater use of technology and innovation in the curriculum (Tyler-Wood, Cockerham and Johnson, 2018). Therefore, it is not surprising, if many tertiary institutions adopted mixed learning approaches as a solution (Nazarenko, 2015). Mixed learning is a perfect blend of F2F classroom education and asynchronous online learning education (Pierce, 2017).

Mixed learning research has long been a concern of researchers, and lately, it has become an important research topic because it has a combined advantage of learning in the classroom and outside the classroom. Unfortunately, research on mixed learning skills is still limited (Nazarenko, 2015). The benefits of mixed learning are the best approach to learning strategy by taking the strengths of face-to-face (F2F) and online learning (Sleator, 2010). One of the strengths of mixed education is that it provides a conducive learning environment for students and supports a variety of

students' cognitive styles (Pierce, 2017). That makes sense that prior research indicated, mixed learning is superior to non-mixed learning in learning achievement (Niekerk and Webb, 2016). Mixed learning can maximize student learning outcomes by applying appropriate technology learning to fit student cognitive style in transferring skills properly and at the right time (Lieser and Taff, 2013). Besides, the right combination of mixed learning provides social support and constructive learning for students (Opina, Velarde and Sicat, 2011) and creates conducive interactions in learning activities (Pierce, 2017). However, the question is: how is student learning skill achievement based on student cognitive style? How is the student skill achievement from two different mixed learning, and is there a reciprocal influence between student cognitive style and mixed learning methods? What will the results be if there is a mutual influence between cognitive styles and mixed learning methods? Therefore, this study aims to determine the effect of reciprocal interaction between cognitive styles and mixed learning methods on learning skill achievement.

The mixed learning method combines education between F2F classroom education and online learning education (Hogarth and Biggam, 2009)(Almpanis *et al*., 2010). F2F class education strength is the high intensity of interaction between students and lecturers in facilitating cooperative learning and clarity of lecture materials (Agosto, Copeland and Zach, 2013). The F2F classroom education offers real and meaningful interactions between students and teachers, while pure online education cannot replace it (Tang and Chaw, 2013). The problem is, the F2F classroom education requires higher tuition fees, especially in well-known tertiary institutions (Norman, 2016). Online learning is a significant part of university education to support conventional F2F learning (Seta *et al*., 2018). Communication that occurs in online learning is synchronous and asynchronous (Clark and Barbour, 2015). In synchronous online, education is delivered remotely in real-time by the teaching lecturer to students (Anggrawan and Satria, 2020). Whereas learning material in asynchronous online education is given indirectly to the student (Anggrawan and Satria, 2020). In asynchronous online, students can access material or modules stored on the server computer anytime and anywhere through computers connected via the internet to specific web addresses (Anggrawan and Satria, 2020). Asynchronous online learning constitutes independent learning for students (Anggrawan and Satria, 2020) or collaborative learning by some students who agree to study. Students and lecturers agree that one of the main weaknesses of online learning is the lack of 'face-to-face' interaction (Król, 2016). Meanwhile, the strength of asynchronous online education is the ability to take advantage of various multimedia forms: text, audio, visual still and moving, and other forms for learning purposes supporting student cognitive styles (Clark and Barbour, 2015).

Every student has a cognitive style that reflects a way of learning that is preferred and easier for students to understand. Students with high specific cognitive styles have more significant difficulties acquiring knowledge than students with weaker cognitive styles (Psycharis, Botsari and Chatzarakis, 2014). There are three types of cognitive styles, namely visual, auditory and kinesthetic (Anggrawan *et al*., 2019). Students with visual cognitive styles prefer and easily understand the lessons presented in writing, pictures, graphs, and tables (Anggrawan *et al*., 2019). In other words, students with visual cognitive styles in learning rely on their sense of sight. Auditory students prefer the lesson presentation in voice or lecture form (Anggrawan *et al*., 2019). So, in other words, students with auditory cognitive style rely on the sense of hearing. Kinesthetic students prefer to learn in interactive information media and special situations (Anggrawan *et al*., 2019). In essence, learning should support student cognitive styles to improve performance and success learning (Eudoxie, 2011). So it makes sense, and inevitable, if later, more and more universities have created systems and organized innovative mixed learning to accommodate student cognitive styles and the learning needs of 21st-century students (Lieser and Taff, 2013).

Substantially, mixed learning provides better effectiveness than education that relies only on the conventional F2F education method (Niekerk and Webb, 2016). Besides, students respond positively and easily adapt to mixed learning (Anggrawan et al., 2019); actually, mixed learning brings excellent opportunities for students to master the subject matter and achieve success in education (Lieser and Taff, 2013). What's more, mixed learning patterns provide a more conducive learning environment and increase student learning achievement (Bazelais and Doleck, 2018). In fact, despite online learning education or conventional F2F classroom education has disadvantages, but mixed learning can overcome it as long as mixed learning is mixed with the right mix (Opina, Velarde and Sicat, 2011). According to Heather Kanuka & Liam Rourke (2013), some experts argue that the portion of the online learning mix in mixed learning is 25% to 50%; meanwhile, other experts determine the amount of the online learning mix in mixed learning is between 30% and 70% (Kanuka and Rourke, 2013). In short, there is no certainty about the portion of the online learning mix in mixed learning. Thus, mixed learning main obstacle lies in the accuracy of the mixture; of course, the right mix in one subject does not mean it is suitable for another subject (Anggrawan et al., 2019). Likewise, although certain subjects have produced evidence of satisfactory learning success with mixed learning, this does not mean that the same conditions apply to other courses. So, the mixture accuracy and the suitability of mixed learning in each subject must be scrutinized scientifically. Thus, in essence, scientific research on mixed learning is necessary to determine how well the student learning success due to the mutual

influence between cognitive styles and mixed learning methods. In other words, if there is a mutual influence between cognitive styles and mixed learning methods, it is necessary to know what the results are?

In short, in connection with this research, the formulation of the research problem explicitly is:

(a) What learning methods are better than the two kinds of mixed teaching methods, is the mixture of 70% learning in class and 30% online learning outside the classroom or 30% learning in class and 70% online learning outside the classroom?
(b) Is there a reciprocal influence between student cognitive styles and mixed learning methods applied in teaching?
(c) If there is a reciprocal influence, how will it affect the achievement of student programming skills?

The programming skill is the ability of students to create computer applications with programming languages. The visual programming language is event-based programming (Anggrawan, 2018). In other words, program code is made based on specific events or functions so that the sequence of program execution is also an event. In contrast to structured or procedural programming, it will execute program code from the beginning to the end of the program sequentially. The visual programming language that is most popular today is Visual Basic.Net or VB.Net (Anggrawan, 2018). In other words, programming language courses are essential for students in mastering programming skills (Anggrawan, 2018).

The structure of the writing of the next part of this manuscript is as follows: section 2 discusses the related work of some of the latest scientific articles before; Section 3 discusses the Research Methodology, which consists of discussing learning treatments, data collection, and research methods, section 4 discusses the research findings and ends with section 5 discusses the research conclusion.

Related Work

This subsection provides a brief literature review of some of the most recent scientific articles relating to cognitive styles, programming, and mixed learning.

- Theodoropoulos, Antoniou and Lepouras (2016) investigated the link between cognitive styles and student capabilities in learning programming using games. This study indicates that the cognitive style is a significant learning characteristic to consider when learning the programming lesson. This study uses a survey method to obtain research results.
- Awang et al. (2017) conducted a study that essentially examined the effect of students' cognitive styles on academic achievement. Their research results indicate that the students' cognitive styles affect academic achievement and each cognitive style has advantages and disadvantages. Their research only focuses on the influence of cognitive style in student learning outcomes using the survey method in face-to-face learning.
- Ceylan and Elitok Kesici (2017) examined the effect of mixed learning on student academic achievement. This research uses survey method with quantitative data type. The results of this study found that mixed learning environment significantly helps student academic learning achievement.
- Lazarinis et al. (2018) examined mixed learning intending to improve teacher programming skills. This study did not link cognitive styles with teacher responses to learning. This previous research also did not mention the percentage of mixing mixed learning materials between face-to-face and online learning materials. The research method used was a survey. This last study concluded that teachers responded positively to mixed learning experiences.
- Maia, Serey and Figueiredo (2019) investigated cognitive styles' application and their effects on programming education in face-to-face teaching. Their research found that students' cognitive styles can affect students' learning abilities. Their study used a survey method.
- Anggrawan et al. (2019) examined the influence between cognitive style and gender on mixed learning in Algorithm and programming lesson. This study has a limitation that only investigates mixed learning by mixing 40% face-to-face material and 60% online material. This means that this earlier study was not a reciprocity effect study; that is, it did not investigate mixed learning with the opposite mixture of mixing 40% face-to-face material and 60% online material. This earlier study found differences in learning outcomes between students who had different learning styles. Male gender students were more successful than students with the female gender, using the experimental research method.
- Alammary (2019) conducted an assessment of the comparison of programming learning experiences between conventional treatments and mixed methods of care. This study concluded that mixed learning is more effective in constructing conventional learning to improve student learning experiences. This study also confirms that there is an increasing trend in the application of mixed learning programming lessons. Besides, this previous researcher also warned that there was still little research related to programming education and mixed learning methods.

Literature review of the relative work as mentioned above: (a). did not examine the comparison of the learning achievement of two mixed learning with the opposite percentage of teaching material mix between face-to-face and online learning materials; (b). did not examine mixed learning with a mix of 70% learning in class and 30% learning online outside of the classroom and 30% learning in class, and 70% learning online outside the classroom; (c). did not research with experimental methods on student learning achievement in two mixed learning

associated with student cognitive styles and learning method;

In essence, the authors in this study conducted research that no one has examined, namely the effect of back and forth between mixed learning methods and cognitive styles on computer programming education. In addition, the authors conducted this mixed learning research with mixed teaching materials divided into 70% online and 30% face-to-face mix and vice versa which so far no one has researched.

Research Methodology

This study is experimental research. Two different classes get a mixed learning treatment of VB.Net computer programming lesson materials with a mixture of different portions between face-to-face learning and asynchronous online learning. The mixture tested was 70% versus 30% between classroom learning and asynchronous online learning in the first class and vice versa, 30% mixture versus 70% between classroom learning and asynchronous online learning in the second class.

Learning Treatment

Two classes received learning VB.Net Programming courses. Two treatment classes resulted from the random selection from 5 classes in the Computer Science study program at Bumigora University. The number of students in each treatment class consists of 50 students in the first semester of the academic year of 2019/2020. The first mixed learning class (mixed learning-1) gets treatment by combining around 30% F2F learning and about 70% online learning. Meanwhile, the second mixed learning class (mixed learning-2) gets treatment by combining around 70% F2F learning and about 30% online learning.

Students acquire VB.Net programming skills through F2F mixed learning materials in class and online learning materials. Students can learn online lessons independently in teaching material modules (or asynchronous online forms) prepared on a computer server. Besides, students can access them anywhere and anytime via the internet and study according to student needs and speed.

This research is an experimental study with two factors. The first factor is mixed learning with two levels, and the second factor is the cognitive style with three levels. Thus this research is an experimental study with a 2 x 3 factorial design.

Mixed learning-1 (ML1) and mixed learning-2 (ML2) are two learning class groups prepared to realize this experimental research. Table 1 shows the model construction methodology of a 2 x 3 factorial design.

Table 1: 2 x 3 Factorial Design

Mixed Learning / Cognitive Style	Mixed Learning-1 (ML1)	Mixed Learning-2 (ML2)
Visual (A1)	A1, ML1	A1, ML2
Auditory (A2)	A2, ML1	A2, ML2
Kinesthetic (A3)	A3, ML1	A3, ML2

So, the reciprocal effect examined in this study is the combined effect of two independent variables (two factors) on mixed learning and cognitive styles in influencing the dependent variable on learning achievement. Fig.1 shows the diagram of the 2 x 3 factorial design model.

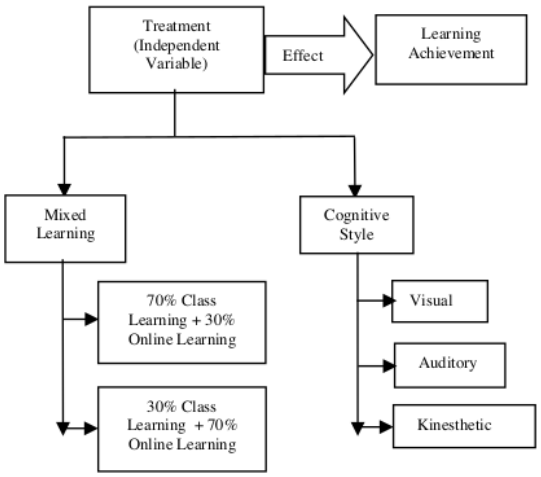

Fig. 1: 2 x 3 Factorial Design Diagram

The number of classroom learning meetings of the mixed learning-1 and mixed learning-2 takes 7-time meetings (does not include the Exam). F2F mixed learning-1 activities occur at different times, days, classes, and buildings to prevent the threat of spreading external validity. Mixed learning-1 and mixed learning-2 learning activities are as follows: lecturers provide F2F class lessons, which are structured modules of F2F learning materials that have been classified materials and materials according to F2F learning schedules. Likewise, online learning with structured material has been prepared on a computer server that can be accessed by students (anytime and anywhere) with the asynchronous (or shared) independent learning method via the website.

Data Collecting

The data collected in this study are data on the learning achievement and cognitive style of each student. The instrument in assessing student skills attainment at the end of the lesson is in essay questions. The test instrument used to evaluate student learning achievement has passed the reliability and validity test before being used in the experimental class in this study. Student cognitive style data were collected using a questionnaire conducted in a

mixed learning class. The student cognitive style questionnaire instrument uses standard VARK (Visual, Auditory, Reading / Writing, Kinesthetic) instruments that have been tested for reliability and validity.

Research Method

Learning skill achievement data in this study is ratio data. Due to in this study two classes are treated, then this research method is experimental research, but based on the type and analytical data, this research method is inferential quantitative parametric research,

Testing for normality and homogeneity of data and the instrument's validity and reliability was carried out using Shapiro-Wilk, Levene, Pearson Correlation, and Cronbach's Alpha. A two-way Anova test was conducted to ascertain a reciprocal influence between student cognitive styles and learning methods; differences in learning achievement due to differences in student cognitive styles, and differences in learning achievement between mixed learning methods with 70% learning in class and 30% via online compared to mixed learning methods with 30% learning in class and 70% via online. The Post-Hoc Tukey test is conducted to analyze the reciprocal effects that occur between cognitive style and learning methods.

Threats to internal validity in this study are overcome by means of students with the same background, namely fresh graduates from high school, meaning that students in this study have equal initial cognitive competence in computer programming, thus can overcome the threat of internal validity in the form of death/friction. Control group in the form of classroom lessons as part of mixed learning prevents this research from threatening history's internal validity. The instrument used is a standard instrument or tested instrument of validity and reliability to free from the instrument's internal validity threat. In overcoming external validity threats in this study, other lecturers (not researchers) carried out the teaching process, thus preventing bias or the deliberate or carelessness of researchers in influencing student achievement. Mixed learning in new students is a new method for students; besides that, students are not aware of the research, thereby preventing the threat of external validity of reactive influence and treatment diffusion. In this study, students only get one experimental treatment so that interplays do not occur before and after treatment, thereby avoiding the threat of multiple treatment disorders.

Research Result and Discussion

The survey results using the VARK instrument show that students who have visual cognitive styles are 35 students, auditory cognitive styles are 37 students and kinesthetic cognitive styles are 28 students, as shown in Table 2.

Table 2: Total Mixed Learning Students Based on Cognitive Style

Mixed learning / Cognitive Style	Mixed learning-1 (ML1)	Mixed learning-2 (ML2)	Frequency
Visual	20	15	35
Auditory	17	20	37
Kinesthetic	13	15	28
Total	50	50	100

The Pearson correlation coefficients of the validity test of the learning achievement instrument (Question-1, Question-2) using the Product Moment were 0.799 and 0.917 (Table 3), which means that the instrument to measure learning achievement has high validity.

The instrument reliability test to measure learning achievement using Cronbach's Alpha was 0.677 (Table 4), indicating that the instrument's internal consistency was very good.

Table 3: Validity Test of the Learning Achievement Instrument with Pearson Correlation

		Exam Score	Question-1	Question-2
Exam Score	Pearson Correlation.	1	0.799**	0.917**
	Sig. (2-tailed)		0.000	0.000
	N.	100	100	100
Question-1	Pearson Correlation.	0.799*	1	0.563**
	Sig. (2-tailed)	0.000		0.000
	N.	100	100	100
Question-2	Pearson Correlation.	0.917**	0.563**	1
	Sig.(2-tailed)	0.000	0.000	
	N.	100	100	100

**.Correlation is significant at the 0.01 level (2-tailed)
*.Correlation is significant at the 0.05 level (2-tailed)

Table 4: Reliability Test of the Study Achievement with Cronbach's Alpha

Cronbach's Alpha	N of Items
0.677	2

The Levene test significance value on the test result score (0.060) is higher than the alpha value of 0.05 (shown in Table 5); this indicates that the data's variance is homogeneous.

Table 5: Homogeneity Test Result

	Levene Statistic	Df1	Df2	Sig.
Exam Score	3.634	1	98	0.060

The normality test of learning outcomes data with Shapiro-Wilk shows the significant value of mixed

learning-1 (ML1) is 0.65 and mixed learning-2 (ML2) is 0.68 (as shown in Table 6). Due to the significance value for the two mixed learning test scores is greater than the alpha value (0.05), so the learning achievement for both mixed learning is normally distributed.

Table 6: Normality Test Result

		Kolmogorov-Smirnov			Shapiro-Wilk		
	ML1ML2	Statistic	Df	Sig.	Statistic	Df	Sig.
Score	ML1	0.172	50	0.001	0.957	50	0.065
Total	ML2	0.125	50	0.049	0.957	50	0.068

Based on the two-way Anova test, there is an interaction between cognitive styles and teaching methods (the significant value of VAK*ML1ML2 is 0.00), which is smaller than the alpha value (0.05) shown in Table 7. Thus the cognitive style and teaching methods influence each other in programming learning.

Table 7: Two-way Anova Test

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected model	2391.060[a]	5	478.212	17.907	0.000
Intercept	483277.397	1	483277.397	18096.459	0.000
VAK	352.599	2	176.299	6.602	0.002
ML1ML2	70.389	1	70.389	2.636	0.108
VAK*ML1ML2	2090.029	2	1045.014	39.131	0.000
Error	2510.330	94	26.706		
Total	497565.000	100			
Corrected Total	4901.390	99			

R Squared = .488 (Adjusted R Squared = .461)

The two-way Anova test showed that the significant value of the difference in learning achievement between students who received mixed learning-1 and mixed learning-2 was greater than the alpha value (ML1ML2 significant value 0.108). Thus, the conclusion is that there is no difference in learning achievement between teaching done with mixed learning-1 and mixed learning-2. There are differences in learning achievement between students with different cognitive styles in mixed learning-1 and mixed learning-2. In this case, the significance level of student cognitive style (VAK) on the two-way Anova test (0.002) is smaller than the alpha value (0.05), which means that there are differences in learning achievement between students who have different cognitive style. So, the conclusion is, even though the two teaching methods show no different student learning achievement, this does not mean that there is no difference in learning achievement based on student cognitive styles.

This finding is the novelty found in this study, that although the accomplishment of learning skills for both teaching methods is equally good, it does not mean that the learning method is suitable for all students. However, it turns out that students with specific cognitive styles may not be ideal for that teaching method. The implication is that students can achieve maximum learning success; the way is, learning methods facilitate learning media that support student cognitive styles.

In mixed learning-1, the results of the Post-Hoc Tukey test show: (a). The learning achievement of students who have auditory cognitive styles is better than students who have kinesthetic and visual cognitive styles; (b). The learning achievement of students who have kinesthetic cognitive styles is not different from students who have visual cognitive styles.

In mixed learning-2, the results of the Post-Hoc Tukey test show: (a). The learning achievement of students who have auditory cognitive styles is worse than students who have kinesthetic and visual cognitive styles; (b). The learning achievement of students who have kinesthetic cognitive styles is not different from students who have visual cognitive styles.

Table 8: Post-Hoc Tukey test of Learning Achievement of Hybrid Learning-1 and Hybrid Learning-2 based on Student Cognitive Styles

(I) Interaction	(J) Interaction	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
AML1	AML2	10.90*	1.768	0.000	5.76	16.04
	KML1	9.92*	2.013	0.000	4.06	15.77
	KML2	2.50	1.864	0.761	-2.92	7.92
	VML1	5.46*	1.749	0.028	0.37	10.55
	VML2	-2.38	1.895	0.807	-7.90	3.13
AML2	AML1	-10.90*	1.768	0.000	-16.04	-5.76
	KML1	-0.98	1.925	0.996	-6.58	4.62
	KML2	-8.40*	1.768	0.000	-13.54	-3.26
	VML1	-5.44*	1.647	0.017	-10.23	-0.64
	VML2	-13.28	1.801	0.000	-18.52	-8.04
KML1	AML1	-9.92*	2.012	0.000	-15.77	-4.06
	AML2	0.98	1.925	0.996	-4.62	6.58
	KML2	-7.42*	2.013	0.005	-13.27	-1.56
	VML1	-4.45	1.908	0.191	-10.00	1.10
	VML2	-12.30*	2.042	0.000	-18.24	-6.36
KML2	AML1	-2.50	1.864	0.761	-7.92	2.92
	AML2	8.40*	1.768	0.000	3.36	13.54
	KML1	7.42*	2.013	0.005	1.56	13.27
	VML1	2.96	1.749	0.539	-2.13	8.05
	VML2	-4.88	1.895	0.113	-10.40	0.63
V ML1	AML1	-5.46*	1.749	0.028	-10.55	-0.37
	AML2	5.44*	1.647	0.017	0.64	10.23
	KML1	4.45	1.908	0.191	-1.10	10.00
	KML2	-2.96	1.749	0.539	-8.05	2.13
	VML2	-7.85*	1.782	0.000	-13.03	-2.66
VML2	AML1	2.38	1.895	0.807	-3.13	7.90
	AML2	13.28*	1.801	0.000	8.04	18.52
	KML1	12.30*	2.042	0.000	6.36	18.24
	KML2	4.88	1.895	0.113	-0.63	10.40
	VML1	7.85*	1.782	0.000	2.65	13.03

Meanwhile, the comparison of learning achievement on the Post-Hoc Tukey test between students taught with mixed learning-1 and mixed learning-2 shows: (a). Mixed learning-1 students who have auditory cognitive styles have better skill achievement than mixed learning-2 students who have auditory cognitive styles; (b). Mixed learning-1 students who have auditory cognitive styles have no different skill achievement compared to mixed learning-2 students who have kinesthetic and visual cognitive styles; (c). Mixed learning-1 students who have

kinesthetic cognitive styles have worse skill achievement than mixed learning-2 students who have visual and kinesthetic cognitive styles; (d). Mixed learning-1 students who have kinesthetic cognitive styles have no different skill achievement than mixed learning-2 students who have auditory cognitive styles; (e). mixed learning-1 students who have visual cognitive styles have better skill achievement than mixed learning-2 students who have auditory cognitive styles; (f). Mixed learning-1 students who have visual cognitive styles have no different skill achievement than mixed learning-2 students who have kinesthetic cognitive styles; (g). Mixed learning-1 students who have visual cognitive styles have worse skill achievement than mixed learning-2 students who have visual cognitive styles.

Conclusion

The two-way Anova test concluded that: (a) there was no difference in the programming skills achieved by students between mixed-1 learning and mixed-2 learning; (b) there are differences in programming skills acquired between students who have different cognitive styles both in mixed learning-1 and mixed learning-2.

The test results with Post-Hoc Tukey concluded that: (a). Students with auditory and visual cognitive styles who learn with mixed learning-1 have better programming skills achievement than students with auditory cognitive styles who study with mixed learning-2; (b). Students with kinesthetic and visual cognitive styles who learn with mixed learning-2 have programming skills that are superior to students with kinesthetic cognitive styles who learn with mixed learning-1.

This means although the student programming skill achievement of the two learning methods when assessed based on the learning method is equally good, it happens that student programming skill achievement of two learning methods differs when evaluated based on the student cognitive styles.

Besides, this study also found that: in mixed learning-1, students who have an auditory cognitive style have superior programming skill achievement than students who have a kinesthetic and visual cognitive style. Meanwhile, students who have kinesthetic and visual cognitive styles do not differ in their programming skill achievement in the mixed learning-1. In mixed learning-2, students with an auditory cognitive style have worse programming skill achievement than students who have a visual and kinesthetic cognitive style. Meanwhile, students who have kinesthetic and visual cognitive styles do not differ in their programming skill achievement in the mixed learning-2.

This study's novelty is to research the reciprocal effects of student cognitive styles and hybrid learning with a mixture of 30% face-to-face subject matter combined with 70% asynchronous online subject matter and vice versa that no one had researched before.

Other new things obtained from this research are: (a). The comparative test to determine which learning method is superior for the achievement of learning skills is not sufficient only with a comparative test based on the learning method but also based on the student cognitive style; (b). This study finding can be the beginning of a breakthrough in teaching with certain learning methods based on groups of students with the same cognitive style to achieve better skills. Or in other words, the division of teaching classes no longer contains a mixture of various cognitive styles with certain teaching methods for better learning achievement.

The next research that needs to be done is to compare various other mixed teaching methods involving cognitive styles and other learning factors.

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Author's Contributions

Author Anthony Anggrawan is responsible for preparing the weight distribution of teaching materials in the two teaching methods of mixed learning-1 and mixed learning-2 and for carrying out the creation of a computer programming application module, including examples of implementing all programming problems into the flow chart as well as the programming language of VB.Net. He is also responsible for writing the article's contents, included in analyzing data on the achievement of student programming skills in both mixed learning-1 and mixed learning-2 teaching methods.

Christofer Satria designs and develops asynchronous online learning modules on a server computer to equip the learning modules with animated images and sounds.

Mayadi Yadi assisted in implementing the VARK survey to determine the cognitive styles of students in both teaching methods. He also implements lesson modules on computer servers and monitors computer systems for all student asynchronous online learning activities.

Meanwhile, Ni Gusti Ayu Dasriani is responsible for completing the relevant references needed in the article, including double-checking the correctness of the manuscript's format and the correctness of writing the text.

Ethics

The authors confirm that this manuscript has not been published in other journals and does not have ethical concerns.

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Science Publications

Article Information

Article Information

ID:	6527-JCS
Manuscript Category:	Research Articles
Submitted On:	Jan 4, 2021

Title

Reciprocity Effect between Cognitive Style and Mixed Learning Method on Computer Programming Skill

Abstract

Many universities undertake mixed learning to meet the required needs. Mixed learning is a blend of F2F classroom education and online learning education. The strength of mixed learning is that it supports students' cognitive styles more than non-mixed learning. The right blend of mixed learning provides more constructive and conducive learning. Meanwhile, programming language is the main skill that students must master well in order to be able to create computer application programs. The question is there an effect on students 'cognitive style and learning methods on mixed material 30% F2F and 70% asynchronous online on student's programming skill? Therefore, the objective of this study is to determine the effect of reciprocal interaction between cognitive styles and mixed learning methods on programming skill achievement. The method of this research is experimental research. The study found that: although there is no difference in the achievement of student learning skills based on tests on mixed learning methods, but further test on students' cognitive styles found that there are differences in the achievement of student learning skills in mixed learning methods; students with auditory and visual cognitive style who learn with mixed-1 learning have better programming skill achievement than students with auditory cognitive style who learn with mixed-2 learning; students with kinesthetic and visual cognitive styles who learn with mixed learning-2 have superior programming skill achievement compared to students with kinesthetic cognitive styles who learn with mixed learning-1. The novelty of the research is there has been no previous research on the reciprocal effect of cognitive styles and mixed learning methods with a mixture of 30% F2F and 70% online and vice versa.

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Subject Area

Computers and Society

Computers and Education

Impact of Computers on Society

Programming Languages

Applicative (Functional) Programming

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Review Rounds

Round	Editor	Actions
Round #2	Francesca Fallucchi	View Review Decision Submit Revised Manuscript

Final Decision (Close)

Decision Letter

Dear Dr. Anthony Anggrawan,

I am writing regarding your manuscript, "Reciprocity Effect between Cognitive Style and Mixed Learning Method on Computer Programming Skill" (6527-JCS), which you submitted to the Journal of Computer Science for review on Jan 4, 2021.

We have now completed the 2nd review round with comments from colleagues whose expertise I am sure you would recognize. In addition, I, along with one of my editors (Mrs. Francesca Fallucchi), have read your manuscript.

Based on the Reviewer feedback as well as our own reading of your manuscript, Mrs. Francesca Fallucchi and I want to strongly encourage you to undertake major revisions and then resubmit your manuscript for consideration for publication in the Journal of Computer Science. Our Editorial Board has made the following decision:

Decision: Major Revision

Comments:

Review #1

Importance of the Topics

Modest

Quality of Writing and Presentation

Good

Conceptual Rigor

Good

Methodological Rigor

Good

General Discussion and Conclusions

Good

Contribution in Current Form

Modest

Contribution in Revised Form

Modest

Recommendation

Accept

Comments

Research methodology is good Introduction is good Background information with external references of the subject matter might be missing Results and analysis is great Conclusion is too vast, please separate the future enhancements and additions Good work

Review #2

Importance of the Topics

Important

Quality of Writing and Presentation

Minor Problems

Conceptual Rigor

Minor Problems

Methodological Rigor

Good

General Discussion and Conclusions

Minor Problems

Contribution in Current Form

Important

Contribution in Revised Form

Important

Recommendation

Minor Revisions

Comments

-need more explanation on the result. -need more discussion tables. -need more enhancement on language. -need more discussion on implications, limitations, future research.

Review #3

Importance of the Topics

Trivial

Quality of Writing and Presentation

Major Problems

Conceptual Rigor

Major Problems

Methodological Rigor

Minor Problems

General Discussion and Conclusions

Major Problems

Contribution in Current Form

Modest

Contribution in Revised Form

Trivial

Recommendation

Major Revisions

Comments

The aim of the author's research is to examine the effects on programmatic efficiency of the reciprocal relationship between cognitive styles and mixed learning methods. Experimental testing is the tool of this inquiry. The study found: while student abilities based on the assessments of blended learning approaches are accomplished no differently. The work idea of this paper is good, however there are many notes : - The paper has a poor structure and has a lot of grammatical mistakes as well as the language used is not well-written academically, that can affect the readability level negatively. - The paper structure should be illustrated in the last paragraph of the introduction section. - The related work in the introduction should be moved into a separate part, with a well-comparative analysis; to show the strength of the authors' contribution. - The references style is weak -many in text citations without linked references- and it is difficult to follow the papers idea arrangement, as many citations were missing. - The authors have jumped directly from the introduction to the research methodology section and the started in describing the experiment environments. - The experiments results should be compared with some recent works to prove the strengths of the contribution as well as the weakness points for the future work. In general, there is a good idea behind the contribution in this paper, but it was poorly represented and written. As a result, it is not advised to publish this paper under such a form; as it is not meet both the journal standards and quality.

Importance of the Topics

Important

Quality of Writing and Presentation

Good

Conceptual Rigor

Good

Methodological Rigor

Good

General Discussion and Conclusions

Good

Contribution in Current Form

Important

Contribution in Revised Form

Important

Recommendation

Minor Revisions

Comments

1. The manuscript is appropriate for the Journal of Computer Science-Science Publication. 2. The subject addressed in this article is worthy of investigation. 3. Uniform the calling of (Table) instead of (table) throughout the manuscript. 4. Rewriting Table 3 and Table 8. Also, put 0 before the fixed point for each real number (all Tables). Thank you and good luck

Mrs. Francesca Fallucchi and I hope that this feedback will be helpful to you in developing your research, and that you will be encouraged to undertake the revisions within the next few weeks. You should know that manuscripts normally are revised at least once (often involving more than one series of Reviewer comments) before being accepted for publication in the Journal of Computer Science. Please don’t hesitate to contact me if you have any questions about the comments above.

To submit a revision, go to http://thescipub.com/es/info.php?id=6527-JCS and log in. You will be able to upload the revision and detailed response to Reviewer comments.

When you submit a revised version of your paper, please include a statement explaining how this version reflects the feedback received from the Reviewers and the editors. Also, note if, and explain why, you decided not to follow any points made by Reviewers or editors.

When we receive your revised manuscript, we will send it to at least some of the previous Reviewers and ask them to assess whether you have addressed the main issues and, thus, whether your work should be accepted for publication.

Finally, we would appreciate it if you would acknowledge receipt of this message and, as soon as possible, let us know a) whether you plan to rewrite your paper as well as b) when you would plan to submit a new version to the Journal of Computer Science for review.

Sincerely,

Prof. Abedallah Rababah
Editor in Chief
Journal of Computer Science

Reviewer Comments

Reviewer # 1

Research methodology is good Introduction is good Background information with external references of the subject matter might be missing Results and analysis is great Conclusion is too vast, please separate the future enhancements and additions Good work

Reviewer # 2

-need more explanation on the result. -need more discussion tables. -need more enhancement on language. -need more discussion on implications, limitations, future research.

Reviewer # 3

The aim of the author's research is to examine the effects on programmatic efficiency of the reciprocal relationship between cognitive styles and mixed learning methods. Experimental testing is the tool of this inquiry. The study found: while student abilities based on the assessments of blended learning approaches are accomplished no differently. The work idea of this paper is good, however there are many notes : - The paper has a poor structure and has a lot of grammatical mistakes as well as the language used is not well-written academically, that can affect the readability level negatively. - The paper structure should be illustrated in the last paragraph of the introduction section. - The related work in the introduction should be moved into a separate part, with a well-comparative analysis; to show the strength of the authors' contribution. - The references style is weak -many in text citations without linked references- and it is difficult to follow the papers idea arrangement, as many citations were missing. - The authors have jumped directly from the introduction to the research methodology section and the started in describing the experiment environments. - The experiments results should be compared with some recent works to prove the strengths of the contribution as well as the weakness points for the future work. In general, there is a good idea behind the contribution in this paper, but it was poorly represented and written. As a result, it is not advised to publish this paper under such a form; as it is not meet both the journal standards and quality.

Reviewer # 4

1. The manuscript is appropriate for the Journal of Computer Science-Science Publication. 2. The subject addressed in this article is worthy of investigation. 3. Uniform the calling of (Table) instead of (table) throughout the manuscript. 4. Rewriting Table 3 and Table 8. Also, put 0 before the fixed point for each real number (all Tables). Thank you and good luck

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Request for Authors Comments on Evaluation for Manuscript # 6527-JCS

Science Publications <customer.support@scipub.org> Thu, Feb 11, 2021 at 12:14 PM
Reply-To: scipub@gmail.com
To: anthony.anggrawan@universitasbumigora.ac.id

Dear Dr. Anthony Anggrawan,

We hope this email finds you in good health.

We have received the reviewer's comments for your manuscript. Comments report is attached for your consideration.

Kindly address all above said points and send your revised file with point wise response so that we may proceed with the publication of your article.

Feel free to contact us if you require any further information. I look forward to hearing from you soon.

Regards,

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Anthony Anggrawan <anthony.anggrawan@universitasbumigora.ac.id> Fri, Feb 19, 2021 at 2:05 PM
To: scipub@gmail.com

Dear
Ms. Zunaira
Editorial Office
Science Publications

With all due respect, I inform you that I just completed the revision of my article (entitled Reciprocity Effect between Cognitive Style and Mixed Learning Method on Computer Programming Skill) according to the suggestions and instructions of the reviewers.
Attached 3 files in this email: revised article document file (Doc); a file containing a list of revisions that have been made; and files that contain the results of checking free of plagiarism.
Hopefully, my article meets the criteria and requirements of the Journal of Computer Science.
Thank you for your attention. God bless you.

Sincerely yours
Anthony Anggrawan

On Thu, Feb 11, 2021 at 12:14 PM Science Publications <customer.support@scipub.org> wrote:
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Anthony Anggrawan <anthony.anggrawan@universitasbumigora.ac.id> Thu, May 13, 2021 at 7:05 AM
To: Science Publications <support@scipub.org>
Bcc: anthony.anggrawan17@gmail.com

Dear
Jeffery Daniels
Editorial Office
Journal of Computer Science

Thank you for your email regarding my article # 6525-JCS.
I hereby respectfully inform you that I have made a revision for the second round of my article and have revised it according to the reviewers' suggestions and have also answered every point of suggestion from 4 reviewers.
I have uploaded a revision file and a list of revisions that I have done to the Journal of Computer Science system (as attached screenshot). After that, I no longer received email instructions for the third round of revisions.
In this email, I also attach four documents; two document files show the narrative of the changes I have made, the point by point from the comments of 4 reviewers, to make it easier to check the revisions I have made according to the instructions of the reviewers. Hopefully, the files I've included are useful.
I ask for further instructions from you if something is missing, and I still have to work on it.
Thank you very much for your kind attention and kindness.
I look forward to getting further information.

Sincerely yours
Anthony Anggrawan

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Science Publications <support@scipub.org> Wed, May 12, 2021 at 9:35 PM
To: "Dr. Anthony Anggrawan" <anthony.anggrawan@universitasbumigora.ac.id>

Hi Dr. Anthony Anggrawan,

Our record shows that we have sent you the reviewer's comments.

Now the sufficient time has been elapsed, therefore, I would like to request you to please login to your profile and submit your revised file on priority basis or inform us if you need more time.

Editor would like to see a point-by-point response of the authors to comments on this manuscript. Please carefully read the reviewer's comments and respond to each point raised by each reviewer. Your own comments will then be reviewed and compared with the evaluation comments.

Your quick response will be highly appreciated.

Comments attached for your consideration.

Sincerely,

Jeffery Daniels
Editorial Office
Journal of Computer Science
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Article Information

Article Information (View Final Version)

ID:	6527-JCS
Manuscript Category:	Research Articles
Submitted On:	Jan 4, 2021

Title

Reciprocity Effect between Cognitive Style and Mixed Learning Method on Computer Programming Skill

Abstract

Many universities undertake mixed learning to meet the required needs. Mixed learning is a blend of F2F classroom education and online learning education. The strength of mixed learning is that it supports students' cognitive styles more than non-mixed learning. The right blend of mixed learning provides more constructive and conducive learning. Meanwhile, programming language is the main skill that students must master well in order to be able to create computer application programs. The question is there an effect on students 'cognitive style and learning methods on mixed material 30% F2F and 70% asynchronous online on student's programming skill? Therefore, the objective of this study is to determine the effect of reciprocal interaction between cognitive styles and mixed learning methods on programming skill achievement. The method of this research is experimental research. The study found that: although there is no difference in the achievement of student learning skills based on tests on mixed learning methods, but further test on students' cognitive styles found that there are differences in the achievement of student learning skills in mixed learning methods; students with auditory and visual cognitive style who learn with mixed-1 learning have better programming skill achievement than students with auditory cognitive style who learn with mixed-2 learning; students with kinesthetic and visual cognitive styles who learn with mixed learning-2 have superior programming skill achievement compared to students with kinesthetic cognitive styles who learn with mixed learning-1. The novelty of the research is there has been no previous research on the reciprocal effect of cognitive styles and mixed learning methods with a mixture of 30% F2F and 70% online and vice versa.

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Subject Area

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Impact of Computers on Society

Programming Languages

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Journal of Computer Science

Original Research Paper

Reciprocity Effect between Cognitive Style and Mixed Learning Method on Computer Programming Skill

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Abstract: Many universities undertake mixed learning to meet the required needs. Mixed learning is a blend of F2F classroom education and online learning education. The strength of mixed learning is that it supports student cognitive styles more than non-mixed learning. The right mix of mixed learning provides more constructive and conducive learning. Meanwhile, the programming language is the primary skill that students must master to create computer application programs. The question is: Is there an effect on student cognitive style and learning methods on mixed material 30% F2F and 70% asynchronous online and on the contrary mixture on student programming skills? Therefore, this study aims to determine the effect of reciprocal interaction between cognitive styles and mixed learning methods on programming skill achievement. This research method is experimental research. The study found that: Although there is no difference in the achievement of student learning skills based on tests on mixed learning methods, further test on student cognitive styles found that there are differences in the achievement of student learning skills in mixed learning methods; students with auditory and visual cognitive style who learn with mixed learning-2 have better programming skill achievement than students with auditory cognitive style who learn with mixed learning-2; students with kinesthetic and visual cognitive styles who learn with mixed learning-2 have superior programming skill achievement compared to students with kinesthetic cognitive styles who learn with mixed learning-1. The research novelty is: There has been no previous research on the reciprocal effect of cognitive styles and mixed learning methods with a mixture of 30% F2F and 70% online and vice versa.

Keywords: Cognitive Style, Mixed Learning, Computer Programming, Learning Method

Introduction

The rapid advancement of Information and Communication Technology (ICT) makes it easier to realize multimedia in learning to support student cognitive styles. Besides that, the use of ICT also has a positive impact on the learning process as well as realizing learning efficiency (Aljuboori *et al*., 2020). However, the rapid development of ICT has increased pressure for universities to include greater use of technology and innovation in the curriculum (Tyler-Wood *et al*., 2018). Therefore, it is not surprising, if many tertiary institutions adopted mixed learning approaches as a solution (Nazarenko, 2015). Mixed learning is a perfect blend of F2F classroom education and asynchronous online learning education (Pierce, 2017).

Mixed learning research has long been a concern of researchers and lately, it has become an important research topic because it has a combined advantage of learning in the classroom and outside the classroom. Unfortunately, research on mixed learning skills is still limited (Nazarenko, 2015). The benefits of mixed learning are the best approach to learning strategy by taking the strengths of Face-To-Face (F2F) and online learning (Sleator, 2010). One of the strengths of mixed education is that it provides a conducive learning environment for students and supports a variety of student cognitive styles (Pierce, 2017). That makes sense that prior research indicated, mixed learning is superior to non-mixed learning in learning achievement (Van Niekerk and Webb, 2016). Mixed learning can maximize student learning outcomes by applying appropriate technology learning to fit student

cognitive style in transferring skills correctly and at the right time (Lieser and Taff, 2013).

The right combination of mixed learning provides social support and constructive learning for students (Opina *et al*., 2011) and creates conducive interactions in learning activities (Pierce, 2017). However, the question is:

- How is student learning skill achievement based on student cognitive style?
- How is the student' skill achievement from two different mixed learning and is there a reciprocal influence between student cognitive style and mixed learning methods?
- What will the results be if there is a mutual influence between cognitive styles and mixed learning methods?

Therefore, this study aims to determine the effect of reciprocal interaction between cognitive styles and mixed learning methods on learning skill achievement.

The mixed learning method combines education between F2F classroom education and online learning education (Hogarth and Biggam, 2009; Almpanis *et al*., 2010). F2F class education strength is the high intensity of interaction between students and lecturers in facilitating cooperative learning and clarity of lecture materials (Agosto *et al*., 2013). The F2F classroom education offers real and meaningful interactions between students and teachers, while pure online education cannot replace it (Tang and Chaw, 2013). The problem is, the F2F classroom education requires higher tuition fees, especially in well-known tertiary institutions (Norman, 2016). Online learning is a significant part of university education to support conventional F2F learning (Seta *et al*., 2018). Communication that occurs in online learning is synchronous and asynchronous (Clark and Barbour, 2015).

In synchronous online, education is delivered remotely in real-time by the teaching lecturer to students (Alammary, 2019; Anggrawan and Satria, 2020). In contrast, learning material in asynchronous online education is given indirectly to the student (Anggrawan and Satria, 2020). In asynchronous online, students can access material or modules stored on the server computer anytime and anywhere through computers connected via the internet to specific web addresses (Anggrawan and Satria, 2020). Asynchronous online learning constitutes independent learning for students (Anggrawan and Satria, 2020) or collaborative learning (Alammary, 2019) by some students who agree to study. Students and lecturers agree that one of the main weaknesses of online learning is the lack of F2F interaction (Król, 2016). Meanwhile, asynchronous online education strength takes advantage of various multimedia forms: Text, audio, visual still and moving and other forms for learning purposes supporting student cognitive styles (Clark and Barbour, 2015).

Every student has a cognitive style that reflects a way of learning that is preferred and easier for students to understand. Students with high specific cognitive styles have more significant difficulties acquiring knowledge than weaker cognitive styles (Psycharis *et al*., 2014). There are three types of cognitive styles: Visual, auditory and kinesthetic (Rhouma, 2016). Students with visual cognitive styles prefer and easily understand the lessons presented in writing, pictures, graphs and tables (Rhouma, 2016; Anggrawan *et al*., 2019). In other words, students with visual cognitive styles in learning rely on their sense of sight. Auditory students prefer the lesson presentation in voice or lecture form (Anggrawan *et al*., 2019). So, in other words, students with auditory cognitive style rely on the sense of hearing. Kinesthetic students prefer to learn in interactive information media and special situations (Anggrawan *et al*., 2019). In essence, learning should support student cognitive styles to improve performance and success learning (Eudoxie, 2011). So it makes sense and inevitable, if later, more and more universities have created systems and organized innovative mixed education to accommodate student cognitive styles and the learning needs of 21st-century students (Lieser and Taff, 2013).

Substantially, mixed learning provides better effectiveness than education that relies only on the conventional F2F education method (Van Niekerk and Webb, 2016). Besides, students respond positively and easily adapt to mixed learning (Anggrawan *et al*., 2019); actually, mixed learning brings excellent opportunities for students to master the subject matter and achieve success in education (Lieser and Taff, 2013). Moreover, mixed learning patterns provide a more conducive learning environment and increase student learning achievement (Bazelais and Doleck, 2018). In fact, despite online learning education or conventional F2F classroom education has disadvantages, but mixed learning can overcome it as long as mixed learning is mixed with the right mix (Opina *et al*., 2011). According to Kanuka and Rourke (2013), some experts argue that the portion of the online learning mix in mixed learning is 25 to 50%; meanwhile, other experts determine the amount of the online learning mix in mixed learning is between 30 and 70% (Kanuka and Rourke, 2013). In short, there is no certainty about the portion of the online learning mix in mixed learning. Thus, the mixed learning main obstacle lies in the accuracy of the mixture; of course, the right mix in one subject does not mean it is suitable for another course (Anggrawan *et al*., 2019). Likewise, although certain courses have produced evidence of satisfactory learning success with mixed learning, this does not mean that the same conditions apply to other courses. So, the mixture accuracy and the suitability of mixed learning in each subject must be scrutinized scientifically. Thus, in essence, scientific research on mixed learning is necessary to determine how well the

student learning success due to the mutual influence between cognitive styles and mixed learning methods. In other words, if there is a mutual influence between cognitive styles and mixed learning methods, it is necessary to know what the results are?

In short, in connection with this research, the formulation of the research problem explicitly is:

(a) What learning methods are better than the two kinds of mixed teaching methods; is the mixture of 70% learning in class and 30% online learning outside the classroom or 30% learning in class and 70% online learning outside the classroom?
(b) Is there a reciprocal influence between student cognitive styles and mixed learning methods applied in teaching?
(c) If there is a reciprocal influence, how will it affect the achievement of student programming skills?

Programming language courses are essential for students in mastering programming skills (Yindi, 2016; Anggrawan, 2018). The programming skill is the ability of students to create computer applications with programming languages. The visual programming language is event-based programming (Yindi, 2016; Anggrawan, 2018). In other words, program code is made based on specific events or functions so that the sequence of program execution is also an event. In contrast to structured or procedural programming, it will execute program code from the beginning to the end of the program sequentially (Anggrawan, 2018). The visual programming language that is most popular today is Visual Basic.Net or VB.Net (Anggrawan, 2018). VB.Net is an object-oriented programming language (Yindi, 2016; Othman *et al*., 2018). VB. Net has the advantage of being of the visual programming language and high interest from students who learn it (Zhang *et al*., 2011). VB.NET is useful for applying network interfaces and operate records databases (Othman *et al*., 2018).

Related Work

This subsection provides a brief literature review of some of the most recent scientific articles relating to cognitive styles, programming and mixed learning:

- Theodoropoulos *et al*. (2016) investigated the link between cognitive styles and student capabilities in learning programming using games. This study indicates that the cognitive style is a significant learning characteristic to consider when learning the programming lesson. This study uses a survey method to obtain research results
- Awang *et al*. (2017) conducted a study that essentially examined student cognitive styles on academic achievement. Their research results indicate that the student cognitive styles affect academic achievement and each cognitive style has advantages and disadvantages. Their research only focuses on the influence of cognitive styles on student learning outcomes using the survey method in F2F learning
- Ceylan and Kesici (2017) examined the effect of mixed learning on student academic achievement. This research uses a survey method with the quantitative data type. The results of this study found that mixed learning environment significantly helps student academic learning achievement
- Lazarinis *et al*. (2019) examined mixed learning intending to improve teacher programming skills. This study did not link cognitive styles with teacher responses to learning. This previous research also did not mention the percentage of mixing mixed learning materials between F2F and online learning materials. The research method used was a survey. This last study concluded that teachers responded positively to mixed learning experiences
- Maia *et al*. (2017) investigated cognitive style application and their effects on programming education in F2F teaching. Their research found that student cognitive styles can affect students learning abilities. Their study used a survey method
- Anggrawan *et al*. (2019) examined the influence between cognitive style and gender on mixed learning in Algorithm and programming lesson. This study has a limitation that only investigates mixed learning by mixing 40% F2F material and 60% online material. This means that this earlier study was not a reciprocity effect study; that is, it did not investigate mixed learning with the opposite mixture of mixing 40% F2F material and 60% online material. This earlier study found differences in learning outcomes between students who had different learning styles. Male gender students were more successful than students with the female gender, using the experimental research method
- Alammary (2019) conducted an assessment of the comparison of programming learning experiences between conventional treatments and mixed care methods. This study concluded that mixed learning is more effective in constructing traditional education to improve student learning experiences. This study also confirms that there is an increasing trend in the application of mixed learning programming lessons. This previous researcher also warned that there was still little research related to programming education and mixed learning methods

Literature review of the relative work as mentioned above: (a). Did not examine the comparison of the

learning achievement of two mixed learning with the opposite percentage of teaching material mix between F2F and online learning materials; (b). did not examine mixed learning with a blend of 70% learning in class and 30% learning online outside of the classroom and 30% learning in class and 70% learning online outside the classroom; (c). did not research experimental methods on student learning achievement in two mixed learning associated with student cognitive styles and learning methods.

In essence, the authors in this study conducted research that no one has examined, namely the effect of back and forth between mixed learning methods and cognitive styles on computer programming education. Besides, the authors conducted this mixed learning research with mixed teaching materials divided into 70% online and 30% F2F mix and vice versa, which so far, no one has researched.

Research Methodology

This study is experimental research. Two different classes get a mixed learning treatment of VB.Net computer programming lesson materials with a mixture of different portions between F2F learning and asynchronous online learning. The combination tested was 70% versus 30% between classroom learning and asynchronous online learning in the first class and vice versa, 30% mixture versus 70% between classroom learning and asynchronous online learning in the second class.

Learning Treatment

Two classes received learning VB.Net Programming courses. Two treatment classes resulted from the random selection from 5 classes in the Computer Science study program at Bumigora University. The number of students in each treatment class consists of 50 students in the first semester of the academic year of 2019/2020.The first mixed learning class (mixed learning-1) got treatment by combining around 30% F2F learning and about 70% asynchronous online learning. Meanwhile, the second mixed learning class (mixed learning-2) got treatment by combining around 70% F2F learning and about 30% asynchronous online learning.

Students acquire VB.Net programming skills through F2F mixed learning materials in class and online learning materials. Students can learn online lessons independently in teaching material modules (or asynchronous online forms) prepared on a computer server. Besides, students can access them anywhere and anytime via the internet and study according to student needs and speed.

This research is an experimental study with two factors. The first factor is mixed learning with two levels and the second factor is the cognitive style with three levels. Thus, this research is an experimental study with a 2×3 factorial design.

Mixed Learning-1 (ML1) and Mixed Learning-2 (ML2) are two learning class groups prepared to realize this experimental research. Table 1 shows the model construction methodology of a 2×3 factorial design.

Table 1: 2×3 Factorial design

Mixed learning\ Cognitive style	Mixed Learning-1 (ML1)	Mixed Learning-2 (ML2)
Visual (A1)	A1, ML1	A1, ML2
Auditory (A2)	A2, ML1	A2, ML2
Kinesthetic (A3)	A3, ML1	A3, ML2

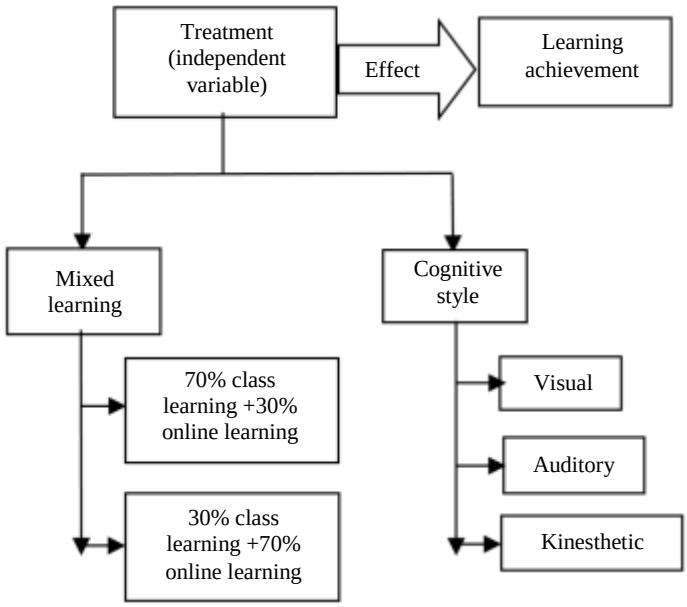

Fig. 1: 2×3 Factorial design diagram

So, the reciprocal effect examined in this study is the combined effect of two independent variables (two factors) on mixed learning and cognitive styles in influencing the dependent variable on learning achievement. Figure 1 shows the diagram of the 2×3 factorial design model.

The number of classroom learning meetings of the mixed learning-1 and mixed learning-2 takes 7-time meetings (does not include the Exam). F2F mixed learning-1 activities occurred at different times, days, classes and buildings to prevent the threat of spreading external validity. Mixed learning-1 and mixed learning-2 learning activities are as follows: Lecturers provide F2F class lessons, which are structured modules of F2F learning materials that have been classified materials and materials according to F2F learning schedules. Likewise, online learning with structured material has been prepared on a computer server that can be accessed by students (anytime and anywhere) with the asynchronous (or shared) independent learning method via the website.

Data Collecting

The data collected in this study are data on the learning achievement and cognitive style of each student. The instrument in assessing student skill attainment at the end of the lesson is in essay questions. The test instrument used to evaluate student learning achievement has passed the reliability and validity test before being used in the experimental class in this study. Student cognitive style data were collected using a questionnaire conducted in a mixed learning class. The student cognitive style questionnaire instrument uses standard Visual, Auditory, Reading/Writing, Kinesthetic (VARK) instruments that have been tested for reliability and validity.

Research Methods

Learning skill achievement data in this study is ratio data. Due to in this study two classes are treated, then this research method is experimental research, but based on the type and analytical data, this research method is inferential quantitative parametric research,

Testing for normality and homogeneity of data and the instrument validity and reliability was carried out using Shapiro-Wilk, Levene, Pearson Correlation and Cronbach's Alpha. A two-way Anova test was conducted to ascertain a reciprocal influence between student cognitive styles and learning methods; differences in learning achievement due to differences in student cognitive styles and differences in learning achievement between mixed learning methods with 70% learning in class and 30% via online compared to mixed learning methods with 30% learning in class and 70% via online. The Tukey post-hoc test is conducted to analyze the reciprocal effects that occur between cognitive style and learning methods.

Threats to internal validity in this study were overcome by means of students with the same background, namely fresh graduates from high school, meaning that students in this study have equal initial cognitive competence in computer programming, thus can overcome the threat of internal validity in the form of death/friction. Control group in the form of classroom lessons as part of mixed learning prevents this research from threatening history internal validity. The instrument used was a standard instrument or tested instrument of validity and reliability to free from instrument internal validity threat. In overcoming external validity threats in this study, other lecturers (not researchers) carried out the teaching process, thus preventing bias or the deliberate or carelessness of researchers in influencing student achievement. Mixed learning in new students was a new method for students; besides that, students were not aware of the research, thereby preventing the threat of external validity of reactive influence and treatment diffusion. In this study, students only got one experimental treatment so that interplay did not occur before and after treatment, thereby avoiding the threat of multiple treatment disorders.

Research Results and Discussion

The survey results using the VARK instrument show that students who have visual cognitive styles are 35 students, auditory cognitive styles are 37 students and kinesthetic cognitive styles are 28 students, as shown in Table 2.

Table 2 also shows that in the mixed learning-1 class, the number of students is 50. As many as 20 students have a visual cognitive style, 17 students have an auditory cognitive style and 13 students have a kinesthetic cognitive style. In the mixed learning-2 class, the total number of students is 50 students. Fifteen students have a visual cognitive style, 20 students have an auditory cognitive style and 15 students have a kinesthetic cognitive style.

A research instrument becomes a useful measuring tool if the instrument measures appropriately (or validity) and can be trusted (or reliable). Therefore, the instrument used in this study must meet the validity and reliability requirements of the test.

The Pearson correlation coefficients of the learning achievement instrument (Question-1, Question-2) using Product Moment were 0.799 and 0.917 (Table 3).

Meanwhile, according to Sugiyono (2004), the minimum requirement to be a correct (valid) instrument using Pearson Moment correlation (or Product Moment correlation) is if the correlation between items with a total score is greater than or equal to 0.3. It means that the instrument to measure learning achievement in this research has high validity.

The instrument reliability test to measure learning achievement using Cronbach's Alpha in this research was 0.677 (Table 4). It is indicating that the internal consistency of the instrument was good. The research instrument has reliable internal consistency if the reliability coefficient is equal to or greater than 0.6 (Siregar, 2014).

Table 2: Total mixed learning students based on cognitive style

Mixed learning\Cognitive style	Mixed Learning-1 (ML1)	Mixed Learning-2 (ML2)	Frequency
Visual	20	15	35
Auditory	17	20	37
Kinesthetic	13	15	28
Total	50	50	100

Table 3: Validity test of the learning achievement instrument with Pearson correlation

		Exam score	Question-1	Question-2
Exam score	Pearson correlation.	1	0.799**	0.917**
	Sig. (2-tailed)		0.000	0.000
	N.	100	100	100
Question-1	Pearson Correlation.	0.799*	1	0.563**
	Sig. (2-tailed)	0.000		0.000
	N.	100	100	100
Question-2	Pearson Correlation.	0.917**	0.563**	1
	Sig.(2-tailed)	0.000	0.000	
	N.	100	100	100

**.Correlation is significant at the 0.01 level (2-tailed)
*.Correlation is significant at the 0.05 level (2-tailed)

Table 4: Reliability test of the study achievement with cronbach's alpha

Cronbach's Alpha	N of Items
0.677	2

Table 5: Homogeneity test result

	Levene statistic	Df1	Df2	Sig.
Exam score	3.634	1	98	0.060

The requirement for conducting a two-way Anova parametric statistical test is that the data used must have the same or homogeneous variants (Siregar, 2014). Therefore, this study uses the Levene test to determine whether the learning outcome data is homogeneous or not. Likewise, the data is must normal distribution as a condition to perform a two-way Anova parametric statistical test (Siregar, 2014). Therefore, this study uses Shapiro-Wilk to test the normality of the data.

The Levene test significance value on the test result score (0.060) is higher than the alpha value of 0.05 (Table 5); this indicates that the data variance is homogeneous.

The normality test of learning outcomes data with Shapiro-Wilk shows the significant value of Mixed Learning-1 (ML1) is 0.65 and Mixed Learning-2 (ML2) is 0.68 (Table 6). The significance value for the two mixed learning test scores is greater than the alpha value (0.05), so the learning achievement for both mixed learning is normally distributed.

Using a two-way Anova is to determine how the combination of two independent variables affects the dependent variable (Montgomery, 2012).

Based on the two-way Anova test, there is an interaction between cognitive styles and teaching methods (the significant value of VAK*ML1ML2 is 0.00), which is smaller than the alpha value (0.05) shown in Table 7. Thus, the cognitive style and teaching methods influence each other in programming learning.

The two-way Anova test showed that the significant value of the difference in learning achievement between students who received mixed learning-1 and mixed learning-2 was greater than the alpha value (ML1ML2 significant value 0.108). Thus, the conclusion is that there is no difference in learning achievement between teaching done with mixed learning-1 and mixed learning-2. There are differences in learning achievement between students with different cognitive styles in mixed learning-1 and mixed learning-2. In this case, the significance level of student cognitive style (VAK) on the two-way Anova test (0.002) is smaller than the alpha value (0.05), which means that there are differences in learning achievement between students who have different cognitive style. So, the conclusion is, even though the two teaching methods show no different student learning achievement, this does not mean that there is no difference in learning achievement based on student cognitive styles.

This finding is the novelty found in this study, that although the accomplishment of learning skills for both teaching methods is equally good, it does not mean that the learning method is suitable for all students. However, it turns out that students with specific cognitive styles may not be ideal for that teaching method. The implication is that students can achieve maximum learning success; the way is, learning methods facilitate learning media that support student cognitive styles.

Tukey post-hoc test is a follow-up test when an interaction occurs in the two-way Anova test (Montgomery, 2012). Tukey post-hoc test can tell precisely where the differences between the two independent variables affect the dependent variable. Therefore, this study conducted Tukey post-hoc test.

Table 6: Normality test result

		Kolmogorov-Smirnov			Shapiro-Wilk		
ML1ML2		Statistic	Df	Sig.	Statistic	Df	Sig.
Score Total	ML1	0.172	50	0.001	0.957	50	0.065
	ML2	0.125	50	0.049	0.957	50	0.068

Table 7: Two-way anova test

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected model	2391.060[a]	5	478.212	17.907	0.000
Intercept	483277.397	1	483277.397	18096.459	0.000
VAK	352.599	2	176.299	6.602	0.002
ML1ML2	70.389	1	70.389	2.636	0.108
VAK*ML1ML2	2090.029	2	1045.014	39.131	0.000
Error	2510.330	94	26.706		
Total	497565.000	100			
Corrected Total	4901.390	99			

R Squared = 0.488 (Adjusted R Squared = 0.461)

Table 8: Tukey post-hoc test of learning achievement of hybrid learning-1 and hybrid learning-2 based on student cognitive styles

					95% Confidence interval	
(I) Interaction	(J) Interaction	Mean difference (I-J)	Std. error	Sig.	Lower bound	Upper bound
AML1	AML2	10.90*	1.768	0.000	5.76	16.04
	KML1	9.92*	2.013	0.000	4.06	15.77
	KML2	2.5	1.864	0.761	-2.92	7.92
	VML1	5.46*	1.749	0.028	0.37	10.55
	VML2	-2.38	1.895	0.807	-7.90	3.13
AML2	AML1	-10.90*	1.768	0.000	-16.04	-5.76
	KML1	-0.98	1.925	0.996	-6.58	4.62
	KML2	-8.40*	1.768	0.000	-13.54	-3.26
	VML1	-5.44*	1.647	0.017	-10.23	-0.64
	VML2	-13.28	1.801	0.000	-18.52	-8.04
KML1	AML1	-9.92*	2.012	0.000	-15.77	-4.06
	AML2	0.98	1.925	0.996	-4.62	6.58
	KML2	-7.42*	2.013	0.005	-13.27	-1.56
	VML1	-4.45	1.908	0.191	-10.00	1.10
	VML2	-12.30*	2.042	0.000	-18.24	-6.36
KML2	AML1	-2.5	1.864	0.761	-7.92	2.92
	AML2	8.40*	1.768	0.000	3.36	13.54
	KML1	7.42*	2.013	0.005	1.56	13.27
	VML1	2.96	1.749	0.539	-2.13	8.05
	VML2	-4.88	1.895	0.113	-10.40	0.63
V ML1	AML1	-5.46*	1.749	0.028	-10.55	-0.37
	AML2	5.44*	1.647	0.017	0.64	10.23
	KML1	4.45	1.908	0.191	-1.10	10.00
	KML2	-2.96	1.749	0.539	-8.05	2.13
	VML2	-7.85*	1.782	0.000	-13.03	-2.66
VML2	AML1	2.38	1.895	0.807	-3.13	7.90
	AML2	13.28*	1.801	0.000	8.04	18.52
	KML1	12.30*	2.042	0.000	6.36	18.24
	KML2	4.88	1.895	0.113	-0.63	10.40
	VML1	7.85*	1.782	0.000	2.65	13.03

Based on the results of Tukey post-hoc test (Table 8), in mixed learning-1, the results of the Tukey post-hoc test show: (a). The learning achievement of students who have auditory cognitive styles is better than students who have kinesthetic and visual cognitive styles; (b). The learning achievement of students who have kinesthetic cognitive styles is not different from students who have visual cognitive styles.

Based on the results of Tukey post-hoc test (as shown in Table 8), in mixed learning-2, the results of the Tukey post-hoc test show: (a). The learning achievement of students who have auditory cognitive styles is worse than

students who have kinesthetic and visual cognitive styles; (b). The learning achievement of students who have kinesthetic cognitive styles is not different from students who have visual cognitive styles.

Meanwhile, the comparison of learning achievement on the Tukey post-hoc test between students taught with mixed learning-1 and mixed learning-2 shows:

(a) Mixed learning-1 students who have auditory cognitive styles have better skill achievement than mixed learning-2 students who have auditory cognitive styles
(b) Mixed learning-1 students who have auditory cognitive styles have no different skill achievement compared to mixed learning-2 students who have kinesthetic and visual cognitive styles
(c) Mixed learning-1 students who have kinesthetic cognitive styles have worse skill achievement than mixed learning-2 students who have visual and kinesthetic cognitive styles
(d) Mixed learning-1 students with kinesthetic cognitive styles have no different skill achievement than mixed learning-2 students with auditory cognitive styles
(e) Mixed learning-1 students who have visual cognitive styles have better skill achievement than mixed learning-2 students who have auditory cognitive styles
(f) Mixed learning-1 students with visual cognitive styles have no different skill achievement than mixed learning-2 students who have kinesthetic cognitive styles
(g) Mixed learning-1 students with visual cognitive styles have worse skill achievement than mixed learning-2 students with visual cognitive styles

The results of this study have also revealed which learning styles are superior in the achievement of student computer programming learning in mixed learning-1 and mixed learning-2. This finding is the strength of the contribution of this study when compared to previous related works.

Conclusion

The two-way Anova test concluded that:

(a) There was no difference in the programming skills achieved between students who learn with mixed learning with a mixture of around 30% F2F learning and about 70% asynchronous online learning and students who learn with mixed learning with a blend of approximately 70% F2F learning and about 30% asynchronous online learning
(b) There are differences in programming skills acquired between students who have different cognitive styles both in mixed learning with a mixture of about 30% F2F learning and about 70% asynchronous online learning and also in mixed learning with a combination of about 70% F2F learning and about 30% asynchronous online learning

The results with Tukey post-hoc test concluded that:

(a) Students with auditory and visual cognitive styles who learn with mixed learning with a mixture of around 30% F2F learning and about 70% asynchronous online learning have better programming skills achievement than students with auditory cognitive styles who study with mixed learning with a blend of approximately 70% F2F learning and about 30% asynchronous online learning
(b) Students with kinesthetic and visual cognitive styles who learn with mixed learning with a blend of approximately 70% F2F learning and about 30% asynchronous online learning have programming skills that are superior to students with kinesthetic cognitive styles who learn with mixed learning with a mixture of around 30% F2F learning and about 70% asynchronous online learning

This means although the student programming skill achievement of the two mixed learning methods when assessed based on the learning method is equally good, it happens that student programming skill achievement of two mixed learning methods differs when evaluated based on the student cognitive styles.

Besides, this study also found that: In mixed learning with a mixture of around 30% F2F learning and about 70% asynchronous online learning, students who have an auditory cognitive style have superior programming skill achievement than students who have a kinesthetic and visual cognitive style. Meanwhile, students who have kinesthetic and visual cognitive styles do not differ in their programming skill achievement in mixed learning with a mixture of around 30% F2F learning and about 70% asynchronous online learning. In mixed learning with a blend of around 70% F2F learning and about 30% asynchronous online learning, students with an auditory cognitive style have worse programming skill achievement than students with a visual and kinesthetic cognitive style. Meanwhile, students who have kinesthetic and visual cognitive styles do not differ in their programming skill achievement in mixed learning with a blend of around 70% F2F learning and about 30% asynchronous online learning.

This research novelty is to study the reciprocal effects of student cognitive styles and hybrid learning with a mixture of 30% F2F subject matter combined with 70% asynchronous online subject matter and vice versa that no one had researched before.

Other new things obtained from this research are:

(a) The comparative test to determine which learning method is superior for the achievement of learning skills is not sufficient only with a comparative test based on the learning method but also based on the student cognitive style
(b) This study finding can be the beginning of a breakthrough in teaching with certain learning methods based on groups of students with the same cognitive style to achieve better skills. Or in other words, maybe the division of teaching classes no longer contains various cognitive styles with specific teaching methods for better learning achievement

This research result implies that each learning method must significantly facilitate learning media that support student cognitive styles. Another implication is the need to test various learning methods to determine which learning method is most suitable for each cognitive style for superior learning outcomes.

Further research will investigate what percentage of cognitive styles affect learning outcomes and compare student achievement between students with strong and weak cognitive styles by grouping or not grouping classes based on student cognitive styles. Thus, further research complements or refines existing research to make it more realistic about how much influence each one has cognitive style towards learning outcomes in mixed learning methods, including strong and weak cognitive styles.

Besides, this study has limitations in the learning factors studied, which only involve cognitive styles and mixed learning method with a combination of mixing 30% versus 70% between F2F subject matter and online subject matter and mixing vice versa, with a mixing variety of 70% versus 30% between F2F subject matter and online subject matter. So, further research needs to involve other internal student factors such as student interest in learning subjects and learning motivation. Likewise, it is necessary to do further research by applying external factors of mixed learning methods with various other variations (other than 30 and 70% or other than 70 and 30%) between F2F and online learning materials and also with other learning methods such as flipped learning and collaborative learning.

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Author's Contributions

Anthony Anggrawan: Is responsible for preparing the weight distribution of teaching materials in the two teaching methods of mixed learning-1 and mixed learning-2 and for carrying out the creation of a computer programming application module, including examples of implementing all programming problems into the flow chart as well as the programming language of VB.Net. He is also responsible for writing the article contents, including analyzing data on student programming skills in mixed learning-1 and mixed learning-2 teaching methods.

Christofer Satria: Designs and develops asynchronous online learning modules on a server computer to equip the learning modules with animated images and sounds.

Mayadi: Assisted in implementing the VARK survey to determine student cognitive styles in both teaching methods. He also implements lesson modules on computer servers and monitors computer systems for all student asynchronous online learning activities.

Ni Gusti Ayu Dasriani: Is responsible for completing the relevant references needed in the article, including double-checking the manuscript format correctness and writing the text.

Ethics

The authors confirm that this manuscript has not been published in other journals and does not have ethical concerns.

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