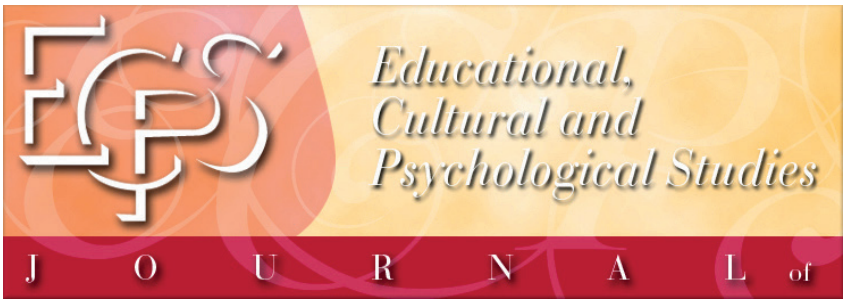

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The Effect of Scaffolding on Assignment Quality and Procedural Learning Achievement

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L'EFFETTO DELL'ATTIVITÀ DI SCAFFOLDING PER IL RAGGIUNGIMENTO DEL SUCCESSO NELL'APPRENDIMENTO PROCEDURALE

Abstract

Some problems experienced by millennial students when they learn by online include learning control, learning disorientation, and cognitive load. This study aims to examine the effect of scaffolding use on assignment quality and procedural cognitive learning achievement in the implementation of inverted or flipped (IF) classroom strategies. This study involved students of the pre-service study program of Indonesian Catholic University of Ruteng. The total research subjects were 78 students. They were divided into experimental and control groups. The experimental group is assisted by scaffolding, while the control group without scaffolding. The study design used a pretest-posttest experimental control group design and data collection using questionnaires and tests. Data analysis using multivariate analysis (MANOVA). The results showed that the use of scaffolding increased the effectiveness of implementing IF classroom strategies on student assignment quality and procedural learning achievement. The implications of the research for future study and learning practices can be explained.

Keywords: Assignment quality; Inverted classroom; Procedure learning achievement; Quantitative research; Scaffolding.

Intruduction

Information and communication technology (ICT) gave birth to the industrial revolution 4.0. Revolution 4.0 encourages and forces educational institutions to integrate internet use in learning. The integration of ICT in learning can improve mobility, accessibility and interactivity of the learning process that has not been fulfilled in traditional learning (Valencia-Arias, Cano, & Arango-Botero, 2019). IF classroom or flipped classroom (IF classroom) as one of the blended learning models adapts to the industrial revolution 4.0. Therefore, inverted classroom is considered as one form of innovative learning (Gannod, Burge, & Helmick, 2008; Strayer, 2012). As an innovative learning, IF classroom is based on the theory of active learning, constructivist learning, social learning, multimedia, and virtual learning (Davis, 2013). Based on these theories, IF classroom emphasizes process skills. By emphasizing process skills, applying IF classroom motivates students to be actively involved in the learning process, doing independent learning and critical thinking (Strayer, 2012; Schlingensiepen, 2014; Foster & Stagl, 2018).

However, are process skills effective in improving student learning achievement? Study done by Thomas & Philpot (2012) and Cruzado & Román (2015) found that although students feel happy with IF classroom, but it does not have an optimal impact on learning achievement. The question is why active learning activities, independent learning, and critical thinking, do not have an optimal impact on learning achievement? Similar studies have found that the application of online learning and or blended learning, on the one hand, can reduce the cost of education, but on the other hand can cause emotional problems for students. Students who study online are more likely to experience feelings of anger, anxiety, and helplessness than traditional learning students (Noteborn & García, 2016).

As one of the blended learning models, the implementation of IF classrooom requires scaffolding. Scaffolding can lead students to learn more directed and can overcome learning disorientation and cognitive load they experience (Kalyuga, 2009; Hsieh, Lee, & Su, 2013), especially when they are not under teacher control or do independent learning (Butz, Stupnisky, & Pekrun, 2015). Although other findings reveal that the cognitive

load experienced by students is also caused by the complexity of the questions and tasks given by the teacher or lecturer to students (Zulu, Haupt, & Tramontin, 2018).

Why does an inverted classroom need scaffolding? IF classroom implementation (by the assist of the internet), on the one hand can provide wider and independent learning opportunities for students (Schlingensiepen, 2014). However, if extensive learning opportunities are not assisted by clear learning guidelines, it can be assumed that students will lose orientation and learning priorities, especially students who have low of self regulated learning (SRL) and self-efficacy (Zimmerman, Bonner, & Kovach, 2002).

Thus, scaffolding as one of the learning method variables (Reigeluth, Beatty, & Myers, 2017; Ige, 2019) is thought to increase the effectiveness of using IF classroom strategies. Previous study has not revealed explicitly, how instructors guide student learning when they conduct online study sessions. This study wants to express the effect of scaffolding on assignment quality and procedural cognitive learning achievement on learning using IF classroom strategies.

Procedural cognitive learning achievement is the ability obtained by students after learning activities to master the processes and criteria that must be met to get things done (Willingham, Nissen, & Bullemer, 1989; Anderson & Krathwohl, 2001). In this study, the procedural cognitive learning achievement which be measured was the ability of prospective teachers to design learning systematically after they attend the Curriculum Development lecture. This ability requires mastery of the curriculum or learning component, the relationship between curriculum components, and the sequence of learning activities.

1. Method

This study used a quasi-experimental design with a type of non-equivalent control group design. The researchers effort to reveal causal relationships among variables by involving experimental and control groups (Tuckman, 1999; Sung *et al.*, 2015). Each group is treated. There are three variables in this study: (1) scaffolding as independent variables (two variations: textual hints and oral hints), (2) procedural cognitive learning achievement, and (3) assignments quality as independend variables as a dependent variables. High and low of assignments quality and procedural cognitive learning achievement are the effects of different treatments. The design shows that

both the experimental and control groups were both given pretest and posttest, treatment, and observation.

Based on the research design, two hypotheses are formulated: (1) There is the effect of implementing scaffolding on the quality of student assignments through the inverted classroom strategy; (2) There is the effect of implenting scaffolding on student procedural learning achievement through an inverted classroom strategy.

The subjects of this study were the third semester students of the pre service study program of Indonesian Catholic University of Ruteng, Indonesia who had taken courses in Curriculum Development. They were divided into the experimental and control classes. The characteristics of the research subjects included gender, age, and place of residence. The gender aspect, women are more than men. The most dominant age is 20-21 year. The majority of them live in boarding house. In summary the characteristics of the research subject are shown in *Table 1*.

Table 1. – The characteristics of the research subject (N = 78).

Descriptor	Experimental group	Control group
	Gender	
Male	10	11
Female	29	28
Total	39	39
	Age (year)	
18-19	10	6
20-21	27	31
> 22	2	2
Total	39	39
	Place of residence	
Boarding house	24	26
Family	15	13
Total	39	39

This research uses observation sheets and test. The observation sheet is used to measure the quality of completion of student assignments and tests are used to measure the prior knowledge and procedural cognitive learning achievement.

The test instruments used were in the form of multiple choices. Before being used, the instrument was tested for validity and reliability.

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The instruments used in this study have met validity (correlation coefficient value of each item is greater than 0.3) and reliability (Cronbach coefficient is greater than 0.7) (Pallant, 2005).

This research goes through three stages: the pre-experimental, experimental, and post-experimental stages. In the pre-experimental stage, the researcher conducted a survey about the habits of students using online media, developing teaching materials and expert validation (two experts), making instruments and conducting tests to determine validity and reliability, and measuring prior knowledge of students. At the experimental stage, researchers form online groups, treatment action, and collect a portfolio of student assignments. Tutorial material, material links, and discussion development are delivered to students by online. Scaffolding in the form of textual hints is delivered online before class meetings, while for control class, oral instruction is given at class meetings. Treatment was carried out for eight meetings. At the post-experimental stage, the researcher assessed the students' portfolios (eight tasks) and carried out the posttest exam.

This study uses multivariate analysis of variance (MANOVA) by the assisted of SPSS for Windows. Before being analyzed, the research data fulfilled the assumptions of data normality and homogeneity of variance. Through the tests of normality using the Kolmogorov-Smirnov technique, the results of both the experimental and control classes data are normality because the probability (P-value/Sig.) is greater than alpha (0.05). Furthermore, Levene's test of equality of error variances shows that the data is homogeneous, because P-value is greater than alpha. The research hypothesis is accepted if the P-value is less than alpha. The strength and weak influence of the independent variable on the dependent variable depends on obtaining the partial eta squar value ($\eta 2$). The $\eta 2$ value < 0.06 includes the category of very low or no effect, the $\eta 2$ value 0.06 to 0.14 is medium category, and the $\eta 2$ value > 0.14 including the strong category (Cohen, 1988; Pallant, 2005).

2. Findigs

The number of questions to measure prior knowledge of students is 20 items and a score range of zero to one hundred. Each correct answer is given one score and the wrong answer is given a zero score. The results of the student pretest (*prior knowledge*) are shown in *Table 2*.

Table 2. – Central tendency values of students' pretest.

Class	N	Mean	Std. Dev.	Std. Error	Min.	Max.
Experimental group	39	26.92	8.321	1.332	10	40
Control group	39	27.18	9.445	1.512	10	45
Total	78	27.05	8.843	1.001	10	45

Table 2 shows that the experimental class has a less mean (0.26) than the control class. However, statistical analysis shows that P-value is greater than alpha (0.899 > 0.05) and F-count is less than F-table (0.016 < 3.967). Therefore, we can say that there was no significant difference in the value of the pretest between the experimental and control classes before being treated.

Student procedural cognitive learning achievement are measured using multiple choice tests. The number of questions is 20 items. Each number of questions answered correctly is given a one score and the incorrect answer is given a zero score. The central tendency values of posttest results are shown in *Table 3* and the significance of the difference will be explained in the next points.

Table 3. – Central tendency values of posttest.

Class	N	Mean	Std. Dev.	Std. Error	Min.	Max.
Experimental Class	39	73.21	9.423	1.509	55	90
Control Class	39	67.82	10.052	1.61	50	90
Total	78	70.51	10.051	1.138	50	90

2.1. *Quality of assignment*

The level of quality of student assignments is divided into three categories: good, enough and less. Good categories are given score 3, enough categories are given score 2, and the less categories are given score 1. The criteria description for each category are: (1) good categories (score 3): construct learning material by their own language, ideas richer and wider, and explore studies using other learning resources; (2) enough categories (score 2): tend to repeat learning material, there is an effort to construct learning materials with their own language but poor ideas; (3) less categories (score 1): answers only repeat learning material. Based on these criteria as a result of the assessment, the accumulated frequency of each category or score (3, 2, 1) in eight assignments are shown in *Table 4* and the central tendency values of student assignments of student are shown in *Table 5*.

Table 4. – Accumulated frequency of score on eight assignments.

Assignment to	Experimental Class (N = 39)			Control Class (N = 39)		
	Score 3	Score 2	Score 1	Score 3	Score 2	Score 1
First	2	10	27	0	14	25
Second	4	26	9	0	17	22
Third	6	23	10	4	17	18
Fourth	4	21	14	1	22	16
Fifth	7	21	11	2	22	15
Sixth	8	24	7	3	23	13
Seventh	7	19	13	5	24	10
Eighth	4	29	6	3	27	9
Total	42	173	97	18	166	128
Percentage (%)	13.5	55.4	31.1	5.8	53.2	41.0

Table 5. – Central tendency values of student assignments.

Class	N	Mean	Std. Dev.	Std. Error	Min.	Max.
Experimental Class	39	1.838	0.3167	0.0507	1.3	2.4
Control Class	39	1.656	0.2836	0.0454	1.1	2.5
Total	78	1.747	0.3124	0.0354	1.1	2.5

Based on *Table 4*, the frequency of each category can be explained that: (a) good category (score 3), experimental class 13.5% and control class 5.8%; (b) enough category (score 2), experimental class 55.4% and control class 53.2%; (c) less category (score 1), experimental class 31.8% and control class 41.0%; (d) both the experimental and control classes, the highest frequency was the less category (score 1), then the enough category (score 2), and finally the good category (score 3).

2.2. *Scaffolding effect on procedural learning achievement and assignment quality*

The alpha level (α) used for the statistical test is 0.05. The partial eta squered value (η2) greater than 0.06 is considered to have an effect (Cohen, 1988; Müller & Seufert, 2018). Hypothesis testing is carried out after fulfilling the assumption of data normality and homogeneity of variance. Using the Kolmogorov-Smirnov technique, the two data groups (experimental and

control classes) obtained P-values greater than alpha (see *Table 6*) and the variances homogeneity test also obtained a P-value greater than alpha (see *Table 7*). Thus, it can be said that the two groups of data are normally distributed and have the same of variance.

Table 6. – Data normality test.

Class	Assignment quality			Procedural learning achievement		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental	.120	39	.167	.116	39	.200
Control	.120	39	.166	.106	39	.200

Table 7. – Variance homogeneity test.

Data	F	df1	df2	Sig.
Assignment quality	.031	1	76	.165
Procedural learning achievement	.060	1	76	.806

After fulfilling the assumptions of data normality and homogeneity of variance, hypothesis testing was carried out. Effect test results between subjects are shown in *Table 8*.

Table 8. – Effect test between subjects.

Source	Dependent variable	F	Sig.	Partial eta squared
Class	Assignment quality	5.892	.018	.072
	Procedural learning achievement	5.956	.017	.073

Based on *Table* 8, it can be explained that: (a) the significance (P-value) of the effect of scaffolding on task quality is 0.018 and procedural learning achievement is 0.017; (b) the partial eta squar value (η2) scaffolding on task quality is 0.072 and procedural learning achievement is 0.073; (c) both the quality of the assignment and procedural learning achievement have a P-values less than alpha. Based on the acquisition of P-values, it can be said that there are significant differences in the quality of assignments and procedural cognitive learning achievement between the experimental and control classes. This means that the use of scaffolding in the inverted classroom strategy has an effect on the quality of assignments completion and the procedural cognitive learning achievement of students.

Thus, the first and second hypotheses are accepted (Hypothesis # 1: There is the effect of implenting scaffolding on student procedural learn-

ing achievement through an inverted classroom strategy; Hypothesis # 2: There is the effect of implementing scaffolding on the quality of student assignments through the inverted classroom strategy). This is reinforced by the partial eta squared values, both the effect of scaffolding on the quality and procedural learning achievement. According to Cohen (1988), Pallant (2005), and Müller & Seufert (2018) the values of partial eta squared (0.072 and 0.073) are in the medium category because they are in the range 0.06 to 0.14.

3. Discussion

3.1. *Effect of scaffolding on the assignments quality*

Completion of assignmnts is considered high quality, if students are able to construct knowledge and develop ideas widely and deeply. Based on these criteria, there are significant differences in the quality of assignments completion between experimental and control classes. Experimental class more quality assignments than the control class. The difference is caused by different treatments.

However, descriptively, only a few students (experimental and control classes) were able to complete the assignments with the best score (score 3). The majority of them tried to construct knowledge, but their ideas were very poor, some even did not fit into the themes discussed. The similarity of patterns in completing assignments among students shows the disadvantages of inverted classroom and online learning strategies in general (Gannod *et al.*, 2008; Schlingensiepen, 2014).

Researchers cannot monitor exactly how students complete assignments, especially when they conduct learning activities before and after class. On the one hand, scaffolding can guide students to focus in learning, but on the other hand scaffolding in the form of hints does not guarantee that their learning activities are of high quality. The quality of learning and completion of assignmnts are not enough to be helped by providing scaffolding in the form of hints. Teachers/lecturers need to provide and use other forms of scaffolding, such as modeling, feedback, instructing, quetioning, suggesting, encouraging problems, and reminder to conduct learning activities independently as suggested by Belland (2012), Lu *et al.* (2010), and Morris *et al.* (2010), especially for students who have low of self-regulated learning and self-efficacy.

3.2. *The effect of scaffolding on procedural cognitive learning achievement*

Through statistical tests it was found the effect of scaffolding on procedural cognitive learning achievement. Thus, this study contradicts the research of Molenaar, Boxtel & Sleegers (2011) and provides a solution to the problems found by Thomas & Philpot (2012) and Cruzado & Román (2015). Molenaar *et al.* (2011) did not find a significant effect of the implementation of scaffolding on student performance, both group and individually. This is suspected due to a incompatibility between the form of scaffolding used with student needs and the type of subject matter (Azevedo & Jacobson, 2008).

Research done by Thomas & Philpot (2012) and Cruzado & Román (2015) revealed that there were no differences in learning achievement between students taught by using inverted classroom and students who were taught by conventional methods. The ineffectiveness of inverted classrooms in the two study groups was because they did not use scaffolding as a learning guide. Inverted classroom implementation, with diverse learning sessions, requires scaffolding, especially for students who do not have learning independence and target procedural skills (Bannert, 2009).

This study supports and reinforces several similar studies. Roschelle *et al.* (2010) reported that students given scaffolding on the use of wireless handheld technology can solve learning problems better. The indicators of excellence they observe are participation in asking, explaining, and discussing problem solving. Simons & Klein (2007) who conducted study on three groups: groups that were required to be given scaffolding, groups that were given scaffolding options as needed, and groups that were not given scaffolding options, revealed that groups that were required to receive scaffolding obtained higher posttest scores than the other two groups. The study of Azevedo & Jacobson (2008) concluded that the use of scaffolding in the use of hypertext and hypermedia can help foster student learning.

The complexity of competencies that must be mastered by students can increase the cognitive and emotional load for students, especially when they study with google or the internet (Kalyuga, 2009; O'Reilly, 2015; Noteborn & García, 2016; Huang, 2019). Inverted learning allows instructors to deliver more material to students (Mason *et al.*, 2013) because the material is not be delivered in the classroom. Through the use of scaffolding, students are guided to use the internet as as a learning media and learning resource and conduct targeted and quality learning activities. This study found that the use of scaffolding in the form of textual hints can increase the effectiveness of using inverted classroom strategies on procedural learning achievement in the curriculum development courses.

4. Conclusions and implications

Based on the results of the analysis and discussion, this study concludes that there is a significant effect of the use of scaffolding in an inverted classroom strategy on procedural learning achievement and the quality of student assignments. The experimental class shows procedural learning achievement and assignment completion better than the control class. By using scaffolding, students are guided to learn with focus. Learning focus helps them to conduct quality learning activities and obtain optimal learning achievement.

Based on these conclusions, this study implies future research and learning practices. First, *Future Study*. The lack of influence of the independent variable on the dependent variables in this study gives an imperative for future research to: (a) needs to examine the learning conditions variables, for example self-regulated learning which also influence student learning motivation; it can occur that the experimental class who are taught by using scaffolding have higher self-regulated than the control class, so they can learn better; (b) need to examine the forms of scaffolding needed by students; in this study, researchers only used hints, there are still many other forms of scaffolding that can be used, such as modeling, feedback, encouraging problems, etc.

Second, *Learning Practices*. Educational institutions (which have integrated internet use in learning) need to use scaffolding based on student needs, because the use of scaffolding forms that are appropriate to the needs of students, can lead them to learn and complete assignments well and achieve optimal learning outcomes.

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Riassunto

Alcuni problemi riscontrati dagli studenti di oggi quando imparano attraverso la formazione online riguardano la loro capacità di controllo dell'apprendimento, il disorientamento nell'apprendimento e il livello di carico cognitivo esperito. Questo studio si propone di esaminare l'effetto dell'uso di procedure di scaffolding sul raggiungimento dei risultati dell'apprendimento cognitivo procedurale, grazie all'implementazione delle strategie didattiche delle classe capovolte o flipped (IF). Questo studio ha coinvolto gli studenti del corso di studi per docenti in formazione dell'Università cattolica indonesiana di Ruteng. I partecipanti alla ricerca sono stati in totale 78 studenti, ripartiti in gruppo sperimentale e di controllo. Il gruppo sperimentale è stato assistito con procedure di scaffolding, mentre il gruppo di controllo non è stato coinvolto in tali procedure. Il disegno di ricerca ha previsto quindi un confronto tra gruppo di controllo e gruppo sperimentale pre-test / post-test e una raccolta di dati utilizzando alcuni questionari. L'analisi di tali dati è stata condotta mediante analisi multivariata (MANOVA). I risultati hanno mostrato che l'uso di scaffolding aumenta l'efficacia delle strategie didattiche nelle classi capovolte (IF) in merito alla qualità dei risultati dell'apprendimento procedurale. Vengono discusse le implicazioni della presente ricerca sulle pratiche di apprendimento e vengono delineati alcuni possibili sviluppi futuri.

Parole chiave: Apprendimento della procedura; Classe invertita; Qualità dell'apprendimento; Ricerca quantitativa; Scaffolding.

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