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The Effect of Just in Time Teaching and Self-Directed Learning on Student Engagement and Cognitive Learning Outcomes

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This research determines the effect of Just in Time Teaching (JiTT) and Self-Directed Learning (SDL) on Student Engagement and cognitive learning outcomes. The quasi-experimental research design with a 2x2 factorial was used to compare the JiTT strategy with conventional strategies. The research subjects were 125 students of Elementary School Teacher Education (PGSD) enrolled in an Islamic Education course in the first semester of the 2019/2020 academic year from Malang State University, Indonesia. The subjects consist of 63 and 62 students in the experimental and control classes using the JiTT and conventional strategies, respectively. Questionnaires were used to measure the SDL on student engagement and an essay test instrument to determine the cognitive learning outcomes. Data were analysed using the Multivariate Analysis of Variance (MANOVA) assisted by SPSS 16 for windows. The result showed that JiTT has a significant effect on student engagement and cognitive learning outcomes compared to conventional strategies. Students with high SDL have better engagement and cognitive learning outcomes compared to those with low SDL. However, the result also showed that there was an interaction between JiTT and SDL on student engagement and cognitive learning outcomes.

Key words: *Just in Time Teaching, Self-Directed Learning, Student Engagement, Cognitive Learning Outcomes.*

Introduction

The research places emphasis on students as active individuals with the ability to learn and find their own competencies, knowledge, technology, and other things needed for development. The initial knowledge and understanding brought by each student into the learning process need to be added, modified, updated, revised, and changed using new information found in the learning process (Gupta, 2008). The three important characteristics of student-centred learning as explained by Mostrom and Blumberg are that learning makes students (1) responsible, (2) be actively involved in the material inside and outside the classroom, and (3) able to complete several formative assessments (Mostrom & Blumberg, 2012).

JiTT is designed based on the constructivism theory, which stated that all students use their individual background knowledge to produce new information. JiTT initiators consider students' background knowledge as an important attribute used to enrich the learning material (Abreu & Knouse, 2014; Guertin & Zappe, 2007; Lorena Andrea López Cupita, 2016; Mcfadyen & Watson, 2013). JiTT was originally developed to help students organise their assignments outside the classroom and to obtain/ create more time with lecturers. The main concept behind the JiTT approach is to make a direct link between pre and classroom activities by utilising online pre-class assignments, commonly referred to as WarmUps exercises. Its main features are pre-class assignments, questions in class with discussion, active learning tasks in small groups, lecturer's input in the targeted class, and supporting online material (Gavrin, 2006; G. M. Novak, 2011).

There are two essential keys to implementing JiTT in certain situations: 1) giving students a series of questions that explore their understanding of pre-class assignments and 2) using student responses as material in classroom learning. The design principles that apply to all JiTT implementations, including pre-class assignments, need to be related to the content, type of lessons and learning activities during class sessions (Formica, Easley, & Spraker, 2010; Reigeluth, Beatty, & Myers, 2017). This makes JiTT more responsive to student needs, and class time is more focussed on difficult topics. However, this advantage requires special effort in implementing JiTT, with the need for some basic infrastructure technology and time for the development of WarmUps. JiTT makes it possible to start discussions with many students and acts as a feedback that connects the classroom with the learning environment. It also provides students with learning interactivity outside the classroom using experience in the school. Everything they learn in class forms the basis of their next reading and warm-up assignment (Gavrin, 2006; Mcfadyen & Watson, 2013).

Short assignments in JiTT must be based on conceptual questions or analysis, which is mandated to be answered before starting class activities. This is to encourage students to read or watch the preview material before the class starts in order to identify their misunderstanding and wrong beliefs quickly. This process is very important because students are heavily influenced by the pre-existing understanding of the subject matter. According to Novak, most times students are unaware of when they misunderstand learning procedures, and this interferes with their ability to absorb new information (Mcgee, Stokes, & Nadolsky, 2016; G. M. Novak, 2011).

JiTT is an innovative learning strategy that allows lecturers to involve students in the learning process through the provision of feedback between online assignments and learning in class, as well as the implementation of tasks that are improved in quality and quantity (Lorena Andrea López Cupita, 2016). It can also increase their attendance and engagement (Deslauriers, Schelew, & Wieman, 2012), thereby ensuring that students have a better understanding (Mcfadyen & Watson, 2013). JiTT also improves measurable cognitive learning outcomes (Marrs & Novak, 2004), student understanding of Newton's third law (Formica et al., 2010), successfully implements their active learning of cell biology (Gaddy & Medlock, 2013) and Algebra learning outcomes (Natarajan & Bennett, 2014).

SDL is expected to make students build and monitor their own learning experiences, creating an active learning environment, both inside and outside the classroom. In the JiTT, assignments and class activities are designed to make students examine their current knowledge to modify, add, and apply it during the learning process (Reigeluth et al., 2017). It is based on Kavitha's research on medical students, which gave significant results on their independence and learning outcomes (De, Kavitha, & Kanagasabai, 2014). Similarly, Maldonado-Fuentes also found that JiTT impacts on students' ability to handle learning with discipline (Maldonado-Fuentes & Rodríguez-Alveal, 2017).

The maximum SDL is required to produce student engagement and cognitive learning outcomes. Studies carried out by Donnell and Jimoyiannis & Tsiotakis, showed that SDL has the ability to increase student involvement and understanding of the material provided (Donnell, 2014; Jimoyiannis & Tsiotakis, 2016). Hennis, Vries, & Veen reported that SDL is the key to successful web-based learning in order to enhance students' understanding (Hennis, Vries, & Veen, 2017).

Therefore, this study was conducted to determine the influence JiTT and SDL towards student engagement and cognitive learning outcomes. The study aims to follow up and complement previous research on the effects of JiTT on student engagement and cognitive learning outcomes using the JiTT and conventional strategies. Therefore, this study answers the following questions:

1. Are there any differences between student engagement using JiTT and conventional strategies?

2. Are there differences between students with high and low SDL?
3. Is there any interaction between JiTT and SDL?
4. Are there any differences in the results of the student cognitive learning taught using JiTT and conventional strategies?
5. Are there differences in cognitive learning outcomes between students with high and low SDL?
6. Are there interactions between JiTT and SDL towards cognitive learning outcomes?

Method

The study used the quasi experimental design with a 2X2 factorial involving the JiTT and a control class by employing conventional strategies. The variables in this study are as follows: (1) The independent variable which is the learning strategy, divided into two levels/dimensions, namely: JiTT and conventional; (2) the moderator variable is SDL which is divided into two dimensions, namely: high and low SDL; and (3) dependent variables, namely student engagement and cognitive learning results.

The research subjects were 125 students of Elementary School Teacher Education (PGSD) that enrolled in an Islamic Education course in the first semester of the 2019/2020 academic year from Malang State University, Indonesia. The subjects consist of 63 and 62 students in the experimental and control classes using the JiTT and conventional strategies, respectively. The themes used to test the influence of JiTT are moral, science, socio-cultural, and contemporary issues in the Islamic perspective. This is in accordance with the competency required by students with the JiTT strategy.

Student groupings in this study are based on the learning strategies. The study consisted of preparatory and experimental phases. The preparation phase includes preliminary study activities on Islamic education, syllabus preparations, validity testing, and instrument reliability. The experimental stage consists of pre-experiment and experiments. Pre-experimentation was conducted by providing SDL polls and preliminary tests, while the experimental activities were carried out for 7 weeks and ended with a post of student engagement tests and polls.

The JITT and conventional learning measures used in this study are shown in table 1:

Table 1: The Stage of JiTT and Conventional Learning

Just in Time Teaching		Conventional Strategy	
Stage	Learning Activity	Stage	Learning Activity
Stage 1 (online) Warm-Up	Students read material online	Stage 1 (offline) Introduction	Motivate students
	Students answer questions (practise JiTT) online.		Stimulate knowledge by reminding of previous studies
	Lecturers chose students ' answers (JiTT response), which are considered interesting and need to be appropriately analysed in class.		
Stage 2 (offline) Adjusting Concept	Lecturers display the students' answers (JiTT response) selected	Stage 2 (offline) Main	Presentation of new knowledge by lecturers
	Students discuss the JiTT.		Student Learning about the concept
	Students find the concept.		Discussion and presentation
Stage 2 (offline) Applying Concept	Students associate the concept with real-life events; therefore, it can be applied in everyday life	Stage 3 (offline) Closing	Revision Result
	Students make conclusions from the materials that have been studied.		Conclusion and Evolution Process
	JiTT Evaluation		

The three types of instruments used to measure this research variable are as follows:
1) Self Directed Learning Instrument (SDLI);
2) Higher Education Student Engagement Scale (HESES)
3) Test of Cognitive Learning Result

Self-directed learning is measured by using SDLI, which contains 20 items in four domains, namely learning motivation (LM, 6 items), Planning and implementation (PI, 6 items), self-monitor (SM, 4 items), and interpersonal communication (IC, 4 items). Learning motivation is defined as self-encouragement and the external stimuli that motivate one to learn and be accountable. Planning and implementation are defined as self-ability in setting learning objectives and using appropriate strategies and resources to achieve its objectives effectively. Self-monitors are defined as the ability to evaluate processes and learning outcomes, while interpersonal communication is the ability of students to interact with others. Respondents were asked to assess each item on a 5-point Likert scale with the total score on the SDLI ranging from 20 to 100. Higher scores indicate higher SDL levels (S. Cheng, Kuo, Lin, & Lee-hsieh, 2010; Shen, Chen, & Hu, 2014). SDLI was conducted at the beginning of the research to determine the SDL students before treatment.

Student engagement is measured using Higher Education Student Engagement Scale (HESES), which is developed based on the five factors evolved from Finn and Zimmer's research that account for the distinctive characteristics in higher education. HESES consists of 28 items consisting of five key aspects including (1) academic involvement, (2) cognitive, (3) social engagement with peers, (4) social involvement with the teacher, and (5) Affective Engagement (Finn & Zimmer, 2012; Zhoc, Webster, King, Li, & Chung, 2018). HESES was also conducted at the end of the study to determine students' involvement.

The cognitive learning results were measured using a test essay developed by researchers. The questions in the pre and post-test are different, with the same level of difficulty. Therefore, to maintain the validity and reliability of the instruments developed, questions in the pre and post-test are measured using content validity. In addition, the validation of test content was carried out by material and learning experts. The specialists used instruments, consisting of a grid of questions and a scoring section for reviews and validation. Lastly, a reliability test was conducted using the Cronbach alpha coefficient and SPSS 16 for Windows software.

The collected data were analysed by inferential statistical analysis techniques using Multivariate Analysis of variance (MANOVA). Furthermore, this analysis was used to reveal differences in student engagement and cognitive learning outcomes between the experimental and control groups.

Results

Test analysis requirements were conducted to determine parametric feasibility before hypothesis testing. Meanwhile, the univariate or multivariate analyses consist of a test of normality and homogeneity.

Testing Data Normality

Data normality test was used to determine the data that has been collected in a normal distribution.

Table 2: Normality Test

Tests of Normality							
	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Student Engagement	Experiment	.119	63	.028	.967	63	.084
	Control	.097	62	.200*	.987	62	.748
Cognitive learning result	Experiment	.118	63	.030	.964	63	.061
	Control	.121	62	.024	.970	62	.140

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 2 showed that students' engagement score from the output table of the statistical and Shapiro-Wilk test results has a significant value of 0.084 (P > 0.05) for the experimental class and 0.748 (P > 0.05) for the control group. This means that the student engagement score in the experiment and control groups are normally distributed. This is similar to the cognitive learning scores of the test result table output statistics, which shows that the significant value for the experiment and control classes is 0.061 (P > 0.05) and 0.140 (P > 0.05), respectively. That means the cognitive learning scores in both classes are normally distributed.

Homogeneity Variant

Levene's test was used to examine the homogeneity of variances with a significant rate of 0.05. If the significant value (SIG) is greater than 0.05, then the research data is homogeneous and heterogeneous when the significant value (SIG) is above and below 0.05.

Table 3: Homogeneity Test

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
Student Engagement	1.289	3	121	.281
Cognitive learning result	.712	3	121	.546

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Group + SDL + Group * SDL

Table 3 shows the Levene test results, with a significance value for student engagement at 0.281, which is higher than alpha 0.05 (p > 0.05). This leads to the conclusion that the variances of student engagement data are homogeneous. The same is true for cognitive-learning results data, with a significance value of 0.546, and higher than alpha 0.05 (p > 0.05). Therefore, the variance in cognitive learning outcomes is homogeneous.

Test Results Influence Self-Directed Learning and Strategies Used by Students for Cognitive Outcomes.

Table 4 shows an analysis of the effects of just in time teaching and self-directed learning on student engagement and cognitive learning outcomes.

Table 4: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Student Engagement	4376.921[a]	3	1458.974	53.775	.000
	Cognitive Learning Outcomes	4610.849[b]	3	1536.950	42.247	.000
Intercept	Student Engagement	730326.630	1	730326.630	26918.234	.000
	Cognitive Learning Outcomes	829041.605	1	829041.605	22788.541	.000
Learning Strategy	Student Engagement	524.655	1	524.655	19.338	.000
	Cognitive Learning Outcomes	280.237	1	280.237	7.703	.006
SDL	Student Engagement	3687.284	1	3687.284	135.905	.000
	Cognitive Learning Outcomes	4138.651	1	4138.651	113.762	.000
Learning Strategy * SDL	Student Engagement	112.731	1	112.731	4.155	.044
	Cognitive Learning Outcomes	146.066	1	146.066	4.015	.047
Error	Student Engagement	3282.887	121	27.131		

	Cognitive Learning Outcomes	4401.951	121	36.380		
Total	Student Engagement	743865.000	125			
	Cognitive Learning Outcomes	844600.000	125			
Corrected Total	Student Engagement	7659.808	124			
	Cognitive Learning Outcomes	9012.800	124			

a. R Squared = .571 (Adjusted R Squared = .561)
b. R Squared = .512 (Adjusted R Squared = .499)

In Table 4, student engagement has an F-value of 19.338 with a significance of 0.000, which is lower than alpha 0.05. This shows that there is an influence of JITT and conventional strategies on student engagement. Cognitive learning outcomes have F-value of 7.703 with a significance of 0.006 lower than alpha 0.05. This shows that there is a significant influence between JiTT and conventional strategies on cognitive learning outcomes.

The F-statistic value for student engagement based on SDL is 135.905, with a significance of 0.000, which is lower than alpha 0.05. Therefore, there is a significant difference in student engagement between those with high and low SDL. Table 3 showed that the F-value for cognitive learning outcomes based on SDL is 113.762, with a significance value of 0.000, which is smaller than alpha 0.05. Therefore, students with high SDL get better cognitive learning outcomes than those with low SDL.

MANOVA test results showed the interaction between JiTT and conventional strategies with SDL on student engagement; this is because it has an F-value of 4.155 at 0.044 significance, which is higher than alpha 0.05. There is interaction between JITT and conventional strategies with SDL on cognitive learning outcomes; F = 4.015 with a significance value of 0.047, which is higher than alpha 0.05.

Discussion

The findings of this study indicate a significant difference in student engagement between JiTT and conventional strategies. Students in the JiTT class have higher engagement compared to their conventional counterparts. This is in accordance with the opinion of some learning experts that use the JiTT strategy through web-based learning to provide online questions, with the discussions carried out in the classroom. According to Sun et al., the use of the JiTT strategy leads to a higher level of students' involvement, which encourages them to undertake challenging tasks (Sun et al., 2016). Online and offline learning strategies are able to increase interaction between teachers and students (Fatimah, Rahman, Yunus, & Hashim, 2019). It also increases student engagement; therefore, it requires special learning designs (Al-sakkaf, Omar, & Ahmad, 2019; Arjomandi, Seufert, Brien, & Anwar, 2018; Khan, Egbue, Palkie, & Madden, 2017). Online pre-class assignments in JiTT can increase student engagement before and after lectures (G. Novak, 2019; Wanner, 2015). It also encourages students to attend class well-prepared and be actively involved in problem-solving (Lenczewski, 2019).

JiTT is also able to lead/ improve students' performance and learning achievement on various calculus topics due to the connection between prior knowledge and new calculus topics (Natarajan & Bennett, 2014). The assessment data for student performance on knowledge-based questions shows JiTT aids in learning. In addition, JiTT-based classes have more consistent test scores compared to those in pharmaceutical science (Madiraju, Tellez-corrales, Hua, & Stec, 2020). Students taught with JiTT have higher learning activities in terms of answering questions in web classes; therefore, they possess higher physics learning outcomes (Sudarma, 2015). JiTT is able to improve student learning outcomes (Sun, 2014) in neurology material (Dominguez et al., 2018), thermodynamics (Liberatore, Morrish, & Vestal, 2017), and biomechanics (Riskowski, 2015).

Students with high SDL tend to possess more cognitive learning outcomes; this is in accordance with the findings of Cheng's research using Team-Based Learning. High SDL tends to encourage interaction between students to increase their engagement, the value of teamwork, and learning outcomes (C. Cheng, Liou, Tsai, & Chang, 2014). SDL also affects students' effectiveness in online learning, especially social involvement in the classroom. Students with high SDL have a stronger zeal in achieving learning goals (Geng, Law, & Niu, 2019) and a high sense of curiosity (Caravello et al., 2015), which ultimately increases their engagement and cognitive learning outcomes.

There was an interaction between JiTT and SDL on student engagement and cognitive learning outcomes. In accordance with Sukardjo's study, SDL had a relationship with student engagement and summative assessment (Sukardjo & Salam, 2020). Self-directed learning proved to be most significant in improving the learning of Social Studies concepts, followed by a combination of Self-directed learning (Oyediji & Okwilagwe, 2015). This is also because there is a direct relationship between the use of technology and student performance (Geng et al., 2019).

Conclusion

In conclusion, JiTT and SDL tend to improve student engagement and cognitive learning outcomes. This proves that JiTT is an active learning strategy that can engage students to improve cognitive learning outcomes. There was an interaction between JiTT and SDL on student engagement and cognitive learning outcomes. In subsequent studies, several recommendations that need to be considered for follow up are: 1) the more optimal application of JiTT. 2) Use the strategy in various disciplines to be more active and innovative in learning.

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