IOP Conf. Series: Materials Science and Engineering **434** (2018) 012098 doi:10.1088/1757-899X/434/1/012098

The effectiveness of flipped classroom in high school Chemistry Education

H Syakdiyah, B Wibawa* and H Muchtar

Universitas Negeri Jakarta, Jakarta, Indonesia

*bwibawa@unj.ac.id

Abstract. The low achievement of learning outcomes in thermochemistry and rate of reaction subject of high school students is caused by students difficulties in solving algorithmic problems, especially procedural capabilities based on calculation in a limited time. Therefore, it is needed a learning strategy to support the achievement of thermochemistry and rate of reaction subject learning outcomes. This study aims to determine the effectiveness of Flipped Classroom in improving the results of learning thermochemistry and rate of reaction subject learning outcomes. Flipped classroom is a teaching method that delivers the subject material to students at home through electronic device and uses classroom time for practical application activities. This research used experimental method with treatment by level 2 x 2. The result of this study concludes that the result of thermochemistry and rate of reaction learning outcomes are higher with flipped classroom instructional strategy than learning with expository instructional strategy. It is recommended that the flipped classroom instructional strategy can be used as an alternative learning process in thermochemistry and rate of reaction.

1. Introduction

Thermochemistry and Reaction Rate subject are the two subject that get the lowest achievement in the result of National Examination 2016, 27% for thermochemistry achievement and 31% reaction rate achievement (Kemdikbud Data). That means 63% students are not able to solve thermochemistry problems, and 69% are not able to solve reaction rate problems. This became the study material for teachers, "what's wrong with thermochemistry and reaction rate?". Thermochemistry and rate of reaction are two subject in High School class that has almost the same characteristics. Both begin with knowledge of concepts facts, legal laws and problem solving involving algorithmics. Algorithms is a sequence of logical problem-solving steps organized systematically. The difficulty felt by the students lies in its algorithmic completion. A learning strategy is needed that provides opportunities for more interaction time between teachers and students, involving active and independents students in learning and incorporating IT technology into it. A flipped class strategy is the most appropriate learning strategy with the strategies required for thermochemistry subjects and reaction rate. Flipped Classroom is a learning process involving active students, independent learning before entering the classroom, the class s used to interact actively to solve difficult problems. [1],[2],[3]. The Flipped Classroom also uses electronic media into the self-learning process before students enter the class [4]. Describes a learning model that incorporates direct learning with constructivist learning experiences While the main goal using Flipped Classroom strategy is to provide a self-learning environment for students in solving problems. Nevertheless the teacher retains control over student learning activities [2].

Some studies suggest that Flipped Classroom is a effective for large classes and raises students positive perceptions of learning and can improve learning outcomes [5], [6], [7],[8],[9]. In addition, the application of ICT into the Flipped Classroom learning process proved to overcome the limitations of time in the classroom, as well as improve the ability to solve students problems. Flipped Classroom can also increase the interaction and communication skills and writing ability of students [10] [11] [12]. There is no significant challenge in the application of Flipped Classroom [11], however there is a study that says the failure of the implementation of the Flipped Classroom strategy, due to the in ability of students un the learning process that is not monitored by teacher, the lack of computer science and technology from teachers [13]. An analysis of Flipped Classroom from 2013 – 2015, it is said to have a positive impact on students, achievement motivation, interaction, in addition to calling for research that takes into account the suitability of the classroom and the quality of the video used. Education educational research, chemistry and medical were the top 3categories and "active learning" and "blended learning" recent major topics of flipped classroom research during the past 16 years [14]. This study will determine how effective the Flipped Classroom learning strategy is used in subjects that contain "algorithmic" calculations on thermochemistry and reaction rates. Competency of students in algorithmic calculations greatly determines the success of students learning, including in chemistry subjects. Factors that influence the application of the flipped classroom strategy are self-directed learning students; students determine their learning direction without the help of others, diagnose needs and learning objectives [15]. The learning strategy of flipped classroom is effective in improving students learning outcomes by considering students self-reliance. This article uses a quantitative approach based on the results of experimental research that conducted on students of XI of science class program with design treatment by level 2x2. This study shows that the application of flipped classroom strategy on the subject of thermochemistry and reaction rate is very effective in improving students chemical learning outcomes.

2. Methods

This research was done by using experimental methods with design treatment by level 2x2 in grade XI science program student at SMAN 1 Setu Bekasi. The study was conducted on chemistry subjects with 17 meetings on thermochemistry and reaction rates subject. The study was conducted by comparing experimental classes studied with flipped classroom strategies with control classes studied with expository strategies. The result of chemistry learning as dependent variable and learning independence as a moderator variable. The research begins by distributing questionnaires to students as needs analysis, followed by making learning instruments of chemistry and self-learning, learning implementation plan (RPP), learning media in he form of video that will be used in the experimental class. Target population in this study is all students of grade XI science program students at SMAN 1 Setu. Sample study was taken randomly from five existing MIPA program classes, one for experimental class, one for control class. Total population in experimental class were 45 students and 47 students in control class. All instruments were tested for validity and reliability before use in the study, by first being tested to grade XII students who have studied thermochemistry and reaction rate. The research data were tested normality with Kolmogorov Smirnov and homogeneity using Bartlet Test with significance level $\alpha = 0,05$. The result of normality test in this research from all group A1, A2, B1, B2, A1B1, A2B1, A1B2, A2B2, all group are stated normal, with value of Sig > 0,05. Accept H0. Homogeneity test was done by Bartlet Test to all the above groups with Sig value > 0,05, it means all population in all group have some variance. Then tested hypothesis with two path ANOVA with result as follow:

Table 1. Tests of between-subjects effects and univariate test.

Tests of Between-Subjects Effects

Dependent Variable: Learnig_outcomes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	621,729[a]	3	207,243	10,596	,000
Intercept	14386,687	1	14386,687	735,564	,000
Strategy	487,688	1	487,688	24,935	,000
Self_directed_learning	46,021	1	46,021	2,353	,132
Strategy * Self_directed_learning	88,021	1	88,021	4,500	,040
Error	860,583	44	19,559		
Total	15869,000	48			
Corrected Total	1482,313	47			

a. R Squared = ,419 (Adjusted R Squared = ,380)

Univariate Tests

Dependent Variable: Learnig_outcomes

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	487,688	1	487,688	24,935	,000
Error	860,583	44	19,559		

The F tests the effect of Strategy. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Based on the analysis data in table 1 above, it can be concluded as followed:

a. Differences in chemical learning outcomes between students who were taught by Flipped Classroom strategy and expository learning strategies. Based on the calculation results obtained differences in student learning outcomes in students who learn with Flipped Classroom strategy with students who studied with expository strategy obtained F arithmetic = 24.935 and F table 3.18. Because the value of $F_{arithmetic} > F_{table}$ then H0 rejected. Then if seen from the value of Sig 0,000 means learning strategy significantly influence the results of learning chemistry.
b. There is Influence of interaction between learning strategy and self directed learning to chemistry learning result. Based on two way anova calculation obtained Fcounting = 4.500 and F table = 3.18. Since the value of $F_{counting} > F_{table}$ then reject H0, and receive H1. The presence of interaction can also be seen in the following figure 1:

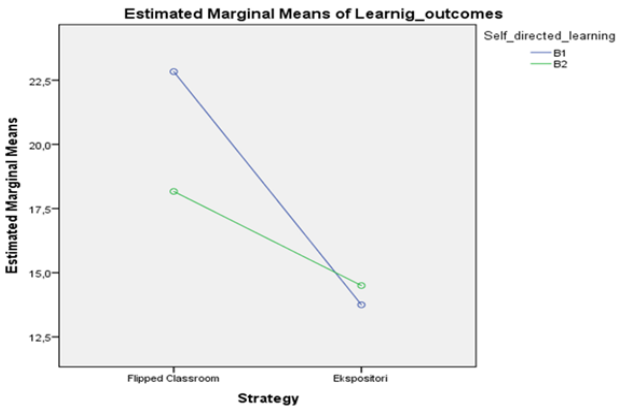

Figure 1. Estimated marginal means of learning outcomes.

c. There are differences in students' chemistry learning outcomes learned by Flipped Classroom and students with Expository strategies for students with high self directed learning Based on the results of the Independent Sample Test obtained Sig (2 tailed) 0,000, using the significance value $\alpha = 0.05$ obtained Sig <0.05 so H0 is rejected. This means that there are differences in the results of chemistry learning between students who learn with Flipped Classroom and Expository strategies in students who have high self directed learning.
d. There are differences in students' chemistry learning outcomes with learning strategies of flipped classroom and students learning with expository learning strategies for students with low self directed learning.

3. Discussion and conclusion

The use of Flipped Classroom learning strategy proved to be effective in the subject of thermochemistry and reaction rate, seen in hypothesis test no. 1, there is significant difference in the result of learning. H Glenn Anderson writes that students' calculations learning outcomes with the flipped classroom strategy are higher than those of the traditional class [16]. From several previous studies, the Flipped Classroom learning strategy has been proven to increase learning motivation, activeness, interest, and positive perception of students to the learning process [5], [6], [7]. In addition, the application of ICT into the learning process of flipped classroom proved to overcome the limitations of time in the classroom, as well as improve the ability to solve students problems. All material in the of factual and conceptual knowledge can students learn independently. Students enter the classroom in conditions ready to apply their knowledge in solving problems in the classroom. Time in the classroom is used to discuss issues that are considered difficult, including algorithmic issues. So the time available at face-to-face learning is becomes effective. The main purpose of learning the Flipped Classroom is to provide a student-centered learning environment. In this case the students are given space to learn independently, build their own knowledge, then in the teacher class guide students in solving problems [4]. Unlike the expository class where the pattern of interaction dominated by teachers in the learning process will lead students maintaining his passive attitude. As a result, student will fail creating problem solving patterns in their learning [17]. This will clearly sharpen the difference in student learning outcomes in Flipped Classroom and expository strategies. In the class of Flipped Classroom students who have high self learning, obtain higher learning results as well. But in the control class, students who have low self learning actually get higher learning result. This can be explained, students who have low self learning will be motivated in learning if given freedom to learn in self. Conversely, students who have high self learning will experience demotivation if forced to follow expository learning, which forces students to accept what is given by the teacher. This is why students with high self-directed learning will get low learning outcomes. ‘

From explanation above, can be concluded that the appropriate learning strategy will improve learning outcomes. Flipped Classroom has a high effectiveness in the thermochemistry substance and reaction rate. In addition, the self learning also influences the improvement of student learning outcomes. Based on this research, it is expected that teachers can apply the Flipped Classroom strategy especially on the subject of thermochemistry and reaction rate, as well as on subjects that have similar characteristics with that two subject. Researchers hope that the chemistry teacher can identify the character of the chemistry subject, making it easier to choose and apply an appropriate learning strategy. In the future, the researcher hopes that there will further research, with other subject in chemistry so as to enrich the knowledge of teachers in the implementation of strategy learning. To teachers who do not have the ability to create video learning media self-disclosure, can download the learning media that are widely available in online media that are widely available in online media, by doing screening first, to ensure the media is feasible or not to be a source of learning. Then for teachers who already have the ability to create online learning media, continue to improve its competence, because the antusiasme and meaningfulness of students self learning is very dependent on the learning media that teachers prepare. Millennial generations that grow with technology will beable to learn effectively with ICT.

References

[1] T Wee Too, K Chwee Daniel Tan, Y Kai Yan, Y Chua Teo and L Wee Yeo 2014 H F T S U C L L C E R and P R *S of C.* **15**
[2] J Bergmann, C Rotellar and J Cain 2016 *J P E*
[3] H Ngee Mok 2007 *T T: The F C J. Of I S E*
[4] S Arnold-Garza 2017 T F C T M and I U F I L I, C in I L
[5] B B Stone , *F Y C to I A L and S E* 2012 Associate Teaching Profesor University of Missiori Columbia *28th Annual Conference on Distance Teaching & Learnin*
[6] J E McLaughlin, Mary T Roth, D M Glatt, N Gharkholonarehe, C A Davidson, L Toya M Griffin, D A Esserman and R J Mumper 2014 T F C : A C R to F L and E in H P S
[7] C L yestrebsky 2014 F the C a L C C _ R U E *Proceedings of Chemistry Departement University of Central Florida*
[8] A Nederveld 2015 F L in the W *J. of W L* **27**(2)
[9] Adam M and Jacqueline E McLaugline 2017 T F C – F T to P in H P E *J. A J P E* **81**(16) 118
[10] X Yang Shu 2015 An E S on F C in O U T B on an E P : A C S on a T T and P C *J. A A O U J* **10**(1) pp53-63
[11] C Kwan Lo and K Foon Hew 2017 A C R of F C C in K-12 E : P S and R for F R, R and P in T E L **12**(4)
[12] R Afrilyasanti 2017 I EFL S P on The I of F C M, J. J L T R *Journal of Language Teaching and Research* **8** (3) pp. 476-484
[13] Yi Li 2018 Current problems with the prerequisites for flipped classroom teaching - a case study Li *Smart Learning Environments* **5** (2)
[14] L Yang, T Sun and Y Liu 2017 A B I of F C R D 2000-2015 *iJET* **12** (6)
[15] N Din, S Haron and R Mohd Rashid 2016 C S –D L E I Q of L? *Procedia-Social And Behavioral Science* **222** 219-227
[16] H G Anderson Jr 2017 C of P C L O A W a T L or F C A *A JPE* **81**(4) 70
[17] N Speizman Wilson and L Smetana 2011 Q as T: M F I C E T *Blackwell* **45**