Team Based Learning in Computer Science Students

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Abstract—This research is an experiment on the implementation of Team Based Learning (TBL) in computer science students. 64 participants from Mobile Game Creative Design class was selected, and 3 variables are measured: motivation, engagement, academic achievement. The finding shows that although motivation and engagement are not affected, academic achievement shows a significant improvement with a p-value of 0.0000271. This research serves as one of the basis to be considered when a university intends to implement TBL into its learning process.

Keywords—team based learning; computer science; learning process

I. INTRODUCTION

Education is the foundation of all activity. Without it, practice is flawed by ignorance and issues in many aspects will arise. In micro context, having better education correlates to higher personal economic stability by increasing their likelihood of finding jobs. Education also increases the well being of one individual to have better living from having a good and steady job. As in macro, it is shown that higher score of Human Development Index directly correlates to better Gross Domestic Product (GDP) [1]. Needless to stress, education is very important.

A lot of methods and best practices are defined to improve the quality of education in Indonesia. Researchers, locally and globally, continuously look for better ways to solve some minor to major issues in education. For example, in secondary school, Huda & Zakaria [2] evaluated the strategy of reading aloud in Islamic subjects while Zakaria et al. [3] utilized cooperative learning to improve mathematic achievement. Both of these methods are proven significantly increase secondary students' achievement in corresponding subjects. In higher education, there is also proposed blended learning framework by Ramakrisnan et al. [4], which then tested by Misut & Pokorny [5], and is proven to actually increase efficiency of learning significantly.

Unfortunately, many of these researches exclusively measure a single dimension of learning, which is their achievement shown by scores on class assessment. While students' achievement is proven to be improved, this claim may be just locally correct. In areas with low student participation, such method may not work as predicted since the active participation is low and measurement of objective assessment is difficult. Looking at the personal aspect of each student, as stated by Csikszentmihalyi & Wong [6], the core issue is not that the students cannot learn the subjects, but they actually do not want to. This is where motivation and engagement come into place. Enjoyable learning environment, where students are actively participating and the teacher is actively moderating, is an ideal condition for learning. Some of many problems affecting this ideal condition are the motivation and engagement. Classroom will not be able to act as an effective learning channel if some of its students are not motivated to attend and take part in class activities.

Motivation and engagement are important internal supporting factors in learning environment–with curriculum design and lecturer competency being external factor–which later corresponds to their current and future academic achievements [7, 8]. This is proven true especially in Computer Science major [9]. In Computer Science major, students' motivation is quite low, presumably caused by ineffective learning method [10]. Besides, some students think that the subject is uninteresting. David Willetts, The Minister of State for Universities and Science in United Kingdom put it as "catastrophically boring" [11]. Ironically, communication and interaction plays a major part in computer science learning environment [12].

II. LEARNING METHOD OVERVIEW

A. Traditional Learning Methods

Traditional learning method as defined by Novak [13] is static with textbook-centered information acquiring. There is also no concern on how student is feeling. Essay exams and group projects are also not the main consideration in learning process. In regards to teacher-student communication, students must do exactly as they are told with no room for creativity. Traditionally, the learning education is highly focused on discipline with no room to spare to consider learner's prior knowledge. Students are considered to be empty vessels ready to be filled with information. If any of the students flop, lack of talent is validated as the reason.

In this conventional method, teacher is the main point of information and all information given to students must be hand delivered in-class. This is actually true and practiced in almost all educational institutes all across Indonesia and probably all over the world. It is the simplest method of information transferring that does not require too much

preparation and the execution – although monotone – is simple.

In some modern institutes, the traditional learning method is slightly improved with the use of information technology to maximize the classroom learning environment and also facilitate the lecturer to have better visual presentation to attract students' attention with Powerpoint presented with a projector. Bartsch & Cobern [14] concluded in their research that students do enjoy lessons more by using power point with some points to consider: using graphic with relating image does not have any positive or negative impact to participants' achievement in comparison to text-only presentation; and the usage of unrelated image meant to grab the participants' attention is actually giving negative impact to their overall achievement.

B. Team Based Learning Method

In Team Based Learning (TBL), the learning strategy is very different from conventional group based learning. Groups are not sufficient; they must be molded into high performing team. Teams are permanent and may not be changed. It is shown that rotating the team for the sake of knowing their classmates have almost no academic benefit. The grades are critically important and must be handed to students immediately. This is because if they anticipated too long for the scores, the focus will be shifted from improving their mistakes into just knowing their grade. For this, feedback is the key to improvement and also is critical to achieve ideal learning environment.

TBL can be implemented to many courses, as long as they met the 2 requirements needed:

1) The course must contain significant body of information and ideas.

2) One of the goals for the course is for students to apply the content of the course by means of problem solving.

The main goal of Team-Based Learning as is defined by Michaelson [15] is to develop high performing team that has the chance and able to engage in robust learning activity.

III. Successful TBL Implementations

There are many published scientific articles that prove that Team Based Learning is truly a compelling learning strategy to implement.

Okubu et al. [16] implemented TBL to increase clinical reasoning skill in 307 medical students in Japan. The results are significantly positive. Another research by Persky [17] with 154 students of pharmacokinetics is involved in the research about TBL with significant improvement in levels of learning, team learning skills, and professionalism.

Related to students' perspective, TBL is approved to be an effective learning strategy by students in school of dentistry [18] From 36 students participating in ten 60-minutes class, there are also higher scores on questions that is taught using TBL material than the ones taught using traditional method.

A recent published paper by Pardamean [19] indicates that the utilization of TBL improve students' independent learning and enabling them to engage in overall academic experience. This research was conducted in Indonesia and is the closest benchmark to this research.

IV. Variables

A. Motivation

Pintrich et al. [20] created a set of question to measure college motivation called Motivation Strategies for Learning Questionnaire (MSLQ) that have been widely used and validated [21] The purpose of this questionnaire is to measure students' motivation and its effect on learning strategies along with its theoretical understanding and the evaluation of cognitive and motivational effect affected by instructional intervention [22].

The questionnaire consists of 81 items with 31 items to measure students' motivation. The indicators are shown in Table I. The students will rate themselves with seven point Likert scale with the lowest being "not at all true to me" to the highest being "very true of me". Some items are marked as "reversed", where the scale must be negated before counted.

TABLE I. Components of Motivation

Indicator	# items
Intrinsic Goal Orientation	4
Extrinsic Goal Orientation	4
Task Value	6
Control of Learning Beliefs	4
Self-Efficacy for Learning and Performance	8
Test Anxiety	5

B. Engagement

Student Engagement Instrument (SEI) is a multidimensional instrument used to measure engagement originally in 9th grade students. With validation by Grier-Reed, et al. [23], SEI is reliable to use in college-age students.

Out of 4 types of engagement – academic, behavioral, cognitive, and affective, academic and behavioral engagement can be measured relatively easy. To measure academic engagement, the indicators are credit accumulation and time on task. For the behavioral engagement, class participation, extracurricular activities, and homework completion is the indicators [23].

SEI is used to measure the perception of students for the remaining 2 subtypes, cognitive and affective engagement with indicators like self-regulation, interest, perceived relevance to the future, belonging and relationship with teacher and peers. The last 2 types of engagement is difficult to observe, because it is internal and need students' own report to be measured.

There are a total of 35 questions in each test with 6 indicators as shown in Table II.

TABLE II. COMPONENTS OF ENGAGEMENT

Indicator	# items
Teacher-Student Relationship	9
Peer Support at School	6
Family Support for Learning	4
Control & Relevance of School Work	9
Future Aspirations and Goals	5
Intrinsic Motivation	2

C. Academic Achievement

For the academic achievement variable, since it's used to measure cognitive functions, the questions are self-made by the instructor and is according to the subject taught, in this case, Mobile Game Creative Design. The questions consist of 25 items, 4 options-multiple choice.

V. EXPERIMENT PROCESS

A. Pre Test Result

From the data shown in Table III, Motivation and Academic Achievement appear to be above dimension average, and engagement is below the dimension average.

TABLE III. SUMMARY OF PRE TEST DATA

Dimension	Indicator	Data Average	SD
Motivation	6	5.306	0.582
Engagement	6	2.043	0.242
Academic Achievement	N/A	16.406	2.280

From the image shown in Fig. 1, Fig. 2, and Fig. 3, the data from the variables are visually appeared as normally distributed. To elaborate the normality of the data, Shapiro-Wilk normality test was applied with an alpha level of 0.05, and the result is shown in the Table IV below.

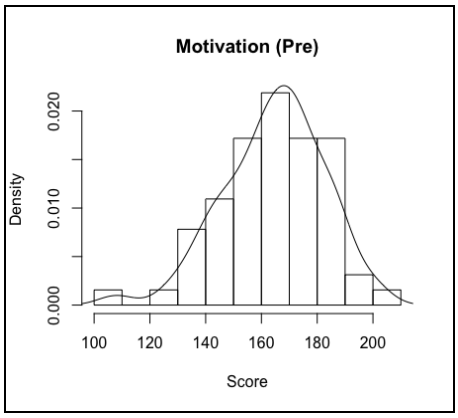

Fig. 1. Motivation (Post) Histogram.

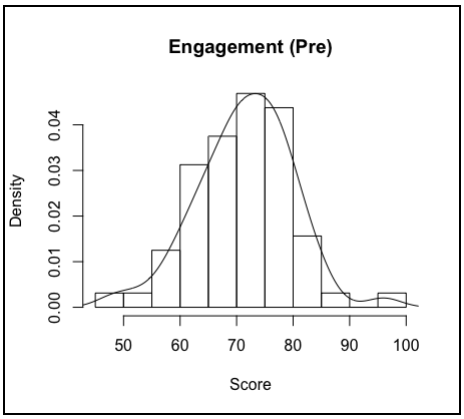

Fig. 2. Motivation (Post) Histogram.

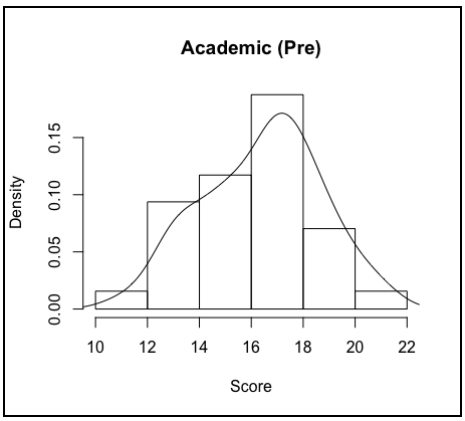

Fig. 3. Motivation (Post) Histogram.

TABLE IV. PRE-TEST NORMAL DISTRIBUTION TESTED WITH SHAPIRO-WILK

Variable	W	p-value	Decision
Motivation (Pre)	0.98213	0.4802	Shapiro-Wilk's H_0 is true and accepted, thus data is most likely normally distributed.
Engagement (Pre)	0.98727	0.7531	Shapiro-Wilk's H_0 is true and accepted, thus data is most likely normally distributed.
Academic (Pre)	0.9701	0.1224	Shapiro-Wilk's H_0 is true and accepted, thus data is most likely normally distributed.

From the gathered pre-test data as shown in Table 3, there are some major findings that can be concluded. Firstly, the students started in a highly motivated state, moderate engagement, and moderate academic achievement. This may happen due to the subject taught. The subject talks about an interesting subject for them, which is mobile game.

Secondly, the data are normally distributed as shown in Table IV. This is important to note because pre-test and post-test are going to be compared using t-test, and one main requirement on doing t-test is that the data must be normally distributed.

B. Post Test Result

From the data shown in Table V, Motivation and Academic Achievement appear to be above dimension average, and Engagement is below the dimension average.

TABLE V. SUMMARY OF POST TEST DATA

Dimension	Indicator	Data Average	SD
Motivation	6	5.363	0.596
Engagement	6	2.037	0.259
Academic Achievement	N/A	18.578	2.273

From the image shown in Fig. 4, Fig. 5, and Fig. 6, the data from the variables are visually appeared as normally distributed. To elaborate the normality of the data, Shapiro-Wilk normality test was applied with an alpha level of 0.05, and the result is shown in the Table VI.

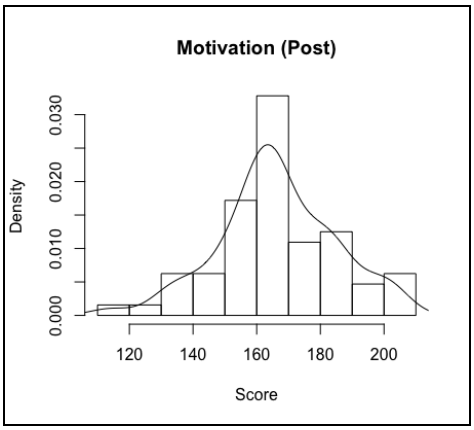

Fig. 4. Motivation (Post) Histogram.

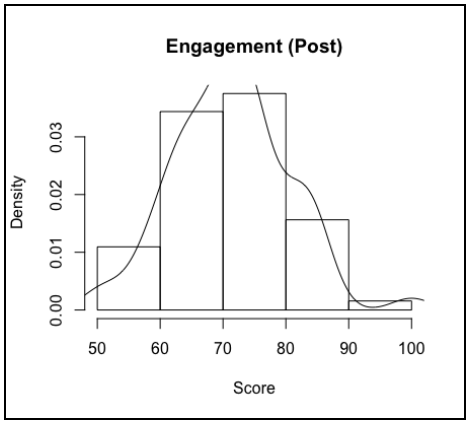

Fig. 5. Engagement (Post) Histogram.

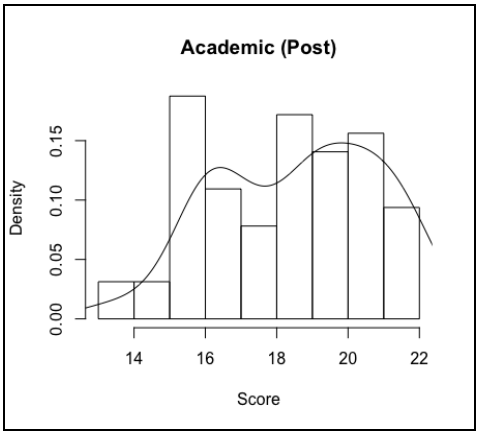

Fig. 6. Academic Achievement (Post) Histogram.

TABLE VI. POST-TEST NORMAL DISTRIBUTION TESTED WITH SHAPIRO-WILK

Variable	W	p-value	Decision
Motivation (Post)	0.98212	0.4801	Shapiro-Wilk's H_0 is true and accepted, thus data is most likely normally distributed.
Engagement (Post)	0.98465	0.6099	Shapiro-Wilk's H_0 is true and accepted, thus data is most likely normally distributed.
Academic (Post)	0.9425	0.004973	Shapiro-Wilk's H_0 is false and rejected, and H_1 is acceped thus data is most likely NOT normally distributed.

There is shown to be an improvement in Academic Achievement variable. Students were starting in a normal bracket, and moved up to high bracket as measure on the post-test. This may happen because of the immersive learning process, and they are able to absorb more information with this method compared to the regular learning process.

The Academic post-test dataset was found to be not normally distributed. This affects the analysis of pre-test and post-test. Since the dataset is not normal, t-test couldn't be applied. So the non-parametric alternative to the t-test was chosen, which was Mann-Whitney U test.

C. Pre Test Vs. Post Test Data Comparison and Analysis

From the datasets collected, 5 out of 6 datasets were normally distributed, and one dataset was not. Based upon that, the not-normal dataset cannot be tested using T-Test, so the decision was to test it using Mann-Whitney U test, which is a non-parametric statistical test that is still valid to use on not normal dataset. The results of the statistical tests are described in Table VII.

TABLE VII. OVERVIEW PRE AND POST TEST STATISTICAL SIGNIFICANCE TEST

Variable	Mean Pre	Mean Post	Test	p-value	Result
Motivation	164	166	T-Test	0.5852	Not-Signifi-cant
Engagement	72	71	T-Test	0.8801	Not-Signifi-cant
Achievement	16	19	Mann-Whitney	0.0000 0271	**Signifi-cant**

Below are the visual impressions of each dimension, compared between pre-test and post-test. The grey or thinner line indicates the pre-test result, and the blue and thicker line indicates the post-test result.

From the data collected and depicted above in Fig. 7, Fig. 8, and Fig. 9, it can be concluded that motivation and engagement are not affected by the implementation of TBL in a computer science classroom, whereas academic achievement is significantly affected.

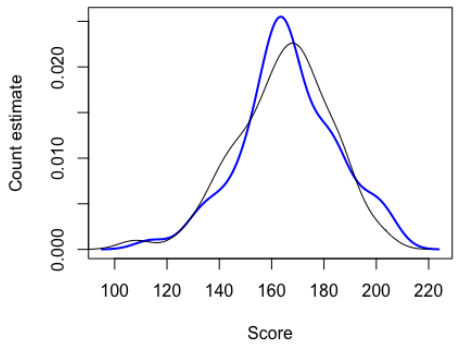

Fig. 7. Comparison Between Pre and Post for Motivation.

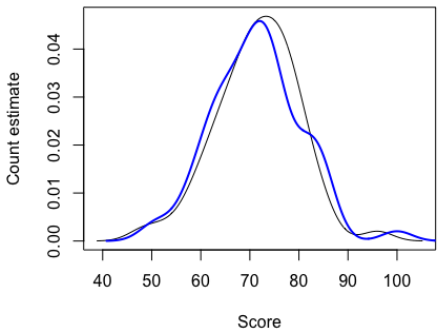

Fig. 8. Comparison Between Pre-Test and Post-Test for Engagement.

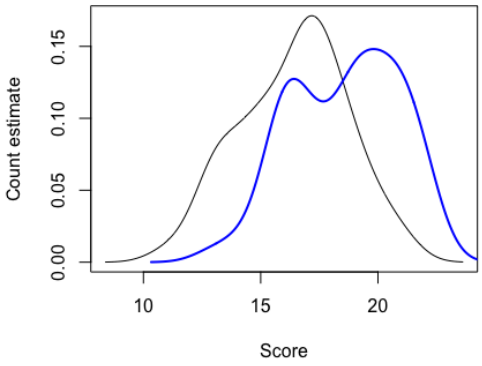

Fig. 9. Comparison Between Pre-Test and Post-Test for Academic Achievement.

VI. DISCUSSION

From all the analyzed data, the motivation score in the pre-test is already high, so the students may already have a high motivation state to begin with. In addition to that, the subject experimented upon is Mobile Game Creative Design, which has a more interesting content than highly theoretical subject like Software Engineering or Object Oriented Programming have.

The class engagement may also not be affected because the time to bond in the team is not enough. It may need to take more time to make the team bonded so the students can have higher engagement.

The academic achievement is shown to be significantly affected, because the students are able to focus more when participating in classroom activity. Some students complained after the lesson because they could barely check their social media or reply to text messages. The classroom activity was so packed, and it was not a one-way interaction from instructor to students anymore.

VII. Conclusion

We have presented a thorough assessment and development of Team Based Learning in computer science student. In the assessment phase, we found that academic achievement is highly affected by the implementation of TBL, whereas motivation and engagement is not. To furthermore increase the effectiveness of TBL in the learning activity, a supportive method must be developed. One of many ways to support the new learning process is through information technology, so the next researches should focus on injected information technology into the development of TBL so that it can be more effective.

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