IOP Conf. Series: Materials Science and Engineering **277** (2017) 012037 doi:10.1088/1757-899X/277/1/012037

Application of scl - pbl method to increase quality learning of industrial statistics course in department of industrial engineering pancasila university

M Darmawan[1] and N Y Hidayah [2]

[1]Department of Industrial Engineering, Pancasila University, Jagakarsa, Jakarta 12640, Indonesia
[2]muchtar_darmawan@univpancasila.ac.id
[3]nurhidayah@univpancasila.ac.id

Abstract. Currently, there has been a change of new paradigm in the learning model in college, ie from Teacher Centered Learning (TCL) model to Student Centered Learing (SCL). It is generally assumed that the SCL model is better than the TCL model. The Courses of 2nd Industrial Statistics in the Department Industrial Engineering Pancasila University is the subject that belongs to the Basic Engineering group. So far, the applied learning model refers more to the TCL model, and field facts show that the learning outcomes are less satisfactory. Of the three consecutive semesters, ie even semester 2013/2014, 2014/2015, and 2015/2016 obtained grade average is equal to 56.0; 61.1, and 60.5. In the even semester of 2016/2017, Classroom Action Research (CAR) is conducted for this course through the implementation of SCL model with Problem Based Learning (PBL) methods. The hypothesis proposed is that the SCL-PBL model will be able to improve the final grade of the course. The results shows that the average grade of the course can be increased to 73.27. This value was then tested using the ANOVA and the test results concluded that the average grade was significantly different from the average grade value in the previous three semesters.
Key words: SCL-PBL, Final Grade, 2nd Industrial Statistics Course, ANOVA

1. Introduction

True learning is based on discovery guided by mentoring rather than the transmission of knowledge. So based on this opinion the actual learning is learning based on self-discovery which is assisted by mentor mentoring rather than by knowledge transfer. Therefore, to get this kind of learning, it is necessary to shift the paradigm that is learning by teacher centered model into student centered. With the Student Centered Learning (SCL) model, the learner will be placed as the focus of the learning process, responsible for what is learned and can take the initiative because of the nature of active learning. In SCL model, teachers more function as a facilitator for the learners. The course of the 2nd Industrial Statistics in the Department Industrial Engineering Pancasila University with 3 credits weight is part of Basic Engineering subject group. Therefore this course is an important, because it will be the basis for other engineering courses. So far, the applied learning model refers more to the Teacher Centered Learning (TCL) model, and the fact of the field shows that the learning outcomes of the 2nd Industrial Statistics courses are less satisfactory. Data on learning outcomes (final score) in the

last three semesters, ie even semester 2013/2014, 2014,2015 and 2015/2016, to be each giving an average score of 56.0; 61.1 and 60.5. Based on the background that has been described then the main issues to be raised in this study are the average grade of Industrial Statistics Course is low in Department Industrial Engineering and how to apply Student Centered Learning model in this course.

The objective of this research is to apply Student Centered Learning model in 2nd Industrial Statistics course in Department Industrial Engineering so that the average grade can be increased. The learning method is by using Problem Based Learning (PBL) method.

2. Methods

2.1. Analisis of variance (Anova)

Anova is a procedure to test whether the mean of several populations is equal, with the number of populations tested more than two. In the hypothesis statement can be written as follows [5]:

$$\text{Ho}: \mu_1 = \mu_2 = \mu_3 = ... = \mu_k \quad (1)$$

with k is the number of groups (population) to be tested. While the alternative hypothesis is at least one population average is different from the other population. So:

$$H_a: \mu_i \neq \mu_k \text{ for an i and k} \quad (2)$$

The procedure to test the hypothesis H_o versus H_a is basically an analysis of the variation of the values of measurement results. There are three types of variation values :

- Variation of values within each group, $x_{11} - \overline{x_1}$
- Variations between the group average and the total mean, $\overline{x_1} - \overline{x}$
- Total Variation, $x_{11} - \overline{x}$

Total Variation = variation in group + variation between groups (see Figure 1)

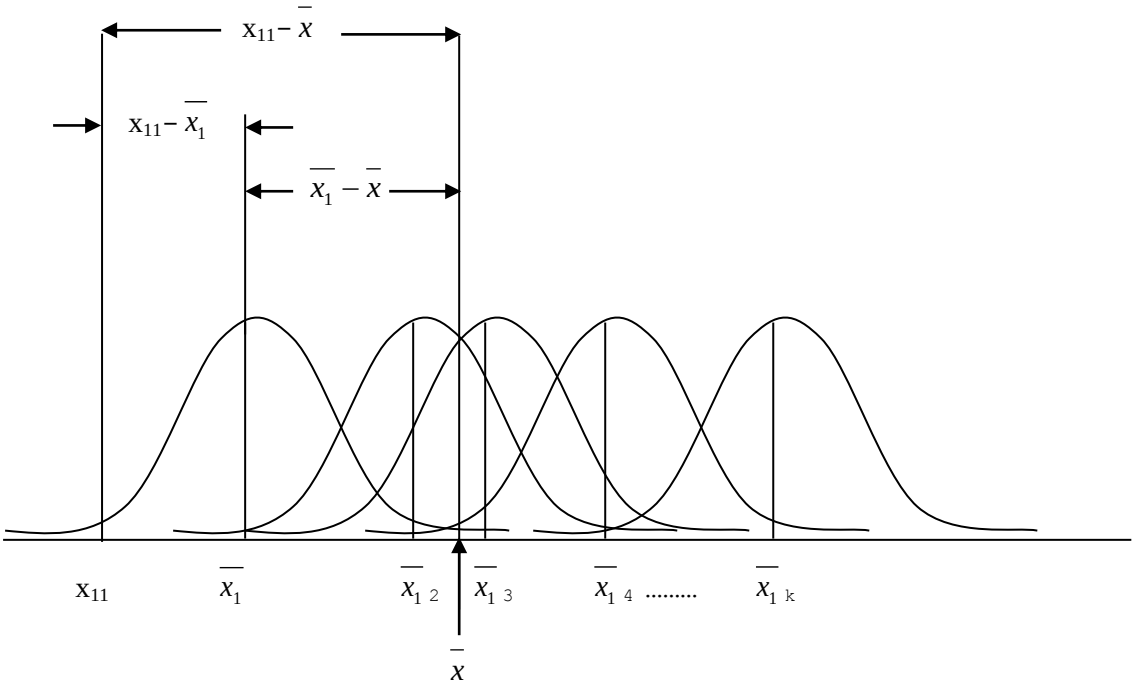

Figure 1. Variation in the anova

From Figure 1 can be derived the following formula.

$$\sum_{k=1}^{k}\sum_{i=1}^{n_k}\left(x_{ik}-\bar{x}\right)^2=\sum_{k=1}^{k}\sum_{i=1}^{n_k}\left(x_{ik}-\bar{x}_k\right)^2+\sum_{k=1}^{k}n_k\left(\bar{x}_k-\bar{x}\right)^2 \quad (3)$$

The above formula explains that :
The sum of squares of the whole deviation (SS_T) = The sum of squares of all deviations in the group (SS_W) + The sum of squares of the entire deviation between the groups (SS_B), where :
SS_T = Sum of Square Total
SS_W = Sum of Square With-in
SS_B = Sum Square Between

Variation = The sum of squares of deviation divided by degrees of freedom. The degree of freedom of variation between groups is = k - 1, whereas the degree of freedom of variation within the group is = N - k, where N = n1 + n2 + n3 + ... n_k.
So the amount of variation between groups is :

$$MS_B = \frac{SS_B}{k-1} \quad (4)$$

MS_B = Between Group Mean Square

While the amount of variation within the group is :

$$MS_W = \frac{SS_W}{N-k} \quad (5)$$

MS_W = Within Group Mean Square.

Further, the differences between the two variations can be tested by using F test which is a comparison between two variations. So the statistical test for Anova is :

$$F = \frac{MS_B}{MS_W} \quad (6)$$

Based on the above description, a summary of variance analysis is presented in Table 1.

Table 1. Anova formula

Source of Varation	Sum Square (SS)	Degree of Freedom	Variation Value	F Test
Between Group	$\sum_{k=1}^{k} n_k\left(\bar{x}_k-\bar{x}\right)^2$	k - 1	$MS = \frac{SS_B}{k-1}$	$\frac{MS_B}{MS_W}$
Within Group	$\sum_{k=1}^{k}\sum_{i=1}^{n_k}\left(x_{ik}-\bar{x}_k\right)^2$	N - k	$MS = \frac{SS_W}{N-k}$	
Total	$\sum_{k=1}^{k}\sum_{i=1}^{n_k}\left(x_{ik}-\bar{x}\right)^2$	N - 1		

2.2. Research methodology

The research methodology will be carried out using the following steps [4] :

Step 1. Determination of research hypothesis

H_o : Application of SCL-PBL method in Dept. Industrial Engineering can not raise the average grade of 2nd Industrial Statistics

H_a : The application of SCL-PBL method in Dept. Industrial Engineering can increase the average grade of 2nd Industrial Statistics

Step 2. Designing learning with SCL-PBL method

a. Preparing Semester Learning Plan (SLP)
   The prepared SLP is the same as the SLP that has been approved by Dept. Industrial Engineering namely SLP 2nd Industrial Statistics which applied to the Curriculum Year 2016.
b. Designing of Implementation Learning Plan (ILP)
   ILP is a further elaboration of SLP, which is adapted to the learning method used, in this case is the SCL-PBL method. Therefore, in the SCL-PBL method, the students will be more active and become the focus of learning by solving cases of real problems, while the lecturers are more facilitators. Therefore, lecture activities of the lecturers will be replaced more by group discussion and student presentation
c. Designing an assessment form
   In the SCL-PBL method, students/student groups are also given the opportunity to assess the other groups of students. Therefore, the existing assessment form so far will be added so as to be as follows [1] :
   - Group discussion assessment form (assessment by student)
   - Group presentation assessment form (assessment by student and lecturer)
   - Group assignment report assessment form
   - Mid semester exam assessment form
   - Final semester exam assessment form
   - Final value recapitulation assessment form (from faculty)
d. Designing a case study
   The SCL-PBL method requires real case studies (triggers) to be solved by the students. Therefore, it is necessary to prepare the case study. The case study is planned to be taken from final project at Department of Industrial Engineering related to statistical problems.
e. Designing assessment weights
   The weight of scores used during this course in 2nd Industrial Courses is as follows:
   - Attendance : 5%
   - Assignment : 25%
   - Mid Semester Exam (MSE) : 30%
   - Final Semester Exam (FSE) : 40%

   In the SCL-PBL method, the volume of student assignment is increasing, therefore the weight of the percentage of assignment scores needs to be increased, so that the design of the assessment weight is changed as follows :
   - Attendance : 5%
   - Assignment : 30%
   - MSE : 30%
   - FSE : 35%

Step 3. Data collection

The data to be collected are as follows:

a. Scores on the learning result of 2nd Industrial Statistics three semesters before.
b. Scores of 2nd Industrial Statistics Even Semester 2016/2017 according to SCL-PBL method includes the following:
   - Attendance score

- Students score in group discussions
- Student score in assignment presentation
- Student score in the assignment report
- Score of Middle Exam Semester and score of Final Exam Semester

Step 4. Data processing and analysis

Score data that has been collected is processed and then analyzed. The analytical method used is the Analysis of Variance (Anova) method. Anova is a hypothesis test of differences in mean values of some populations (more than two populations) by comparing their variance values, ie the variance values in groups with inter-group variance. The assumptions used in the Anova method are [2]:

- The random samples taken are independent of each other
- The population distribution from which the sample is taken is normal
- Variants of population distribution are considered equal

The next steps of hypothesis testing using Anova are as follows [2]:

a. Set the hypothesis test

$H_o : \mu_1 = \mu_2 = \mu_3 = ... = \mu_k$

$H_a : \mu_i \neq \mu_k$ for an i and k

b. Calculate statistical test value

Anova test is comparing the variance value, the test statistic used is F test (eq.6).

c. Set the H_o acceptance / rejection area

With the level of confidence given (C, in%) and the degree of freedom according to the number of data owned is known then the acceptance/rejection zone H_o can be determined (Table F, $F_{\alpha;v1;v2}$).

Note: α = error rate = 1 - C

v_1, v_2 = degree of freedom

In this study, to ensure that the results are convincing there will be three different levels of confidence : 90%, 95%, and 99%.

d. Take the conclusion

H_o will be accepted if the F test statistic is inside the H_o acceptance area (F-test value < F-table value). Conversely H_o will be rejected if the value of statistical test F is within the rejection region H_o. (F-value test > F-table value). If H_o is accepted then H_a automatically rejected, otherwise if H_o is rejected then H_a is accepted.

Using Anova method do hypothesis test that the average grade of 2nd Industrial Statistics Even Semester 2013/2014, 2014/2015, and 2015/2016 (three semesters) are the same. The allegation of equality of the average value is based on the fact that in the three semesters the learning of 2nd Industrial Statistics uses the same method, that is a Teacher Centered Learning method. So our hope here is H_o will be accepted. As noted earlier, the assumption that needs to be taken is that the variations in data from these three groups are considered equal.

After the final value of the 2nd Industrial Statistic in the Even Semester of 2016/2017 is obtained, then do the next Anova test to prove that the average grade of 2nd Industrial Statistics courses in Even Semester of 2013/2014, 2014/2015, 2015/2016, and 2016/2017 (four semesters) is to be not the same. The allegation of average value inequality is based on the fact that the method of study of the subject of 2nd Industrial Statistics is now used unequal method, ie in Even Semester 2013/2014, 2014/2015, 2015/2016 used Teacher Centered Learning method, while in Even Semester 2016/2017 used the Student Centred Learning method. So here we hope will reject H_o which means accept Ha. Assumptions that need to be taken in this case are also the same ie the data variations of these four groups are considered the same.

Step 5. Conclusion and suggestion

Based on the results of the analysis that has been done, it will be given a conclusion and suggestions in accordance with the results.

3. Result and discussion

In accordance with the research steps outlined above, after the research hypothesis has been established, the design of the appraisal form and case study is prepared then the implementation of this study will begin with data collection and then proceed with the processing and analysis of the data.

3.1. Data collection

The learning process of 2nd Industrial Statistics course with SCL-PBL method in Even Semester 2016/2017 implemented in accordance with SLP and ILP as follows :

a. Twelve meetings designed to discuss 4 (four) case studies allocated into 4 (four) cycles where each cycle consists of three meetings, ie
   - The first meeting was filled with lecture activities from lecturers that explaining the theories to be used in solving case studies.
   - The second meeting was filled with group discussions by students discussing case studies provided by lecturers and how to solve the case study. At this meeting the student group also prepared a presentation of what was discussed to be presented at the next meeting.
   - The third meeting is filled with the presentation of each group and then the results of this presentation are reported in writing to the lecturer. Figure 3. below is a presentation of tasks performed by students.

b. Two meetings are designed to explain other theories that are not directly related to the case studies that have been given to the students.

c. One meeting for Mid Semester Exam and one meeting for Final Semester Exam. So the total number of meetings is 16 times.

From the results of the lecture consisting of theoretical explanations by the lecturers, group discussions, task presentations by students and then the implementation of Mid Semester Exam and Final Semester Exam then the evaluation score data is collected consisting of data score of discussion, presentation score, Mid Semester Exam score, and score of Final Semester Exam. The entire score data is combined to produce the final score.

3.2. Processing and analysis of data

In accordance with the methodological steps outlined before, the data processing and analysis are carried out as described below.

a. Analysis of Variance (Anova) for the score of 2nd Industrial Statistics three semesters previously.
   Hypothesis test procedure is as follows:
   - Statement of H_o and H_a
     H_o: $\mu_1 = \mu_2 = \mu_3$
     H_a: $\mu_i \neq \mu_j$ for i = 1, 2, 3 and j = 1, 2, 3
     Where :
     μ_1 = The average value of the Class population of 2nd Industrial Statistics Even Semester 2013/2014.
     μ_2 = The average value of the Class population of 2nd Industrial Statistics Even Semester 2014/2015.
     μ_3 = The average value of the Class population of 2nd Industrial Statistics Even Semester 2015/2016.
   - Value of F-Test
     Using the data score and the Anova formula in Table 1, F-test values can be obtained as follows:

Table 2. Anova summary table

Variation Source	SS	DF	MS	F-Test	F-Table		
					0.01;2;98	0.05;2;98	0.10;2;98
Between Group	480.95	2.00	240.47	1.06	4.79	3.07	2.35
Within Group	22225.17	98.00	226.79				

- Determination of Acceptance / Rejection Area of H_o (Df_1 = 3-1=2 and Df_2 = 101-3 = 98).
  With 99% confidence level (or α = 1%) then obtained F-table = 4.79.
  With a 95% confidence level (or α = 5%) then obtained F-table = 3.07.
  With a confidence level of 90% (or α = 10%) then obtained F-table = 2.35.
- Conclusion :
  Since the F-test value < F-table for all confidence levels, then the F-test value is at the acceptance area of Ho. So Ho is accepted which means the grade point average for Even Semester 2013/2014, 2014/2015, and 2015/2016 is not significantly different, so it is considered the same.

b. Anova for 2nd Industrial Statistics courses score three previous semesters plus semester 2016/2017. As previously, hypothesis test procedure is as follows:

- Statement of H_o and H_a
  H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
  H_a: $\mu_i \neq \mu_j$ for i = 1, 2, 3, 4 and j = 1, 2, 3, 4
  Where :
  μ_1 = The average value of the class population of 2nd Industrial Statistics Even Semester 2013/2014
  μ_2 = The average value of the class population of 2nd Industrial Statistics Even Semester 2014/2015.
  μ_3 = The average value of the class population of 2nd Industrial Statistics Even Semester 2015/2016.
  μ_4 = The average value of the class population of 2nd Industrial Statistics Even Semester 2016/2017.
- Value of F-test
  Using the data score and the Anova formula in Table 1 then F-test values can be obtained in Table 3.
- Determination of Acceptance / Rejection Area of H_o (Df_1 = 4-1=3 and Df_2 = 145-4 = 141).
  With 99% confidence level (or α = 1%) then obtained F-table = 3.78.
  With a 95% confidence level (or α = 5%) then obtained F-table = 2.60.
  With a confidence level of 90% (or α = 10%) then obtained F-table = 2.08.
- Conclusion: Since the F-test value > F-table for all confidence levels, then the F-test value are inside the H_o's rejection area. So H_o is rejected which means that the average value for Even Semester of 2013/2014, 2014/2015, 2015/2016, and 2016/2017 are not significantly the same, so are considered different. This difference occurs due to the entry of the average score of Even Semester 2016/2017 ie 73.27. Rejection H_o here means that the SCL-PBL method can improve the previous learning method, ie TCL, so as to increase the average grade. The average value of Even Semester 2016/2017 is the highest, which is 73.27 compared to the previous three semesters, ie. 56.1, 61.1, and 60.5.

Table 3. Anova summary table

Variation Source	SS	DF	MS	F-Test	F-Table		
					0.01;2;141	0.05;2;141	0.10;2;141
Between Group	6325.28	3.00	2108.43	9.87	3.78	2.60	2.08
Within Group	30133.48	141.00	213.71				

4. Conclusion

Based on the explanations and explanations that have been stated previously it can be given the following conclusions:

- Hypothesis testing that the learning method of Student Center Learning - Problem Based Learning (SCL-PBL) can improve the learning result of Industrial Statistics course in Department Industrial Engineering of Pancasila University is true.
- The truth of hypothesis test above is limited to the assumptions taken in this study such as the value data assumed to be normally distributed, samples that have been taken are independent of each other and the variation of value data is considered equal.

5. References

[1] Rahmawati H and Farida Y 2006 *Upaya Peningkatan Kualitas Belajar Mahasiswa Melalui Model Pembelajaran Koperatif Kepala Bernomor Pada Pembelajaran Topik Reaksi Kimia Mahasiswa Semester Satu di Fakultas Farmasi Universitas Pancasila* Laporan Penelitian Tindakan Kelas (Jakarta: Universitas Pancasila)

[2] Hinkle, Dennis E, Wiersma, William, Jurs and Stephen G 2003 *Applied Statistics for Behavioral Sciences Fifth Edition* (Houghton Mifflin Company)

[3] Mitra A 2008 *Fundamentals of Quality Control and Improvement Third Edition* (John Wiley & Sons)

[4] Priyatmojo and Achmadi 2010 *Student Centered Learning (SCL) dan Student Teacher Aesthethic Role-Sharing (STAR)* Buku Panduan Pelaksanaan Pusat Pengembangan Pendidikan (Yogyakarta: Universitas Gajah Mada)

[5] Walpole R E 2011 *Probability and Statistics for Engineers and Scientists* (Prentice Hall International)