Problem Based Learning in Online Class of Mass Transfer Operation Course

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Abstract

Outcome based education (OBE) helps to evaluate how well learning process achieves the outcome program and how far students achieved the intended learning outcomes. Problem based learning (PBL) approach is potential to assess the achievement of OBE. The aim of the present work is to describe how teaching and student assessment methods for implementing problem based learning (PBL) in Mass Transfer Operation course were adapted to the online learning during covid-19 pandemic. Based on the result of online class of Mass Transfer Operation course, the problem based learning method may be implemented well and interested to be developed. The students are motivated to experience the new collaborative learning way. The digital education will remain in place even when offline class is allowed.

Keywords
OBE, PBL, Mass Transfer Operation, Chemical Engineering, online class.

1. Introduction

The covid-19 pandemic since December 2019 was spread rapidly across the globe. This affected on education which conventional offline class was immediately moved online. The lecturers were forced to quickly adapt their courses and learning methodologies without training in online class and often unfamiliar digital technologies. This was a great challenge for lecturer at universities.

Universitas Sebelas Maret, Surakarta, Indonesia moved swiftly to emergency remote learning since March 2020. Chemical Engineering Department, Engineering Faculty, Universitas Sebelas Maret (UNS) implemented outcome based education (OBE) in process learning. A clear set of student outcomes has been well defined for each course and program. These outcomes were well recorded in curriculum document. Student-oriented approach is important in learning process to obtain the set outcomes learning. OBE helps to evaluate how well learning process achieves the outcome program and how far students achieved the intended learning outcomes. Therefore the Chemical Engineering Departement, Universitas Sebelas Maret has established a programme predicated on problem based learning (PBL) approach.

The PBL approach provides the skills to pursue with life-long learning, to carry out team work, to formulate problems and to find appropriates solution to real life problems (Idrus and Abdullah, 2018). Good problem provides a focus and motivation for learning and developing student's problem solving skill (Gomes and Barton, 2005). The problems can come from a variety of sources: newspapers, magazines, journals, books, textbooks, and television/ movies. Some are in such form that they can be used with little editing; however, others need to be rewritten to be of use (White, 2002). Before implementing the PBL, the students should be skilled in problem solving. So, it was important to provide an effective method for supporting the weaker students that was not staff intensive (Rossiter et al. 2010).

Problem-based learning can be supported by teamwork assignments. Team members work together by sharing knowledge and perceptions to achieve their team goals in solving problems. Team members who are willing to participate, work together, and contribute to support each other and maintain a positive environment will result in

successful teamwork. Engineering students must prepare themselves with teamwork skills in solving multi-disciplinary problems if they want to become successful engineers in the future (Samsuri, 2017).

The aim of the present work is to describe how teaching and student assessment methods for implementing PBL in Mass Transfer Operation course, one of courses in Chemical Engineering Department UNS, were adapted to the online learning during covid-19 pandemic.

2. Teaching methodology

In Mass Transfer Operation course, there are several topics, namely mass transfer concepts and applying them in mass exchanger design, especially gas-liquid separation including absorber, stripper, dryer, and cooling tower. A sequence of learning activities was designed not only to deliver the mass exchanger design concept by lecturer, but also to assess the student's knowledge, calculation skill, and communication skill. This course was held one semester or 16 weeks. Each week was 150 minutes. The online learning used virtual platform at class room google and google meet. The complete sequences of learning activities and assessment are shown below.

- **a.** The lecturer give concept fundamental of each topic every week. The material of relevant topic was available in digital notes uploaded by lecturer in the virtual platform. In the earlier time of the course, it was about 100 min the students were tasked for studying the material. The students were pushed to ask if any questions and then the lecturer answered. Therefore the discussion between lecture and students was conducted, although only in written chat form. The next rest 50 min, the assignment for problem based learning was announced. The problem given was related with the topic course in the week.
- **b.** Students were asked to work the assignment in group of 4. They were allowed to choose their own group member. The case problem was taken from problem in text book. Every group was tasked different problem. The problem taken from text book was modified so that each student did task personally. Hopefully they discussed the findings in their group and then the results were compiled in one report. After one week, the digital paper report was submitted in the google class room.
- **c.** The lecturer assessed the submitted report of assignment. The result of assessment was returned to student. The lecturer was available to clarify the student's question during the assignment, addressing misconceptions and providing additional information. The assessment was done every week in online class room and discussed in the beginning time of the course.
- **d.** Several times, the reports of assignment were presenting orally in google meet. The ability to communicate clearly was evaluated in this sessions. The discussion and question answer was also pushed to be conducted.
- **e.** Midterm test (week 8) and final test (16) were conducted as individual test.

3. Results and Discussion

In this course, there were 30 students. During online class, students stayed at their home town. More than 20 students stayed in city which are far from Surakarta. The number of assignments that could be asked were 12 problems (Table 1).

Table 1. The topic problem for PBL

No.	Assignment problem
1	Separation equipment and separation agent in chemical industries.
2	Diffusivity determination.
3	Molecular diffusion steady state.
4	Molecular diffusion pseudo steady state
5	Gas-liquid mass transfer coefficient determination.
6	Falling film dan packed bed mass transfer coefficient determination.
7	Mass exchanger design: number of ideal stage ideal of absorber & stripper.
8&9	Mass exchanger design: number of actual stage and minimum rate of solvent.
10	Mass exchanger design: height packed of absorber & stripper.
11	Humidification: drying rate and time for drying.
12	Humidification: height of cooling tower

The course content and assignment are designed to exposes students to a variety of tasks, namely problem solving, case studies, and presentation. Lecture take a role as learning facilitator instructing student in their learning goals. Based on the task load and the submitted assignment report, the compiled report expressed that communication and digitalization skill of student were good. They could well utilize the information and communication technology (ICT). The task load were asked not different with offline class conventional. The level of difficulty was the same. Each group received different case problem, but the all at the upper intermediate of difficulty. The contribution of each student in their group was also measured by the work of each student. The variety parameter of cases was given by different number ID of student.

The result of midterm and final test can be used the mayor assessment for individual student's mastery the goal of this course. To avoid cheating or copying between students, each student was given different parameter process of the case, for example different concentration, flow rate, etc. The work was also must be arranged sequentially as the number of problem given. Compared to the previous offline class one year ago, the student's mastery of concept fundamental of this online course was not significant different. The students showed similar concept mastery of mass balance and equilibrium phase for designing of mass exchanger.

The efforts of student to study was harder than offline class. The online class drives the student study hard. This means that problem based learning in this methodology online learning may enhance the student's learning ability. Interesting and good sources of digitalized material course help strongly to enhance the student's motivation for learning.

Teamwork was indispensable in online learning. Teamwork could be used as a student-centered learning method. Teamwork assignments could be used as scaffolding to improve students' cognitive abilities in designing equipment; analyze and solve problems in mass transfer operations. The success of teamwork could be assessed when presenting the results of problem solving, as well as individual understanding in solving problem in exams.

4. Conclusion

Based on the result of online class of Mass Transfer Operation course, the problem based learning method by teamwork assignments may be implemented well and interested to be developed. The students are motivated to experience the new collaborative learning way. The digital education will remain in place even when offline class is allowed. The challenge for lecturer is how to innovate the digital tool including the content of the course and to assess the achievement of student on gaining the outcome learning set.

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Biography (12 font)

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