ASEAN Journal of Science and Engineering Education 1(1) (2021) 31-36

Indonesian Journal of Science & Technology

Journal homepage: http://ejournal.upi.edu/index.php/ijost/

Portfolio Workbook as an Effective Method for Student-Centered Learning of Principles of Chemical Engineering

Muhammad Roil Bilad[1,2,*] *and Saiful Prayogi*[1]

[1]Faculty of Applied Science and Engineering, Universitas Pendidikan Mandalika (UNDIKMA), Jl. Pemuda No. 59A, Mataram 83126, Indonesia

[2]Department of Chemical Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, Perak 32610, Malaysia

*Correspondence: E-mail: muhammadroilbilad@ikipmataram.ac.id

ABSTRACTS

Principles of Chemical Engineering (PCE) course is a core and highly important subject to study Chemical Engineering program that caters most fundamental concepts that bridge science to engineering. This study assess the effectiveness of portfolio workbook as a strategy to enhance student active learning in PCE. It was implemented for a full-semester and the student feedbacks on perceptions and implementation of the method was obtained after the course was completed. Results show that most participant agreed on the imposing mark on the workbook to enhance their study motivation. Vast majority of the students (>82%) admit that the workbook significantly helped them in mastering the subject, thus recommended the method for other subjects (>85%). The workbook as well as the method implementation can further be improved by providing short-answer as well as more intense scaffolding.

ARTICLE INFO

Article History:
Submitted/Received 13 Nov 2020
First revised 14 Jan 2021
Accepted 13 Feb 2021
First available online 26 Feb 2021
Publication date 01 Mar 2021

Keyword:
Principles of Chemical Engineering,
Portfolio Workbook, Student Centered Learning, Chemical Engineering Education

1. INTRODUCTION

The Principles of Chemical Engineering (PCE) course is a core subject in Chemical Engineering program. It is a highly important subject that caters most fundamental concepts that bridge science to engineering. PCE course is an essential building block of chemical engineering curriculum. It covers the concepts, models, theories, methods and tools of chemistry and bring those concepts into basic implementation in engineering. PCE has multiple facets and aspects, and has large coverage, including mass conservation, thermodynamics, chemical reactions, and to a lesser extent, chemical unit operations (Tsaparlis & Finlayson, 2014). Topics in PCE are very abstract and demanding. Ability for formulating macroscopic phenomena about matter and energy requires in-depth understanding. The use of effective delivery methods or tools for teaching PCE is thus very important to address the challenges.

Traditionally, the delivery mode for PCE teaching consists of traditional face-to-face lectures, tutorials, projects, and some time includes adjunct lecture and chemical plant site visit. On top of those, innovative methods have been developed through research for effective teaching of PCE. Problem-based learning approaches have been shown to be effective (Kelly & Finlayson, 2007), but the mathematical challenge in PCE influences the student's to be expository (Jones & Kelly, 2015). Context-based learning uses a real-life case as the starting point in teaching, and is also known to enrich environment for education, increasing students' interest and motivation (Eilks & Byers, 2009).

To attain deep understanding of macroscopic phenomena, visualization of the process is very crucial. The advantages of using computers in PCE education have also been recognised. Integration a computer-based modelling exercise into PCE course have also been successfully implemented (Johnson & Engel, 2011). The availability of computer-based resources that use models, simulations, and animations provides rich tools for educational investigations (Stieff & Wilensky, 2003; Tasker, 2005). Interactive visualization tools (Sims) have recently emerged as uniquely powerful in chemistry education. Sims provides dynamic access to multiple representations, makes the invisible visible, scaffolds the inquiry process, and allows for multiple trials and rapid feedback cycles, while being engaging and fun to use. It is also worth noting that the effectiveness of the Sims depends on the quality of the simulation design and its implementation method.

Because of the wide coverage of the PCE materials, it is important to develop strategies and tools for effective teaching of the subject. For similar context, portfolio workbook has been demonstrated as an effective student-cantered learning tool. It has been extensively implemented in nursing education (McMullan et al., 2003), like for monitoring the progress of competency (Jasper, 1995) or learning experiences (Coffey, 2005). The method has also been widely practiced in statistic subjects (Carlson & Winquist, 2011), and to a lesser degree in chemistry related subject (Nainggolan et al., 2020).

This study reports implementation of portfolio workbook as a strategy to enhance learning for PCE subject. The method was implemented for a full-semester and the student feedback was obtained after the course was completed. The implementation, student perceptions and opinion on the method were assessed.

2. MATERIALS AND METHODS

The study was conducted during September 2018 Semester in Chemical Engineering department Universiti Teknologi Petronas. Out of 79 students taking the subject, 58 answered the survey. The workbook material was pre-prepared before the semester started. It consisted of a brief summary of the concept, self-exercises and problems; they were aligned

DOI: http://dx.doi.org/10.xxxxx/AJSEE.v1i1
p- ISSN 2528-1410 e- ISSN 2527-8045

strictly according to the syllabus. The whole workbook was 170 pages about 500 number of self-exercises and problems. Overview of the workbook is shown in **Figure 1**.

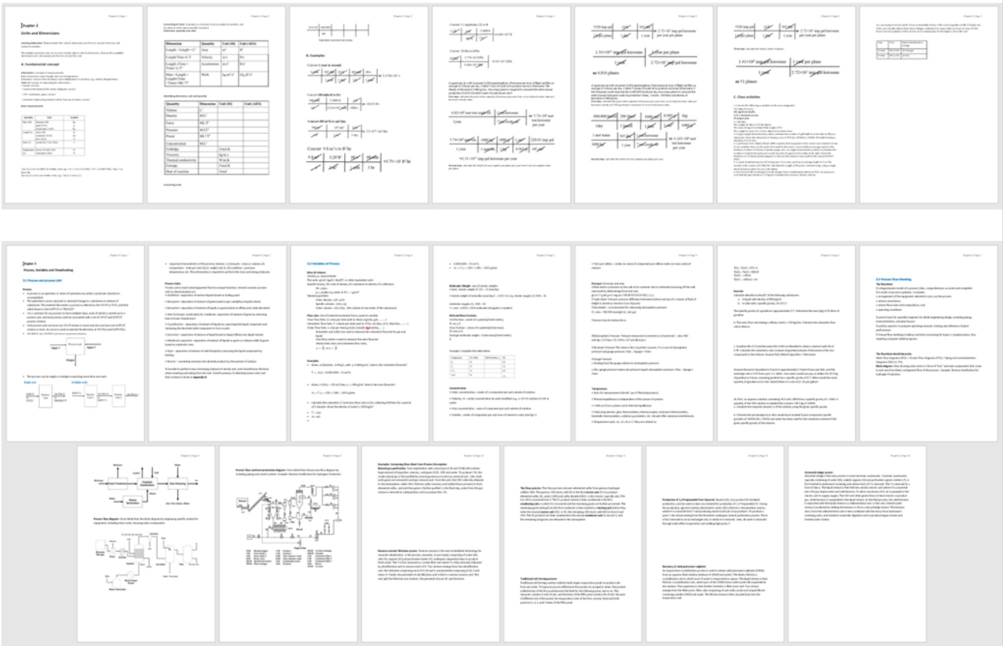

Figure 1. Overview of student workbook.

The workbook was distributed to the students on the first week of the semester; and they had to submit the progress at the middle and at the end of semester. All of the exercises must be done hand-written and must be submitted in person to the course lecturer to allow direct feedback to the students.

The workbook activity was graded of only 3% of the total course marks. The grading was focussed on the completeness, not the correctness of the work. The workbook was provided without detail solutions of the given problems, nor the final answers. The student perception, acceptance and the opinion on the workbook, as well as the approach for implementation of the method were gathered at the end of semester after their final grade was announced. They were asked voluntarily to fill in an online survey via Microsoft Form.

3. RESULTS AND DISCUSSION

Figure 2 shows the snapshot of portfolio prepared by the students. All of them fully submitted the workbook on time, most probably because of the grading enforcement. The enforcement of the method by assigning mark is accepted by most of the students (69%) (**Figure 3**). They mentioned that the quality of the workbook as the main driving force in utilizing it. Unlike the reference textbook that partly covers the syllabus, the workbook was designed to strictly follows the syllabus. Many students used the workbook as their personal study note, as also recommended by the course lecturer. The rests (31%) used the workbook motivated by the mark.

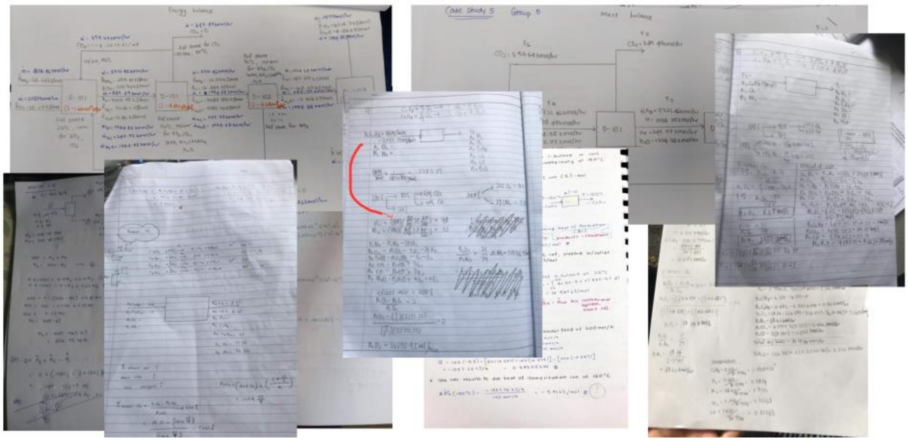

Figure 2. Snapshots of submitted student's workbook.

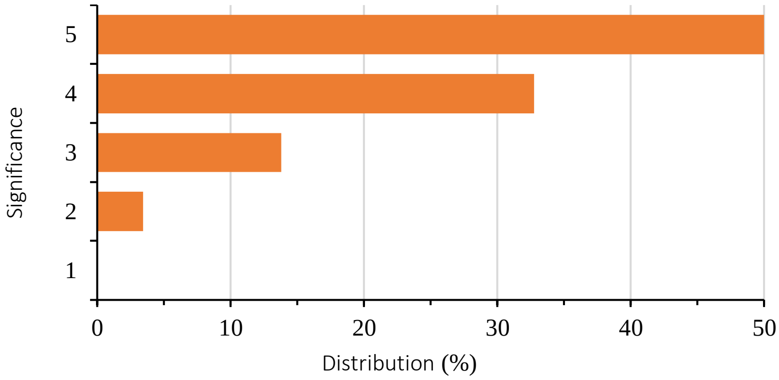

Figure 3. The student perception on the significance of the workbook portfolio in enhancing their understanding

When asked about their opinion on the best implementation of the workbook, most of them suggest for assigning the mark (52%) mainly because it enhances their motivation to study/work on it. 22% of the students prefer for grading in form of bonus point and the rests recommend conducting the method voluntarily. The quality of the workbook portfolio method is best judged by the highly positive opinion of the students on its role in enhancing their overall understanding of the subject (**Figure 3**). 50% of the student rate highest (5) and no student rate the lowest (1). Over 82% of the student give a strong opinion on the positive role of the workbook portfolio in helping them mastering the subject.

The positive role of the workbook in strengthening student understanding can be ascribed by the large number of the exercises provided in the workbook coupled with no solution. The problems were arranged from the simplest to the most complicated, often requiring computational tools to be accurately solved. It then encouraged students to study in groups where they implemented peer-to-peer teaching/coaching and cross-checking their portfolio. The role of the course lecturer in giving feedbacks as a scaffolding method at times is also universally appreciated by the students.

When asked about "how strong would you recommend the application of student workbook for learning in another subject," >55% of the student opted for the strongest option (**Figure 4**). Vast majority (>85%) of them assigned highly recommended by scoring >4. However, few students also did not recommend (<6%). As a coronary of the favourable implementation and positive impact of the workbook in enhancing understanding and

DOI: http://dx.doi.org/10.xxxxx/AJSEE.v1i1
p- ISSN 2528-1410 e- ISSN 2527-8045

learning experience, most of student recommend the method implementation for the other subject.

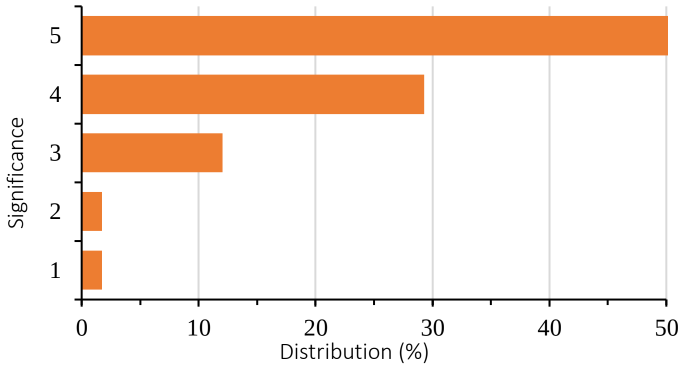

Figure 4. The recommendation for implementation of the method for another subject

The feedbacks on the method and the workbook can be classified into two: (1) providing short-answer and (2) more intensive scaffolding. The short answer can be treated as the guide by the students to evaluate the correctness of their work. Scaffolding is highly required in the form of regular checking to monitor the progress and discussion of the selected problems.

4. CONCLUSION

Portfolio workbook as a strategy to enhance student active learning has been implemented and assessed. Most of the student agreed on the imposing mark on the workbook to enhance their motivation to study. Vast majority of the students (>82%) think that the method significantly helps them in mastering the subject and which also convince them to recommend the method for implementation by other subject (>85%). The workbook as well as the method implementation can further be improved by providing short answer as well as more intense scaffolding over the semester period.

5. ACKNOWLEDGEMENT

I would like to sincerely acknowledge all students involved in this study and responded well to the survey.

6. AUTHORS' NOTE

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. Authors confirmed that the data and the paper are free of plagiarism.

7. REFERENCES

Aldahmash, A. H., and Abraham, M. R. (2009). Kinetic versus Static Visuals for Facilitating College Students' Understanding of Organic Reaction Mechanisms in Chemistry. *Journal of Chemical Education*, *86*(12), 1442.

Carlson, K. A., and Winquist, J. R. (2011). Evaluating an Active Learning Approach to Teaching Introductory Statistics: A Classroom Workbook Approach. *Journal of Statistics Education*, *19*(1), 1.

Coffey, A. (2005). The clinical learning portfolio: A practice development experience in gerontological nursing. *Journal of Clinical Nursing*, *14*(2005), 75–83.

Eilks, I., and Byers, B. (2015). Innovative methods of teaching and learning chemistry in higher education. (Eds.). New York. Cambridge: Royal Society of Chemistry

Jasper, M. (1995). The portfolioworkbook as a strategy for student-centred learning. *Nurse Education Today*, *15*(6), 446–451.

Johnson, L. E., and Engel, T. (2011). Integrating Computational Chemistry into the Physical Chemistry Curriculum. *Journal of Chemical Education*, *88*(5), 569–573.

Jones, L. L., & Kelly, R. M. (2015). Visualization: The Key to Understanding Chemistry Concepts. In M. V. Orna (Ed.), *ACS Symposium Series*, *1208*(2015), 121–140.

Kelly, O. C., and Finlayson, O. E. (2007). Providing solutions through problem-based learning for the undergraduate 1st year chemistry laboratory. *Chem. Educ. Res. Pract.*, *8*(3), 347–361.

McMullan, M., Endacott, R., Gray, M. A., Jasper, M., Miller, C. M. L., Scholes, J., and Webb, C. (2003). Portfolios and assessment of competence: A review of the literature. *Journal of Advanced Nursing*, *41*(3), 283–294.

Moore, E. B., Chamberlain, J. M., Parson, R., & Perkins, K. K. (2014). PhET Interactive Simulations: Transformative Tools for Teaching Chemistry. *Journal of Chemical Education*, *91*(8), 1191–1197.

Nainggolan, B., Hutabarat, W., Situmorang, M., & Sitorus, M. (2020). Developing Innovative Chemistry Laboratory Workbook Integrated with Project-Based Learning and Character-Based Chemistry. *International Journal of Instruction*, *13*(3), 895-908.

Plass, J. L., Milne, C., Homer, B. D., Schwartz, R. N., Hayward, E. O., Jordan, T., and Barrientos, J. (2012). Investigating the effectiveness of computer simulations for chemistry learning. *Journal of Research in Science Teaching*, *49*(3), 394–419.

Stieff, M., & Wilensky, U. (2003). Connected Chemistry—Incorporating Interactive Simulations into the Chemistry Classroom. *Journal of Science Education and Technology*, *12*(3), 285–302.

Tan, K. C. D., & Kim, M. (2012). *Issues and Challenges in Science Education Research: Moving Forward*. In Springer Science & Business Media. (Chapter 1, pp. 1-4). New York: Springer.

Tasker, R. (2005). Using multimedia to visualize the molecular world: Educational theory into practice. In *Chemists' Guide to Effective Teaching,* (Chapter 16, pp. 195 – 211). USA: Pearsom Prentice Hall.

Tsaparlis, G., & Finlayson, O. E. (2014). Physical chemistry education: Its multiple facets and aspects. *Chem. Educ. Res. Pract.*, *15*(3), 257–265.

DOI: http://dx.doi.org/10.xxxxx/AJSEE.v1i1
p- ISSN 2528-1410 e- ISSN 2527-8045