EDUCATION FOR CHEMICAL ENGINEERS XXX (2016) XXX–XXX

Contents lists available at ScienceDirect

Education for Chemical Engineers

journal homepage: www.elsevier.com/locate/ece

Team-based learning for first year engineering students

Q1 *Vesna Najdanovic-Visak*

Energy Lancaster, Engineering Department, Lancaster University, Gillow Avenue, Lancaster LA1 4YW, United Kingdom

ARTICLE INFO

Article history:
Received 22 April 2016
Received in revised form 22 August 2016
Accepted 6 September 2016
Available online xxx

Keywords:
Teaching practices
Pedagogical innovation
Group work
Active learning

ABSTRACT

Although it was originally developed for a business school environment to promote the benefits of small-group teaching in a large group setting, the method of the team-based learning (TBL) has recently been increasingly used within medical education. On the other hand, the reports on its implementation in engineering and science education are much scarcer. The aim of this work is to discuss the experience, evaluation and lessons learned from the implementation of the TBL within a Year 1 engineering module—Process Engineering Fundamentals, enrolling 115 students, and the TBL method was introduced for the first time.

To evaluate the acquired knowledge and perception of TBL, a students' performance analysis and questionnaire were completed on two occasions. It was observed that the TBL approach improved student learning, enhanced their integration and sharing of knowledge in class, supporting the implementation of this method in engineering disciplines.

© 2016 Institution of Chemical Engineers. Published by Elsevier B.V. All rights reserved.

UNCORRECTED PROOF

1. Introduction

The traditional approach of teaching engineering subjects is efficient in presenting a large amount of information to large numbers of students. However, the downside of this approach is that it fosters passive learning where students expect to be told what to learn and how to learn it (Felder, 2012), without developing the skills and enthusiasm for the course. Evidence suggests that, relative to traditionally-taught students, the students who had proceeded through the student-centred methods emerged with more positive attitudes about the quality of their instruction, higher levels of confidence in their engineering problem solving abilities, a greater sense of community among themselves, and perhaps a higher level of employability resulting partly from their extensive experience Q2 with team projects (Felder, 1995).

A large body of literature in this area addresses theory, research, practices and faculty development (Prince, 2004; Prince and Felder, 2006). The most commonly published methodologies are cooperative/collaborative learning (Cabrera et al., 2001; Maceiras et al., 2011), problem-based learning – PBL (Hmelo-Silver, 2004; Harris and Briscoe-Andrews, 2008), web-based learning (Chumley-Jones et al., 2002; Brault et al., 2007), team-based learning – TBL (Thompson et al., 2007; Lamm et al., 2014) and enquiry based learning – EBL (Levy and Petrulis, 2012; Glassey et al., 2013). Development of strong teamwork capabilities are highly required by employers in engineering sectors since engineering graduates are increasingly expected to work in team-based product and process design projects (Natishan et al., 2000). The recent study published by Zou and Ko (2012) demonstrated enhanced awareness of teamwork concepts among chemical engineering students through a three-year systematic teamwork development project. Therefore, it is not surprising that in last few decades, various group based learning methodologies have emerged in engineering education as a practical and effective approach. As evidence, undergraduate group design projects were introduced a half century ago in almost all chemical engineering courses in the world, evolving ever since due to the enormous commitment from the chemical process industry in terms of efficiency, environmental impact, safety, sustainability, and flexibility (Pekdemir et al., 2006). On the contrary to this traditional group work, such as design

E-mail address: v.najdanovic@lancaster.ac.uk
http://dx.doi.org/10.1016/j.ece.2016.09.001
1749-7728/© 2016 Institution of Chemical Engineers. Published by Elsevier B.V. All rights reserved.

Please cite this article in press as: Najdanovic-Visak, V., Team-based learning for first year engineering students. Education for Chemical Engineers (2016), http://dx.doi.org/10.1016/j.ece.2016.09.001

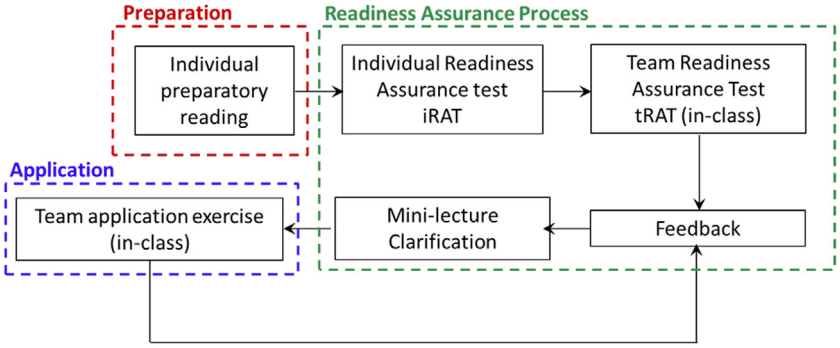

Fig. 1 – Team-based learning procedure.

projects, which typically produce a paper and/or presentation, groups in TBL, PBL and EBL are more structured and actually do their group work during class time.

From all above mentioned learning methods, PBL is the most used alternative strategy within engineering education. Developed in medical education in the late 1960s, problem-based learning was a major breakthrough in curriculum reform (Frenk et al., 2010), causing many schools to adopt an alternative to then dominant teacher-centred approach. It has been described as 'reflecting the way people learn in real life' (Biggs and Tang, 2007). PBL presents a spectrum of various different practices, but in general follows the following sequence: (1) group analyses a given problem; (2) group brainstorms possible solutions and hypotheses and then decides what further information is needed to solve the problem; (3) independent study by each member of group; and, (4) group shares gathered information and tests previous hypotheses in light of the new information. PBL delivery involves the supervision of each group by one tutor. A number of publications suggests that problem-based learning has several clear advantages over the more traditional delivery techniques, such as increased retention of information, an integrated knowledge base, the development of lifelong learning skills, an exposure to real-life experience at an earlier stage in the curriculum, increased student-faculty interactions, and an increase in overall motivation (Klegeris and Hurren, 2011). The main disadvantage of PBL lays in the fact that each group of six to ten students is supervised by one tutor, impeding its effective implementation in large classes such as first-year introductory modules with typically more than one hundred students.

Another pedagogical approach, team-based learning (TBL) was firstly introduced in the literature in 1982 as a way to promote the benefits of small-group teaching in a large group setting, considerably enhancing students' engagement and their knowledge retention (Michaelsen et al., 1982). TBL is promoted as a special pedagogical approach comprising four elements for implementation (Michaelsen et al., 2004): (i) strategically forming permanent teams of 5–7 members (to guarantee sufficient intellectual resources), (ii) Readiness Assurance Process (pre-class individual assignment, e.g. readings, followed by in-class Individual Readiness Assurance Test, iRAT, and Team Readiness Assurance Test, tRAT), (3) developing students' critical thinking skills by using carefully-designed, in-class activities and assignments; and, (4) creating and administering a peer assessment and feedback system.

In contrast to PBL which covers many different practices, TBL is a well-defined set of practices and principles with only few variations. In TBL, one tutor simultaneously facilitates many small teams of 5–7 members, typically 20 or more. Usually material to be covered is organised into a few major units and for each of them the sequence of activities is implemented as shown in Fig. 1. In the first phase, students are given pre-class individual assignments (e.g. readings) that are designed to familiarise students with the key concepts of that unit. Based on this preparation, in the next phase students are expected to take an Individual Readiness Assurance Test (iRAT), guaranteeing their preparation. After, students re-take the exact same Readiness Assurance Test as a team (tRAT) by coming to consensus on their answers. The role of tRAT is two-fold: (1) mutual transfer of knowledge between teammates; and, (2) motivation through competition with other teams. In the next phase, students receive real-time feedback from the instructor with clarification of concepts related to the test questions that students struggled with. The instructor can also provide feedback (e.g. mini-lecture) which is usually short and always very specific in corrections of any misperception. In the final stage, the team application assignments are designed for students to put course content to use by working in teams on progressively more difficult questions. It is essential to carefully design these application assignments in order to achieve the higher Bloom's levels of learning (abilities to analyse, evaluate and create) according to the so-called '4S' strategy coined by Michaelsen and Sweet (2008):

1) Significant problem—the application exercise should be meaningful and complex enough to motivate student to generate fruitful discussions within teams.
2) Same problem—all teams should work on the exact same problem which allows teams to compare their answers with answers of other teams. In this way, teams get more curious, assuring that students pay more attention, resulting in enhanced engagement. Mock
3) Specific choice—although open-ended questions can lead to lively discussions, the application exercises should be designed as a specific choice questions, such as multiple-choice, calculating a parameter, creating a list, ordering items, organizing into categories, etc. Asking students to make a collaborative decision giving a specific answer simulates a read world situation in professional environment. In this way, teams learn to justify, elaborate, defend and argue for their chosen decision.
4) Simultaneous reporting—teams should report their answers simultaneously in order to encourage accountability and prevent answer drift.

The last essential element of the team-based learning is peer-to-peer assessment, aiming to hold individuals accountable to their teams and to lessen the likelihood of social

UNCORRECTED PROOF

Please cite this article in press as: Najdanovic-Visak, V., Team-based learning for first year engineering students. Education for Chemical Engineers (2016), http://dx.doi.org/10.1016/j.ece.2016.09.001

Download English Version:

https://daneshyari.com/en/article/4766413

Download Persian Version:

https://daneshyari.com/article/4766413

Daneshyari.com