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Book Review

Research on PBL Practice in Engineering Education

Marjahan Begum

Du, Xiangyun, Erik de Graaff, and Anette Kolmos, eds. *Research on PBL Practice in Engineering Education*. Rotterdam: Sense Publishers, 2009. 225pp. ISBN 978-90-8790-930-7 \$49.00 (pbk).

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The main strength of *Research on PBL Practice in Engineering Education* is the diversity of its coverage, including both application of PBL in science and engineering education and research questions addressing various facets of PBL. There is often a debate between educators and researchers about the definition of what counts as PBL, and this book provides some good definitions, especially in chapter 2. As can be seen throughout this book, despite variations in PBL implementation, student-centered learning is one theme that binds them all together.

This book addresses three main stakeholder audiences, though specific needs may overlap depending on an individual's interests and role. These stakeholders are the PBL course team (staff members who are involved with decision making and support), education researchers, and implementers or educators of PBL practice. Chapter 1, "Diversity of Research Questions and Methodologies," is important and equally relevant to all three groups. Chapters 2 to 4 are more significant for the first group, chapters 5 to 9 are more relevant to researchers, and chapters 10 to 17 are more important for the practitioners of PBL.

The first chapter, "PBL: Diversity of Research Questions and Methodologies," provides a brief history of research on PBL since the 1960s. It explains that in some traditions, this type of research may not be considered the kind of "true" scientific research that many engineering and science educators are most familiar with. The chapter makes the case that the type of research carried out in PBL may be descriptive, normative, or conceptual, but it nonetheless "plays an important part in the development of ideas as it contributes to the understanding and creation of an analytical framework for new innovative practice"

(1). Therefore, the impact on student learning and evaluation to improve practice are key themes both in this book and PBL research in general. On the other hand, the authors stress that despite increasing interest in PBL research, most has been of the small-scale exploratory type and confined within one institution, and they emphasize the need for more cross-institutional focusing, at both the national and international levels.

Chapter 2, "Diversity of PBL: PBL Learning Principles and Models," begins with a brief history of PBL in North America and Europe. The chapter advocates for PBL principles with roots in learning theories and specifically for a framework called PBL Learning Principles. The framework is based on learning, content, and social dimensions, thus incorporating experiential and independent learning while also integrating theory and application with collaborative learning. It is a useful framework for either design PBL-based courses and programs or research aspects of PBL.

Chapter 3, "Problem Based Learning and Instrumental Realism," argues for more research in the philosophy of engineering education with the aim of balancing teaching of engineering and science with developing engineering solutions for real-world problems. It posits instrumental realism as a philosophy of engineering education. This concept takes the view that science should be taught in context and that it is important to understand how both external and internal factors can shape engineering solutions. Unfortunately, this chapter is difficult to read because it largely fails to make instrumental realism accessible for engineering academics, practitioners, or even engineering education researchers.

Chapter 4, "Problem-based Learning: Effectiveness, Driver, and Implementation Challenges," is important for both educators and the PBL course team group. Within these groups, there are often heated discussions about the effectiveness of PBL as a learning and teaching strategy, and this chapter addresses some of these issues. It is reassuring to see that there is some sound evidence of the effectiveness of PBL, even though the literature cited is mostly from medical education. For example, studies of short-term knowledge retention produced mixed results but favored the more traditional learning approach, whereas evaluations of skill-based performance favored the PBL approach.

The second part of this chapter is about challenges and drivers for PBL implementation at the organizational or institutional level. One important driver is from the employers and businesses who claim that graduates are ill prepared for the professional world. Some challenges and issues are identified: the changing role of both teacher and student, with the teacher moving away from being a knowledge provider and the student taking more responsibility; constraints on current education systems (such as a lack of attention to critical thinking abilities); and a limited understanding of PBL and how it can be applied in relation both to academics and the infrastructure of the learning environment.

It is encouraging to see five chapters (5 to 9) devoted to a wide range of research approaches and methods, with some grounded in sound research methodologies and educational theories literature. Not surprisingly, most of the chapters in this section fo-

cus on measuring the impact or effectiveness of PBL or identifying ways to improve its implementation. Chapter 5, "Using the CIIP Model to Evaluate the Impact of Project-Led Education: A Case Study of Engineering Education in Portugal," uses the Context, Input, Process, Product (CIPP) evaluation framework. It shows that by using such a framework, research can give a more holistic view of a project, making it easier to improve factors that can influence the success of education strategies like PBL or project-led education (PLE). Too often the focus is on only outcomes for students, such as their knowledge, motivation, or experience in general. The results of the research from chapter 6, "Group or Individual Assessment in Engineering, Science and Health Education," are aimed towards policy makers, focusing on the preferences and effectiveness of group assessment versus the individual assessment of group projects in a PBL context. It also argues that if educators are to encourage students to do innovative and highly integrated team projects, the assessment systems need to match the learning activity.

Chapter 7, "Gauging the Effectiveness of Design Projects in Engineering Education, and chapter 8, Socio-emotional Quality of Small Groups during Project-Based Collaborative Learning in Engineering Education," are, respectively, positioned within education theories of self-directed learning and socio-constructive learning. Chapter 7 is focused on measuring effectiveness of PBL in relation to the quantity of self-directed learning. Effectiveness is measured in terms of student perceptions of general improvement in two dimensions: design ability and transferrable skills. The implication of the result shows that a different proportion of self-directed learning (SDL) produces different levels of improvements. There is no doubt that finding an optimal level of effectiveness is a big challenge from a research and implementation perspective. Promoting self-directed learning will need to be done with caution, as this research shows that the relationship between SDL and skills development is very complex.

Chapter 8 explores the extent to which inter-group socio-emotional quality (SEQ) influences team members' perceived successes in cognitive and interaction skills. This is an interesting chapter for researchers who want to understand group dynamics and how to research group interaction within a collaborative environment. Even though the link between SEQ and success is weak, this chapter points toward further avenues to explore, for example, how practitioners cope with low levels of SEQ, and designing learning experiences where a team's success can be achieved earlier.

Chapter 9, "Group Project Assessment in a PBL Environment," is about identifying the alignment of learning activities and the assessment of learning outcomes. The results show that there seems to be a poor alignment between learning outcomes related to project management, and only a basic understanding of problem-based learning as a conceptual framework for teaching and learning. Recommendations are made for changes at both the curriculum content and structure levels.

Chapters 10 to 17 give details of case studies of PBL from around the world and in wider disciplines than pure engineering. For example, chapter 10 is about the role of technical support staff in the PBL curriculum in Australia while chapter 11 focuses on the chemistry discipline in Finland and looks at how PBL was applied in a laboratory-based course, including its impact on students and teachers. Chapter 12 shows the educational structure which practitioners can use to develop their teaching in Computer Science in Spain, and chapter 13 shows how PBL has evolved in Brazil. These chapters provide snapshots that show how widely the PBL approach has been adapted around the globe and the fact that many countries face similar issues from institutional, staff, and student perspectives. I suggest that practitioners be selective about choosing which case study to investigate based on the abstract. These kinds of findings and observations, coupled with the other chapters in this volume, will hopefully inform future efforts to study and implement PBL in engineering education.

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