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Cat D. Jackson
University of Oklahoma

Theresa A. Cullen
Arkansas Tech University

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Theresa Cullen
University of Oklahoma, tacullen@ou.edu

Cat D. Jackson
University of Oklahoma, catjackson@ou.edu

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The Interdisciplinary Journal of Problem-based Learning

BOOK REVIEW

Problem-Based Learning in the Life Science Classroom, K–12

Theresa Cullen and Cat D. Jackson (University of Oklahoma)

McConnell, T., Parker, J., & Eberhardt, J. *Problem-Based Learning in the Life Science Classroom, K–12.* Arlington, VA: National Science Teachers Association (NSTA) Press. 200 pp. ISBN 978-1-941316207. $39.95 (Paperback). $29.96 (E-book).

Introduction

Problem Based Learning in the Life Science Classroom is a book published by the National Science Teacher's Association (NSTA) with a target audience of K–12 teachers. This book fully integrates the Next Generation Science Standards (NGSS) and is designed to assist teachers in justifying and applying a problem-based learning (PBL) approach using NGSS practices. It is designed for those who are actually teaching in the classroom and, after a basic introduction to problem based learning, gives a series of applied lesson plans that can be used at a variety of grade levels. Other audiences who may be interested in this book are professional developers and educational researchers who want to create usable content from their work. This book is the direct result of a National Science Foundation (NSF) grant, where teachers engaged with science researchers to develop PBL lessons for the classroom. In that regard, this book is an excellent example of research translated to practice, broader impacts, and creative dissemination of research work.

Book Overview

The book begins with a preface that does a nice job of establishing how the book was written, ~~and~~ its intended audience, and why they chose PBL as their method of instruction. Their argument is that PBL provides a framework that is flexible for both experienced and inexperienced learners with different levels of content knowledge. The authors advocate that PBL can be adapted to a variety of classroom settings and different science content areas. As in any NSTA book, the preface ends with a statement of safety and ethical practices in science. This statement is consistent throughout all their publications and reinforces not only basic science classroom safety, but also best science education practices.

Overview of Introductory Chapters

After the four introductory chapters, chapters 5–8 are example lesson plans. They are arranged in major categories: "Life Cycle Problems" (chapter 5), "Ecology Problems" (chapter 6), "Genetics Problems" (chapter 7), and "Cellular Metabolism Problems" (chapter 8). Throughout the four chapters there are 16 problems that a teacher could use in their class. While the book is published in black and white, additional files are downloadable with color graphics and links to videos and other multimedia content. Providing QR codes for the teachers to scan and see the pictures would have added an extra layer of ease in the usability of the book. We were struck by the randomness of the topics; while big ideas in biology, by no means were these topics overall representations of the NGSS major themes.

Overview of Lesson Chapters

The second half of the book is dedicated to example lessons. Each of the lesson chapters (chapters 5–8) has a basic format starting with a general overview of the topics and connections to NGSS. Next, in each of the chapters is a more comprehensive list of big ideas covered in the chapter followed by the conceptual barriers that teachers might encounter when facilitating the projects. We have one concern with the conceptual barriers sections. Each chapter lists some general conceptual barriers that the students would have when working with the problem. However, the section does not give specific information or key citations about how to address these barriers in a way to bring about conceptual understanding that students will retain. This issue is somewhat addressed previously in chapter 3; however, it will be important for teachers

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to understand why students might have specific conceptual barriers and suggestions for how to address those in each lesson. Chapter 5 and 7 provide the least comprehensive overview, whereas chapter 6 is much more thorough.

Each lesson chapter (5–8) also contained a section on interdisciplinary connections with the topics. Specifically within an elementary context, interdisciplinary connections are incredibly helpful. However, the suggestions could have been fleshed out more to include reading level for the literature suggestions and maybe a standards connection for the different suggestions—specifically considering the fact that each lesson has the flexibility to be used across several grade levels. For example, if the authors had linked directly to the NGSS web page, this would have linked to references to interdisciplinary Common Core State Standards that are helpful for teachers developing interdisciplinary lesson plans.

We do have one concern with the overall function of the beginning of these lesson chapters. If a teacher were teaching lessons from a chapter after reading it thoroughly and they needed to glance over the information a second time, would they be able to pick up the most pertinent information quickly? A quick reference sheet would be helpful for each lesson. As discussed in chapter 1, each lesson has a basic set of elements: standards, the story, more information, resources/investigations, a teacher guide, and assessment. Additionally, each lesson plan has its own comprehensive list of safety precautions that are very well-thought-out and thorough. Further, the chapters are similarly structured and many of the scenarios have the same general feel after reading through the lessons.

Introductory Chapter Breakdown

On pages xiii and xiv of the preface there is a matrix of all the applied lesson plans at the end of the book, including a list of keywords and target grade levels based on the Next Generation Science Standards (NGSS) grade level bands. This is a very useful feature and allows the reader to review the content provided quickly.

Chapter One

Chapter 1 provides an overview of PBL and why it is an appropriate approach for science learning. The background provided is high level with key citations. Chapter 1 is clearly written for someone who does not have a background in PBL. It makes the case for why PBL is an appropriate approach and does this by taking a historical perspective (i.e., Barrows, 1986; Bransford & Schwartz, 1999; Hung, Jonassen, & Liu, 2008). Further, chapter 1 goes on to make the case for PBL as an appropriate science pedagogy by its inquiry nature. The authors argue that a classroom regularly engaged in PBL encourages students to approach problems in a new way and creates a "habit of mind." It goes on to explain how the book was developed as part of a NSF grant to encourage inquiry, increase teachers' scientific content knowledge, and develop lesson plans that use PBL to explore scientific content. The grant had four cohorts of participants and all of them contributed in some form to the lessons in this book.

There were several things we liked about chapter 1. The PBL process was well explained even though it was brief. The chapter cited important work so that an engaged teacher can read more about PBL. The authors also explain the format of their example lessons including NGSS frameworks and cross-cutting concepts, which we will explore in more detail in our discussion of them. Overall this chapter makes PBL highly accessible to a novice while still grounding its arguments in the research.

Chapter Two

Chapter 2 is specifically focused on tying PBL in the life sciences to the Next Generation Science Standards (NGSS). Considering we are familiar with NGSS, reading this fast overview of NGSS standards is a little overwhelming and a bit unnecessary. The main points are found at the end of the chapter; that is, problem-based learning helps to meet some of the NGSS performance standards like being able to explain a scientific concept. They also deal with the concern over scientific misconceptions during the problem solving process where students may hang on to incorrect beliefs, thus complicating their problem solving activities. We would have liked to see some references to misconception research (i.e., Posner, Strike, Hewson, & Gertzog, 1982; Lin, Yen, Liang, Chiu, & Guo, 2016) to better support both this concern and resolution.

Chapter Three

Chapter 3 builds on chapter one's general format of a lesson and the concern voiced in chapter 2 by providing solid guidance for facilitating PBL. It breaks down examples into key actions like "Launch," "Unpacking Ideas," and different teacher roles like facilitator and expert. The authors present these guidelines by creating vignettes that show how to encourage student voice in PBL discussion. They also provide examples of poor PBL discussion facilitation. This is useful for a novice teacher to see how a discussion could go, but a more experienced teacher may not respond well to the scripting.

Chapter Four

Chapter 4 focuses on how these lessons could look in classroom practice. The authors challenge educators to mix up the content while still maintaining the basic lesson plan template they have been provided. This chapter has a robust discussion of using different kinds of student artifacts (such as drawings to illustrate their ideas and/or transfer tasks to

help students apply content to a new context) for assessment. They also discuss how to deal with the common concern that students working in groups are not individually accountable. The book suggests countering this issue by understanding the work habits of your students and grouping them accordingly. By addressing these concerns teachers who consider using PBL can plan to deal with major concerns they may encounter and discuss them in advance with their curriculum director or administrator. Overall, our concern is that a novice teacher may cling too firmly to the template and miss some opportunities for richer and messier problems.

Lesson Chapter Breakdown

Chapter Five

Chapter 5 focuses on elementary life cycles problems. According to the catalog the lessons range from K–2, 3–5, and 6–8 grade bands. There are four lessons: "Baby Hamster," "Wogs and Wasps," "Humongous Fungus," and "Baby, Baby Pear." When creating lesson plans that are suitable for a variety of grade levels, it is necessary to provide the modifications to fulfill the standards. For example, the first lesson, "Baby Hamster," is paired with a kindergarten and a third grade NGSS. However, the lesson does not discuss the death part of the NGSS third grade standard, an important aspect of the life cycle. An extra page of modification for the higher grade level and standard here would be helpful for third grade teachers wanting to implement this lesson. The authors put a great deal of work into scaffolding crosscutting concepts. We can see this specifically in lessons "Wogs and Wasps" and "Baby, Baby Pear," in which students are asked to identify patterns in the life cycles of two very different living things.

Chapter Six

Chapter 6 focuses on ecology problems and the grade bands range between 3–5, 6–8, and 9–12. There are five lessons: "Where's Percho?," "Lake Michigan—A Fragile Ecosystem," "Bottom Dwellers," "Bogged Down," and "The Purple Menace." Some lessons are very thorough, providing several examples and background information for students and teachers as they work through the problem. One such lesson is "Where's Percho?," which provides background on different conflicts (between humans and animals alike) in the appearance of new species (specifically predatory species) in an area. We think technology integration was missing here. This lesson would have provided a great opportunity for technology integration as students were asked to create a concept map of an ecosystem. Students could create a concept map using pencil and paper, or a mobile application or web-based program (e.g., mind vector, mind meister, CMAP tools, popplet, kidspiration, etc.). Teachers and other stakeholders would benefit from suggestions of unplugged and plugged activities that can be used by teachers in a variety of resource settings.

Chapter Seven

Chapter 7 focuses on genetics problems, a great subject area that lends itself well to PBL, and the grade bands are 6–8 and 9–12. There are four lessons: "Pale Cats," "Black and White and Spots All Over," "Calico Cats," and "Cat Puzzles." Each lesson is thorough and visually supported with pictures, diagrams of chromosomes for added clarity, and figures to illustrate concepts such as pedigree. The authors use cats as a common household pet in the majority of the lessons to create some relatability with the students. This chapter is unique from the previous two, in that the four lessons are scaffolded and connected, rather than operating independently from one another.

Chapter Eight

Chapter 8 focuses on cellular metabolism problems addressing the 3–5, 6–8, and 9–12 grade bands. There are three lessons here: "Torching Marshmallows," "Mysterious Mass," and "Why We Are Not What We Eat." Some of the lessons in the chapters need more background and support from the facilitating teacher's curriculum. One example is the "Torching Marshmallows" lesson, where several concepts regarding matter and energy are introduced with a brief explanation. However, one would need to consider the grade level prior to developing the necessary background materials and concept scaffolding. The three lessons in this chapter used a continuing storyline, which makes it fun and easy to follow. Like chapter 7, each lesson is connected to the last in terms of content and context.

Chapter Nine: Creating and Designing Your Own Problems

Chapter 9 is probably the most important chapter to us in the book. The chapter is titled, "Creating and Designing your Own Problems." We believe that teachers learning about PBL would benefit from using chapter 9 as a way to breakdown the PBL format in chapters 5–8. The authors are honest about how teachers often typically design lessons (starting with the standards and then trying to design an interesting question). They challenge teachers to focus on the interesting question and then link them to the NGSS standard that is most appropriate. This chapter does a nice job of taking a complex task like designing a PBL lesson and making it accessible. However, we have one concern in that the directions are a little too templated. We worry that if a teacher wanted to incorporate PBL regularly in their teaching, it could become mundane and routine in a negative way. While we want students to develop that way of thinking as mentioned earlier in the book, we also need to encourage the teacher to deviate from a set pattern to create varied problems

with richer constraints. We would have liked to see additional contexts discussed in more detail. It is a difficult consideration because this format makes PBL very accessible to a teaching audience. However, though it is very structured scaffolding, this format may create too much of a worksheet for PBL instruction. Even though in chapter 4 the authors encouraged adding existing materials to augment the model, overall it may be too prescribed. This could have been addressed by more discussion of how the format could be further developed or mixed up in practice at the end of the book.

Conclusion

Overall, *Problem Based Learning in the Life Science Classroom* is a good basic book for someone who is not very familiar with PBL, and it makes an effective case for using PBL as it builds upon important scientific pedagogy like inquiry. This book would be appropriate for those new to PBL or those looking to design PBL activities, but would not be appropriate for a class on research in PBL. We could easily see this book being used in a professional development reading group in a science department or even as a support text in an undergraduate science education methods course. We do think its greatest merit is as a resource to educational researchers who engage in professional development activities. As federal funds become more and more competitive, the responsibility to make sure that your findings and work reach classroom teachers becomes more important. *Problem Based Learning in the Life Science Classroom* is an effective example of how that kind of outreach can look.

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