Interdisciplinary Journal of Problem-Based Learning

Volume 11 | Issue 1 Article 4

Published online: 1-18-2017

Problem-Based Learning in Engineering Ethics Courses

Robert Kirkman
Georgia Institute of Technology, robert.kirkman@gatech.edu

IJPBL is Published in Open Access Format through the Generous Support of the Teaching Academy at Purdue University, the School of Education at Indiana University, and the Jeannine Rainbolt College of Education at the University of Oklahoma.

Recommended Citation

Kirkman, R. (2017). Problem-Based Learning in Engineering Ethics Courses. *Interdisciplinary Journal of Problem-Based Learning, 11*(1).
Available at: https://doi.org/10.7771/1541-5015.1610

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.

This is an Open Access journal. This means that it uses a funding model that does not charge readers or their institutions for access. Readers may freely read, download, copy, distribute, print, search, or link to the full texts of articles. This journal is covered under the CC BY-NC-ND license.

The Interdisciplinary Journal of Problem-based Learning

VOICES FROM THE FIELD

Problem-Based Learning in Engineering Ethics Courses

Robert Kirkman (Georgia Institute of Technology)

Abstract

I describe the first stages of a process of design research in which I employ problem-based learning in a course in engineering ethics, which fulfills a requirement for students in engineering degree programs. The aim of the course is to foster development of particular cognitive skills contributing to moral imagination, a capacity to notice, respond to, and think about basic values in open-ended problem situations. In the course, groups of students develop their own problem situations based on their experience and expertise in engineering practice, then respond to those situations through a guided process of inquiry and problem solving designed to focus their attention on basic ethical values. I close with observations on the process of designing the course, laying the groundwork for subsequent formal assessment.

Keywords: ethics, moral imagination, engineering, design research

Introduction

I teach a number of courses in practical ethics at the Georgia Institute of Technology, mainly for students who are pursuing undergraduate degrees in engineering. My focus here is on PHIL 3109 Engineering Ethics, a stand-alone, semester-length course in professional ethics for engineers.

Stand-alone courses in practical ethics typically combine lecture and discussion in ethical theories and principles of practice with discussion of cases in which individuals or communities are faced with especially difficult choices. As taught by philosophers, the objectives of such courses may be decidedly mixed: to introduce students to the philosophical tradition of ethical inquiry through primary texts and to familiarize them with practical principles that apply within a particular domain (e.g., "reasonable care") while at the same time introducing tools for ethical problem solving. In terms of students' moral cognition, the philosophical approach aims toward the development of *moral judgment*, a capacity to appeal to principles and to theoretical frameworks to determine whether a given course of action is ethically justifiable.

Although my training is in philosophy, the context in which I teach and my own work in the assessment of ethics courses (Berry, Levine, Kirkman, Blake, & Drake, 2015; Drake, Griffin, Kirkman, & Swann, 2005) gradually led me to shift my practical ethics courses away from primary sources and an emphasis on moral judgment. Instead, I came gradually to understand my courses as aiming to help students to cultivate what has been termed *moral imagination* (Johnson, 1993; Werhane, 1999).

The key insight behind this emerging understanding is that human moral experience and decision making do not consist in gathering bare facts and applying to them abstract principles in order to arrive at a judgment (see Johnson, 1993). Rather, it consists of a more immediate engagement with problem situations in which we may find ourselves immersed. We strive to make sense of such a situation through various schemas or mental models that direct and focus attention, indicate connections among facts and values, and establish relevance and priorities. A richer moral imagination is one that can draw from a wider array of schemas (Johnson, 1993; Werhane, 1999).

Imagination has a number of functions in shaping moral experience and informing decision making (after Werhane, 1999): directing attention in sizing up particular problem situations, including awareness of the context and the opportunities and constraints it affords; connecting a particular situation to analogous situations and to wider ethical considerations; and fostering creativity in responding to a situation by opening up the possibility of reframing it (regarding which see Weston, 2007).

http://dx.doi.org/10.7771/1541-5015.1610

By spring 2012, I had already shifted toward thinking of my courses in terms of the development of students' moral cognition. I was interested in finding ways to engage students more actively in the development of particular cognitive capacities that contribute to moral imagination. It was in that moment that a colleague introduced me to problem-based learning (PBL). The approach seemed an especially good fit with the aims of my courses, perhaps especially my course in engineering ethics.

As it was introduced to me at the time, a course designed on the PBL model is set up as a "cognitive apprenticeship." Like any apprenticeship, a cognitive apprenticeship aims at "successive approximation of mature practice" (Collins, Brown, & Newman, 1987) through repetition of a guided process of inquiry and problem solving. Since my goal is, in effect, to help students to emerge as mature professionals with a strong sense of their ethical responsibilities, it seemed to me I could do this most effectively by guiding them as they approximate mature practice in grappling with complex, open-ended problem situations in professional ethics.

Now, students do not arrive in my classroom as ethical blank slates: they are already ethical beings in development, already capable—to one degree or another—of ethical awareness, responsiveness, and creativity. The key to designing a PBL experience in practical ethics is to determine how much further students can reach with appropriate assistance in terms of the refinement of their awareness, their motivation to respond, and their capacity to imagine new possibilities. This gap between what students can do already and what they can do with assistance is what Vygotsky (1978) termed "the zone of proximal development" (ZPD).

What has taken me longer to figure out is how best to provide appropriate assistance so students can reach beyond what they currently grasp, that is, how best to provide *scaffolding* for student development (Pea, 2004; Wood, Bruner, & Ross, 1976). As the metaphor implies, scaffolding is an artificial structure that allows students in effect to climb up to a higher level of proficiency in given cognitive skills, perhaps to the high end of their zone of proximal development. Much of the account I have to offer here is of my own, stepwise process of devising, implementing, and, indeed, understanding the need for scaffolding of various kinds.

When I set myself the task of redesigning all my courses in practical ethics on the problem-based learning model, in preparation for the fall 2012 term, I was not able to find many precedents from which to draw inspiration. PBL originated in the MD Program at McMaster University in the 1960s (Neufeld & Barrows, 1974). Since then, it has been adapted for courses and programs in other health professions, as well as in the natural sciences, mathematics, and engineering (Newstetter, 2005). There is a scattering of instances of PBL in other disciplines (Amador, Miles, & Peters, 2006) and in programs in reading and writing (Collins, Brown et al., 1987), but I found only a small handful of examples of PBL in practical ethics for engineers (Chang & Wang, 2011; I. R. van de Poel, Zandvoort, & Brumsen, 2001). There have been a number of projects on the use of PBL in practical ethics at Georgia Tech, one of which has involved course design at the graduate level with a focus on contentious public debates about emerging technologies (Berry, Borenstein, & Butera, 2015).

In taking on this task, I thought I might be embarking on an iterative design process that could serve as a central focus of my professional life for many years. Only gradually did it occur to me that this iterative process amounts to a program of *design research* that might lead me to contribute to the scholarship of teaching and learning (regarding which see Brown, 1992; A. Collins, Joseph, & Bielaczyc, 2004).

The main task of design research in education is simply the design and implementation of pedagogical innovation combined with some sort of assessment. There should be a "progressive refinement" (Collins, Joseph et al., 2004) of the design over time, and assessment may involve both qualitative and quantitative data (Brown, 1992). In my own project, I have not yet advanced to the systematic collection and analysis of data; that is the next step I will take. What I have to offer in the meantime is an account of my design work as it developed through observation of my students, the classroom environment, and my own activity as the instructor of my courses.

Before I move on to describe the context in which I am working, I should say something further about my background and my overall approach to this project. As noted, my degrees are in philosophy, with a specialization in practical ethics. I have been teaching courses in ethics and other areas of philosophy for more than two decades and, while I had attended some workshops and read sporadically in the scholarship of teaching and learning, I launched into designing and implementing a problem-based approach to practical ethics without any formal background in the theory of pedagogy and of instructional design. It could be said that I have taken a problem-based approach to my own learning about how to implement problem-based learning, seeking help and insight from mentors and from the literature as the need for and relevance of particular resources has become clear to me in trying to cope with the open-ended design task at hand.

1. Context and Stakeholders

Georgia Tech has neither a philosophy department nor a degree program in philosophy; philosophy courses are offered by the School of Public Policy. Faculty in the school with PhDs in fields other than philosophy sometimes teach

courses with the philosophy designation (PHIL), and a number of philosophers offer courses in the wider reaches of public policy. As a consequence, the aims of philosophy courses at Georgia Tech are necessarily different from those intended for philosophy majors.

For my part, my main teaching responsibilities are in philosophy. Most of the courses I teach are on a "menu" from which undergraduate students in several large engineering programs must choose one course in order to fulfill an ethics requirement for their degrees. The courses also fulfill a general education requirement in the humanities.

The course on which I am focusing here, PHIL 3109 Engineering Ethics, has some unusual features. Although it is listed at the 3000 level, the course is generally taught as an introduction to practical ethics, as most students who enroll have never before taken a course in philosophy or in ethics. At the same time, because of high demand for courses that fulfill the ethics requirement for engineering degree programs, most students are unable to enroll until their fourth or even fifth year of undergraduate study. While some sections of PHIL 3109 are offered in a large lecture format with 180 or more students, the sections in which I have implemented problem-based learning are capped at 35 students each.

I had the good fortune, after my first semester of using problem-based learning, of teaching in classrooms specially designed for collaborative learning, with furniture that can easily be moved into a wide variety of configurations, whiteboards all around, and even flat-screen display panels built into the walls for use by groups of students.

An important constraint is that resources are not available to provide paid undergraduate or graduate teaching assistants for small sections of the course. Problem-based learning typically involves a number of facilitators to work with and advise student groups (Newstetter, 2005), a role that is perhaps best separated from that of instructor. In my implementation of the design, I have been both instructor and facilitator.

Admission to Georgia Tech is increasingly competitive, and students tend to be quite intelligent, often articulate and capable of critical and analytic thought at a fairly high level, at least in technical matters. By the time they reach my classroom, many of the students have had internship or co-op experience, giving them some practical insight into the complexities of working as a professional. That said, very few of them have prior experience in thinking rigorously and critically about ethical values; ethical theory is unknown to most of them.

2. The Design Process

Like many such processes, the development of my current approach to problem-based learning has not been tidy and linear. I here distinguish a number of elements in the design to which I made frequent adjustments and occasional revisions. I would sometimes change one element on its own, sometimes changes among elements would run in parallel, and sometimes I made higher-level changes in response to tension among the design elements. I have adjusted elements of the design to better fit the stated outcomes of the course (see next section), and I have adjusted the stated outcomes to better fit the constraints of the design and the responses of my students. It has been a messy process but not, I hope, an incoherent one.

I will proceed here by setting out the various threads in the design process separately for consideration, noting points of connection as they arise. Many of these changes were incremental, amounting to little more than tweaks to the design, some of them made while a term was already in progress. I would note that there was one moment, at the end of fall 2014, in which a number of small tensions added up to something of a crisis, spurring a more thorough overhaul of the design for spring 2015.

To begin, though, I offer a brief overview of the current model for the course.

Course Structure and Flow

I divide the term into three roughly equal parts. In the first part, I assign student to working groups, each with five or six members, and have them start working through open-ended problem situations, if only briefly and informally, to help them to get accustomed to the main work of the course. On the first day, for example, I might introduce them to a fictionalized version of a historical case study, putting them in the middle of the situation with an urgent decision to be made; I then instruct them to develop options and to think through the implications of those options in ethical terms. The class discussion at the end of the session helps me to establish a baseline understanding of their ethical development to that point.

As the first part of the term goes on, I have students work together in groups to acquire some of the basic tools of ethical inquiry, including enough ethical theory (from primary and secondary sources) to give greater focus to their consideration of various options. I check in with groups as they work, assess their developing understanding, and conduct whole-class discussions or offer short (10- to 15-minute) lectures to help them to focus on what is most important in the work of a given class session.

By the third week of the term, groups turn to developing problem situations of their own. That is, I have each group write the story of someone in a complex, open-ended situation that calls for a decision. This is a departure from conventional problem-based learning in that I am not selecting and presenting a problem for them. Rather, I am preparing

them to notice and attend to ethically fraught situations they may have encountered in their own prior experience as students: by the time they reach my classroom, many of my students have already worked in laboratories or on design teams on campus, and many of them have had internships or co-op work experiences in engineering. This can give the stories they develop a level of relevance, authenticity, and technical sophistication I would have difficulty matching.

In the first round, problem situations are fairly simple and circumscribed; the messier problems are yet to come. Students have a great deal of leeway in how they organize their in-class work time, but I often check in with them or have them make brief preliminary reports to their classmates about the stories they are developing, encouraging them to look beyond comfortably closed, yes-or-no decisions. Students are generally quite good at introducing a twist or a confounding detail into their stories to make them messier and hence more ethically interesting.

As the basic story of the problem situation takes its final shape, groups turn to analyzing the situation in terms of the opportunities and constraints that bear on the protagonist. Selected readings and discussions about professional roles, organizational culture, and other aspects of the working life of engineers inform this phase of the project. The aim is to keep students' attention focused on the point of view of the protagonist and what the protagonist can and cannot do in responding to the problem situation. I have observed a tendency for my students to offer options in terms of *what should happen*—a general end state with an ethical judgment ("this would be best") built into it—without addressing the much more urgent practical question of *what I should actually do*, step by step, from this very moment.

So, in developing a set of options, I encourage groups and work with them, as needed, to frame them as *possible continuations of the story*, a step-by-step telling of what the protagonist might do. For example, rather than "I should avoid any conflict of interest"—which is already a statement of general principle rather than a course of action—the protagonist might say something like this: "I could send an email to my boss asking politely to set up a meeting to discuss a matter of concern. At that meeting, I would start by saying . . ." and so on.

When each group has settled on three distinct options for consideration, they begin the process of drawing out the ethical implications of each option by identifying concrete, specific instances of basic ethical values.

I should note at this point a further departure from problem-based learning as it is generally understood, which is that I have my students hold back from *solving* the problem, which in this case would involve selecting and defending their own preferred option. I will go into the reasons for this in greater detail below, but suffice it to say now that this is in keeping with the spirit of philosophical inquiry, which aims at considered judgment. I ask students to defer judgment, for purposes of their course work, in order to give them practice in the skills of consideration.

Each group then makes a presentation to the class, introducing the problem situation and the three options they have selected, and facilitating a class discussion of the basic values implicated in each of the options. The assignments specifies that group presentations should take some creative form, and students have responded by performing skits and even producing short, dramatic videos.

After the group presentations, each individual student submits a written exercise, called a *consideration*, based on her or his group's problem situation. I will say more about the consideration exercise below.

The second and third parts of the course begin with a brief introduction to a general kind of problem in engineering ethics (e.g., risk), before groups turn again to developing a plausible, open-ended problem situation in the form of a story. Students proceed through a structured process of inquiry and option-generation, again culminating in a group presentation and an individual written exercise.

I evaluate all presentations and written exercises using a rubric based directly upon the stated learning outcomes for the course. My hope and intention is that students become more competent and more confident in meeting the expectations of the course—and less dependent on the scaffolding I provide for them—as the term goes on.

These, then, are the elements of the course design on which I will focus in my account of its development: the stated *learning outcomes* of the course, the structure and scope of *problem situations*, the way in which I introduce *ethical theories* and *principles*, and the *scaffolding* I provide. The last element, scaffolding, is especially interesting in that my understanding of what scaffolding is and how it works has developed along with my practice as a teacher; it currently includes a *stepwise approach to inquiry*, the very particular structure of the *written assignments* I set for students, and a set of tabular *templates* to guide students as they identify and describe instances of basic ethical values.

In what follows, I will take up each of these elements in turn, giving an account of how and why I revised each into its current form. While I have not yet undertaken a formal assessment of my approach, the design process has been driven by the evidence I could gather by observation and reflection: how well the elements of the design fit the stated outcomes; how well the stated outcomes fit the design; degrees of student engagement and enthusiasm, as well as degrees of student frustration directed at me or at particular design elements; direct feedback from students on their experience in my courses; how many students are able to

meet or exceed the expectations of the course; and how much lecturing and other kinds of direct instruction I find myself doing late in the term, when students should in principle be less dependent on direct instruction.

Learning Outcomes

As already noted, my aim in teaching ethics is to foster particular kinds of cognitive change in my students, encompassed by the notion of *moral imagination*: by the time they leave one of my courses, I hope they may exhibit higher degrees of *awareness*, *responsiveness,* and *creativity* when faced with complex, open-ended problem situations.

When I first started implementing PBL in my courses, though, the learning outcomes as included in my syllabi were still tied to a conventionally philosophical approach to teaching ethics, with an emphasis on understanding theory, making judgments, and offering arguments in support of judgments. One of the drivers in my revision of the learning outcomes, then, was simply the inconsistency between my emerging understanding of moral imagination and its prerequisites, and what appeared in the syllabus. Ethical theory gradually came to take on a different and more modest role, for example, as I will describe below.

At the same time, there was a more serious tension between the stated outcomes and the standards by which I evaluated student work, a tension that was the source of a great deal of confusion and frustration on the part of my students. Addressing that tension required not only a change in the nature of the assignments I set for students—which I will also describe below—but also a clarification of the outcomes of the course and the creation of an evaluation rubric based directly on those outcomes (see Table 1, next page).

The current evaluation rubric takes the three main headings and the three auxiliary outcomes as its criteria: *contextual awareness*, *critical consideration,* and *theoretical understanding* have more weight in the evaluation of student work (x2) than do *creativity*, *communication,* and *collaboration*. The rubric is arranged as a table (see Appendix A), with criteria down the side and columns representing various degrees of quality of work, on a 5-point scale; cells in the table include a detailed description of work that exceeds expectations, meets expectations, approaches expectations, and so on.

Ethical Theories and Principles

As indicated above, among the goals of more conventional courses in practical ethics is to introduce students to historical texts in moral theory and to train them in the skills of navigating and responding to those sources as would an academic philosopher. The philosophical mode of ethical inquiry involves critical debate about the terms of ethical theories themselves, attempting, for example, to establish that one theory is more adequate than another by some measure.

My own implementation began with a rejection of this goal for my own courses, as what my students need is to be able to notice and respond to ethical values as they arise in particular situations in their professional and personal lives. In that context, ethical theories are best introduced as models or as heuristics. Each theory focuses attention on particular kinds of values while downplaying or ignoring others; each theory also frames questions of the meaning of human life in the world, the character of rationality, the highest good, and so on, in different terms. Taking up a number of distinct heuristics and playing them off one another can bring to light a much richer array of value considerations, fostering a richer and livelier moral imagination.

Secondary sources, perhaps with brief excerpts from original texts, have proven most useful for introducing students to moral theories as heuristics. Anthony Weston's *A 21st Century Ethical Toolbox* (2012) has been most consistently on the mark for this purpose. In standard courses on ethics grounded in the philosophical tradition, three such frameworks may be on offer: utilitarianism, the ethics of duty (or of respect for persons), and virtue ethics. I usually introduce these to students in terms of the varieties of basic values on which they focus (following Weston, 2012, pp. 85–90): utility values (or *instances of the good*), autonomy values (or *instances of the right*), and virtues, respectively.

In addition to ethical theories, there are in practical ethics various mid-level principles that may be of use in further refining students' focus on basic values in that context. I provide students with excerpts from works related to engineering ethics regarding principles such as *reasonable care* (Harris, Pritchard, & Rabins, 2009), *acceptable risk* (van de Poel & Royakkers, 2011), and even the basic idea of a *profession* (Greenwood, 1957). The codes of ethics of professional organizations (e.g., National Society of Professional Engineers, 2007) serve as compendia of such mid-level principles though, I insist to my students, those principles are always to be connected to more basic values with the help of one or another theoretical lens.

Problem Situations

Much hinges on the character of the problems on which students are to work. To serve the purpose, a problem should be "complex, ill-structured, and open-ended," as well as "realistic" (Hmelo-Silver, 2004); "authentic" (Belland, Kim, & Hannafin, 2013; Newstetter, 2005); and presented in a format that allows for "free inquiry" (Barrows, 1986). For practical ethics in particular, especially in an engineering context, ethical problems follow design problems in being "multiply constrained" and "dynamic" (Whitbeck, 2011).

In engineering ethics, *problem situations* differ from *case studies* in a number of ways. Case studies typically concern

Table 1. Comparison of learning outcomes for PHIL 3109, 2012–2015.

Fall 2012	**Fall 2015**
By the time you finish a course fulfilling the ethics requirement, you should be able to: • identify and analyze the ethical aspects of particular problem situations; • describe and explain how each problem situation would look from various points of view, with a full and fair-minded understanding of how each point of view makes sense on its own terms; • describe and explain how ethical frameworks have bearing on each problem situation including, at least, virtue ethics, consequentialism, and the ethics of respect for persons; • effectively collaborate with others in analyzing problem situations and devising creative solutions; and • offer concise, coherent and fair-minded support for proposed solutions to problem situations.	***Contextual Awareness*** By the end of the term, you should be better able to • choose an appropriate scale for framing a problem situation and its implications; • identify plausible opportunities for and constraints on choice and action within the situation; and • connect opportunities and constraints to wider systems and institutions on which they are conditioned. ***Critical Consideration*** By the end of the term, you should be better able to • identify concrete instances of basic ethical values that are in play in a problem situation; and • identify concrete instances of basic ethical values implicated in particular options for action within a problem situation, including values that tell for and against each option. ***Theoretical Understanding*** By the end of the term, you should be better able to • organize and connect concrete instances of basic values by appropriate use of theoretical frameworks; • use appropriate terminology for each theoretical framework; • draw appropriate connections among concepts within theoretical frameworks; and • manage the connections among concepts between frameworks. ***Three Auxiliary Outcomes*** By the end of the term, you should be better able to: • generate a variety of distinct, practicable options for responding to a problem situation, which includes reframing the situation (Creativity); • organize written work for ease of understanding, using clear and precise language that is accessible to a general audience (Communication); • collaborate effectively with others (Collaboration).

events that have already happened, inviting only a kind of forensic examination (see Harris Jr., 2008), while problem situations start in the middle of things with an orientation toward the future.

Many case studies are presented as third-person reports from a detached point of view, while problem situations take the form of a second-person narrative calling for a first-person response. The idea is for students to imagine themselves into a situation and to respond to it as though they are living through it from within a particular role with a particular point of view, including all the uncertainty and all the feeling that comes along with it.

While the response to a case study is often judgment and blame, the response to a problem situation is to create several versions of how the story might continue from this point and to think through the implications of each option in terms of basic values.

Here, for example, is a problem situation I created for use in an earlier iteration of the course as part of a take-home "practical exam":

You are in your last semester of a graduate program in mechanical engineering, hard at work on the final research project required for the degree you are pursuing.

Most of the data strongly support your conclusions as well as prior conclusions developed by others. However, some of the data are not fully consistent with your conclusion.

At first, convinced of the soundness of the report and concerned that inclusion of the variant data would detract from and distort your conclusions, you decide to omit the outlying data points from the analysis. You produce a draft report on the basis of that analysis, and submit it to your adviser, Dr. Elaine Baldwin, for comments.

You begin to have second thoughts about omitting the data, but decide to keep them to yourself.

After two weeks, you have not yet heard back from Dr. Baldwin about your report, so you send her a quick email to request a meeting.

In reply, she forwards you an email from the editor of a prominent journal in your field acknowledging submission of the manuscript of an article on which you are listed as lead author, with Dr. Baldwin as second author. The editor expresses lively interest in the manuscript and promises a decision within a few months.

You have never submitted a manuscript to this particular journal but, from the title of the article in question, it seems clear what has happened: Dr. Baldwin took material from your draft report and worked it into publishable form.

You are aware that Dr. Baldwin, currently an associate professor, will soon be going up for promotion to full professor, and so may be feeling some pressure to publish.

What should you do?

In my instructions to the students, I specified that they should take up the story from the point at which they receive the email from Dr. Baldwin: if you are sitting at your computer, reading her email, what is the *very next thing* you should do?

One significant change in the spring 2015 overhaul of the design was in having students develop their own problem situations, either as hypothetical situations they might encounter as professionals or as adapted or fictionalized versions of real-world problems. My thought was that I could make the course more engaging by giving students a chance to exercise creativity and by giving them some investment in the problem to which they would be devoting time and effort. More than this, writing their own problem situations allows students to draw from their own experience as engineers in training, whether in the context of their studies or in their work in industry as interns or co-ops. In general, my students have brought greater technical and contextual sophistication to the problem situations they develop than I could bring to it, with my background and experience as an academic philosopher.

I typically provide some sort of focus for the problem situations. In a given part of the course, for example, I might ask the students to develop a problem focused on data management, or on risk to public health and safety, or on the complexities of working within organizations. I also provide numerous examples of each kind of problem situation as models after which students can pattern their own stories.

Scaffolding: The Procedure

The first form of scaffolding I employed in my own courses was to break the process of understanding and responding to a problem situation into discrete steps, each with explicit instructions and products. For each unit of the course, the sequence of activities is the same: (1) frame the problem; (2) bring ethical theory to bear on the problem; (3) develop options; and (4) consider each option by drawing out its ethical implications as revealed by theory. Note that this kind of scaffolding is especially artificial in that it forces into a linear sequence processes that, in the full richness of human experience, are entangled and iterative.

By the second year of my implementation of PBL, I had refined this sequence into a "problem guide," a detailed document that sets out objectives, guiding questions, resources, and assignments to be handed in for each class session. Here, for example, is the timetable that appears at the top of a problem guide from fall 2014:

10/7	Session 1	Framing	group fragment
10/9	Session 2	Theory	group and *individual* fragments
10/16	Session 3	Options	group fragment
10/21	Session 4	Consideration	group and *individual* fragments
10/23	Session 5	Iteration and Composition	group fragment
10/28	Session 6	Peer Evaluation and Class Reflection	***group consideration***

The timetable would be followed by the problem situation itself, presented as a story, then by instructions for each class session. Here are the instructions from Session 1:

Session 1: Framing—group fragment (in class)

What to do:

- Your aim is to start making sense of the problem situation in its broader context.
- Establish a system for keeping a collective record of the work you do as a group in making sense of and responding to the problem situation, as a reference for the final Group Consideration.
- The problem situation is presented as a fragment of a story in progress. Read the story carefully and talk about who is involved in it and what is at stake for them and at what scale you might best make sense of the story. Fill in what you can of the backstory and the broader context of the problem situation described, making note of any questions of fact or value that remain unanswered or unanswerable.
- Play with alternate ways of telling the story, to see if it might mean something different and have different stakes for different people if it is told from other points of view, at a different scale, or on the basis of different values or assumptions.
- List the opportunities for and constraints on choice and action for the protagonist(s) of the story and connect those opportunities and constraints to the wider context of the story.
- Formulate research questions and use resources available to you in class and outside of class to follow up on those questions, keeping careful notes of questions, division of labor, and sources consulted, with complete documentation.

What to hand in:

- Group fragment (*contextual awareness*): At the end of class, submit (in hard copy) a group fragment consisting of (1) a brief summary of the choice or choices that present themselves to the protagonist(s) of the story, and (2) a description of the opportunities for and constraints upon choice and action on the part of the protagonist(s). This will be assessed using the *contextual awareness* criterion on the evaluation rubric. **Note:** the fragment must include the names of all and only those members of the group who participated in producing it.

One important function of scaffolding is to limit the degrees of freedom students have in carrying out particular tasks (Wood et al., 1976). By the end of the fall 2014 term I had come to the conclusion—based on my own experience and on observation of my students—that this particular form of scaffolding was far too limiting. The procedure left no time or space for free inquiry, or to pause and talk about something of interest, or even to slow down and go back to something with which students were struggling. By the end of the term, the course had begun to feel like a forced march.

One important feature of scaffolding is that, in the best case, it should *fade* as learning proceeds (Belland, 2011; A. Collins, Brown et al., 1987). As I implemented this procedural form of scaffolding, there was also little possibility of letting the scaffolding fade as the term went on because, by design, each step in the procedure was tied to a written assignment, and the gradebook required a certain number and sequence of inputs.

Another part of the spring 2015 overhaul of the course, then, was to drop the "problem guide" approach, at least as a detailed and prescriptive document. Instead, as groups of students in more recent versions of the course develop their own problem situations, I introduce and model the sequence of steps they should take and provide more detailed scaffolding for some of those steps (see below), but leave them far more latitude in how they approach the problem so long as the final product of their work meets the criteria set out in the rubric.

Scaffolding: Written Assignments

With this shift away from a strict procedural scaffolding, a second form of scaffolding came into its own in my design: an unusual form of written assignment I had developed for fall 2013. Called a *consideration*, the assignment is designed to focus students' attention on the concrete instances of basic values that follow from one or another response to an open-ended problem situation. As of spring 2016, I describe an individual consideration assignment as follows:

> An ***individual consideration*** is an ethical investigation of a practical problem situation, including (1) a thorough analysis of the situation to identify practical questions about which there might be disagreement as well as issues of philosophical salience; (2) two or more practical options for responding to the situation; and (3) a thorough, even-handed, critical consideration of each option that makes use of several distinct philosophical perspectives (as specified). Each *individual consideration* will start with the problem situation and *one* of the options from the *group presentation*; each student

> will carry out an independent analysis of the situation and one of the options presented by the group *as well as* an additional option of her or his own devising. The work submitted should take the form of paragraphs consisting of complete sentences, but it can remain open-ended and, in a sense, unfinished. In fact, a consideration should not reach any conclusions or include any arguments for one "side" or another; there may be indications of further areas of inquiry that are still open.

One of the keys to the consideration assignment is a blanket ban on conclusions and summary judgments, not only in the assignment but in the entire course. Some version of the following has appeared in the syllabus of every course I have taught since fall 2013:

> **NOTE:** The focus of the course is on imagining and grappling with complex problem situations and critical consideration of possible options for responding to such situations. You will not be asked to *solve* a given problem, nor will you be asked to offer a *defense* of any one option over any other. For the purposes of this course, *your opinion* on any matter of practice, of policy, or of principle *is irrelevant*; in all fairness, however, *the instructor's opinion* is likewise irrelevant. You may come to your own conclusions on your own time.

Both the rationale for this kind of assignment and the name I have given it derive from the very old idea that philosophy aims to move us from *opinion* to *considered judgment*. As soon as people are asked to offer their considered judgment, though, the tendency seems to be to rush to judgment and cast consideration off to the side. What I have done, then, is to turn things around so that every aspect of the course is based on the *process* of consideration itself, a kind of focus that may be easier to achieve if judgment is kept out of the way. In this respect, the consideration exercise serves two of the basic functions of scaffolding, in that it limits degrees of freedom and so directs students' "critical features" of the task at hand (Wood et al., 1976).

What has surprised me most about assigning considerations is how resilient student expectations can be regarding written work: in spite of what I thought at first to be adequate instruction, guidance, and modeling, students seemed drawn as if by a force of nature back to the formulas of essays and reports, complete with unconsidered summary judgments (e.g., "This option is obviously just wrong"). Observing this tendency has led me to clarify the expectations of the assignment, drawing a clear and explicit contrast between a consideration and an essay, and even going so far as to provide a specific format for setting out options and instances of basic ethical values.

One concern I have about the consideration assignment is that, like the procedural scaffolding discussed above, it is locked in: the syllabus, the rubric, and the gradebook all require written exercises in this one particular form. This does not leave much room for student creativity or for the possibility of having this particular form of scaffolding fade as the semester proceeds.

Scaffolding: Values Templates

One of the most daunting challenges students encounter in the work of the course is in identifying, distinguishing, and describing instances of basic values, drawing from the theoretical frameworks derived from the philosophical tradition. This is in part a matter of mastering the vocabulary of each framework: utility values should be described in terms of cause and effect, benefit and harm, for example, while autonomy values should be described in terms of intentions and attitudes, consent and reciprocity. It is also in part of matter of finding those values in concrete forms, for example, that such-and-such a person may be made better off in such-and-such a way.

To help them along, I have more recently developed a third, finer-grained kind of scaffolding: templates in tabular form for each of the theoretical frameworks or heuristics I provide to students. I post the templates as Excel documents, though they can easily be offered in paper form or as the basis for a "structured whiteboard" that can serve as the focus for collaborative inquiry (Hmelo-Silver, 2004; Newstetter, 2005).

The templates serve to draw students' attention to instances of basic value as they are carrying out the step of considering the implications of options. Here are two model templates I recently provided for my students (see Figures 1 and 2, next two pages), drawn from a fictional problem situation in which a group designing facilities for children with various mental health diagnoses is discussing the terms they should use in describing the end users of their design after one member of the group used a disparaging term in referring to them.

With this finer-grained scaffolding, the overall order in which students approach a problem becomes less crucial, allowing for more flexibility and responsiveness in the use of class time. This form of scaffolding may also be allowed to fade over time, as students become more adept at identifying and distinguishing kinds of basic ethical values and using the vocabulary appropriate to each.

3. Interpretation

As I noted at the outset, I do not yet have rigorous empirical evidence that my design achieves its goals in fostering the development of students' moral cognition. My purpose here has mainly been to offer an account of the design process, up

to now, as a basis for subsequent research. That said, I can at least offer some initial observations from my own experience, as limited and as prone to confirmation bias as those observations might be.

In presenting a first sketch of an assessment of my design work, I will loosely follow the model established by A. Collins, Joseph et al. (2004) for reporting the outcomes of design research in terms of three sets of dependent variables (which are italicized in the text below). Again, I have only my own perceptions and reflections to offer at this point, but I hope these observations may be the basis for more rigorous assessments to come.

Climate Variables

The most striking change for me, from the first days of the fall 2012 term, was a sharp increase in the degree and intensity

Option: Refer to the residents as "children" or as "children with mental health diagnoses" all the time, when working together and when presenting to clients.

Specify a particular individual or group affected by the decision.	In what particular way would they be affected? What particular *state* would be changed as a consequence of the option (e.g., health, pleasure, well-being, etc.)?	By what chain of cause and effect would the option lead to this change of state? Note where complex systems may be involved, and where effects are probabilistic or uncertain.	Is the effect positive or negative?	Summarize this instance of value or disvalue in a single, complete sentence.
Current residents	Thriving as human beings, development; mental health	If we think of and act toward them as people, current residents may respond by becoming more confident, which could contribute directly to improved mental health.	Positive	If, in our words and our behavior, we show we are interested in what the children think and what makes them happy, they may become more confident. This in turn could contribute to improved mental health and toward their growth toward adulthood.
Future residents	Happiness and fun; mental health	If we think of and act toward them as people, current residents may be more open with us, feeding new ideas into the design process; this increases the odds of a successful design that can be more fun and more helpful for future residents.	Positive	It could be that the residents will open up to us with lots of good ideas – or even interesting bad ideas! – for us to incorporate into our design process. This could contribute to the success of our design process, which in turn contributes to the happiness of future residents who can take advantage of a better designed play space.
Current and future residents	Mental health; fun and reduction of stress	We adopt the same language the staff uses, which reduces friction and misunderstanding; with better communication, our design process is more responsive to the staff and the residents, possibly leading to a design that works better for the residents.	Positive	The staff at the facility use the language of "mental-health diagnoses" so, by adopting the same language, we could be reducing possible misunderstanding or friction between us and them. With better communication, we could make more informed design decisions, which in the end could make the children themselves better off in that they would have more opportunities to have fun and relieve stress; this could in turn contribute to improved mental health.
The design team	Cognitive load (opportunity cost)	By having to monitor our own language and thoughts, we use up time and attention that could be spent on other aspects of the design problem.	Negative	On the other hand, continually reminding ourselves to monitor our language, to use "children" and "children with mental health diagnoses" would be one more thing the team has to think about, an additional load on our minds as we work through a problem that is complicated enough as it is!

Figure 1. Template for identifying utility values.

Option: Refer to the residents as "children" or as "children with mental health diagnoses" all the time, when working together and when presenting to clients.

Specify a particular individual or group affected by the decision.	To what degree does the decision-making process take into account their autonomy? (positive, negative, neutral)	In what particular way does the decision-making process respect or disrespect their autonomy? (consent, equity, reciprocity, etc.)	Summarize this instance of value or disvalue in a single, complete sentence.
The children	Positive	Referring to them as children may keep or focus on their dignity as persons, even if they are persons in development who are facing particular challenges just now	If we consistently refer to them in more plainly human terms (i.e., as "children"), and if we refer to the reason they are at the facility by using neutral, medical language (i.e., "mental health diagnoses"), we may keep in mind that they really are people, that they really matter, regardless of what challenges they may now be facing.
The children	Negative	Referring to them as children could lead us to think of them as *not yet autonomous*	Thinking of them all as "children" may keep us focused on their immaturity, the fact that they are not yet fully able to make decisions on their own behalf. This could lead us too easily to look down on them, to assume that they are incapable of having ideas and arguments on their own behalf.

Figure 2. Template for identifying autonomy values.

of student *engagement* over what I had seen in the years just prior, at least in that more students have shown up to class and a larger proportion of them have been actively engaged in the work. Much of this change may have been due to expectations within working groups—peer pressure can be a powerful motivator—and the relative ease and safety of speaking within a small group of peers rather than speaking to the whole class.

I did also start to note a period in the middle of any given term during which stress, disengagement, and even anger became more prevalent, especially before the revisions of spring 2015. During that period, students were more likely to object to or express frustration at various aspects of the course, and a general atmosphere of sourness pervaded the classroom. Grade anxiety may have played a part in this, but also a degree of confusion over course expectations and over the requirements of particular assignments. There may also have been some frustration with me as instructor and facilitator.

For the most part, classes found their way out of the doldrums by about the two-thirds point of the term. After that point, most students would begin to show more confidence in their understanding of what was expected and their ability to meet expectations.

Regarding *cooperation,* students seem to realize very quickly that, in my classroom, they are not in competition with one another, and they treat one another accordingly. This may be most evident when students work across groups. In the first part of practical exams, in earlier iterations of the course, students would often move from group to group, swapping ideas and insights. In the new version of the course, when a group is facilitating a discussion as part of their presentation, the other students are generally attentive and active in picking over the presenters' options for connections with basic values.

It is more difficult to say much about *risk taking,* at this point but, in the new version of the course, students do seem to throw themselves into creative presentation of their problem situations, even acting out scenes that may be awkward or uncomfortable. This differs from past courses in which students seemed only to toe the line on assignments, and presentations to the class could be awkward and perfunctory exercises. One group in the spring 2015 version of the course ventured beyond the bounds of the assignment as given to take on a wider issue in the role of technology in human life.

I also have little to say about *control,* save for the fact that the Spring 2015 revision shifted much more control to students, relying on the assignments and the finer-grained scaffolding to help students maintain their focus. It is a fearful thing for academic faculty to give over so much control to students. At this moment it seems worthwhile, and it seems to have made my classes more enjoyable for all involved, but I lack rigorous evidence regarding its impact on learning.

Learning Variables

The main *content knowledge* of the course is a working knowledge of ethical theory, which I take as being able to use the language of a theory to identify and connect instances of basic values. This involves just enough of a grasp of the content of the theory for the language to be meaningful for students.

This, frankly, has been the most elusive goal of my design, the criterion on the rubric on which students consistently receive the lowest scores even at the end of the term. The most recent overhaul was meant to address this problem, and it seems promising but, again, I have only anecdotes. My hope at this points rests in the more refined scaffolding I have been developing.

Much the same goes for the more general *skills* I seek to foster in my students. I do see promising signs of students getting the hang of the process of consideration, including identification of concrete instances of basic values and of generating options, but I do not see these signs as consistently as I would like.

And, yet again, the same regarding *dispositions.* I have only the hope, based on observation and anecdote, that students leave my classroom at least slightly more inclined to notice and respond to moral values in practical contexts—or at least to notice ethical problems when they arise.

The most hopeful anecdotes I have to offer are the instances when students have told me or written to me that the work of my course has changed the way they think, or even the way they perceive situations they encounter in various contexts: at work, listening to the news, interacting with friends, and so on. They report noticing the relevance of moral values to such situations, at least enough to prompt them to ask questions. One student even blamed me—jokingly, I hope—for having "ruined" things by making it impossible *not* to attend to values in such situations!

Systemic Variables

Regarding *sustainability,* one advantage to an approach to PBL that does not rely on facilitators is that it does not incur extra institutional costs and commitments; on the face of it, this seems to suggest the approach might be more easily sustainable over time. It does, however, require the time and energy and attention of the instructor who is also at the same time acting as facilitator; there is even some cognitive load involved in trying to play both roles at once. So far, I have been happy to cover that cost, and I suppose I will remain willing to do so for quite a number of years. Given my own history of teaching through lecture and discussion, the facilitator role did not come easily to me at first; I am finding my skill and judgment in that regard has been improving, at least in that I more readily perceive when and how I should sit down with a group and ask questions and when I should leave them alone.

I cannot speak to the sustainability of the model beyond that scale, other than to suggest that as so much of the course is driven by the basic design, there is a degree to which it might become self-sustaining once materials and scaffolding are in place.

I do not know the degree to which my design work has *spread* and been taken up by others. I have posted elements of the design online (Kirkman, 2015), discussed my approach with a number of colleagues, and presented on PBL at conferences and in workshops. Because I am an instructor working in a context that gives a great deal of autonomy to individual instructors, I do not have much control over whether or when others here take up and use my design work. As for myself, though, the approach has also made its way into the courses I teach in other areas of practical ethics, especially environmental ethics, and I have been working to adapt it to more theory-heavy courses like political philosophy.

As for *ease of adoption,* I have designed the course to be adaptable and portable across contexts. Switching to PBL necessarily involves some up-front investment of time, attention, and energy, and it requires a willingness to take risks. But, just as I benefited from the experience and insight of colleagues who had ventured into PBL before me, I hope this record of my process might ease the way for others committed to teaching and learning in practical ethics to try out PBL for themselves.

References

Amador, J. A., Miles, L., & Peters, C. B. (2006). *The practice of problem-based learning: A guide to implementing PBL in the college classroom*. Bolton, MA: Anker.

Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education, 20*, 481–486.

Belland, B. (2011). Distributed cognition as a lens to understand the effects of scaffolds: The role of transfer of responsibility. *Educational Psychology Review, 23*(4), 577–600. http://dx.doi.org/10.1007/s10648-011-9176-5

Belland, B. R., Kim, C., & Hannafin, M. J. (2013). A framework for designing scaffolds that improve motivation and cognition. *Educational Psychologist, 48*(4), 243–270. http://dx.doi.org/10.1080/00461520.2013.838920

Berry, R., Borenstein, J., & Butera, R. (2015). Contentious problems in bioscience and biotechnology: A pilot study of an approach to ethics education. *Science & Engineering Ethics, 19*(2), 653–668.

Berry, R. M., Levine, A. D., Kirkman, R., Blake, L. P., & Drake, M. (2015). Navigating bioethical waters: Two pilot projects in problem-based learning for future bioscience and biotechnology professionals. *Science and Engineering Ethics*, 1–19.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the Learning Sciences, 2*(2), 141.

Chang, P.-F., & Wang, D.-C. (2011). Cultivating engineering ethics and critical thinking: A systematic and cross-cultural education approach using problem-based learning. *European Journal of Engineering Education, 36*(4), 377–390.

Collins, A., Brown, J. S., & Newman, S. E. (1987). *Cognitive apprenticeship: Teaching the craft of reading, writing and mathematics*. Champaign, IL: Center for the Study of Reading.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *Journal of the Learning Sciences, 13*(1), 15–42.

Drake, M., Griffin, P., Kirkman, R., & Swann, J. (2005). Engineering ethical curricula: Assessment and comparison of two approaches. *Journal of Engineering Education, 94*, 223–231.

Greenwood, E. (1957). Attributes of a profession. *Social Work, 2*(3), 45–55.

Harris, J., Charles E., Pritchard, M. S., & Rabins, M. J. (2009). *Engineering ethics: Concepts and cases* (4th ed.). Belmont, CA: Wadsworth.

Harris Jr., C. E. (2008). The good engineer: Giving virtue its due in engineering ethics. *Science & Engineering Ethics, 14*(2), 153–164.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235–266.

Johnson, M. (1993). *Moral imagination: Implications of cognitive science for ethics*. Chicago, IL: University of Chicago Press.

Kirkman, R. (2015). How I teach. *Field notes of a practical ethicist*. Retrieved from http://ethicsafield.com/how-i-teach/

National Society of Professional Engineers. (2007). *Code of ethics for engineers*. Retrieved from Alexandria, VA: http://www.nspe.org/sites/default/files/resources/pdfs/Ethics/CodeofEthics/Code-2007-July.pdf

Neufeld, V. R., & Barrows, H. S. (1974). The McMaster philosophy. *Journal of Medical Education, 49*, 1040–1050.

Newstetter, W. C. (2005). Designing cognitive apprenticeships for biomedical engineering. *Journal of Engineering Education, 94*, 207–213.

Pea, R. D. (2004). The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity. *Journal of the Learning Sciences, 13*(3), 423–451.

van de Poel, I., & Royakkers, L. r. M. M. (2011). *Ethics, technology, and engineering: An introduction*. Malden, MA: Wiley-Blackwell.

van de Poel, I. R., Zandvoort, H., & Brumsen, M. (2001). Ethics and engineering courses at Delft University of Technology: Contents, educational setup and experiences. *Science and Engineering Ethics, 7*(2), 267–282.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, v. John-Steiner, S. Scribner, & E. Souberman Eds.). Cambridge: Harvard University Press.

Werhane, P. H. (1999). *Moral imagination and management decision-making*. New York: Oxford University Press.

Weston, A. (2007). *Creative problem solving in ethics*. Oxford: Oxford University Press.

Weston, A. (2012). *A 21st century ethical toolbox* (3rd ed.). Oxford: Oxford University Press.

Whitbeck, C. (2011). *Ethics in engineering practice and research* (2nd ed.). Cambridge: Cambridge University Press.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem-solving. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 17*(2), 89–100. http://dx.doi.org/10.1111/1469-7610.ep11903728

Robert Kirkman received his PhD in Philosophy from Stony Brook University in 1995, with a specialization in environmental ethics. He is the author of *Skeptical Environmentalism: The Limits of Philosophy and Science* (Indiana 2010) and *The Ethics of Metropolitan Growth: The Future of Our Built Environment* (2010), as well as numerous articles in environmental ethics and ethics education. He is Associate Professor in the School of Public Policy at the Georgia Institute of Technology and Director of the Center for Ethics and Technology.