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PROBLEM-BASED LEARNING FOR PROFESSIONALISM AND ETHICS TRAINING OF BIOMEDICAL GRADUATE STUDENTS: PROCESS EVALUATION

Nancy L. Jones, Ph.D.^a, Ann M. Peiffer, Ph.D.^b, Ann Lambros, Ph.D.^c, J. Charles Eldridge, Ph.D.^d, and ACEP*

^aDr. Jones is a Planning and Evaluation Specialist, LTS Contractor, at the National Institute of Allergy and Infectious Diseases, NIH, Adjunct Associate Professor of Public Health Sciences, Wake Forest University Health Sciences and Adjunct Professor of Bioethics at Trinity International University.

^bDr. Peiffer is a Postdoctoral Research Fellow in the Department of Radiology, Wake Forest University Health Sciences.

^cDr. Lambros is Assistant Dean for Education and Director of the Center of Excellence for Research, Teaching and Learning, Wake Forest University Health Sciences.

^dDr. Eldridge is Professor of Physiology and Pharmacology, Wake Forest University Health Sciences.

Abstract

Purpose—A process evaluation was conducted to assess whether the newly developed Problem-Based Learning (PBL) curriculum designed to teach professionalism and ethics to biomedical graduate students was achieving its objectives. The curriculum was chosen to present realistic cases and issues in the practice of science, to promote skill development and to acculturate students to professional norms of science.

Method—The perception to which the objectives for the curriculum and courses were being reached was assessed using 5-step Likert-scaled questions, open-ended questions and interviews of students and facilitators.

Results—Process evaluation indicated that both facilitators and students perceived course objectives were being met. For example, active learning was preferred over lectures; both faculty and students perceived that the curriculum increased their understanding of norms, role obligations, and responsibilities of professional scientists; their ability to identify ethical situations was increased; skills in moral reasoning and effective group work were developed.

Conclusions—Information gathered was used to improve course implementation and instructional material. For example, a negative perception as an “ethics” course was addressed by redesigning case debriefing activities that reinforced learning objectives and important skills. Cases were refined to be more engaging and relevant for students, and facilitators were given more specific training and resources for each case. The PBL small group strategy can stimulate an environment more aware of ethical implications of science and increase socialization and open communication about professional behavior.

Corresponding Author: J. Charles Eldridge, Ph.D., Department of Physiology and Pharmacology, Wake Forest University Health Sciences, Winston-Salem, NC 27157-1083 Telephone = 336-716-8570 Fax = 336-716-8501 eldridge@wfubmc.edu.
 *Advisory Committee for Ethics and Professionalism at Wake Forest University

Training in the responsible conduct of research (RCR) is endorsed as a means for ensuring scientific integrity and public trust, but there is scarce evaluation of RCR curricula to show whether the courses meet their intended goals. Assessment aligning to the training goals of increasing knowledge, gaining skills in ethical decision-making, developing a positive attitude about RCR and increasing frequency of discussions outside the classroom have showed a statistically significant improvement in increasing knowledge¹. Further, there has been variable success with increasing moral-reasoning skills²⁻⁵. According to a nation-wide survey of early- and mid-career NIH funded researchers⁶, mentoring and RCR training have had mixed success, and in some cases were counter-productive, for reducing questionable research practices.

At Wake Forest University a problem-based learning (PBL) format was developed and implemented to provide a professionalism and ethics curriculum for biomedical graduate students. The PBL format was chosen because of its active, rather than passive, learner-centered approach with problems relevant for scientific practice⁷⁻⁹. We proposed that the format could be adapted to promote skill development such as recognizing ethical issues in the practice of science, developing sound moral reasoning, developing effective group work and self-directed learning and increasing students' ability to articulate, defend and critique one's professional decisions. Other goals of the curriculum were to acculturate students into a professional identity steeped in the norms, principles, virtues and obligations of scientists, with a clear understanding of the practice and nature of science (Table 1 and companion paper). A process evaluation was conducted to examine whether curricular objectives were being met and to identify areas for improvement.

Methods

Beginning in the Fall of 2005, the authors and the Advisory Committee for Ethics and Professionalism (ACEP) began designing a PBL curriculum to teach ethics and professionalism to biomedical graduate students. Four 1-semester courses were developed: GRAD 713&714 *Scientific Professionalism: Scientific Integrity* (1st year) and GRAD 715&716 *Scientific Professionalism: Bioethics and Social Responsibility* (2nd year; see companion paper). Beginning with the Fall semester of 2006, entering graduate students from 11 Ph.D. and 1 M.S. programs at Wake Forest University Health Sciences were enrolled in the mandatory curriculum. Present findings are from graduate students who entered in the Fall of 2006, 2007 and 2008, taking the courses ending in Spring of 2009.

Feedback was collected anonymously at the end of each semester course from facilitators and students using 10-13 five-step Likert scaled questions and 3-4 open-ended questions (Appendix 1). Group interviews of 2 to 8 students and facilitators probed for additional information on the open-ended questions, and were conducted at the end of each course.

Results

Did the curriculum achieve its goals?

Both facilitators and students agreed that the objectives of the PBL curriculum were being met. The greatest agreement occurred in three areas (Table 2). One, active learning was preferred over lectures. Two, the curriculum increased students' understanding of norms, role obligations, and responsibilities of personnel, e.g. faculty, principal investigators (PI), postdoctoral fellows, and laboratory technicians. Third, students increased their knowledge of expectations, responsibilities and rights as graduate students. After participation in the entire two-year curriculum, students continued to agree most strongly with these three areas. Focus groups and open question responses of facilitators and students supported the

sentiment, that “[t]he overall format is good, the facilitated discussions are much better than lecture,” (Student in GRAD 713, 2006).

Students also agreed, though less strongly, that case discussions enhanced their understanding of dealing with difficult situations, increased their knowledge of norms and expectations for science practice, and helped improve their skills for working effectively in groups. “It opened my eyes to the variety of potential issues that may arise within a lab environment, which places me in a better position to know how to deal with them if they occur,” (Student in GRAD 714, 2008). Most, but not all, agreed somewhat that hearing viewpoints of their peers influenced their consideration of these topics. “I appreciated the group composed of students from different programs. This encouraged (forced) interaction and meeting new people outside of one’s own program, but more importantly facilitated different viewpoints on each issue,” (Student in GRAD 714, 2009).

Less consensus was achieved in whether case discussion improved students’ ability to explain and support their positions. Many, particularly domestic students, felt they already had these important skills. “Perhaps [the course made it] more likely to think of other issues, but my ability for discussion is the same,” (Student in GRAD 714, 2009). The least agreement was whether intersession assignments helped students learn about locating credible resources or preparing for in depth discussion during the second session. Nonetheless, there was at least some agreement that the PBL design was achieving these intended goals.

Critique of the Curriculum Implementation

Process evaluation revealed several key areas for improvement in curriculum implementation (Table 3). First, orientation sessions for our initial class (2006) did not prepare students adequately to participate in PBL experiences with a clear sense of purpose. Some resistance to PBL method was anticipated, especially for students who were very comfortable learning through a didactic lecture format. However, as one faculty member stated, “the students were not given guidance on how to function as a team. [The o]rientation session needs to be more “structured,” (Faculty in GRAD 713, 2006). Students also expressed a lack of understanding for the curricular goals: “It was too open-ended. There wasn’t anything we felt we were working for. People just spoke their opinions and we tried to reach a consensus, but there wasn’t a clear goal for what we were trying to accomplish,” (Student in GRAD 713, 2006). The facilitators also asked for more training on expectations of the curriculum, group process, and moral reflection embedded in the cases.

Another major misconception was what an “ethics” course should be. “The cases didn’t really deal with ethics and the “solutions” to the cases were painfully obvious. They were more concerned with human interaction issues in research environments. If part of the goal of this semester was to introduce students to issues that may be faced in these environments, then mission accomplished. ... we were expecting an ethics course and got something else,” (Student in GRAD 713, 2006). Student feedback also indicated that some believe “ethics is personal” i.e. that there is no right or wrong answer (Table 4). Further, the administrators had to overcome a more persuasive negative perception of both faculty and students that any activity that takes trainees out of the laboratory is a “waste of time.”

Grading was a contentious part of the initial implementation (Table 4). Originally, student performance in each case was scored on 6 criteria, with an underlying rubric to assign letter grades. The rationale for letter grades was to overcome a past negative connotation that “ethics” courses are not taken seriously and do not teach content important for research scientists. However, inconsistent grading between groups and facilitator variability in the application of criteria was a source of extreme discontent. Some students thought it

unethical to be graded on one's moral development. Also, both facilitators and students were concerned that receiving "less than an A" in "scientific integrity" would stigmatize a student when applying for funding, such as National Service Research Awards.

While students and faculty provided very explicit critique of curricular aspects that needed improvement, most conveyed wholehearted endorsement of the PBL format and the chosen content. "I first want to state that the course has been informative and I believe is going in the right direction...as developing scientists, we are being provided with valuable tools which will give us a head start if or rather when we are faced with situations which require a depth of thought and insight into the impact on others," (Student in GRAD 713, 2006).

Improvements to the Curriculum

The first adjustment was to frame curricular expectations and provide better preparation for both students and facilitators. A more in-depth student orientation explained the expectations and philosophy for the curriculum and provided more training in the PBL group process. To overcome the critique that the program was "fluid" or "not concrete," debriefing activities were developed for each case that explicitly emphasized what students should have learned. The facilitator guide was expanded to explain the curricular philosophy and expectations, give tips on improving PBL group process and collecting feedback on evaluation policies. Additionally, each case guide outlined learning objectives, RCR elements, moral reflection, guidance on group developmental, and case-specific background resources.

Course grading was changed to Satisfactory/Unsatisfactory. The number of evaluation criteria was reduced to four and the underlying rubric was modified to be more specific for the curriculum objectives. Facilitators were also given more guidance on the philosophy of the program and how to apply evaluation criteria consistently with the PBL method (Table 2).

To overcome the negative connotation of an "ethics course", the curricular expectations were better framed (to students and facilitators) as training in professionalism, rather than merely learning regulations, rules or a single correct answer. In fact, the focus of the curriculum had always been for students to learn the expectations of the profession, a scientist's role obligations and to acquire skills to enable them to work through issues in science practice. Students were reminded how they have now joined the scientific community and that part of their professional duty is to justify their decision(s) and choice of action(s) to their peers and society. Supplying training in two methods for moral reasoning^{10,11} reinforced that there are objective means to evaluate choices. Some are exemplar (above and beyond the ethical duty of an individual), some ethical (right), and some unethical (wrong).

A small subset of students and faculty continued to question whether anything that takes them away from the laboratory is worth the time invested. Some weariness appeared during the second year of the curriculum, as other course demands increased. However, even after the first year, the curriculum gained a positive reputation for its relevance. "Embedding the issues in "real life" in the lab was enormously instructive. Rather than memorizing principles the students worked through conflicts that really were important to them as if they were happening," (Faculty in GRAD 713, 2006). The strongest endorsements came from senior graduate students, those with some research experience, postdoctoral fellows, and junior faculty, especially if they had been previously exposed to issues that negatively impacted someone's research progress or career success. "I appreciated a couple of the cases regarding authorship issues because I, myself, have had some similar experiences and did

not know how to handle them in the most appropriate way. I believed these cases to be directly applicable to graduate work in a research lab,” (Student in GRAD 713, 2006).

Conveying Professionalism Issues Using PBL Cases

Feedback on the specific cases reinforced principles for case development (Table 4). First, the most realistic scenarios were the best tool. Cases were toned down and more exemplars were included. Resistance to PBL case process was overcome by helping students see relevance for where they currently were, or hoped to be. Adjustments were made to ensure relevance for the cultures of all graduate programs, “...we don’t do rotations, don’t generally work in lab involving reagents, etc....The bottom line is ...it needs to be designed to address the difference between the programs; one size doesn’t fit all,” (Student in GRAD 713, 2006).

Cases generated frustration when students did not relate well to their scenario role or when the content was entirely new (e.g., a “conflict of interest” case). Some of that is unavoidable and part of the PBL process to drive independent learning. There was strong irritation with completely unfamiliar content, “The dual use case required knowledge about biosafety committees that were not available during the first 2 hours and made for too much confusion/speculation,” (Faculty in GRAD 715, 2008). Exposing the students to cases that demand more intersession learning or topics that are contentious should be delayed until after they have acquired confidence in the PBL format, formed cohesiveness as a group, and received adequate metacognitive coaching by facilitators.

There was little tolerance for repetition of ideas between cases. Some of this was compensated when facilitators became more confident in the PBL method and exercised the intended latitude to divert from structured questions to flow with the group’s learning needs. More cases were designed to force decisions in response to the critique that some “[s]tudents were unsatisfied when the cases ended open-ended (without resolution),” (Faculty in GRAD 713, 2006). Activities were included to prompt discussion of current events that demonstrated case relevance. Interjecting different types of learning activities into the cases was also well-received. A very effective final case was to view and discuss a professionally acted film about science. This broke away from the predictable nature of case structure with a real-life, albeit very dramatized, story about characters in research.

Intersession Learning and Written Assignments

Written assignments and intersession learning consistently scored the lowest on agreement for achieving the aims of the PBL curriculum. Some frustration stemmed from difficulty in finding appropriate resources, “[f]rustrating assignments- all websites were difficult to navigate and seemed to take time away from research,” (Student in GRAD 716, 2009). Another contention was that students who invested a lot of time felt a disparity between the grades and their effort, because some who barely did an assignment still received a satisfactory grade. While some students perceived the exercise as busy work, overall, facilitators typically remarked “[s]tudents didn’t like the assignments, ...[the faculty] think they are important,” (Faculty in GRAD 713, 2006).

Feedback indicated, despite the lower overall rating, that intersession written assignments were achieving the goal of stimulating independent learning. “The assignments between group sessions helped me learn about the topics so that subsequent discussions were more in-depth,” (Student in GRAD 714, 2008). “The first sessions were difficult to get through because of the lack of information and background on the cases. The second sessions always went much better than the first ... which allowed for a more involved discussion,” (Student in GRAD 713, 2006). Assignments also helped students learn about available resources, and

they frequently cited the Office of Research Integrity and our institution's Office of Research as useful resources. "I have a much better understanding of what is expected of students throughout the graduate process. I can identify the appropriate resources to turn to when I need to handle potentially difficult situations," (Student in GRAD 716, 2009).

Written assignments are also important for quiet and especially international students, to demonstrate knowledge gain. Facilitators noted that some were initially at a disadvantage in the conversation-driven PBL design. However, the small group format provided acculturation and comfortable long-term relationships that facilitated openness to discussion. This became particularly important for international students, who reported making continual progress throughout the curriculum in communicating beliefs and ideas.

Unexpected Gains for Facilitators

Facilitators were universally surprised at the naiveté of graduate students concerning the science culture. "I learned that graduate students, in general, do not understand the roles of PIs, postdoc[toral fellow]s, and tech[ician]s in the lab, and that they need to be introduced to these things when they start to work in a lab," (Faculty in GRAD 714, 2009). The curriculum also provided greater insight into mentoring students: "As a developing, 'hope-to-be', independent researcher, I learned quite a bit about what first year graduate students understand and expect from science and their mentors. This was very enlightening for me, as I don't remember my own expectations when I started," (Postdoctoral Facilitator in GRAD 713, 2008). Further, "It has helped me to be more sensitive to the concerns of students today. It keeps me better connected... than I was when I started," (Postdoctoral Facilitator in GRAD 713, 2008).

Changing Culture

A further insight was that the PBL strategy stimulated communication about professional behavior beyond the curriculum. At the end of 2009, 80% of responding students in GRAD 714 (15) and 52% in GRAD 716 (33) strongly agreed or agreed that "I am more likely to identify and discuss with others potential issues in the practice of science because of participating in this program." Most, but not all, students *and faculty* reported the program influenced their skills to recognize and discuss ethical issues, and that they had gained confidence. "I learned how to support my viewpoints with more substantive evidence. I have facts to support the viewpoints instead of just feelings," (Student in GRAD 714 2009). "I feel more prepared now to discuss these issues in a 'non-supportive' environment," (Student in GRAD 716, 2009). "[I] learned how to better participate within a group and defend my position on controversial issues," (Student in GRAD 716, 2009).

Students and faculty also related discussions of laboratory practice and ethical issues with colleagues and in workplace and social settings. "This course has given me the opportunity to discuss with other colleagues about ethics and science both in the lab and in social settings. It's made it easier to talk with new scientists," (Faculty in GRAD 714, 2009). "This course opened an avenue of discussion between me and my advisor concerning ethical considerations," (Student in GRAD 716, 2009). Evidence of greater moral reflection was seen. "I look at situations from different aspects and begin to analyze and research them before 'jumping to conclusions,'" (Student in GRAD 713 2008). "It has helped me to recognize issues more easily and to discuss with colleagues how to possibly change them. Mostly it helps to recognize how science goes, that they are unethical and the cycle needs to be broken in the future," (Facilitator in GRAD 713, 2008).

Conclusions

Through the process evaluation we have preliminary evidence that our curriculum achieves multiple purposes proposed for RCR training, including empowering trainees, increasing their awareness and sensitivity to issues in research, providing information on regulations and policies that govern research, improving their ability to deal with ethical issues, and creating a positive attitude about RCR^{12,13}. Further, conducting the process evaluation was a useful tool, in and of itself, by providing an opportunity for students and faculty feedback, that increased their ownership of curricular objectives.

Students and faculty continually preferred this format over lectures. However, a minority of student learning styles did chafe at the time-consuming, somewhat messy PBL process, voicing a preference for quicker lectures or web-based learning. While web-based formats can be an effective and cost-efficient means of delivering standardized rule-based knowledge^{14,15}, our curricular design provides outcomes that cannot be delivered through lectures or web-learning formats. Most professionalism issues in science fall short of prescriptive rules. We placed high value on acculturating our students and developing their skills, rather than simply seeking knowledge gain *per se*. In fact, we did not directly assess knowledge gain, although the students and facilitators believed their knowledge of the learning objectives embedded in the cases was enhanced.

Who should teach RCR?¹⁶ Senior scientists bring more credibility to the sessions, an essential element for relevance and positive attitude toward RCR. But the trade-off is that research faculty are often ill-prepared and ill-equipped to teach ethics¹⁷. Further, some mentoring can have an unintended consequence of justifying cutting corners to survive, or a tolerance for living within gray areas^{6,18}. Anderson proposed group mentoring as a solution to enhance the positive effects of mentoring and mitigate the negative effects of outliers promoting unethical means; "Group mentoring brings the weight of social norms, shared expectations, disciplinary culture and common experiences to bear on ethical questions."¹⁷ Our curriculum is uniquely structured to engage these crucial role models with a creative, relevant format in a group mentoring setting. It also provides a unique, nonobtrusive means for faculty to have their professional norms reinforced and gain practice in recognizing and dealing with ethical issues in the practice of science. Our experience taught us that well-trained, committed and passionate metacognitive coaches are essential for the program's success¹. Students reported that one of the most useful, relevant aspects of the curriculum was the sharing of personal professional experiences by their facilitators.

Our hope is that the faculty-student small group interactions around moral reflection and issues in science would extend beyond the classroom and positively affect the school's research culture so that considerations about the ethical conduct of science becomes more interwoven into the practice of science and a respected element in the student's training. We have preliminary evidence that our curriculum did increase communication about professional behavior outside the classroom. Internal laboratory conduct was affected, e.g. several students negotiated with their advisors to construct written authorship rules ahead of research projects, while others were able to have their advisors notify editors of the student's contributions to review. Other participants initiated ethical and bioethical discussions at their laboratory meetings¹⁹ or graduate program seminar series.

Overall the PBL scientific professionalism curriculum provided a means for graduate students to acquire skills to recognize ethical issues in the practice of science, develop sound moral reasoning, and develop skills for effective group work and self-directed learning. The PBL cases were effectively adapted to introduce issues within the practice of science, norms and scientific professional obligations, and to explore moral reflection such as moral

reasoning. Further, this type of format fostered an environment supportive of RCR within the daily practice of science. The very nature of supporting this resource-intensive curriculum (both in student time and faculty involvement) sends a positive message about the commitment of the institution and faculty for creating professionals, and it further endorses the importance of responsible research conduct.

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Appendix A

Appendix A

Student End of Course Evaluation Form^f

Scoring: 5: Strongly Agree, 4: Agree, 3: Neither Agree nor Disagree, 2: Disagree, 1: Strongly Disagree

- 1 Using the Problem Based Learning (PBL) method and discussing cases with small groups helped me learn more than listening to lectures on the same topics.
- 2 Discussing the cases with the group enhanced my understanding of how to deal with difficult situations, decisions, and discussions.
- 3 Hearing the viewpoints of my group members influenced my consideration of these topics.
- 4 Being in a small group help me practice and improve my skills to work effectively in a group.
- 5 The assignments between group sessions increased my knowledge of and ability to find resources to learn the standards of science and how to deal with issues in science[@]
- 6 The assignments between group sessions helped me learn about the topics so that subsequent discussions where more in depth[@]
- 7 Having to discuss cases with my peers helped me to learn how to better explain and support my position.
- 8 Discussing cases increased my knowledge of the expectations, responsibilities, and rights I have as a scientist.
- 9 Discussing the cases increased my awareness of responsibilities, roles and concerns of other personnel in science such as faculty members, principal investigators, postdocs, and technicians.
- 10 Discussing the cases increased my knowledge of the norms and expectations for how science should be practiced.
- 11 The cases increased my knowledge about student and advisor relationship, laboratory personnel dynamics, research collaborations, attribution of credit for work, and plagiarism[#]
- 12 I am more likely to identify^{*} and discuss with others potential issues in the practice of science because of participating in this course^{*}
- 13 When a new situation arises in the practice of science, I often think about who has a stake in the situation, potential courses of action, and consequences for those actions^{*}

Open-Ended Questions:

- What case(s) or parts of the case(s) worked well and why? Include discussing if the movie was useful as a case.
- What case(s) or parts of the case(s) were not useful or were frustrating and why?

Scoring: 5: Strongly Agree, 4: Agree, 3: Neither Agree nor Disagree, 2: Disagree, 1: Strongly Disagree

What were the most useful and relevant thing(s) you learned from this course?

Do you think this course has influenced your abilities to engage in discussions about issues in science outside of the course setting? (Are you more likely to identify issues, have more skills to examine the issues, or more confidence, etc.? What setting and with whom do you have discussions?)*

^LFor facilitator course evaluation forms, questions 1-11, were modified to ask whether these aims were achieved by the students. Questions 12, 13 and the open-ended questions remained the same.

[@]By the Fall semester of 2007, these questions were adapted from "The written assignments and subsequent discussions helped me learn where and how to find credible resources."

[#]This question (specific for GRAD 713) was adapted for each course to cover the objectives for the cases covered in the course. For example, the question for GRAD 715 was, "The cases increased my knowledge about standards for reporting research results, parameters for using animals in research, intellectual property in research projects, and values in scientific systems and research questions."

^{*}These questions were added in the Spring semester of 2008.

LITERATURE CITED

1. Powell ST, Allison MA, Kalichman MW. Effectiveness of a responsible conduct of research course: a preliminary study. *Sci Eng Ethics*. Jun; 2007 13(2):249–64. [PubMed: 17717736]
2. Bebeau MJ, Thoma SJ. The impact of a dental ethics curriculum on moral reasoning. *J Dent Educ*. Sep; 1994 58(9):684–92. [PubMed: 7962920]
3. Clarkeburn H, Downie JR, Matthew B. Impact of an Ethics Programme in a Life Sciences Curriculum. *Teaching in Higher Education*. 2002; 7:65–79.
4. Kalichman MW, Friedman PJ. A pilot study of biomedical trainees' perceptions concerning research ethics. *Acad Med*. Nov; 1992 67(11):769–75. [PubMed: 1418260]
5. Mumford MD, Connelly S, Brown RP, et al. A Sensemaking Approach to Ethics Training for Scientists: Preliminary Evidence of Training Effectiveness. *Ethics Behav*. Oct 1; 2008 18(4):315–39. [PubMed: 19578559]
6. Anderson MS, Horn AS, Risbey KR, Ronning EA, De Vries R, Martinson BC. What do mentoring and training in the responsible conduct of research have to do with scientists' misbehavior? Findings from a National Survey of NIH-funded scientists. *Acad Med*. Sep; 2007 82(9):853–60. [PubMed: 17726390]
7. Brookfield, S. *Understanding and facilitating adult learning: A comprehensive analysis of principles and effective practices*. Jossey-Bass; San Francisco, CA: 1986.
8. Cross, K. *Adults are Learners: Increasing participation and facilitating learning*. Jossey-Bass; San Francisco, CA: 1981.
9. Knowles, M. *The modern practice of adult education: Andragogy versus pedagogy*. New York Association Press; New York, NY: 1970.
10. Bebeau, MJ.; Pimple, KD.; Muskavitch, KMT.; Borden, SL.; Smith, DH. *Moral Reasoning in Scientific Research: Cases for Teaching and Assessment*. Indiana University Poynter Center; Bloomington, Indiana: 1995.
11. Iserson KV. Principles of biomedical ethics. *Emerg Med Clin North Am*. May; 1999 17(2):283–306. ix. [PubMed: 10429629]
12. Kalichman MW, Plemmons DK. Reported goals for responsible conduct of research courses. *Acad Med*. Sep; 2007 82(9):846–52. [PubMed: 17726389]
13. Steneck NH, Bulger RE. The history, purpose, and future of instruction in the responsible conduct of research. *Acad Med*. Sep; 2007 82(9):829–34. [PubMed: 17726385]
14. Braunschweiler P, Goodman KW. The CITI program: an international online resource for education in human subjects protection and the responsible conduct of research. *Acad Med*. Sep; 2007 82(9):861–4. [PubMed: 17726392]

15. Bulger RE, Heitman E. Expanding responsible conduct of research instruction across the university. *Acad Med.* Sep; 2007 82(9):876–8. [PubMed: 17726396]
16. Kalichman MW. Responding to challenges in educating for the responsible conduct of research. *Acad Med.* Sep; 2007 82(9):870–5. [PubMed: 17726394]
17. Anderson MS. Collective openness and other recommendations for the promotion of research integrity. *Sci Eng Ethics.* Dec; 2007 13(4):387–94. [PubMed: 18044009]
18. Plemmons DK, Brody SA, Kalichman MW. Student perceptions of the effectiveness of education in the responsible conduct of research. *Sci Eng Ethics.* Jul; 2006 12(3):571–82. [PubMed: 16909159]
19. Peiffer AM, Laurienti PJ, Hugenschmidt CE. Fostering a culture of responsible lab conduct. *Science.* Nov 21.2008 322(5905):1186. [PubMed: 19023060]

Table 1**PBL Professionalism and Ethics Curriculum Objectives**

Objective	Strategy
Acculturation to science profession, gain familiarity with obligations of scientists and norms for practice of research	Exposure to principles and virtues of science, standards of RCR, exemplars, moral motivation and commitment Identify resources, such as ORI, Office of Research and professional organizations
Acquire skills to recognize ethical issues in practice of science	Cases with real life ethical issues in the practice of science Moral reflection exercises to expose students to many stakeholder perspectives
Acquire skills in moral reasoning and ability to evaluate peers and provide justifications	Practice in moral reasoning and judgment in a group setting
Active- rather than passive-learner centered	Problem driven learning Discussion participation Independent intersession assignments
High degree of socialization around professional behavior	Small group setting interacting with peers and faculty/post-doc Used to identify and discuss professional behavior
Improve skills for effective group work	Practice working in a group, e.g. communicating and constructively critiquing others' concepts Evaluated on group work Debriefing activity on how to improve group process
Realistic understanding of the culture of science	Cases with relevance to the practice of science Exposure to role obligations of students, mentors, technicians, postdoc, etc.
Improve appreciation of the importance of RCR	Program required for all graduate students Participation of all students and many faculty and postdocs Unobtrusive refresher for faculty in RCR and professionalism

Table 2**Student Evaluation Mean Scores of GRAD 713**

5: Strongly Agree, 4: Agree, 3: Neither Agree nor Disagree, 2: Disagree, 1: Strongly Disagree

	2006 N=33	2007 N=21	2008 N=21
Using the Problem Based Learning (PBL) method and discussing cases with small groups helped me learn more than listening to lectures on the same topics.	4.09 (1) ^a	4.35 (1)	4.29 (2)
Discussing the cases increased my awareness of responsibilities, roles and concerns of other personnel in science such as faculty members, principal investigators, postdocs, and technicians.	3.67 (2)	4.00 (4)	4.33 (1)
Discussing cases increased my knowledge of the expectations, responsibilities, and rights I have as a scientist and graduate student.	3.64 (3)	4.20 (2)	4.24 (3)
The cases increased my knowledge about student-advisor, lab personnel dynamics, collaborations, and attribution of credit	3.63 (4)	4.05 (3)	n/a
Discussing the cases with the group enhanced my understanding of how to deal with difficult situations, decisions, and discussions.	3.63 (5)	3.95 (5)	3.95 (6)
Hearing the viewpoints of my group members influenced my consideration of these topics.	3.52 (6)	3.85 (6)	3.90 (7)
Discussing the cases increased my knowledge of the norms and expectations for how science should be practiced.	3.42 (7)	3.85 (6)	4.05 (5)
Having to discuss cases with my peers helped me to learn how to better explain and support my position.	3.36 (8)	3.85 (6)	3.86 (8)
The assignments between group sessions increased my knowledge of and ability to find resources to learn the standards of science and how to deal with issues in science.	2.55 (10)	3.15 (10)	3.43 (12)

^a Rank order of greatest agreement for statement

Table 3**Improvements Made to Curriculum Since Start-Up**

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- *Facilitator Orientation/Support*: Provided more explanation of curricular philosophy, expectations, group process, feedback on grading policies and course objectives
 - *Facilitator Case Notes*: Learning objectives, RCR instructional element(s), principles and virtues of science, moral reflection, strategy for leading groups, guidance on group development stages, and case-specific background resources and references.
 - *Student Orientation*: More explicit focus on program philosophy and expectations, PBL and group process, and importance of the curriculum content to their development as professional scientists.
 - *Cases*: Restructured to force more decisions; added debriefing activities on case objectives, learning skills, and improved written assignments; rewritten with less dramatic characters; included more exemplars with negative examples.
 - *Debriefing Activity*: Exercises to reinforce the 1) program expectations, 2) “concrete” learning objectives, 3) skills students were acquiring, and 4) relevance of the content for the practice of science. Exercises to strengthen group function.
 - *Grading*: Changed final grade in courses from A, B, C, F to Satisfactory/Unsatisfactory while retaining 4 scoring criteria in grading template (1-Problem Analysis, Reasoning and Moral Reflection, 2-Self-Directed Learning, Knowledge Acquisition and Written Assignments, 3-Individual Skills in Group Process and 4-Group Process Development). Decreased number of criteria from 6 to 4 (1-Problem analysis and reasoning process; 2-Knowledge acquisition; 3-Self-directed learning; 4- Moral Reflection and Professionalism; 5-Communication and Cooperation; 6-Individual skills in group discussion process). Removed unfair connotation of “B” in scientific integrity.
 - *Ethics*: Articulated the expectations of curriculum, where ethics and professionalism each play a role in science. Expectation that students will gain a realistic understanding of the practice of research, learn norms of the profession and obligations of scientists, become familiar with issues in the practice, acquire skills to manage competing interests of various stakeholders, and deal constructively with difficult conversations and issues in practice of science.
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Table 4**Selected Feedback Quotations in Specific Areas****Grading:**

"The grading is also frustrating. I know that in some groups the moderators are very easy on grading where in my group they are very harsh. Some groups if you just show up and talk you get an A, however, in our group it is more demanding and it is almost like a competition where you have to score points with the moderators or you are going to fail," (Student in GRAD 713, 2006).

"I am at a loss on how a person can "ethically" be graded for the speed at which their morals and ethical values progress???" (Student in GRAD 713, 2006).

"THE COURSE SHOULD BE PASS/FAIL!!!! The group continually questioned how a specific grade in Ethics would be viewed by outside individuals. If a student gets a B in ethics, does this mean the student is not as ethical as the one who got an A?" (Faculty in GRAD 713, 2006).

Facilitator Feedback on PBL Method:

"Personally, I learned just how well the PBL process works. At the end of the first case, I NEVER expected to see our group develop into such a cohesive unit. Yet by the 4th case, they were working together beautifully. The students also made the same observation, which I think surprised them too. I am also seeing professional personalities appearing that I recognize amongst my colleagues. It is clear their professional mindset is beginning to form already. We are reaching them at the best time in their professional development," (Faculty in GRAD 713, 2006).

"I had always heard the saying, "to teach is to learn;" and I feel my learning from this course is a good example of how this extends to the cases of, "to facilitate is to learn." I am certainly more aware of authorship issues, and ways in which to avoid specific problems with authorship (this is big for a postdoc). For example, I have initiated meetings with my mentor to work on establishing authorship before the work is complete, and ideally before it has even started. I have also examined ways in which I want to run my laboratory, by avoiding certain pitfalls provided by the PIs in the scenarios," (Postdoctoral Facilitator in GRAD 713, 2008).

Case Elements:

"I would never do that...The scenarios were very extreme, so the discussion was usually not as good as it could have been if they had been more subtle," (Student in GRAD 713, 2006).

"Cases and parts of cases to which students could relate worked better," (Faculty in GRAD 713, 2006).

"All of the students were able to relate to the issues associated with data presentation and animal use, so they were able to share their experiences and opinions with the group," (Faculty in GRAD 714, 2009).

"Case 2 was frustrating. This was mostly due to the fact that the students did not have any concept as to the role of a post-doc," (Faculty in GRAD 713, 2007).

"Some people thought that pretending to be a postdoc or older grad student was unrealistic, but I thought this was a good tool for getting you to think about how to handle issues as a professional," (Student in GRAD 713, 2006).

"The role playing activity in Case 8 worked well because it forced you to participate in a discussion with a stance that may not have been your own. This was a better way to understand different sides of an issue, rather than just talking about somebody else having a different opinion," (Student in GRAD 714, 2009).

"Writing their own standards for lab authorship and then writing a consensus on the board was a great way to compare their own standards with others, and then realizing how difficult it may be in some cases to decide authorship. It also helped to understand how variable the motivation for inclusion on a paper can be, despite the perceived objectivity of the decision," (Faculty in GRAD 713, 2008).