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Intervention to promote responsible conduct of research mentoring

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Abstract

Although much of the focus on responsible conduct in research has been defined by courses or online training, it is generally understood that this is less important than what happens in the research environment. On the assumption that providing faculty with tools and resources to address the ethical dimensions of the practice of research would be useful, a new workshop was convened ten times across seven academic institutions and at the annual meeting of a professional society. Workshops were attended by 91 faculty, 71 (78% response rate) of whom completed evaluations strongly supportive of the value of the workshop. Surveys of trainees identified by the faculty allowed for invitations to complete an online survey before and six months after the workshops, respectively resulting in response rates of 43% and 51%. Faculty and trainees were highly supportive of the feasibility, relevance, and effectiveness of the implementation by the faculty of one or more of the five strategies featured in the workshop. However, surprisingly over 70% of the trainees reported use of one or more of those strategies prior to faculty participation in the workshops. In sum, the workshops for faculty were successful, and the proposed strategies were deemed of value, but it is likely that the faculty voluntarily choosing to participate in these workshops were perhaps not surprisingly faculty who are already doing this. This model is likely a useful adjunct to encouraging a culture of ethics, but it is not by itself sufficient to do so.

Keywords

Research ethics; Responsible conduct of research; Mentoring

Introduction

After over 25 years of responsible conduct of research (RCR) education requirements in the US (NIH 1989), agreement about the desired impact remains elusive. The range of proposed goals for such education is diverse (Kalichman & Plemmons 2009). Although there is reason to believe that one argument for RCR education is to decrease the incidence of research misconduct (Steneck & Bulger 2007, Kalichman 2013a), this is likely to be difficult to measure and unlikely to substantially change based on brief educational interventions (Kalichman 2011). It is therefore not surprising that there is no evidence yet of a positive impact of RCR education on research misconduct (Kalichman 2013b). Other more plausible

outcomes have been studied widely, including improved knowledge, ethical decision-making or sensemaking skills, attitudes, and self-reported behaviors. Many studies have demonstrated a positive impact in one or more of these domains (Antes et al 2009, Mulhearn et al 2016, Watts et al 2016).

Despite findings of respectable effect sizes -- based on diverse outcomes -- in meta analyses for RCR education outcomes (Mulhearn et al. 2016; Watts et al. 2016), the magnitudes of changes are arguably modest (Antes et al. 2009; Kalichman 2014) and in some cases absent or even negative (Eastwood et al. 1996; Heitman et al. 2001; Schmaling & Blume 2009). One factor is likely that such programs are highly variable along many dimensions – content, format, instructor – with some better than others (Mulhearn et al. 2016). A case might be made, then, that the problem is to somehow ensure the quality of RCR training programs. However, debating the quality of training may not be the most appropriate first locus of attention, and begs the question: how is it that science proceeded for so many years without having special training in the ethical practice of science? Of course, it may be that the integrity of science was diminished by the absence of such training, but concerns among scientists and observers of science about the integrity of science did not seriously arise until the 1980s (Steneck and Bulger 2007; Kalichman 2013a). One response was to create requirements for more formalized and explicit RCR training (NIH 1989; Steneck & Bulger 2007). Over the past 25 years, the extent and specifics of these requirements have increased (NIH 2009, NSF 2009, NIFA/USDA 2013, and increasing numbers of graduate programs requiring RCR education for all students), but if anything, concerns about the integrity of science have only increased (Alberts et al. 2014; National Academies of Science, Engineering, and Medicine 2017).

Continuing concerns about the integrity of science may be related to a second observation. In practice, the number of hours of RCR training tend to be limited (e.g., NIH calls for only eight hours each four years: NIH 2009) and almost invariably to be conducted as an activity that is separate from, not part of, research (e.g., Phillips et al 2017). In contrast to such limited and otherwise constrained training, during four years of graduate study (during which the NIH recommends eight hours of formal training), a typical researcher easily spends 8,000 hours conducting research with other researchers (Kalichman 2013a). It would be remarkable to expect such limited RCR training to have a substantial impact in the face of the overwhelming experience of the practice of science. This is consistent with observations that the research environment, which includes mentors, is likely to be more important to perceptions and behavior than RCR courses (Anderson & Louis 1994; Faden et al. 2002; Fryer-Edwards 2002; Institute of Medicine 2002; Anderson et al. 2007; Peiffer et al. 2008; Anderson 2011).

Under the circumstances, it may be that science would be best served if conversations about the responsible conduct of research (RCR) could be moved beyond the classroom and into the hands of research mentors (National Academies of Science, Engineering, and Medicine 2017). Unfortunately, being a faculty advisor is not necessarily synonymous with being a good mentor; mentoring particularly with respect to RCR remains all too rare (e.g., Swazey & Anderson 1996; Brown & Kalichman 1998; Hartmann & Mullins 2003; Langlais 2006; Artino & Brown 2009; Langlais & Bent 2013). The goal of this project is to empower

research faculty members with the tools and resources to be more effective mentors and to foster RCR discussions with their research groups. This is not proposed to replace, but instead be a valuable adjunct to existing formal RCR programs. With support from the National Science Foundation, a curriculum was developed for workshops for research faculty to prepare them to effectively be mentors of not just science, but of the *responsible* conduct of research. The methods for developing the workshop curriculum are described in Plemmons and Kalichman (2017). The purpose of this manuscript is to describe the results of using that curriculum.

Methods

This project was reviewed and approved for exempt status by the UC San Diego Institutional Review Board (#111244). Using a curriculum and syllabus developed through an iterative process involving subject matter experts, interviews, focus groups, and pilot testing (Plemmons & Kalichman 2017), the proposed workshop was piloted by invited subject matter experts who had participated in developing the curriculum, and through convenience sampling of programs and individuals in the networks of those experts. While convenience sampling risks bias, announcements were made through a variety of networks via those individuals, which were considered an appropriate choice for this first effort. Interest was expressed by 29 institutions and 2 professional societies. Largely because of the end date for funding for this project, 21 institutions who expressed interest in participating in a workshop were unable to make the timely, necessary arrangements or were not otherwise prepared to participate at the time of the invitation. Participating faculty presented the workshop ten times across seven different research institutions and one professional society (Arizona State University, Hampton University, Old Dominion University, San Diego State University, University of Cincinnati, University of San Diego, Virginia Commonwealth University, and the American Association for the Advancement of Science [AAAS]). The curriculum was taught twice for Old Dominion University and the AAAS, resulting in a total of ten iterations.

The curriculum focused on five approaches for mentors to promote conversations about RCR (Table 1). Outcomes were assessed by feedback from faculty participants, their trainees, and in some cases observers of the workshops. All materials, including an Instructor's Guide, are posted online on websites of the University of Illinois Urbana-Champaign (EthicsCORE: http://nationalethicscenter.org), the National Academy of Engineering (Online Ethics Center: http://onlineethics.org), and the University of California San Diego (Resources for Research Ethics Education: http://research-ethics.net).

Faculty Assessments

Faculty participants completed two brief evaluations. At the close of each workshop (Appendix 1), participants were asked to complete an evaluation of the workshop. At least six months later, workshop participants were invited to complete a brief online survey (Appendix 2) about their uses of approaches covered in the workshop.

Trainee Assessments

Prior to each workshop, potential faculty participants were polled to request contact information for their research trainees. When available, this allowed for pre- and postworkshop surveys of trainees (Appendix 3) similar to the questions asked of faculty. Trainees identified by faculty participants in the workshops were invited by e-mail to complete an online survey before the faculty had a chance to implement what was learned in the workshop (pre-workshop survey) and again six months later (post-workshop survey).

Workshop Observers

Observers of some of the workshops were asked to complete a qualitative review. These reviews were not structured other than to meet the general guideline of assessing what worked well and what could be improved.

Results

Workshop Participants

A total of 91 individuals attended one of the ten workshops, averaging just over nine people per workshop, with a minimum of four and a maximum of 14. Evaluations after the conclusion of the workshops were completed by 71 (78%) of the participants.

Evaluations of the Workshop by Faculty Participants

In open-ended responses to the question "How, if at all, have your perceptions or understanding been changed by participating in today's workshop?" participants typically reported valuable new insights or appreciation. Responses to this question were provided by 68 of the respondents, only two indicated no change, and five others mentioned that the workshop reinforced what they already knew. For example: "Re-emphasized challenges + expectations regarding research ethics." The remaining 61 (90% of respondents) responses clearly identified specific or general ideas or information that were new and valuable. Typical examples included:

"Yes, in the sense that these topics are more effective when engaged one on one with students outside of the classroom setting."

"It made me aware of issues I was not addressing."

"Learned new ideas. Got me thinking about things I would not have thought about."

"I knew this was important, but I felt uncomfortable designing/training through a workshop. Now I believe I could do this."

In open-ended responses to the question "How would you describe the value of this workshop to your plans for teaching or promoting research ethics?" participants often elaborated not just generically on the value of the workshop, but specifically about what they planned to do as a result. Responses to this question were provided by 70 of the 71 respondents, only two indicating that it was NA (not applicable?) or that they did not feel prepared to teach this topic, three specifically focused on perspectives of administrators rather than researchers or teachers, and five emphasized that the workshop only reinforced

what they already knew. For example: "A good reminder and motivation for constant integration of these principles into my teaching and mentoring activities." The remaining 60 responses (86% of respondents) clearly identified many ways in which the workshop was transforming, how they specifically planned to use what they had learned, or at least had concrete plans to do so. Specifics about components of the workshop being particularly valuable to plans for the next steps were cited by 36 of the respondents. An additional 24 respondents simply made clear that they thought the workshop was excellent while providing no specific explanation as to what was valuable. Typical examples included:

"I will discuss these topics with my lab group"

"This workshop gave solid methods for implementing materials into courses/ research, which I would not likely have come up with in my time that I put aside to prepare my course(s)."

"Great!! I came in with essentially zero knowledge how to teach, now feel okay."

In open-ended responses to the question "What changes would you recommend to help improve future versions of this workshop?" participants typically concluded that little if anything should be changed. Responses to this question were provided by 58 of the respondents, 14 (24% of respondents) explicitly noted no changes needed. Although four respondents suggested the program should perhaps be shorter (e.g., half day instead of full day), and twelve respondents offered a variety of specific logistic suggestions (e.g., making the syllabus available in advance of the workshop), 28 (48% of respondents) respondents proposed considering a larger, more diverse audience (N=13) or adding more content or discussion (N=15). Typical examples included:

"Everything was well planned and carried out"

"Encourage dept. chairs to make it "strongly suggested" or required for tenure seeking (junior) faculty."

"Example of assessment tools would be helpful, also a website or online community allowing participants to continue the discussion would be excellent."

"I enjoyed the discussions. I would have appreciated even more. I do understand time is a factor."

In open-ended responses to the prompt "Please use the space below or the back of this page if you have any additional comments or suggestions about future workshops on this topic," participants offered comments largely consistent with answers to previous questions. Only 35 (about half) of the respondents completed this question. Two respondents raised questions about the duration of the program, but the workshop was otherwise simply described as excellent or with specific examples of why it was excellent by 17 (49% of the respondents), and an additional 14 (40% of respondents) suggested doing something more, including expanding the audience (N=4), more depth on assessment (N=3), or more content or training (N=7). The remaining two comments suggested that "Perhaps the working groups could've been divided along disciplinary lines." and to note only that they would "…think more & write to you." Typical examples of other comments included:

"The workshop has the usual problem of self-selection."

"You could target all faculty who teach research methods courses."

"Excellent workshop! Very useful, interesting mind-engaging, hands-on exercises were very practical and interesting. THANK YOU!"

Consistent with the qualitative responses above, responses to forced choice questions about whether the workshop had succeeded in meeting the four defined learning objectives or overall were very high, averaging between 4.5 and 4.7 on a 5 point scale, with 5 being the best. Out of 355 scores completed, only two were left blank, 13 ranks were scored as three, and one as two. The remaining 339 scores (95%) were four or higher.

Pre- and Post-Workshop Surveys of Faculty Participants and their Trainees

Faculty and trainee respondents were representative of diverse disciplines, although trainees did not include representatives of computer or engineering sciences (Table 2). Faculty implementation of approaches covered in the workshops was assessed at least six months after the workshop. Because contact information was not available for all participating faculty, email survey invitations were sent only to 84 (92%) of the 91 workshop participants. Of these, complete responses were received from 49 faculty (58% response rate), plus three respondents only partially completed the survey. Because the latter three did not indicate having used any of the approaches taught, nor did they include any demographic information, those were excluded from analyses. One of the three did include a note that this was not relevant to them as they had no students. Responding faculty reported an average of 5.4 trainees, a median of 3, with 12 reporting no current trainees, and a maximum of 51 trainees. Trainees identified by faculty participants in the workshops were also invited by email to complete pre- and post-workshop online surveys. Names and e-mail addresses were provided in time for the pre-workshop survey for 56 trainees, three of whom opted out. Complete responses were received from 24 trainees (43% response rate), plus two respondents only partially completed the survey. The two partial responses were deleted from analyses because neither included demographic information nor answers to most questions. For the post-workshop survey, approximately six months or more after the workshop, faculty participants provided additional names, allowing for invitations to 77 trainees. Responses, including demographic information, were received from 39 trainees (51% response rate), plus ten respondents who only partially completed the survey. The partial responses were deleted from analyses because none included demographic information nor answers to most questions. In a comparison of trainee respondents to the pre- and post-workshop surveys, 18 provided complete responses to both surveys, six responded to the pre-workshop survey only, and 19 to the post-workshop only. In addition, partial responses were received from two and nine respondents for the pre- and postworkshop surveys, respectively.

A high percentage of faculty respondents, as well as trainees in both pre- and post-workshop surveys, reported the use of one or more of the five approaches in their research environments during the most recent academic term (Figure 1). Each of the five approaches was scored as effective (74% - 100%) and relevant (73% - 100%) by pre- and post-workshop trainee and faculty respondents. Only faculty were asked about feasibility (i.e., whether it

would be practical to use the specific approach in the research environment), which was confirmed by 91% - 100% of respondents.

Both faculty and trainees tended to report that these approaches were most frequently used in a group setting, with the exception of individual development plans, which were not surprisingly more often used one-on-one (Table 3).

Perceived impact of discussions

Open ended responses from faculty and trainees were provided in response to three prompts. The first for faculty was "Please note any observations you've had that speak for or against the effectiveness for your research group of any of the above strategies you have used," while trainees were asked a related question: "what impact, if any, did those conversations have on you?" A total of 12 faculty responses were received with the remainder of the respondents either leaving this response blank or simply noting "NA" (presumably, "not applicable").

Three of the pre-workshop trainee respondents reported no hours of interaction (and therefore were not asked about the impact). The rest reported a median of one hour with faculty mentors and two hours with others, resulting in a total of 12 responses to the prompt.

Five of the post-workshop trainee respondents reported no discussions, with the remainder reporting a median of one hour of discussion with faculty mentors and two hours with others, and 22 responses to the prompt. Although four pre-workshop responses and five post-workshop responses noted little or no value for these discussions, the majority of faculty and trainee responses indicated general value of the discussions or very specific benefits. For example, two faculty responses highlighted the value of the approaches covered by the workshop:

"The strategies worked extremely well to increase the work ethic and integrity of the experimental completion and data analysis."

"They worked well. The students actively contributed their input to the strategies."

And similarly, three trainee responses:

"...serve[s] as a reminder that as an engineer and a researcher, I am held to a high standard of ethics within the scientific research community. Ultimately, the goal of our work is to improve understanding, and performing our work in an unethical manner will directly contradict that objective."

"I made sure my research was performed while giving credit to those who deserve thus promoting an overall moral environment in the scientific community."

"Those conversations helped me become a better scientist in that I was able to maintain good notes and write manuscripts about my research under the guidance of my mentor."

One other response should be noted because it is a reminder of the variation in such discussions: "I now understand the basics of research ethics and its importance, but I still have no clear idea of how to implement these principles in real-life, practical ways."

Other Strategies

The second prompt for faculty was "Please share with us any other strategies, whether purposeful or ad hoc, you have successfully used to generate discussions about research ethics in your research group" and a parallel version for trainees: "Could you briefly describe any other approaches your mentor has used to generate discussions about research ethics in your research group?" Most faculty left this query blank and two marked it "NA," but responses were provided by 13 individuals. Nine of the pre-workshop trainees responded to this prompt with the remainder of the respondents either leaving this response blank or marked as "None" or "N/A." Post-workshop trainees provided 16 responses with the remainder of the response blank or marked as "None."

Responses to this question added little to what has already been covered above, but it is noteworthy that four of the 13 faculty specifically cited the value of a focus on "real life" cases (e.g., news media and journal articles).

The pre-workshop trainees largely described elements of proposed approaches, especially cases, but one example was marginally distinct from approaches already discussed: "My mentor often uses current research to discuss ethical issues." Post-workshop trainee responses were in a similar vein, but four of the responses highlighted approaches that deviated somewhat from those proposed. For example:

"Sending us journal articles that are pertinent to particular "hot topics" in research ethics."

"My mentor has asked us to come up with our own code of ethics and why the principles we chose are important to us as individuals and its importance for the overall lab."

Other comments

The final prompt for faculty and trainees was: "Please provide any other comments you may have." Not counting a few instances of "None at this time," ten faculty provided responses, as did four of the pre-workshop trainees and three of the post-workshop trainees. These responses tended to either echo comments already made or to reflect on very specific, individual circumstances. However, two of the pre-workshop trainees offered evidence of differences for people early or late in their careers:

"I am brand new to my research group and have not had any particular ethically based discussions with my mentor yet."

"I have been in the lab for over five years so I think my mentor is very comfortable with my ethic [sic] code of conduct and does not feel it is necessary to discuss this topic with me."

And one post-workshop trainee summed up the importance of an effective mentor: "My mentor leads and trains by example. His explanations of how to properly analyze and display data, instead of direct conversations about ethics, helps me to understand what is the right and wrong way (ethically) to perform science. We have had some Journal Club articles that

helped stimulate great conversations about ethics in the past; I will bring up the idea of presenting more [of] these in the future."

Evaluations by Workshop Observers

For six of the workshops, observers were enlisted to provide additional perspectives on effectiveness of teaching of the workshops. Because these reports were largely ad hoc, and varied greatly in both form and content, the data are not shown. However, the results can be summarized as largely consistent with the faculty participant and trainee evaluations (above). Typically, the greatest value of these observer reports was to refine workshop logistics (e.g., timing or the nature of materials to be included in the syllabus).

Discussion

While this new model to promote RCR discussion was highly appreciated and valued, it is important to note that the purpose of this project was not to determine if trainees (or faculty) were in some way "more ethical" as a result of faculty participation in one of the workshops. However, if the goal is to pursue a culture of ethics, then it seems likely that such a culture would depend on increased conversations about ethics, in contrast to the commonly reported absence of such conversations (Swazey & Anderson 1996; Brown & Kalichman 1998; Hartmann & Mullins 2003; Langlais 2006; Artino & Brown 2009; Langlais & Bent 2013). For the purpose of this project, the goal was to assess perceptions of the feasibility, relevance, and effectiveness of implementing one or more of the five proposed approaches to promoting RCR conversations. By that standard, this model is worth considering as a strategy complementary to the relatively common reliance on a single, isolated course or training program (Steneck & Bulger 2007; Kalichman 2013a).

Faculty and trainee feedback was overwhelmingly positive. Faculty evaluations of the workshop indicated robust perceptions that all workshop objectives were met, consistent with text responses relaying self-reported confidence in being able to make effective use of what had been covered. Taken together, faculty and trainees expressed the perception that these five approaches were feasible, relevant, and effective. Although trainees surprisingly reported widespread use of many of the proposed approaches *before* the faculty had attended the workshop, the use of one or more approaches did increase from 71% pre-workshop to 87% post-workshop. With such high baseline rates of the use of these approaches, it is not surprising that the observed increases in frequency or duration of trainee conversations about RCR were insufficient to demonstrate statistical significance. On the other hand, with the context of the highly positive qualitative responses, a case can be made that adoption of these workshops will help make the case of an institutional commitment to a culture of integrity.

This first attempt to focus on faculty as RCR mentors is characterized by several limitations. One disappointment was the level of faculty attendance at the workshops. Based on experience with other similar workshops, the plan was to maximize engagement by limiting attendance to 15-20 people. This was effectively never an issue. Although it was expected to be possible, albeit challenging, to recruit busy faculty for a full day, or even half day, workshop, it was often difficult to schedule sufficient participation to even run the workshop.

One of the institutions that declined to run a workshop at the time of this project did so because they failed to recruit *any* faculty to participate.

A second limitation was that the low level of faculty participation begs the question of "How do these faculty differ from those who chose not to attend?" Although this question was not addressed by the project's design, some of the findings offer a relevant insight. It was assumed based on the authors' experience of having talked to many faculty at their own institution, as well as faculty at numerous institutions nationally, that outside of courses the proposed approaches were rarely used to meet the goal of better attending to the ethical dimensions of the practice of research. Remarkably, the results of surveying trainees *before* the corresponding faculty attended the workshop indicated high rates of use of the proposed approaches. Over 40% of the trainee respondents indicated that their faculty mentors were using three or more of the five proposed approaches. While it is plausible that some of these answers were based on misunderstandings, such high rates suggest a possible bias in which faculty chose to attend the workshop. These may be faculty already strongly disposed to discuss RCR issues and who are likely strong proponents for RCR mentoring. In that case, the project might be expected to reinforce, or perhaps enhance, existing good practices, but not to otherwise expand the number of research groups in which such conversations occur.

A third limitation is that while response rates were high (43-51%), the number of trainees identified by participating faculty was low (77 for 91 faculty), and in many cases names were not provided until well after the workshop – precluding a pre-workshop survey. It had been assumed in theory that these faculty would typically have multiple trainees, but several factors likely confounded the goal of surveying numerous trainees both before and after the workshop: (1) some faculty did not currently have trainees; (2) many faculty were slow to respond to requests, if at all; (3) e-mail addresses were occasionally incorrect; (4) three trainees explicitly asked to opt out when invited; and (5) grad students and postdocs are transient populations, increasing the likelihood that potential respondents had not arrived in time, or departed the group too soon to participate in both surveys. Taken together with pressures and schedules characterizing the experience of most trainees, response rates were nonetheless remarkably high.

A fourth limitation is the possibility that at least some faculty may have misunderstood the focus on their role as mentors in their research groups rather than in the classroom. In their text responses, several faculty cited application of this material to courses. On the one hand, it is gratifying to consider that this new model might be extended to a domain other than the research environment, for which it was designed. Even so, this does raise a concern that these faculty may be missing the novelty of this proposal and have reverted to what they know: the course model. Assuming this new model is of value, it will be important to ensure that the vocabulary, training materials, and approaches sufficiently emphasize the move from the classroom environment into the research environment.

Taken together, this project represents only one tool that might be useful to promote discussion fostering responsible conduct in research (RCR). The original proposal was based on the assumption that supporting faculty as RCR mentors should complement, not replace, other strategies for promoting RCR education. This distinction is even more important in

light of the discovery that the faculty who participated are few in number, and likely to be those who are already doing much of this. Meeting the challenge to move these conversations into the research environment (Anderson & Louis 1994; Faden et al. 2002; Fryer-Edwards 2002; Institute of Medicine 2002; Anderson et al. 2007; Peiffer et al. 2008; Anderson 2011) remains; this project represents only one strategy. As noted above, the resulting curriculum is now widely available for use on several websites: Online Ethics Center, EthicsCORE, and Resources for Research Ethics Education, and has been adopted for use in several places not only nationally, but internationally.

These results taken together with personal experience and published data prompt suggestions for other tools that might be added to the toolbox for encouraging RCR conversations. (1) Design courses, workshops, and seminars to include components that challenge or require participants to return to their peers and mentors and engage them in discussion. (2) Enlist motivated graduate students and postdocs to generate simple, periodic programs or activities that will prompt such conversations among peers. (3) Empower faculty champions with tools and resources so that they are prepared to advocate for, and expand the focus on, attention to RCR conversations in their disciplines and departments. It remains important to find other ways to shift isolated conversations about RCR and hopefully serve to promote a broader culture of ethics and integrity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Percent of Faculty (Post-workshop), Trainees (Pre-workshop), and Trainees (Post-workshop) reporting: (1) the use of at least one of the proposed approaches during the most recent academic term and (2) the use of three or more of the proposed approaches.

Table 1

Approaches covered in workshops

Approach	Description of Discussion Tools				
Code	Relevant professional code(s) of conduct				
Checklist	Checklist of items to be covered at defined points in the career of trainees.				
Cases	Real or fictional scenarios with ethical dimensions.				
IDP	Individual Development Plan, including roles and responsibilities of trainee and mentor				
Policy	Development of group policy to formalize definitions, roles, and responsibilities for responsible conduct in an area of particular importance to the research group				

Table 2

Number of faculty respondents to post-workshop survey and trainee respondents to pre- and post-workshop surveys. Faculty were given option to identify with multiple disciplines (eight listed two or more); trainees were asked to self-identify with only one discipline.

Discipline	Faculty Post-workshop	Trainees Pre-workshop	Trainees Post-workshop	
Biological Sciences	17	8	19	
Biomedical Sciences	8	5	8	
Computer or Engineering Sciences	10	0	0	
Physical Sciences	10	5	6	
Social Sciences	13	6	6	
Other	4	0	0	

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Table 3

Percent of Faculty (Post-workshop), Trainees (Pre-workshop), and Trainees (Post-workshop) reporting perception that each of the five proposed approaches was used more frequently one-on-one or in a group setting.

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licy		25%	%0	11%		38%	%0()4%
DP Po		91% 2	15%	18% 1		23% 8	12% 10	5 %81
Cases]		39%	38%	30%		79%	75% -	7 %06
Checklist		47%	50%	44%		76%	83%	89%
Code		50%	40%	50%		57%	80%	82%
	ONE-ON-ONE	Faculty (Post)	Trainees (Pre)	Trainees (Post)	GROUP	Faculty (Post)	Trainees (Pre)	Trainees (Post)