

A Qualitative Approach to Responsible Conduct of Research (RCR) Training Development: Identification of Metacognitive Strategies

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Abstract Although Responsible Conduct of Research (RCR) training is common in the sciences, the effectiveness of RCR training is open to question. Three key factors appear to be particularly important in ensuring the effectiveness of ethics education programs: (1) educational efforts should be tied to day-to-day practices in the field, (2) educational efforts should provide strategies for working through the ethical problems people are likely to encounter in day-to-day practice, and (3) educational efforts should be embedded in a broader program of on-going career development efforts. This article discusses a complex qualitative approach to RCR training development, based on a sensemaking model, which strives to address the afore-mentioned training concerns. Ethnographic observations and prior RCR training served the purpose of collecting information specific to a multi-disciplinary and multi-university research center with the goal of identifying metacognitive reasoning strategies that would facilitate ethical decision-making. The extensive

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qualitative analyses resulted in the identification of nine metacognitive reasoning strategies on which future RCR training will be developed. The implications of the findings for RCR training in the sciences are discussed.

Keywords Integrity · Ethics · Scientific misconduct · Training · Sensemaking · Qualitative analysis

Introduction

Progress in the sciences, and public willingness to commit resources to scientific work, depends on the integrity of the research enterprise [60]. Integrity, moreover, may be a critical determinant of the overall effectiveness of research organizations with regard to the production of high quality science and the effective education of the next generation of researchers [54, 90]. However, a number of well-publicized misconduct cases have exposed potential problems with regard to the integrity of the scientific enterprise [67].

Although misconduct studies have traditionally tended to focus on fabrication, falsification and plagiarism, they are thought to be relatively rare events in the scientific community [74]. A more common, and perhaps more pervasive problem, may be found in objectionable research practices such as data hoarding, data trimming, deceptive bids and contracts, and conflicting interests [53].

These problems have been further exacerbated by recent trends in the scientific community. Interdisciplinary approaches have introduced a new level of complexity due to cross-field differences with regard to the identification and management of objectionable research practices. In addition, strong connections between science and industry have placed a new set of pressures on research organizations in terms of conflicting interests, intellectual property rights, and start-up technology ventures. Furthermore, international cooperation and globalization of the scientific enterprise has introduced cross-cultural differences in expectations for ethical conduct [11, 31].

A number of interventions have been used to address the problems posed by these new pressures with regard to objectionable research practices, such as organizational climate interventions [21, 71], revisions of codes of conduct [78], and the development of career management and mentoring programs [80]. One of the most common intervention strategies is Responsible Conduct of Research (RCR) training [20, 22, 61].

A number of prior RCR training courses have been developed on the basis of the underlying assumption that professional integrity is shaped by the decisions that people make when they are faced with complex and ambiguous situations in which ethical considerations are critical [3–5, 18, 23, 32]. Consequently, providing scientists with a framework of ethical decision-making and acceptable professional practices is believed to enhance their research integrity [48, 57, 62, 72]. Some studies have provided evidence indicating that RCR training may enhance ethical decision-making among researchers [2, 5, 17, 57], whereas other researchers suggest that ethics training does not significantly contribute to the ethical decision-making

of scientists [42, 50]. In spite of the positive effects found for a few of these studies, it is still unknown what type of instructional approach to RCR training may have the greatest potential to enhance researchers' integrity.

Prior research has suggested three key factors that are essential in developing an effective education program, where educational efforts: (1) are tied to day-to-day practices in the field [14, 36, 49], (2) provide explicit recommendations, for example reasoning strategies, for working through day-to-day problems encountered [17, 57, 69], and (3) are embedded in on-going career development efforts [77, 79, 81, 91]. To address the afore-mentioned training concerns, this study attempts to develop an ethical decision-making theoretical framework built on specific metacognitive reasoning strategies to help researchers address within-field and cross-field ethical problems and their potential antecedents in the physical sciences and engineering. Qualitative data within the grounded theory framework [33, 34, 75, 76] have been used to identify metacognitive reasoning strategies essential to the ethical decision-making process. Collection of qualitative information during actual RCR training and validation of the collected information in relation to the ethnographic workplace observations is a novel approach to developing RCR training using a metacognitive reasoning strategy framework.

Responsible Conduct of Research (RCR) Training

There have been a number of theoretical models proposed to explain how people interpret a moral issue, make judgments about the correct course of action, and engage in moral behavior [29, 40, 41, 68, 82]. Some researchers claim that ethical decisions are made on the basis of an individual's moral values [66], the level of a person's cognitive moral development [45, 46, 68, 82], or the moral intensity of the experience [41]. Other researchers have promoted a contingency framework by focusing on the severity of consequences determined on the basis of social norms [29, 40].

The most frequently used approaches in ethics education are based on Kohlberg's [45, 46] six moral judgment development stages or Rest's [68] moral reasoning model. These models have demonstrated positive effects on the development of an individual's moral judgment [3–5]. Although moral reasoning models have shown some promise for developing educational programs to enhance ethical decision-making, they are not the only approach that might be applied in RCR training. A large body of research has shown that other basic cognitive processes, such as retrieving, evaluating, categorizing, and synthesizing information are used by people when making ethics-related decisions [73, 84]. Typically, objectionable research practices arise from a poor decision as to how to act in response to a socio-technical problem where multiple competing concerns are operating [89]. Thus, decisions involving ethical research practices could be viewed as a complex, ill-defined problem [30] in which a person must appraise the appropriateness of alternative actions in relation to the guidelines provided by ethical principles and current professional practices [53].

The afore-noted assumptions suggest that ethical decision-making regarding research practices may be understood as a complex form of cognition known as sensemaking [26, 86]. The sensemaking model developed by Mumford et al. [57] is presented in Fig. 1. Typically, in situations leading to objectionable research practices, operative goals are not aligned with ethical principles and professional standards with regard to the work, introducing a sense of ambiguity, conflict, and even crisis, as well as potentially debilitating emotional reactions [37]. Resolution of this ambiguity, conflict and crisis is held to depend on an individual's sensemaking activities [86, 87].

Sensemaking involves the construction and application of a mental model for understanding the origins of a crisis, critical issues involved, and the likely outcomes of alternative actions [1, 26]. The development of the mental model starts with the researcher's initial appraisal of the situation that helps decide whether the problem has ethical implications by considering professional codes of conduct, perceived causes of the situation, personal and professional goals, and perceived requirements for goal achievement [59, 85]. Understandably, this creates a variety of emotions within the person which will determine whether the person will focus on potential opportunities or threats during sensemaking [19, 88]. To find a solution to an ethical dilemma, an individual typically refers to prior experiences by focusing on goals, outcomes, key causes, restrictions, and contingencies that might provide a framework for examining the current situation [16, 39, 44]. The mental model developed on the basis of past experiences is then applied to forecast potential consequences for the self and others [24, 63]. People tend to assess the outcomes in terms of their perceptions of themselves and other people or institutions. The self-reflection results in the selection of the actual mental model applied in ethical decision-making [86]. This mental model, needed for understanding critical causes,

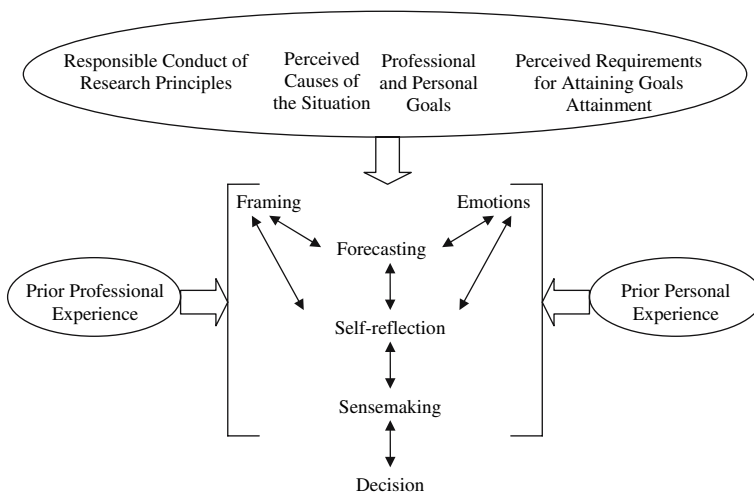


Fig. 1 Sensemaking model of ethical decision-making (Mumford et al., in press)

goals, outcomes, and actions then provides a basis for decision-making and the mental strategies applied in resolving the issue at hand [55].

Regarding the development of research ethics education, this sensemaking model is noteworthy for two reasons. First, it suggests that ethics education will prove most effective when it provides people with a basis for sensemaking by articulating viable professional practices for coping with ethical issues. Second, it suggests that such education should move beyond case discussion to identify the precursors to ethical dilemmas and illustrate the metacognitive reasoning strategies that can be applied to make sense of ill-defined problems people encounter in day-to-day activities [57]. In other words, the strength of sensemaking approach to RCR training lies in providing people with a mental framework for reasoning through a complex ethical dilemma rather than giving them clear-cut answers on what is the right or wrong behavior in a particular situation, especially when the problem is “grey” in nature.

Although studies explicitly examining the development of sensemaking skills are lacking, a number of studies have sought to identify the educational methods most effective in helping people solve complex and ambiguous problems that require sensemaking [25, 51]. Sensemaking and metacognitive strategy application has been commonly studied in relation to the development of creative problem-solving skills—a form of problem-solving involving novel and ill-defined problems [58].

A meta-analysis conducted by Scott et al. [69] indicates that strategy-based training interventions enhance people’s performance in solving complex and ambiguous problems requiring creativity. These findings were supported in an experimental paradigm showing that individuals generate higher quality and more original solutions to complex problems when they are prompted to apply cognitive strategies [70]. Furthermore, Mumford et al. [57] developed and conducted a 2-day strategy-oriented RCR training for graduate students in the social, health, and biological sciences. This training focused on seven types of metacognitive reasoning strategies, such as (1) recognizing one’s circumstances, (2) seeking outside help, (3) questioning one’s own judgment, (4) dealing with emotions, (5) anticipating consequences of actions, (6) analyzing personal motivations, and (7) considering the effects of actions on others. The effectiveness of this training program was assessed using a pre-post design, and showed that strategy application significantly improved students’ ethical decision-making for both immediate and follow-up measures. Other studies by Butler et al. [12] and Mumford et al. [56] also illustrate the utility of a strategy-based approach.

In the context of ethical decision-making, the findings obtained in these studies show that attempts to develop the necessary sensemaking for ethical decision-making should focus on the education of viable professional practice strategies. However, the in-depth understanding of the professional field and the problems researchers face in that particular field are essential to the development of applicable metacognitive reasoning strategies. One approach that has been widely used across multiple disciplines to discover underlying relationships on the basis of which field-specific training could be built is known as the grounded theory approach [33–35, 75, 76].

A Qualitative Approach to RCR Training Development

The grounded theory approach uses qualitative research methods to generate theory grounded in the data collected, rather than forcing data into pre-existing frameworks and testing existing theories [33–35]. Generally, this approach begins with a data gathering phase that comprises such data collection methods as field observations and interviews. Once collected, data are coded and analyzed using multiple frameworks, which then help to categorize the data revealing inherent relationships. Once these relationships are determined, theory or model building can begin [13, 15, 38, 43, 52, 65, 83].

Although data collected during field observations and interviews clearly contribute to specific theory building, these data collection methods are problematic when trying to identify metacognitive reasoning strategies used in ethical decision-making. Metacognitive strategies are implicit in ethical decision-making and are not easily inferred from observable behaviors [69]. In addition, ethics is a sensitive topic which is not usually discussed during daily organizational interactions [47]. Finally, different metacognitive strategies are salient to different fields of sciences, depending on the nature of common research procedures and methodologies used as well as types of social interactions and collaborations built. Given the difficulty in determining which key metacognitive strategies might be of the most use to multiple and often contrasting disciplines, coupled with the possibility that there may be entirely new ethical considerations that have to be accounted for within these different disciplines, the standard approaches of data collection using the grounded theory framework are of limited use in this context.

In the present effort, we attempt to identify metacognitive reasoning strategies through data collection procedures within the ethics-training context and validate them against ethnographic information. In other words, an actual RCR training is used as a tool for extracting metacognitive strategies essential to ethical decision-making. During RCR training, individuals are asked to review a variety of cases followed by group or class discussion. In addition, trainees are encouraged to ask questions and initiate discussion during the training sessions or breaks [22, 61]. The questions or concerns communicated by trainees, as well as common reasoning mistakes observed in relation to case analyses, provide a rich set of qualitative information that aids in identifying metacognitive strategies that might help trainees make better ethical decisions in relation to their discipline and across disciplines. For example, if the majority of trainees argue only from their own perspective and do not consider other individuals in collaboration-oriented case analysis, there is likely a need for training a strategy that covers short-term and long-term consequences for others or considering the potential for personal biases in the situation.

Taking into account the potential utility in applying grounded theory to ethics training development, we suggest that qualitative data gathered from prior training interventions can fruitfully be used as a source for metacognitive strategy identification and future RCR training development using a sensemaking approach. These emergent reasoning strategies are validated against ethnographic data collected using interviews and observation in the trainees' organization to obtain accurate results.

Method

Research Site

The theoretical framework of metacognitive reasoning strategies essential to ethical decision-making was developed in the context of a large, multi-cultural, multi-disciplinary and multi-university research center concerned with the application of remote sensing technology for studies of weather. This 4 year-old research center involved collaboration between industry and three major US universities and one in Puerto Rico. At the time of this study, the research center employed 21 undergraduates, 38 graduate students, 10 postdoctoral fellows and research staff, and 44 faculty members specializing in the fields of electrical engineering, computer science, and meteorology. Overall, non-administrative professional staff in the research center included 26 women and 84 men, of which 12 were from under-represented groups.

A Qualitative Approach to Metacognitive Reasoning Strategy Development

The study took place over an 18-month period in which we used a combination of data gathering approaches, using different methods and analytic stages. The first two stages of data gathering consisted of an ethnographic examination of professional practices prevailing in the research center. In the first stage, two trained ethnographers collected professional life histories at one of the research center branches. The southwestern university was chosen for data collection because of its proximity to the research team. In the second stage of data collection, this same sample was observed with emphasis placed on researchers' day-to-day work practices. The analysis of the initial information revealed ethics-related issues salient to the research center.

Building on the obtained qualitative information, an RCR training program was developed by three psychologists during which specific cases necessary for metacognitive reasoning strategy identification were collected from trainees (Stage 3). Each of the procedures for data gathering and analysis are discussed in the following sections below.

Ethnography

Ethnography is an effective tool in gaining a necessary understanding of an organization's professional practices and common issues. In this study two anthropologists identified the practices and beliefs that may affect ethical decision-making, communication, and collaboration between and among the different universities and disciplines based on a practice theory of everyday social life [7, 10].

Practice theory is prominently used in sociology and anthropology to discover, through ethnographic observations and interviews, the habitus that reflects the

learned habits and daily practices of individuals, groups, or societies [8, 10]. Habitus is made up of internalized schemas (i.e., cases) developed on the basis of individual's prior experiences that are necessary to perceive, interpret, and act in novel situations [7]. Particular forms of habitus are shared by individuals who have had similar formative experiences. For instance, professional disciplines or universities are often comprised of individuals with a shared habitus.

Habitus is not the sole determining factor in the way a person appraises and acts in a particular situation. The context in which the individual is immersed, the specific personal history of an individual, and the habitus to which the individual is familiar all work together to shape individual's choices [10]. Practice theory remains mindful of these variables by incorporating ethnographic observations and interviews to better understand how specific behavior patterns differ depending on the individual and the context [7, 8, 10].

Stage 1: Interviews

Professional life histories were gathered from 17 research center members (students and faculty) via individual semi-structured interviews lasting 60–90 min. All interviews were recorded and later transcribed with no personal identifiers present. Individuals were asked to describe their professional career from when they first entered their field of study to the present. The interviews allowed the ethnographers to better understand the personal context of the participants and how that might affect their ethical decisions and professional practices. More importantly, these interviews helped uncover how accepted professional behavior is instilled upon those entering the field (i.e., how people in a certain field of study come to share a habitus).

Stage 2: Observations

Before implementing the RCR training, the ethnographers spent several hours per week with participants in a variety of professional contexts, including research meetings (student and faculty), conference calls, workshops, classes, discussion groups, as well as luncheons and retirement parties. While the majority of ethnographic data were recorded at a single university, the ethnographers also attended an annual sponsor site visit and a research retreat in which all four universities were represented. Attending these events allowed the ethnographers to observe how research center members from all involved universities and disciplines interacted with one another. Moreover, ethnographers were able to identify competing and overlapping habitus of each discipline by identifying (1) channels of information-seeking across ranks, (2) hierarchical structures existing within and between universities, (3) expected behavior for students and professors, (4) paths of information sharing and blocking, (5) appropriate context and relationships needed for supportive and motivational behavior, and (6) ways interactions occurred across disciplines and universities and their impact on successful collaboration.

Analytic Stage

Through interviews, observations and steady interaction with research center members, ethnographic data were then analyzed to better understand the ethical dilemmas, and the behavioral antecedents to such dilemmas, that are likely to occur in an organization involving multiple disciplines and universities. Analysis of the ethnographic data was carried out by means of discussion between two ethnographers [34, 35].

First, ethnographers categorized the information presented in their field-notes individually and then combined their information after a discussion. Once theoretical categories started to emerge (substantive codification), the information became denser (theoretical codification) which enabled the identification of “core categories” and “basic social processes” (selective codification) [33–35]. The ethnographers then met with the psychologist team to discuss ethnographic findings for the purpose of validating results.

Of note, however, is that while the ethnographers provided a wide range of cases of ethical or unethical conduct and the potential precursors to such behavior, the afore-described methodology was not conducive to identifying specific metacognitive reasoning strategies. Ethnographic observations provided instances of behavior; however they did not provide insights into actual decision-making processes. Therefore, the initial RCR training served as a means of collecting cognitive processes-oriented data that would facilitate the identification of metacognitive strategies applicable to the multi-disciplinary and multi-university research center.

Description of RCR Training

Initial RCR training was conducted at each of the four university sites, prior to the start of the 2007 Spring semester, by two trained psychologists highly involved in training development. All research center members were notified about the training through research center contact people, student leadership, and department heads. Student population was targeted during the recruitment. The recruitment resulted in a trainee sample consisting of 35 undergraduate, graduate, and post-doctoral students (51% participation rate) and seven faculty members and research scientists (16% participation rate) across all four university sites.

The RCR training originally developed by Mumford et al. [57] for the social, biological and health sciences was adapted for the physical sciences and engineering. One researcher in meteorology and another in computer science helped the research team to redevelop the original training materials and assessment measures by tailoring content to address issues applicable to the physical sciences and engineering. The goals of the RCR training were to introduce trainees to the sensemaking model and collect additional qualitative information necessary for metacognitive strategy development that would facilitate ethical decision-making in multi-university and multi-disciplinary research centers in the physical sciences and engineering.

The RCR training was conducted over a 2-day period with 6 h of instruction each day.¹ The course consisted of ten blocks of instruction (see Table 1).

Each module was structured in such a way that both lecture and discussion components addressed major elements of ethical decision-making, such as (1) guidelines and professional codes of conduct, (2) common reasoning errors, (3) broad decision-making strategies, (4) information integration, and (5) final decision-making. Following the lecture and discussion of case studies, a number of interactive exercises (e.g., role-play) occurred encouraging cooperative learning.

Stage 3: Data Gathering During RCR Training

In addition to the presiding psychologists, the ethnographer was also present at the training at southwestern university for observation. The two instructors shared the workload, with one trainer starting the training and the second trainer continuing the sessions after lunch on both days. While one trainer was conducting the training, the other instructor and the ethnographer were taking detailed notes of participants' reactions, behavior, and learning process. Researchers recorded all questions, remarks or comments trainees made during the sessions. The researchers were especially focused on comments made during case analyses, exercises, role-plays, and discussions in individual and group settings. In addition, the written responses provided by trainees in relation to interactive group activities were collected by researchers to make sure the ideas trainees had, but did not necessarily have an opportunity to express orally, were recorded.

Training groups were medium in size (ranging from 5 to 13 people) and trainees were encouraged to express their opinion and actively engage in the learning process. In-depth discussions of a variety of familiar and novel situations presented in cases and exercises enabled trainees to engage in metacognition [6]. This process was further encouraged by feedback given by trainees and instructors. As the majority of cases were developed to address “grey areas” of ethical dilemmas—cases that do not easily lend themselves to a straightforward right or wrong answer—the observation of trainees' problem-solving and decision-making processes often demonstrated either cognitive strategies that were (1) used effectively and led to an optimal solution, or (2) were overlooked or applied inappropriately, leading to a suboptimal decision.

Trainees were also encouraged to interrupt instructors during the presentation or approach them during the breaks or after training to offer their own insight. For example, a sensemaking model being presented was targeted at the individual level of analysis. In their attempts at integrating the various components of the model at the individual level, trainees further extended the model to include group and organizational variables. This kind of elaboration became typical in training, often resulting in the generation of metacognitive reasoning strategies that were more

¹ The RCR training materials are available from the authors upon the request.

Table 1 Summary of RCR training^a

Module	Title	Objectives	Content
1	Application of ethical research guidelines	• Apply fundamental research guidelines in ethical decision-making	• Guidelines packet • Four case studies with questions
2	Complexity in ethical decision-making	• Discuss differences between an ordinary decision-making and ethics-related decision-making • Discuss limitations of rule-based approach	• Self-reflection activity • Pre-training measures • Module 1 case discussion
3	Personal biases influencing ethical decision-making	• Understand the existence of cognitive biases • Identify personal biases in one's decision-making	• Self-enhancement demonstration • Milgram's study video • Behavior predictions activity
4	Common reasoning errors encountered in ethical decision-making	• Identify and generate typical reasoning errors that inhibit decision-making	• Identification of common myths in research ethics • Reasoning error identification • Reasoning error generation
5	Decision-making strategies	• Understand and apply decision-making strategies to address typical reasoning errors	• Case analysis • Strategy generation • Training evaluation: day 1
6	Field specific differences	• Locate one's field specific guidelines • Apply ethical decision-making model utilizing strategies	• Locate field specific guidelines on the web • Two case analyses with questions
7	Sensemaking in ethical decision-making	• Interpret sensemaking model and its importance to ethical decision-making	• Module 6 homework review • Role play activity
Module	Title	Objectives	Cases and exercises
8	Complex field differences	• Understand disparities in ethical decision-making across disciplines	• Field specific guidelines review
9	Outcomes of different perspectives	• Make decisions while considering multiple perspectives (other individuals, institutions, etc.)	• Group case analysis • Case study • Role play activity

Table 1 continued

Module	Title	Objectives	Cases and exercises
10	Key components of ethical decision-making	• Rehearse key components of ethical decision-making • Apply acquired knowledge in testing situations	• Training summary and class discussion • Training evaluation: day 2 • Post-training and personality measures

^a Module 1 is self-directed pre-training; Modules 2 through 5 are presented in day 1 classroom training; Module 6 is self-directed between training days; Modules 7 through 10 are presented in day 2 classroom training

collaborative in nature. Finally, at the end of each day, trainees were asked to provide reactions to the training by completing both Likert-type and open-ended items relating to activities performed during training.

Analytic Procedure

Because the information obtained during RCR training came in different formats, a common framework for data analysis was needed. An open coding system helped to determine the major strategy categories existing in the data. The two instructors and the ethnographer first categorized the information individually and then compared and discussed their respective field-notes to ensure accuracy of considered information.

First, a bottom-up approach was used to identify the core problems—common precursors to unethical research practices—that the research center faced to assist in understanding the social processes that led to the issue at hand. Initially, a substantive codification was performed, allowing for subordinate categories to emerge, followed by theoretical codification to identify superordinate categories [43, 52, 64]. For example, participants mentioned that different university teams were not willing to share data. This statement was linked to another statement that every university team prioritized their projects instead of focusing on the overall center success. These subordinate categories, such as data withholding and self-promotion were ultimately classified under the major problem dimension, *Lack of Collaboration*.

The problem dimensions were developed following criteria predominantly applied in the qualitative research [33–35]. The criteria were as follows: (1) an issue under consideration had to be recorded by each of the researchers—anthropologists and psychologists—during RCR training and ethnographic observations, (2) the same issue had to be recorded no less than five times by each researcher, (3) the same issue had to be recorded several times on different

occasions (e.g., different training days, different training activities, ethnographic interviews, formal and informal conversations), (4) the same issue had to be recorded in reference to different individuals (e.g., students and faculty), (5) the same issue had to be recorded across individuals at different universities making sure the issue was salient across the entire research center, and (6) the issue had to be highly ranked in criticality (i.e., criticality was assessed in terms of frequency of issue occurrence and its importance as communicated by center personnel) by each researcher.

After the core problem groupings were identified, the social-cognitive processes leading to emergence of the identified problem categories were examined, and reasoning strategies to address the precursors to unethical behavior were generated. To develop strategy dimensions, first, all the researchers reviewed their individual field notes and made a list of strategy-oriented statements verbalized by center personnel or observed in their behavior during RCR training and ethnographic observations. Statements reflecting a failure of different groups to work collaboratively towards the common goal that would benefit the entire project rather than individual groups illustrate some of the social-cognitive processes that have been described in relation to conflicting interests. These statements were reworded using active verbs (e.g., consider, assess, apply, etc.) to represent a particular reasoning strategy, such as assessing personal and other people's motives. The generated strategies were later sorted following similar criteria that were applied in relation to problem dimension generation by eliciting only the most salient and reoccurring strategies. In the next step, researchers worked individually in sorting strategies into higher level groupings (e.g., considering others' perspectives). After the strategy groupings were formed, descriptive titles and definitions were generated to distinguish the suggested categories. Consensus was reached on each dimension title, definition, and subordinate categories assigned to each of the major dimensions, eliminating overlap between the strategies across the dimensions (see Table 3 for strategy dimensions). In addition, the researchers made sure that strategies retained original linkages to the problem dimensions determined in terms of frequency of strategy-oriented statements made or observed in relation to a particular problem area. For example, to address frequent miscommunication incidents in the center the largest number of strategies were developed to emphasize importance of considering other people's perspectives.

At this point of the analyses, a thorough literature review on decision-making and problem-solving was performed, which served as an additional tool for the development and contrasting of identified strategies to ensure their distinctiveness (e.g., environment assessment, considering consequences, weighing competing considerations), along with the further generation of metacognitive reasoning strategies to address these processes. Finally, all subordinate strategies were then progressively classified into theoretical strategy categories. For example, the strategies "Considering the potential strengths and weaknesses of the outcomes" and "Thinking about severity of consequences for self and others" were then classified into the overarching theoretical strategy category, "Anticipating Consequences."

Results

Classification

The qualitative analyses performed by two instructors and the ethnographer following the grounded theory framework resulted in the identification of five major issues the research center was facing. The problem dimensions that are common precursors to unethical behavior are as follows: (1) Conflicting Interests; (2) Lack of Communication; (3) Poor Resource Management; (4) Lack of Collaboration; and (5) Poor Publication Practices (see Table 2).

Subordinate metacognitive strategies were then identified to address the problem dimensions and grouped into higher-order theoretical dimensions. Eight key dimensions of strategies are as follows: (1) Looking Within; (2) Assessing Emotions; (3) Questioning One's Judgment; (4) Considering Others' Perspectives; (5) Assessing Situational Demands; (6) Defining "Best Case" Course of Implementation; (7) Anticipating Consequences; (8) Weighing Competing Considerations; and (9) Recognizing One's Circumstances (see Tables 2 and 3).

Conflicting Interests

A number of subordinate problem categories are subsumed under the *Conflicting Interests* dimension. One example is *Conflicting Goals* (see Table 2). During training, some trainees mentioned that there often seemed to be conflicting goals amongst researchers that evidently stemmed from conflicting interests. Strong focus on individual or group's success resulted in the neglect of overarching center goals.

A number of metacognitive strategies were developed: (1) assessing if one's motives are selfish and (2) keeping in mind that people are generally biased in their thinking, and prone to biases. In combination these subordinate metacognitive strategies form the higher-order strategy dimension, *Looking Within* (see Table 3).

Additional strategies found to be important in dealing with conflicting interests include (1) identifying any emotions that may be playing a part in a situation and (2) discussing emotions with others, subsumed under the *Assessing One's Emotions* dimension. Other strategies such as (1) making sure that a decision is consistent with a team or an institution's goals and objectives and (2) considering future actions in relation to decision made are grouped under *Questioning One's Judgment* dimension (see Table 3).

Lack of Communication

The review of the training data point to another problem dimension named *Lack of Communication*. One example is *Lack of Mutual Understanding* (see Table 2). It was noted during the training that researchers often face communication issues due to conflicting mindsets and opinions stemming from interdisciplinary nature of

Table 2 Problem and metacognitive reasoning strategy dimensions

Problem dimension	Training data example	Ethnographic data example	Strategy dimension
1 Conflicting interests	<i>Conflicting goals</i> “Sometimes it seems that many branches of the organization are thinking of what is good for their own projects rather than what is good for the research center as a whole.”	<i>Conflicting opinions</i> “Different universities are contributing to different parts of the product, so who owns the intellectual rights to it?”	1. Looking within • Assessing motives
2 Lack of communication	<i>Lack of mutual understanding</i> “For this project to work our part of the project must be done this way—our partners don’t seem to understand this.”	<i>Lack of information exchange</i> “We often don’t know what they are doing, so when they make certain adjustments to their product, we are not informed about it, and this can result in wrong or redundant product development.”	2. Assessing one’s emotions • Discussing emotions with others 3. Questioning one’s judgment • Considering if the decision is consistent a team or an institution’s goals and objectives 4. Considering others’ perspectives • Being mindful of others’ goals

Table 2 continued

Problem dimension	Training data example	Ethnographic data example	Strategy dimension
3 Poor resource management	<i>Unfair resource distribution</i> “The overall budget is allocated by a particular university; if one branch of the research center exceeds the budget, then other branches need to cut their budget—it doesn’t seem fair.”	<i>Unfair resource distribution</i> “The budget is reshaped annually to allow room for adjustments, but it also leaves us with a lack of security.”	5. Defining “best case” course of implementation Accounting for constraints and obstacles
4 Lack of collaboration	<i>Data withholding</i> “We are having trouble getting the data (from other branches) that we need to do our jobs, and this appears to be because they are withholding it for some reason.”	<i>Silo mentality</i> “From the beginning of this project, people from different disciplines have had their own ideas of what we can feasibly do; it can become frustrating when these differences interfere with progress.”	6. Assessing situational demands - Having a broad picture of the issue 7. Weighing competing considerations - Contrasting decision variables
5 Poor publication practices	<i>Lack of overarching publication rules</i> “There is no set standard to determine how to rank authorship—or even where to publish—between some of the disciplines involved in the research center.”	<i>Disagreement regarding other’s publication rules</i> “When collaborating with so many people on a project, there is often a debate as to who should be an author. Some people don’t want a lot of names, others don’t mind, but the final decision can create friction which did not previously exist.”	8. Anticipating consequences - Thinking about long-term consequences 9. Recognizing one’s circumstances - Determining expertise needed

Table 3 Metacognitive reasoning strategy dimensions and subdimensions

Dimension	Definition	Subdimensions
1	Looking within Considering one's personal biases, values, beliefs and goals	• Assess if your motives are self-centered or others-oriented • Assess if the decision is consistent with your values and beliefs • Assess if your decision is free from biases • Assess your personal strengths and weaknesses • Keep in mind that the decisions you make define your life as you live it now and what it will become • Consider your opinion of yourself as compared with those people that you respect • Do not ignore your emotions, but do not let them rule you either. Use emotions as a source of information for decision-making
2	Assessing one's emotions Assessing and regulating emotional reactions to situations	• Identify what emotions you are experiencing (e.g., guilt, insecurity, confusion, etc.) • Examine the event or situation in detail to understand what situational factors have caused the emotional state • Share and discuss your emotions with others • Express your emotions constructively when communicating information or your opinion to others • Be cautious if your gut feeling is telling you that your decision is wrong. Reconsider your decision and actions to see if there is an alternative solution. You may want to discuss the situation with other people if you have "a bad feeling" about your decision or situation

Table 3 continued

Dimension	Definition	Subdimensions
3	Questioning one's judgment	Considering common reasoning errors in ethical decision-making • Take time to think about your decision before acting • You may not have all the information, so do a thorough information search • Explore alternative solutions • Consider how controversial your decision is • Consider the value of a compromise • Think about your future actions in relation to the decision made • Consider if your decision is consistent with your group's beliefs and values • Consider if your decision is consistent with institutional norms and requirements • Consider if your decision is consistent with ethical guidelines and social norms • Be mindful of others' goals, obligations and time commitments
4	Considering others' perspectives	Being mindful of other people's goals, responsibilities, and concerns • Be mindful of how people involved are connected with one another • Be mindful of how others will interpret your actions • Forecast other people's reactions in relation to the situation • Directly or indirectly ask for other people's opinion on the issue if you cannot forecast their reactions • Consider how you will explain your actions to your peers, subordinates, supervisors, sponsor, cooperator, or public • Consider if your actions are just and fair towards others

Table 3 continued

Dimension	Definition	Subdimensions
5	Assessing situational demands	Thinking about factors in the environment that facilitate or constrain individual's choices and behavior • Make sure you have a broad picture of the issue • Review individual, group, and organizational mission statements • Make sure you understand the true cause of the problem • Research into what others have done in similar situations • Assess important organizational factors such as organizational climate and culture (e.g., in-group vs. out-group) • Consider prevailing values in the organization • Consider appropriate channels in obtaining lacking information • Consider credibility of obtained information • Consider all key players and their vested interests
6	Defining "best case" course of action implementation	Thinking about factors that will help or prevent from implementing the decision • Consider the feasibility of the decision in terms of financial constraints, current and future obstacles • Make sure you have organizational support • Consider the most effective communication channels • Consider all possible solutions and alternatives • Generate back-up plans

Table 3 continued

Dimension	Definition	Subdimensions
7 Anticipating consequences	Thinking about consequences for others, and short-term and long-term outcomes based upon possible decision alternatives	• Think about the consequences for yourself • Think about the consequences for others: peers, team, institution, sponsor, and public • Think about magnitude and severity of consequences for self and others • Think about the short-term and long-term effects of what you do • Consider the potential strengths and weaknesses of the outcomes of your decision • Sort through all the relevant and irrelevant information
8 Weighing competing considerations	Assessing pros and cons of potential decisions by examining the importance of each piece of information	• Search for additional information if necessary • Contrast each of the variables with each other and determine ranks of importance to you personally and others • Weigh the importance of each variable carefully • Consider contextual variables in relation to your situation, such as your job role, your position in the organizational chart, your future career goals, etc. • Consider direct and indirect threats and opportunities the situation poses to you personally, your in-group, and institution • Consider if you have the necessary professional expertise and/or personal experience to solve the problem • Consider sources of potential help
9 Recognizing one's circumstances	Thinking about one's position and decision-making capacity in the situation	

research. The researchers often fail to understand the challenges that other research groups are facing within their respective domains.

The strategies meant to address this issue include (1) being mindful of other's goals, obligations, and time commitments, (2) being mindful of how others will perceive one's actions, and (3) considering the fairness of one's actions in relation to others. In combination these strategies form *Considering Others' Perspectives* dimension (see Table 3).

Poor Resource Management

The third problem dimension extracted from the training data is *Poor Resource Management*. One example is *Perceptions of Unfair Resource Distribution* (see Table 2). The data show that researchers have disagreements regarding the fairness of the way the resources are distributed within the center. Many of these disagreements stem from poor planning for the implementation of center decisions, with some researchers or groups left unaccounted for.

A number of strategies developed to remedy this situation include (1) considering all key players when implementing a center decision, (2) considering the feasibility of the decision by accounting for restrictions and contingencies, and (3) considering alternative solutions and back-up plans. These strategies are grouped under *Defining "Best Case" Course of Implementation* dimension (see Table 3).

Additional strategies relevant to addressing poor resource management include (1) making sure one has a broad picture of the issue and (2) assessing important organizational factors, such as current political and social climate. These strategies fall under *Assessing Situational Demands* dimension (see Table 3).

Lack of Collaboration

A number of problem categories are subsumed under a *Lack of Collaboration* dimension. One example is *Data Withholding* (see Table 2). Trainees mentioned that researchers were often withholding data, and thus were inhibiting overall project progress. The data show that the root cause of data withholding might be conflicting interests. Researchers might be inappropriately prioritizing their own concerns over that of the collaborative effort.

Strategies developed to address this issue are as follows: (1) asking participants to weigh the importance of each variable within a decision carefully and to further think about the outcomes, losses, and gains, and (2) contrast each of the variables within a decision with all other variables and determine ranks of importance. In combination, these strategies form the *Weighing Competing Considerations* dimension (see Table 3).

Additional strategies important in addressing a collaboration problem include (1) considering short-term and long-term consequences and (2) thinking about the severity of any consequences of decisions for self and others. These strategies are subsumed under *Anticipating Consequences for Self and Others* dimension (see Table 3).

Poor Publication Practices

The final problem dimension extracted from the training data is *Poor Publication Practices*. One example is a *Lack of Overarching Publication Guidelines* (see Table 2). As explained by trainees, disagreements in relation to authorship are founded on differences of professional expertise and discipline.

Strategies developed to remedy this issue include (1) self-assessing one's own level of expertise and experience, and then determining if one has the requisite expertise and experience to effectively deal with the issue at hand and (2) determining whom one could ask for help or advice. These strategies are classified under *Recognizing One's Circumstances* dimension (see Table 3).

Validation

As mentioned previously, ethnographic information was collected for the validation of data obtained during the RCR training. Upon review of the field-notes, it was found that the themes emerging from the ethnographic data corroborate the training findings. As in the training data, the problematic themes included *Conflicting Interests*, *Lack of Communication*, *Poor Resource Management*, *Lack of Collaboration*, and *Poor Publication Practices*.

The participants in this study came from several different universities, disciplines, cultural backgrounds, and professional standings; thus, it is not surprising that one of the major themes found in the ethnographic field notes was *Conflicting Interests*. With each university contributing to different parts of the project, researchers were curious as to who would ultimately own the intellectual rights to the different project components. The high number of potential key players—individuals, research teams, departments, industry partners, and other research organizations and universities, all with vested interests—made this topic salient. The ethnographic data strongly support the training findings, suggesting that problems related to conflicting interests stem from protecting interests of one's in-group rather than focusing on the well-being of the entire center.

Clarifying the issue of intellectual rights is often a matter of proper communication between different universities and hierarchical levels that make up an organization. Poor communication can lead to unnecessary work or redundancies which can be financially, temporally, and emotionally costly. For example, a research team was caught off-guard at a professional meeting when it was announced that a collaborating team had made a significant change to the project product. This particular alteration directly affected the work of a collaborating team. Had the information reached the team sooner and more directly, the time and effort to make changes to their work would have been expedited. This data lend further support to the training findings on *Lack of Communication*.

Equally important to research center success is proper resource management. It was noted that the budget for the research center was reshaped annually to allow for needed adjustments. Although this process provided the center with much-needed flexibility during turbulent financial times, it also had the unintended effect of

leaving many research center members with a lack of funding security. The researchers voiced concern about methods of resource allocation and potential conflict that might hinder the collaborative aspect of the project. These examples further corroborate training findings on *Resource Management* in relation to perceptions of fairness in fund distribution.

Feelings of unfairness can lead to a *Lack of Collaboration*. As each university specializes in a different field of physical sciences and engineering, a collaborative effort is essential for the project's success. A lack of understanding of other fields and their capabilities, coupled with poor attempts to work together on overall designs, led to product development complications. When the final products were developed and put into use, the product worked well for some, but it was difficult for others to utilize given the discrepancies created by miscommunication. As one member of the organization stated, "From the beginning of this project, people from different disciplines have had their own ideas of what we can feasibly do. It can be frustrating when these differences interfere with progress." Clearly, not making an attempt to resolve differences between disciplines can be detrimental to the collaborative process.

When collaborations are successful and a project is completed, the results often lead to publication generation. Unfortunately, this also often leads to *Poor Publication Practices*. Within the research center the combining of several individuals on a single project led to debates as to who should be listed as an author. Some co-authors were dissatisfied with numerous authors, while others accepted it as typical protocol. These debates and final decisions created tension among colleagues and potentially halted some future collaborative opportunities. The ordering of authorship is also a common point of contention among members, especially between students and their professors. Students generally remain either unaware of what is considered appropriate ordering or are apprehensive to question their professor's decision. As related previously during training, problems with publications extended even beyond who to include as an author—they were also concerned with how to rank the authors and where to publish when more than one discipline is involved.

Conclusions and Implications

Before discussing the broad implications of these findings, the limitations of this study should be addressed. To begin, difficulties were experienced in applying grounded theory in this particular study. The greatest challenge was the generation of data derived from conversations. Grounded theory uses dialog as the object of the study rather than an instrument in research [13]. Given the difficulty of obtaining a high quality discourse in a large training session, the grounded theory approach could not be strictly applied here.

Furthermore, a tendency to use logical elaboration by researchers in relation to obtained data often leaves grounded theory behind. Therefore, the accuracy of the findings is determined by the theoretical sensitivity of researchers who are expected to objectively identify relationships between the data points and aggregate them to

higher-level constructs [33]. Due to the qualitative nature of the study the findings could not be validated using quantitative analytic methods.

In addition, the metacognitive reasoning strategies derived through this research were identified on the basis of the information that trainees volunteered to share during the RCR training. The sample (mainly graduate students) has limits here, since certain ethical issues related to research centers may have not been addressed due to students' lack of familiarity with higher-level research center issues (e.g., politics, leadership practices). Therefore, as the provided list of strategies is not exhaustive, researchers and training instructors should collect additional information on reasoning strategies to expand the proposed list of strategies by paying a special attention to higher-level organizational issues.

The final limitation pertains to external validity. The RCR training here was conducted in a multi-cultural, multi-disciplinary and multi-university research center that focuses on research in physical sciences and engineering—the results of which might not be easily generalizable to other research centers (e.g., social or biological sciences). In spite of the overarching nature of the metacognitive strategies, certain issues, such as lack of communication, might be more prevalent in collaborations built between representatives of physical sciences rather than social sciences [9]. Furthermore, ethnographic observations were only performed at one branch of the research center, which also somewhat hampers the generalizability of the findings. Consequently, future research should take a systematic approach to the identification of metacognitive strategies in different research center samples to develop an overarching taxonomy of strategies that facilitate ethical decision-making in professional settings.

Bearing these limitations in mind, the findings of the present study have some noteworthy implications. The major objective of this research was to develop a comprehensive framework of metacognitive strategies applied in sensemaking when an individual is faced with a complex ethical dilemma. The conceptualization of ethical decision-making within a sensemaking framework is founded on the application of a variety of metacognitive strategies [57]. This study introduces a new perspective in ethical decision-making theory applied in the development of RCR training interventions.

The implications of the present study for ethical decision-making are based on the assumption that ethical decision-making is a dynamic process which occurs in highly dynamic contexts [30, 62]. Holistic methodologies, such as grounded theory, can provide insight into these cognitive processes [33–35, 75, 76]. More importantly, an application of grounded theory to data collected through several different methods, such as the collection of ethnographic data and qualitative data obtained during an actual RCR training, has now been shown to assist researchers in developing global, more complex and deeper insights into how different cognitive processes operate. As ethics is a sensitive topic and people often do not feel comfortable discussing ethical issues related to them personally or their organization at the workplace the potential for rich and accurate data collection using traditional interviewing or observational methods is limited. Prior research has attempted to identify cognitive processes using a think-aloud protocol [27, 28]. However, thinking-aloud in relation to a given scenario does not necessarily reflect

actual decision-making and its complexity in naturalistic settings, which may require the generation of more complex and diverse metacognitive strategies.

In addition, organizations rely on a number of methods for promoting integrity in research, such as developing ethics-oriented organizational policies and regulations, educating employees on responsible conduct of research, establishing ethics-oriented criteria for rewards and recognition, and developing processes for evaluation of institutional behavior [79]. Therefore, organizations could potentially apply the methodology discussed in the study as a part of institutional self-assessment to ensure the integrity of the research process and foster a work environment that favors responsible conduct of research.

Finally, different cognitive strategies are critical to different fields of sciences, and are dependent on the nature of common research methodologies and procedures used, as well as types of professional collaborations built. As it is difficult to determine beforehand what key ethical decision-making strategies might be critical to multi-cultural, multi-disciplinary and multi-university types of collaborative research efforts without first understanding the nature of these collaborations and the issues that they face, standard approaches of data collection are limited. Consequently, the present study proposes a novel approach to data collection by using prior RCR training as a framework for obtaining rich information on prevailing ethical issues and their antecedents within research centers.

The goal of the present study was to identify critical issues within a multi-disciplinary and multi-cultural research center. The recurring concerns recorded during the 2-day RCR training were classified into the following dimensions: (1) Conflicting Interests, (2) Lack of Communication, (3) Poor Resource Management, (4) Lack of Collaboration, and (5) Poor Publication Practices. The dimensions generated using training data were validated using ethnographic information that demonstrated considerable overlap between the dimensions.

The identification of problem areas provided a comprehensive framework for the generation of metacognitive strategies implicit in the obtained qualitative information. Consistent with the prior literature in complex problem-solving and decision-making [24, 30, 55–57], the following list of strategies was generated: (1) Looking Within, (2) Assessing One's Emotions, (3) Questioning One's Judgment, (4) Considering Others' Perspectives, (5) Assessing Situational Demands, (6) Defining "Best Case" Course of Implementation, (7) Anticipating Consequences, (8) Weighing Competing Considerations, and (9) Recognizing One's Circumstances. The identification of metacognitive strategies is noteworthy for both theoretical and practical reasons. Practically, prior RCR training programs have focused on providing knowledge of basic guidelines. Familiarity and understanding of field-specific guidelines is important; however, knowledge of guidelines may not be sufficient in addressing complex and ambiguous real world situations which do not have a clear "right or wrong" answer [53, 74]. Alternatively, a training approach underlying a sensemaking model [57] has been developed to introduce researchers to the ambiguities of real-life ethical dilemmas with the use of metacognitive strategies applied as a cognitive tool. This tool could help researchers work through ethical problems systematically and potentially substantiate the achievement of an ethical decision.

Subsequently, the findings of the present study demonstrate a new direction for research in ethical decision-making and RCR training. The metacognitive strategies demonstrate the complexity of the underlying cognitive mechanisms that shape ethical decision-making. Therefore, future research should examine the identification and application of metacognitive strategies by explicitly focusing on the processes that enhance ethical decision-making.

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