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Team-Based Learning Instruction for Responsible Conduct of Research Positively Impacts Ethical Decision-Making

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Abstract

Common practices for responsible conduct of research (RCR) instruction have recently been shown to have no positive impact on and possibly to undermine ethical decision-making (EDM). We show that a team-based learning (TBL) RCR curriculum results in some gains in decision ethicality, the use of more helpful meta-cognitive reasoning strategies in decision-making, and elimination of most negative effects of other forms of RCR instruction on social–behavioral responses. TBL supports the reasoning strategies and social mechanisms that underlie EDM and ethics instruction, and may provide a more effective method for RCR instruction than lectures and small group discussion.

Keywords

responsible conduct of research; ethical decision-making; team-based learning

INTRODUCTION

Responsible conduct of research (RCR) training programs have become widespread in biomedical science PhD and postdoctoral training programs, in part due to RCR training requirements for research trainees funded by the National Institutes of Health (NIH) and National Science Foundation (NSF). The effectiveness of RCR training is called into question when one considers that ~2% of scientists admit to committing at least one act of research misconduct and 33% admit to questionable research practices (Fanelli, 2009). Furthermore, the number of retracted scientific papers has increased dramatically over the past 6 years, with 67% of retractions due to research misconduct (Fang *et al.*, 2012). It is unclear whether this observation reflects an actual increase in research misconduct, perhaps driven in part by today's intensely competitive research environment (Casadevall & Fang, 2012), or is simply due to increased awareness and recognition of misconduct, driven in part by RCR training programs.

As reviewed by Steneck & Bulger (2007), there has been little consensus on best practices for RCR education and training, or for assessing the quality of RCR instruction and its impact on research behavior. Although researchers may be tempted to commit research misconduct for a variety of reasons at all stages of their careers, the trainees that are most subject to RCR training may be particularly vulnerable to the pressures of attaining an advanced degree, publishing their research, and entering an extremely competitive job market. RCR training is expected to lead to increased awareness about research misconduct

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and lower rates of misconduct by trainees, but that does not appear to be the case. Analysis of annual reports from the U.S. Office of Research Integrity (ORI) from 1994 to 2011 and 2012 case summaries (http://ori.dhhs.gov) reveals that during the first half of this time period, 33% of all research misconduct findings involved student or postdoctoral trainees, and during the second half of that time period 50% of all such findings involved trainees (data not shown).

Nine core instructional areas originally proposed in the 2000 Public Health Service policy statement (data management, mentor/trainee responsibilities, publication/authorship practices, peer review, collaboration, human subjects, animal research, research misconduct, and conflicts of interest and commitment) are often used to guide the content of RCR training to meet NIH and NSF requirements. Institutions are ultimately responsible for choosing the teaching methods to be used, although the NIH does provide guidelines: "Substantial face-to-face discussions among the participating trainees/fellows/scholars/participants; a combination of didactic and small-group discussions (e.g. case studies); and participation of research training faculty members in instruction in responsible conduct of research are highly encouraged" (NIH Notice NOT-OD-10-019). Furthermore, NIH guidelines recommend "substantive contact hours ... at least eight contact hours", and online-only training is acceptable only for short-term training programs.

A recent consensus panel report by DuBois and Dueker (2009) recommended changes to the core areas of RCR content, including two new areas (social responsibilities of researchers and current issues in RCR) and changes to RCR instruction assessment to create "a culture of ethics and integrity that goes beyond minimum compliance or risk management." One way this may be accomplished is by tailoring RCR training to specific populations (Kalichman, 2007). A Council of Graduate Schools report (2009) recommended a tiered approach to RCR training, emphasizing that training for graduate students must be directly relevant to their experience. Similarly, DuBois and Dueker (2009) suggested that formal training programs for graduate students "might be less comprehensive even as they are more relevant and engaging, perhaps focusing more on the development of higher-order skills."

Despite ongoing discussion within the RCR education community and these recommendations, there is little evidence that most common RCR education efforts are effective. In an evaluation of graduate students in health-related disciplines, Schmaling and Blume (2009) reported that students demonstrated increases in RCR knowledge, but not moral judgment, following an RCR course. Although limited by the necessity of aggregating instructional effects across a variety of different outcome measures, meta-analyses of ethics instruction in science and business revealed minimal to moderate effectiveness (Antes *et al.*, 2009; Waples *et al.*, 2009). The test of ethical decision-making (EDM test) developed by Mumford and colleagues (2006) may provide the most relevant measure for assessing RCR training effectiveness, and has been used in studies across many types of RCR instruction. The EDM test has the advantage of focusing on behavioral outcomes rather than learning outcomes such as knowledge, skills and attitudes. If the ultimate goal of RCR training is to influence future research behavior and prevent research misconduct, it is reasonable to suggest that assessing a proximal outcome such as ethical decision-making would be most relevant. The EDM test examines four key behavioral domains of research ethics, including data management, study conduct, professional practices, and business practices (Helton-Fauth, *et al.*, 2003). Furthermore, alternative scoring scales allow the assessment of meta-cognitive reasoning strategies and social-behavioral responses that are involved in ethical decision-making.

Using the EDM measure, Mumford and colleagues (2008) demonstrated the effectiveness of the sensemaking approach to RCR training, which emphasizes the importance of making

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sense of ethical problems before making a decision, taking into consideration such issues as perceived causes, personal and professional goals, recognizing ethical implications, and emotions produced by ethical dilemmas. Using a pretest/posttest comparison at the beginning and end of RCR instruction, significant positive gains were observed in all four domains of decision ethicality and all seven dimensions of metacognitive reasoning strategies (Mumford *et al.*, 2006). However, a subsequent nationwide study of RCR courses at 21 research institutions revealed that the more common methods of RCR instruction have either no impact or a negative impact on decision ethicality, and have a negative impact on many metacognitive reasoning strategies and social/behavioral responses (Antes *et al.*, 2010). These RCR courses were typically semester-long, aimed primarily at biomedical science graduate students, covered all nine ORI content areas, included both individual and group work, involved moderately complex case discussions and some consideration of solving ethical problems.

In addition to receiving informational content, students should actively engage in discussions about shared ethical values and, most importantly, practice EDM skills using a structured framework (Kalichman, 2007). We hypothesize that most other RCR courses do not have the same positive impact on EDM as the sensemaking approach because most small group discussions in graduate courses are typically not well structured and do not hold students accountable for coming to class prepared to engage in meaningful discussion. We propose that the team-based learning™ (TBL) method developed by Larry Michaelsen and colleagues (Michaelsen *et al.*, 2004, 2008) will provide the necessary engagement in RCR training to have a more positive impact on ethical decision-making than traditional lecture, online, and/or small group teaching methods. TBL is an instructional format that was originally developed in business education, but has been used increasingly in a wide range of disciplines and levels of education, including high school, undergraduate, graduate, and professional education (Michaelsen *et al.*, 2004, 2008; Haidet *et al.*, 2007; Parmelee & Michaelsen, 2010). There is accumulating evidence the use TBL results in improved academic performance compared to other forms of instruction, especially in medicine (Goldberg & Dintzis, 2007; Koles *et al.*, 2010; Zingone *et al.*, 2010) and in pharmacy (Letassy *et al.*, 2008; Persky, 2012). The teaching of medical ethics also benefits from a TBL format, as one study showed increased student satisfaction (Kim, 2008) and another study found improved student performance (Chung *et al.*, 2009), although ethical decision making was not assessed.

TBL allows multiple teams of 5-7 students each to work in parallel within a single room, facilitated by one or more instructors, and with a total class size that may range from dozens to hundreds. TBL combines the interactivity of small-group collaborative learning with the efficiency of large group teaching, and incorporates key design elements to foster engagement with course content and with teammates. Constructive controversy allows teams to make decisions about real-world problems, and use course concepts to work collaboratively as an entire class to address disagreements and discuss alternative solutions to the problem. TBL creates open, safe discussions in the classroom environment, and gives learners experience working with, acknowledging, and managing the uncertainty of complex problems. TBL uses repeating cycles of learning to move students from exposure, to acquisition, to the application of course concepts (Michaelsen *et al.*, 2004, 2008).

In this report we provide the first evidence that use of TBL for RCR instruction engages biomedical science trainees sufficiently to result in positive gains for one dimension of decision ethicality and most dimensions of meta-cognitive reasoning strategies and social-behavioral responses.

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METHODS

Institutional Approval

The structure of the RCR course and use of EDM data for this were reviewed and approved by the University of Florida Behavioral/NonMedical Institutional review Board (IRB02) under protocol #2011-U-1271. EDM tests were coded using the method of Yurek *et al.* (2008) for learner generation of easily reproducible ID codes that cannot be reverse-identified, allowing matching of pre-test and post-test results while preserving student anonymity.

Participants

Course attendees included 33 first-year biomedical science Ph.D. students, one biomedical science M.S. student, six Ph.D. students from other health-related graduate programs (biomedical engineering, food science, health & human performance, and veterinary medicine), two postdoctoral fellows, and one faculty member (43 total).

RCR Course Format

The course consisted of ten 1.5-hour instructional sessions, with an introductory lecture about the need for RCR instruction, an introduction to ethical decision-making and to TBL, and team formation, followed by nine TBL sessions emphasizing content from each of the nine ORI content areas. The three phases of TBL are preparation, readiness assurance, and application (Figure 1). The specific application of TBL for RCR instruction is detailed below according guidelines recommended by Haidet *et al.* (2012) for reporting TBL activities in education literature.

Team Formation

Seven teams of 5-6 learners each (41 total) were formed by asking female students to line up based on the amount of their previous research experience, followed by a similar lineup of male students. Students then counted off 1 thru 6, 6 thru 1, *etc.* to evenly distribute the intellectual resource deemed to be most important by the course director (WTM), *i.e.*, research experience, and to ensure a female/male balance across teams.

Learner Preparation

To prepare for each TBL session, learners must assimilate knowledge beforehand, and this is often accomplished via self-learning. Learners were provided with ample resources for self-learning, including assigned readings from the free on-line textbook “ORI Introduction to the Responsible Conduct of Research” (Steneck, 2006). In previous versions of this course interactive faculty lectures were alternated with TBL sessions, but student feedback via course evaluations revealed that TBL sessions were preferred over lectures. Rather than scheduling class time for lectures on the ORI topics, videotaped lectures from a previous year or voice-over PowerPoint presentations are now made accessible to all students via a course management system. The faculty members serving as co-facilitators of the TBL sessions also served as the “lecturers” for these online lectures. There was no tracking of student reading or lecture viewing. Other options that may be considered to support learner preparation include the use of alternative RCR and/or research ethics textbooks, other interactive lecture or discussion sessions, and/or online learning modules.

Readiness Assurance Process

The first in-class activity of each TBL session was a closed-book readiness assurance test (individual RAT, or iRAT), with answers recorded on Scantron forms to allow efficient scoring after class. The iRATs were comprised of ten multiple-choice questions relevant to

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each module, based on the reading assignments and lecture material, and designed to have one best answer. The iRAT holds students accountable for coming to class prepared through gaining a knowledge base that is the foundation for application exercises.

The second in-class activity was a closed-book team RAT (tRAT), in which teams answered the same 10 RAT items as a team, which promotes cooperative learning and team-building. Students used an Immediate Feedback Assessment Technique (IF-AT) “scratch-off” card (Epstein Educational Enterprises) to record their team answers. Rectangles for answer choices A-D on the IF-AT cards have a thin opaque covering similar to a lottery ticket, which students scratch off to determine whether their answer is correct, indicated by the presence of a star somewhere within the rectangle. Finding the star on the first attempt earns full credit, with subsequent attempts resulting in lower credit each time (*i.e.*, 4 points full credit, 2 points for second scratch, 1 point for third, and 0 points if all four boxes are scratched off). Use of the IFAT card incentivizes students to work together to arrive at the best answer to earn the most points possible. At the conclusion of the team RAT, teams could raise issues that were unclear in the RAT, and teams that disagreed with the instructor's correct answer were allowed to submit an appeal within 24 hours, with a written justification for their answer. No more than 25-30 minutes total was devoted to the readiness assurance process.

Application Exercises

Application exercises are based on complex cases and are designed to promote deep thinking, content-focused discussion about ethical dilemmas, and ethical decision-making. Key TBL principles for the design of application exercises to engage students and provoke rich discussion are described by the “4 S's”. (1) Students considered *significant problems* based on real-life scenarios. Application exercises were adapted from cases available from other web-based RCR resources by writing a series of 8-10 multiple choice questions raising ethical issues related to the case. Answer choices varied in their level of ethicality, and sometimes more than one acceptable choice was provided. Whenever possible, scenarios were written or adapted to include graduate students and/or postdoctoral trainees, in order to make the situations more relevant to the learners. (2) All teams worked on the *same problems* at the same time, so all teams could participate in an inter-team discussion in which consensus was usually reached by the class. (3) Teams made *specific choices* in response to very specific questions. Teams were required to commit to a single answer choice, and to be ready to defend their answer during the inter-team class discussion. (4) *Simultaneous reporting* from all teams was accomplished during the inter-team class discussion by having a team representative hold up one of four flash cards labeled A thru D on different color card stock. (Note: We have since migrated to using an audience response system for simultaneous team reporting.)

Typical team responses to application questions involved multiple answer choices being revealed, which provided opportunities for rich discussion to explore the reasons why different teams chose different answers, exploration of assumptions made about the characters in the scenario, and different conditions under which different answers might be the best. In summary, within each TBL module students cycled through engaging with course content via self-learning, working within their team and then across teams (*i.e.*, whole class) to learn from each other and develop confidence in their abilities to discuss complex issues, work in teams, and practice ethical decision-making.

Incentive Structure

As described above, use of the IF-AT card for tRAT scoring incentivizes teams to work together to find the one best answer for RAT items, which fosters team development.

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Additional incentives to support teamwork were built into the course grading scheme. The RCR course was letter-graded, with final student scores determined by their average individual and team performance on the RAT (90% total), plus points awarded for completing the EDM pretest and posttest (5% each). Relative weighting of the iRAT and tRAT scores was determined by a class vote after several TBL sessions. By that time students recognize that tRAT scores are always higher than iRAT scores, which sends a powerful message to them about the benefit of working in teams, fostering continued team development and buy-in for TBL. Students were allowed to weight the iRAT and tRAT within a range of 30% to 60% each, and the final weightings based on the class mean responses were 34% for the iRAT and 56% for the tRAT. Final letter grade cut-offs were set in a way that made it mathematically possible to earn an A without completing the EDM tests.

Peer Feedback

Students were provided an opportunity to provide formative peer feedback after several TBL sessions to help ensure that students were coming to class prepared and were participating in the team discussions. We used a modified form of the method described by Michaelsen *et al.* (2004), in which students were asked to assign teammates a score based on the extent to which they believe each teammate contributed to the team's learning. For example, for a 7-person team, each student divided 60 points among their 6 teammates within a range of 5-15 points each, and students could not simply assign every teammate 10 points, *i.e.*, they were forced to discriminate among teammates (Levine, 2008). The overall score for an individual is based on the average peer score. Students also had an opportunity to provide qualitative comments structured around 1-3 questions: what could this teammate start doing to help the team learn better, stop doing because it wasn't helping the team learn, and/or continue doing because it is really helping the team learn.

Ethical Decision-Making Test

This study used the same version of the Health EDM test as was used by Antes *et al.* (2010), which consisted of a pre-test and post-test, each comprised of 18 questions based on 12 research scenarios. For each ethical problem, test-takers were asked to select two of eight possible answer choices as the best responses to the scenario. As described by Antes *et al.* (2010), each response was coded for low, moderate or high levels of ethicality, scores were averaged for the two responses for each item, and mean scores for subsets of questions were aggregated to provide scores for the four dimensions of ethicality. Similarly, alternative scoring keys using 7-point scales were used to calculate average item scores and aggregate scores representing seven domains of meta-cognitive reasoning strategies and seven domains of social-behavioral responses.

Statistical Analysis

Forty-two EDM pretests and 40 EDM posttests were available for the analysis of pre/post changes in the four domains of ethicality scores, seven dimensions of meta-cognitive reasoning strategies, and seven dimensions of social-behavioral responses. From the starting class of 43 learners, two students did not complete the course and one opted out of the research study. Data are presented in a fashion analogous to Antes *et al.* (2010) for comparison purposes, including mean scores, standard deviation, and the Cohen d statistic to describe the magnitude of the effects of instruction. Cohen's d was calculated as the mean difference between pretest and posttest scores divided by the standard deviation of the differences. P values were calculated using the Wilcoxon signed-rank test. A level of significance of 0.05 was set for all testing.

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RESULTS

Readiness Assurance Tests

In addition to holding students accountable for coming prepared to engage in discussion, the RATs provide a measure of learning for the knowledge base of RCR training. Individual student averages for the iRAT across all nine TBL sessions ranged from 61-91% correct, with an overall class average of 76% correct. Team averages for the tRAT across all nine TBL sessions ranged from 94.9 to 99.4% correct, with an average of 96.5% correct. Average tRAT scores for the nine separate TBL sessions ranged from 93.8% to 100% correct, with an average score of 97.5%.

Ethicality Scores

Table 1 provides the means, standard deviations, and effect sizes for decision ethicality scores. In comparison to the results of Antes *et al.* (2010), pre/post changes with the TBL RCR curriculum were mixed. Two results may be considered as gains as compared to the Antes study. The largest effect for the TBL curriculum was a significant positive gain for professional practices ($p < 0.0001$), compared to no change in the Antes study. No significant change was observed for business practices ($p = 0.16$), compared to a significant decline observed in the Antes study. No significant pre/post change was observed for study conduct in either study ($p = 0.30$ for TBL). A significant decline was observed for data management ($p < 0.0001$), compared to no change in the Antes study.

Meta-cognitive Reasoning Strategies

Table 2 provides the means, standard deviations, and effect sizes for meta-cognitive reasoning strategy scores. Mixed effects were again observed with the TBL RCR curriculum. The greatest gains compared to the Antes study were for considering others ($p = 0.0036$) and anticipating consequences ($P = 0.018$), in which other teaching methods have small but non-significant decreases. Pre/post gains were seen in both studies for managing emotions ($p < 0.0001$ for TBL) and analyzing personal motivations ($p < 0.0001$ for TBL). Both studies revealed a decrease in seeking help ($p = 0.022$ for TBL). Whereas gains were seen in the Antes study for both recognizing circumstances and questioning one's judgment, in this study there was no significant change ($p = 0.12$) or a decrease ($p = 0.0019$), respectively.

Social-Behavioral Responses

Table 3 provides the means, standard deviations, and effect sizes for social-behavioral response scores, which reveal positive results with the TBL RCR curriculum for six of the seven dimensions. The greatest gains compared to the Antes study were for involvement of others in decision-making ($p < 0.0001$) and active involvement ($p < 0.0001$), for which small changes in the Antes study were not significant. Scores were unchanged for deception ($p = 0.57$), avoiding personal responsibility ($p = 0.079$), and closed-ended decision-making ($p = 0.83$), whereas learners endorsed all three of these behaviors in the Antes study to a significant level. Selfishness was significantly lower ($p = 0.001$) with the TBL RCR curriculum, as compared to no change in the Antes study. Both studies revealed an increase in retaliation ($p < 0.0001$ for TBL).

DISCUSSION

Based on ethical decision-making as a learning outcome, the best method for RCR instruction reported to date may be the sensemaking approach developed by Mumford and colleagues at the University of Oklahoma, described by Kligyte *et al.* (2008) as being conducted over a two-day period by trained psychologists, with ten blocks of instruction

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spanning 12 hours of instruction. The effects of the team-based learning (TBL) curriculum for RCR instruction on ethical decision making were mixed, but were an improvement over more common methods of RCR instruction, as reported by Antes *et al.* (2010). The ethicality of decisions made with respect to professional practices (*e.g.*, adherence to professional commitments, mentoring, and collaboration) was significantly improved, compared to no change for other methods (Table 1). The significant decline in ethicality for decisions related to business practices (*e.g.*, contracts and grants, conflicts of interest, and laboratory management) with other RCR courses was not observed with TBL; although a small decrease was observed, it was not statistically significant. As reported for other RCR courses, the ethicality of decisions pertaining to study conduct (*e.g.*, human and animal subjects, IRB issues, maintaining confidentiality and anonymity) was unchanged for TBL. Unlike other RCR courses, in which the ethicality of decisions related to data management (*e.g.*, handling, storing, sharing, and reporting data) was unchanged, we observed a significant decrease in ethicality with the TBL curriculum. The TBL module with content related to data management had the highest iRAT and tRAT scores of all of the TBL modules, and the application exercises did not generate as much discussion as in other TBL sessions (personal observations), suggesting that this module was not sufficiently challenging to engage the students as well as other modules.

Pre/post gains in meta-cognitive reasoning strategies suggest that TBL instruction encouraged the use of four of the seven helpful strategies, including anticipating consequences, managing emotions, analyzing personal motivations, and considering others (Table 2). Perhaps most dramatically, most of the negative effects of other instructional methods on social–behavioral responses were not observed with the TBL curriculum. Significant gains were observed for the involvement of others in decision-making and being actively involved rather than passively doing nothing, and significantly less selfishness was indicated decisions made after TBL instruction. The deception, closed-ended decision-making, and neglect of personal responsibility observed after other forms of instruction were not observed after TBL instruction, although decisions still indicated retaliatory behavior.

Overall, we find the pattern of effects observed with the TBL format of RCR instruction to be very encouraging. Learners used more helpful reasoning strategies and displayed more attention to the social dimensions in their decision-making after TBL instruction, leading to improvement in two domains of ethical decision-making, suggesting that TBL has great potential as a model for RCR instruction. Perhaps the most significant finding is that most of the detrimental effects reported by Antes *et al.* (2010) for other forms of RCR instruction are not observed after TBL instruction.

Strength of the TBL format is provided by its emphasis on learning from teammates and shared problem-solving and decision-making, which may limit the development of self-protective behavior, as learners become accustomed to making ethical decisions in a team setting. TBL also provides continual feedback not just about student performance in terms of knowledge acquisition, via the readiness assurance process, but also about strategies and processes involved in ethical decision-making. Improved student satisfaction with TBL (Sisk, 2011; and our unpublished results) suggests that the increased learner engagement that occurs with TBL may help students overcome the notion that RCR training is simply a requirement that must be endured. We believe that the intensely social nature of TBL supports the group dynamics needed to develop the “culture of ethics and integrity that goes beyond minimum compliance or risk management” envisioned by DuBois and Dueker (2009).

This study is limited in that it involves a relative small sample size from a single RCR course at one institution, but additional studies of the TBL RCR curriculum are being

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initiated at other institutions both to confirm these findings and demonstrate the portability of the TBL curriculum. We used a single measure of RCR instruction effectiveness, the EDM test, which has been shown to be valid and has already been shown to be useful for comparing different modes of instruction, but it is desirable to use additional ethics measures as they are developed to monitor the effectiveness of RCR instruction. In addition, some scenarios used in the application exercises did not include many of the content characteristics recently described as being important for influencing ethical decision-making, such as the social context and the goals of the characters involved (Bagdasarov *et al.*, 2012), embedding codes of conduct into content with long-term forecasts (Harkrider *et al.*, 2012), and modeling mastery behavior and providing forecasting prompts (Harkrider *et al.*, 2013). Thus, application exercises are being revised to incorporate these important case elements and to provide additional coaching and guidance for ethical decision-making throughout the curriculum.

TBL may be a more effective framework for RCR instruction than most other commonly accepted methods involving lectures, online training, and/or less structured small group case-based discussion. Most of the potentially harmful effects of RCR instruction suggested by the study of Antes *et al.* (2010) do not occur with TBL instruction, and some gains in ethical decision-making have been observed. A TBL curriculum can be easily adopted at other institutions with only a modest time commitment for faculty development in order to recognize the facilitation skills that are critical for ensuring its successful implementation. TBL supports the reasoning strategies and social mechanisms that underlie ethical decision making and ethics instruction, and more extensive investigation of the effectiveness of TBL for RCR instruction is needed.

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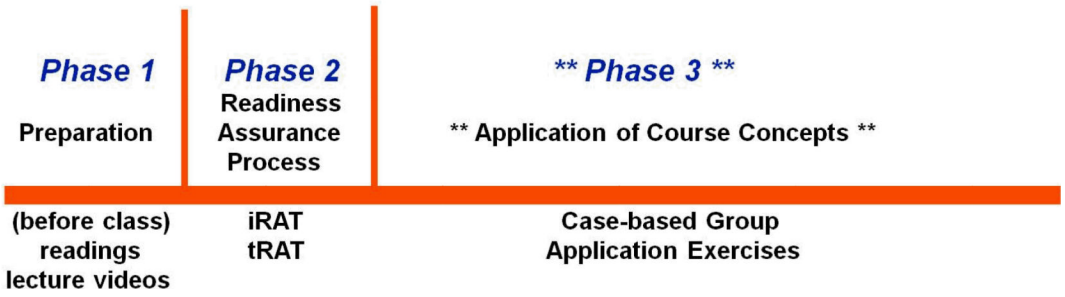

Figure 1.
Three Phases of Team-Based Learning

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Table 1

Pre-Post Changes in Decision Ethicality Scores

	Team-Based Learning RCR					2005-07 RCR[§]
	Pretest		Posttest		Effect size	Effect size
	M[*]	SD[*]	M	SD	Cohen d	Cohen d
Data management	2.38	0.34	1.88	0.33	−1.14[‡]	−0.21
Study conduct	2.33	0.13	2.30	0.21	−0.13	0.05
Professional practices	1.94	0.21	2.57	0.18	2.16[‡]	0.17
Business practices	2.22	0.32	2.07	0.32	−0.31	−0.37[†]

[*] M = mean, SD = standard deviation

[†] $p < 0.05$

[§] 21 RCR Courses, 2005-2007 (Antes, *et al.,* 2010)

[‡] $p < 0.01$

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Table 2

Pre-Post Changes in Meta-Cognitive Reasoning Strategy Scores

	Team-Based Learning RCR					2005-07 RCR[§]
	Pretest		Posttest		Effect size	Effect size
	M[*]	SD[*]	M	SD	Cohen d	Cohen d
Recognizing circumstances	3.41	0.20	3.48	0.19	0.23	0.86[‡]
Seeking help	0.72	0.15	0.62	0.18	−0.42[†]	−1.79[‡]
Questioning one's judgment	2.73	0.20	2.53	0.18	−0.62[‡]	0.99[‡]
Anticipating consequences	3.27	0.22	3.40	0.22	0.36[†]	−0.28
Managing emotions	2.66	0.20	3.07	0.22	1.26[‡]	0.38[†]
Personal motivations	2.34	0.20	2.63	0.20	0.87[‡]	0.56[‡]
Considering others	2.83	0.22	2.99	0.19	0.47[‡]	−0.29

[*] M = mean, SD = standard deviation

[†] $p < 0.05$

[§] 21 RCR Courses, 2005-2007 (Antes, *et al.,* 2010)

[‡] $p < 0.01$

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Table 3

Pre-Post Changes in Social-Behavioral Response Scores

	Team-Based Learning RCR					2005-07 RCR[§]
	Pretest		Posttest		Effect size	Effect size
	M[*]	SD[*]	M	SD	Cohen d	Cohen d
Involvement of others	2.17	0.18	2.66	0.23	1.92[≠]	0.19
Retaliation	1.32	0.18	1.64	0.19	1.08[≠]	1.16[≠]
Deception	1.62	0.22	1.61	0.21	−0.03	1.53[≠]
Active involvement	3.50	0.14	3.75	0.14	1.21[≠]	−0.35
Avoidance of responsibility	1.86	0.23	1.77	0.19	−0.28	0.78[≠]
Selfishness	1.85	0.26	1.65	0.24	−0.56[≠]	0.10
Closed-ended decision-making	3.28	0.23	3.25	0.24	−0.09	0.59[≠]

[†] $p < 0.05$

[*] M = mean, SD = standard deviation

[§] 21 RCR Courses, 2005-2007 (Antes, *et al.,* 2010)

[≠] $p < 0.01$