

Progress toward Optimizing Student Team Skill Development using Evidence-Based Strategies

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Daniel M. Ferguson is the recipient of several NSF awards for research in engineering education and a research associate at Purdue University. Prior to coming to Purdue he was Assistant Professor of Entrepreneurship at Ohio Northern University. Before assuming that position he was Associate Director of the Inter-Professional Studies Program [IPRO] and Senior Lecturer at Illinois Institute of Technology and involved in research in service learning, assessment processes and interventions aimed at improving learning objective attainment. Prior to his University assignments he was the Founder and CEO of The EDI Group, Ltd. and The EDI Group Canada, Ltd, independent professional services companies specializing in B2B electronic commerce and electronic data interchange. The EDI Group companies conducted syndicated market research, offered educational seminars and conferences and published The Journal of Electronic Commerce. He was also a Vice President at the First National Bank of Chicago [now J.P. Morgan Chase], where he founded and managed the bank's market leading professional Cash Management Consulting Group, initiated the bank's non-credit service product management organization and profit center profitability programs and was instrumental in the breakthrough EDI/EFT payment system implemented by General Motors. Dr. Ferguson is a graduate of Notre Dame, Stanford and Purdue Universities, a special edition editor of the Journal of Engineering Entrepreneurship and a member of Tau Beta Pi.

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Overview

The broad goal of this work is to study the effectiveness of various approaches to teach students about teamwork, to be more effective team members and to be more effective at rating their teammates. This research requires the use of a common model of teamwork and a system for training, collecting ratings data, and providing feedback. We will leverage the NSF's prior investment in the CATME system, which meets the research criteria and automates some of the data collection and feedback, which will aid in executing the research protocol consistently. Seven empirical studies will determine the effect sizes of training, practice in teams, practice rating, and feedback interventions on cognitive development (improvement of team skills) and metacognitive development (improvement of self- and peer-evaluation skills).

Outcomes

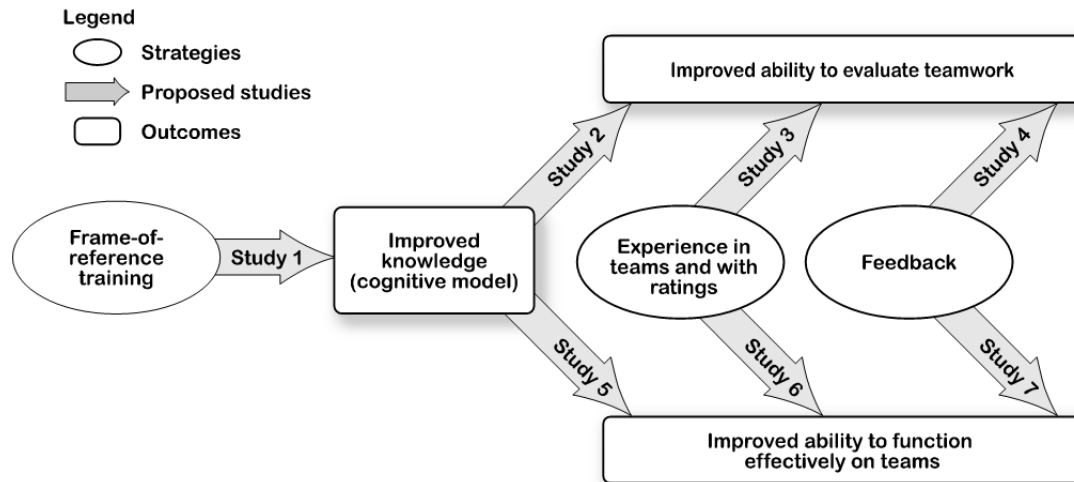
We focus both on cognitive skills related to team-member effectiveness and on metacognitive skills that enable competent self- and peer-evaluation of team members' effectiveness. An intermediate knowledge-level outcome affects both—developing an improved cognitive model of teamwork. Students must learn what skills are necessary for effective teamwork to be able to develop and evaluate them.

Strategies

To achieve these outcomes, we have several strategies. Frame-of-reference training, which is well-established and empirically supported, will align students' cognitive model of teamwork with ours by teaching students the ways team members can contribute effectively to teams in the five key areas summarized earlier. Experience working in teams and evaluating teamwork will improve team skills and self- and peer-evaluation skills. Experience in teams increases as students work on multiple teams. Rating practice will be accomplished by showing students descriptions or videotapes of fictitious team members and having them rate the contributions these fictitious team members make, in addition to rating themselves and their real teammates following work in teams. Finally, we will examine how the degree to which and manner in which feedback on team skills is provided affect student outcomes.

Research design and progress

To establish the relationships shown in the figure, seven studies are needed—some to be sure that our work agrees with earlier research findings, some because the literature is unclear on a particular issue, and some because there is no literature at all.



Study 1 (completed): Frame-of-reference training (FORT) fosters learning a cognitive model of teamwork

Purpose of study: Study 1 measured the differences between trained and untrained participants in recalling, recognizing, and categorizing team behaviors.

Status of study: Participants were recruited to the experimental and control groups at UNC Charlotte and Purdue University for lab studies. Combined with Study 2 in publication below.

Study 2 (completed): FORT and accountability make participants better raters

Purposes of study: (1) to show that participants with a more accurate cognitive model of teamwork have better self- and peer-evaluation skills than untrained participants as measured by their ability to accurately classify teamwork behaviors. (2) to show that participants held accountable for their ratings are more likely to rate more accurately. Varying the rater training is used to achieve more variance in the independent variable (the accuracy of participants' cognitive model of teamwork) than would naturally occur.

Status of study: The full version of this alternate frame-of-reference training was deployed in two first-year engineering classes at Purdue University with enrollment of more than 100 students each and a management class at Georgia Southern University with enrollment of 40. A reduced version was evaluated in three additional experimental sections of first-year engineering classes at Purdue University. Current and historical sections of the same classes will provide a comparison group.

Publication: *Facilitating Peer Evaluation in Team Contexts: The Impact of Frame-of-Reference Rater Training* (Loignon, Woehr, Thomas, Loughry, Ohland, & Ferguson, 2017). This study examines the impact of Frame-of-Reference rater training on team members' understanding of a specific model of teamwork and the quality of peer evaluations in a team-performance context. This multi-university study showed that trained participants are better able to classify team-member behaviors into the appropriate categories of a science-based model of teamwork and

more accurately identify the performance level of those behaviors. Using round-robin data from students working on a highly interdependent task, we utilized the social relations model (SRM) to test whether trained participants provide higher quality peer ratings. SRM analysis estimates the variance in team members' ratings of teammates' performance attributable to various effects (rater, group, error, etc.). We found that trained groups had nearly twice the proportion of rating variance attributable to target effects (people being rated) as untrained groups.

Study 3: Changes in self- vs. peer-ratings as an indicator of learning.

Purpose of study: To show that students who use a particular peer evaluation system repeatedly have self-ratings of their team contributions that are more modest compared to how their teammates rate them than do participants who have not previously used the peer evaluation system. This will demonstrate that experience using a consistent peer evaluation system is associated with metacognitive learning, specifically the ability to accurately perceive one's own skill level. Prior research shows that this greater self-understanding is evidence of learning; in other words, these metacognitive gains are evidence of concomitant cognitive gains.

Status of study: Historical data for Study 3 has been identified and is being analyzed.

Study 4: Giving students feedback on their use of the rating system improves rating behavior.

Purpose of study: The purpose of Study 4 is to determine whether giving students feedback on the degree to which their ratings match those of other raters improves their rating practices.

Status of study: a comprehensive research protocol merges Study 4 and Study 5 into a single protocol. See below.

Study 5: Frame-of-reference training makes participants better team members

Purpose of study: This study explores the effect of cognitive model development (measured by a knowledge test as in Study 2) on team performance and team-member effectiveness. Training members of teams to develop a more accurate cognitive model of teamwork should increase team performance, team cohesion, team self-efficacy, and satisfaction, and reduce team conflict.

Status of study: Participants were recruited to the experimental and control groups at UNC Charlotte and Purdue University for lab studies, and the results of that work are being published.

A significant research protocol was designed, developed, and launched at Purdue University. Students in 15 sections of the Fall 2016 class experienced various training and feedback interventions. The same students (with less than 10% attrition typical) have enrolled in a follow-on class in the Spring. The training intervention received in the Fall will be tracked, but not considered in forming teams in the Spring, resulting in randomly composed teams. This will make it possible to measure the effect of various training and feedback interventions on student's ability to rate their teammates, perform in teams, and effects on a variety of other outcomes including conflict, cohesion, and satisfaction. Faculty will be recruited for intervention studies. Faculty at other institutions have agreed to participate in research in their classrooms, comprising

various studies in the project, including replication studies that will make our findings more robust.

Study 6: Structured experience working in teams and doing self and peer evaluations makes participants better team members.

Purpose of study: Explore the effect of structured team experiences and use of a peer evaluation system on team skills and team-member effectiveness. Prior research has found that completing peer evaluations familiarizes students with team skills and improves new teammates' satisfaction with those team members on a future team.

Study 7: Feedback improves team skills.

Purpose of study: We explore the effect of five feedback alternatives on team performance, satisfaction, team cohesion, team efficacy and team conflict: (1) self and peer evaluation data collected but no feedback given, (2) feedback by the peer evaluation system, (3) personal coaching by instructional staff, and (4) personal coaching by instructional staff and feedback from the peer evaluation system, and (5) no self or peer evaluation data collected nor feedback given (comparison group). All protocols involve faculty partners who assign students to teams to perform team assignments as a required part of the courses. All PIs have experience doing team-skills coaching and will jointly develop a coaching protocol. One or more of these investigators will train faculty partners to follow that protocol when using the coaching intervention. Faculty partners will document their coaching activities.

Improving research methods for studying teams

Publication: *Elaborating on team-member disagreement: An approach for examining patterned dispersion in emergent states* (Loignon, Woehr, Loughry, & Ohland, in revision). This was received positively by *Organizational Research Methods*. The analysis of large scale team data both requires and advances the science of research on teamwork. Specifically, this paper provides evidence that supports a previously unverified theory of rating patterns, but provides evidence to extend the theory to include additional patterns identified in CATME data.

Publication: *The impact of task interdependence, warmth, and competence on the desire to work together in the future in teammate dyads* (Thomas, Loignon, Woehr, Loughry, & Ohland, in revision). This work is being revised at the request of the *Journal of Organizational Behavior*. It refutes findings of earlier studies that overestimate the importance of warmth and underestimate the importance of competence. This work also shows that there is an interaction with task interdependence, such that warmth is more important when there is low task interdependence and competence is more important when there is high task interdependence.

Conclusion

The results from Study 1 and Study 2 already show that there is learning benefit in using the CATME system. Study 2 further provides evidence that an effective training protocol has been developed for students using CATME. Study 4 and 5 are expected to test further outcomes from the use of CATME and various methods used to teach students to function in a team and to rate the team behaviors of their teammates. The results from Study 4 and 5 should be available for the poster session, and we expect to release classroom materials based on the training approaches tested. These training materials have already been released on a limited basis upon request, and instructor feedback is good.

By conducting these studies in diverse settings, the research findings are robust and the curriculum materials are immediately applicable in a wide range of classes. CATME has been studied in engineering and management classes, at multiple class levels (first-year, sophomore, junior, senior), and at institutions with varying missions and selectivities.

The potential impact of this work

Through its large user base, the CATME system is already having a large impact on the management of student teams; this research shows that the system's popularity translates into a learning benefit for a large number of students. Each study has implications for instructional practice.

References

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