Work in Progress: Micro-skills and Mini-habits in Engineering Student Teams: Facilitating a Confluence of Perspectives and Talent

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Rodney Boehm is the Director of Aggies Invent and an Associate Professor of Practice in the Dwight Look College of Engineering. He has broad industry experiences, including over 30 years in all aspects of the telecommunications industry (sales, marketing, manufacturing, business development, and technical design), the creation of a telecommunications standard (SONET - Synchronous Optical Network) for the fiber optics industry that is still in use internationally over 30 years later, a wide variety of business experiences in international companies, and start up experiences that have helped him lead a very successful industry career. He holds a BS and ME in Electrical Engineering from Texas A&M University. Currently he is using his technical business experiences to develop and run innovation and entrepreneurial programs for the Engineering Innovation Center, a 20,000 sq ft rapid prototyping facility. These include Aggies Invent, Engineering Project Showcase, Inventeer, and Pop Up Classes. In addition, he mentors multiple entrepreneurial teams.

WIP: Micro-skills and Mini-habits in Engineering Student Teams: Facilitating a Confluence of Perspectives and Talent

Motivation and Background

Teams for creative problem solving consist of members that each bring unique qualities such as perspective, experience, and specialized knowledge, which, combined, may match the complexity of their joint challenge (Beyerlein, M., Han, S. J., & Prasad, M, 2017). Team effectiveness emerges when the interaction process enables those unique qualities to blend into a whole, with each member engaged. However, few teams have the skills or process habits that enable a high level of blending to occur. Therefore, this study's focus is to identify the micro-level patterns of behavior (habits) in student teams that enable full realization of the value of member diversity.

Diversity is commonly defined as a characteristic of groups of two or more people and usually indicates demographic differences among group members. By leveraging diversity, teams may achieve higher levels of project performance through improved teamwork (Van Knippenberg, van Ginkel, & Homan, 2013). Two layers of diversity attributes were identified by researchers: (a) the surface level (e.g., age, gender, race, and physical disabilities; Mannix & Neale, 2005); and (b) the deep level (e.g., cognitive ability, personality traits, values, beliefs, and attitudes; Harrison, Price, Gavin, & Florey, 2002). However, the majority of studies on team diversity have focused solely on surface-level attributes because deep-level diversity tends to be difficult to measure. The present study aims to explore micro-level patterns of behavior where effects of deep level diversity are manifested to create a collaborative environment and attenuate the effect of implicit biases or stereotyping that interfere with leveraging of diversity.

A better understanding of the micro-level habits that facilitate positive processes in teams, and subsequently generate value from deep-level diversity, will provide a step forward in developing better team structures for learning and creativity. Recognizing underlying causes of team members' conflicts due to diversity and using appropriate interventions that empower team members to deal with future challenges can be helpful for managing teamwork (Brett, Behfar, & Kern 2006; Han, Liau-Hing, & Beyerlein, 2017). Thus, the negative effect of perceived individual differences may be alleviated by an effort to actively understand differences and build towards shared goals and vision (Woehr, Arciniega, & Poling, 2013). The research in support of this assumption tends to be based on questionnaire data rather than micro-level examination of team processes.

Research Questions

Studies of teams often use the phrase "team dynamics." Although the conceptual goal of scholars is to understand the dynamic interaction teams display, most methods available for the decades of scholarship have not been capable of capturing a truly dynamic picture. Teams learn as the knowledge acquired via individual learning is shared, discussed, and integrated (Law, & Ngai, 2008). Collaborative learning and the knowledge acquired shape subsequent individual learning. The learning may be observable at a macro-level, because it is generated by micro-level patterns of behavior.

Consequently, understanding learning through research is a challenging process. A variety of

methods of research and measurement have been developed over the history of scholarly effort focused on groups and teams. Most team dynamics and team learning research utilizes surveys or interviews, focused on single points in time, to assess the team learning model or advance theories (Leenders, Contractor, & DeChurch, 2016). In this study, methods range from a focus on observable behaviors to self-reported attitudes and from collections of quantitative data to qualitative data. Rigor increases by combining multiple methods to provide more comprehensive pictures of team activity. Therefore, the present study uses a mixed-methods design to lay the groundwork for subsequent research on teams, specifically in the context of new measurement and analysis strategies for team dynamics, interactions, and learning. Research questions reflect tracking micro-level patterns of teams from project launch, through process development, to final solution. The research questions are:

1. What micro-level patterns of behavior
    a. influence the effectiveness of sharing (e.g., inclusiveness, openness, and mutual encouragement) in team member interaction?
    b. enable winning teams to form a cohesive identity in the initial stage of the project?
    c. enable teams to make the best use of available resources, including each other, mentors from the sponsoring organizations, information searches, and equipment and supplies in the room?
2. How do micro-level patterns of team behavior change over time to build a collaborative environment and solve project problems?

Methods

To examine the processes and performance of teams that value surface and deep level diversity, we will conduct a mixed methods study consisting of (a) observations, (b) survey analysis, (c) video analysis, and (d) focus group interviews. Participants will be university students in STEM fields who are participating in a 48-hour intensive design experience called Aggies Invent (AI), which is conducted in a large engineering lab. This study will provide an initial look at successful teams within AI to answer the research questions. Future research will include a comparison of the team behaviors of the highest rated teams with the lowest rated to identify patterns of interaction that may result in performance differences. The location will allow researchers to monitor teams in a controlled environment for the duration of the project and team lifespan, from team formation to task completion. About 70% of participating students are engineering majors (undergraduate and graduate), and 30% from other disciplines. Teams range in size from 4 to 6 students. At the beginning of the session, individuals roam around the room, reading the array of problem statements, and begin to coalesce into groups with shared interest in one of statements. Some selection bias may be inherent in the Aggies Invent sample given that the experience is voluntary. Typically though, students participate as individuals and do not know their teammates prior to beginning the project, so team composition tends to be rather random. Within a couple hours, they are working intently on the first stage of their design project with the requirement of presenting preliminary alternative solutions within 3 hours. On day 2, they focus on development of one idea. On day 3, they finish development and build the business case for a presentation to a panel of professionals who use a rubric to rate and select 3 winners based on innovation quality of their solution and strength of the business case and its presentation.

To conduct the observations, we will set high-resolution digital cameras to capture video data during the event for all teams, but we will analyze the three winning teams only. We will analyze the video data using the software tool BORIS, focusing on winning teams' interactions to leverage their creative efforts and achieve a shared goal. BORIS enables video content analysis comparable to the software packages that aid in text analysis such as Atlas.ti and Nvivo. Badges worn by individuals in the video enable compiling clips showing their activities. Using a rubric for coding, specific behaviors can be identified in video segments and pulled together into a pool of examples, such as nodding to indicate agreement, offering a piece of equipment or drawings on paper to show support, and moving to the whiteboard to show initiative.

We will also conduct post-event focus group interviews with the three winning teams and ask teams to provide additional insight regarding the collected video data. We will choose five to seven critical moments of teams captured in the video and ask participants to explain or elaborate on their experience, thought processes, and interactions. In this way, we plan to explore some ways that deep-level diversity attributes impact participants' micro-level behaviors that build collaboration, transcending individual differences. The matching focus group data with video data will aid in identifying critical patterns of behavior.

Our research team expects to develop insights about team learning processes. The research will produce new insights on forms of team collaboration that affect: (a) development of a group into an effective team, (b) patterns of team behavior that underlie successful invention behavior, (c) patterns of behavior that enable full inclusion of members to enrich the resources available to the team, and (d) nuances in the shift from the brainstorming or divergence stage to the focusing or convergence stage in creative work. Our process of analyzing detailed video data of team interaction will identify behavioral patterns that relate to successful teamwork. These findings are expected to align with success in terms of the Aggies Invent competition. The complexity of the challenge is such that a team entirely dependent on a single individual is ultimately not competitive, based on observations from previous Aggies Invent events.

The research calls for assembling interdisciplinary experts in engineering and human resource development (HRD), which focuses on employee development and organizational learning to work together as an integrated research team. The integration of expertise and perspective from engineering and HRD is a principal strength of our approach.

To answer the research questions, data collection and analysis include:

a. Archival data currently being collected by Aggies Invent staff, including demographics (ranges from freshman to PhD), etc.;
b. Time-lapse videos of the whole event – photo frames taken every 10 seconds and archived – to identify patterns of movement and communication;
c. Interviews with 3 winning teams in the form of focus groups to elicit descriptions of critical incidents that occurred during the project;
d. Micro-level video analysis of selected teams based on focus group results, analyzing interaction patterns during critical incidents;
e. Observations of team behaviors by research team members during the event.

Anticipated results

The key results of this study will be the identified critical patterns of behavior for valuing diversity and inclusion of each member's perspective and talent in producing high quality team outputs. The critical patterns observed within student teams will be useful for developing the foundation for new team learning models based on all levels of diversity. Findings from the current study should lead to a larger investigation that will help shape team theory for both practice and education settings where learning, knowledge sharing and effective collaboration lead to outstanding performance.

Significance

Other universities in the US, Australia, and Belgium are now adopting the model to provide intensive design experiences for their students. Developing a better understanding of team learning, especially in STEM fields, is critical for the educational experience of students and future professionals. As educators of the future workforce, the present study will contribute to guidelines for faculty to enable students to work well in diverse teams and successfully collaborate in unfamiliar, uncomfortable working environments. It will also impact student teamwork for co-creation of solutions and outcomes and facilitation of joint decision-making and effective knowledge sharing. A better understanding of project team diversity will lead to creating learning spaces that allow for more engagement, which in turn may lead to higher retention rates among STEM students.

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