AC 2008-335: IDENTIFYING ROLES AND BEHAVIORS OF INFORMAL LEADERS ON STUDENT DESIGN TEAMS

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Introduction

Design faculty endeavor to create an authentic engineering design experience for their students. Since many engineers work at least part of the time in team environments, teamwork has become a significant facet of design curricula. However, it appears challenging to create an authentic and successful design experience involving teamwork within the classroom. Every instructor is familiar with teams that fail to successfully complete the task, degenerate into conflict, or both.

A team's leadership affects the team's productivity and outcomes. [1, 2] Since student teams frequently operate without explicitly assigned roles or established authority their team leadership is classed as "informal." However, as with formal leadership, the quality of informal leadership can vary. LaFasto and Larson [3] noted that "a team without a formal leader eventually surfaces a leader from the available talent, but in ways that are not always predictable." Thus, group processes will generate a group leader, but not always the best leader. Since team leadership affects performance, the quality of the informal leader can add or detract from team success and learning.

One could argue that the way to ensure quality leadership and high team performance would be for faculty to explicitly assign formal leadership on each team. However, unless faculty are very familiar with students' abilities, there is no guarantee of an improved result. While leadership appears to be a key factor in a team's success, neither the group nor faculty can guarantee the quality of the leader and the team's success.

Further, Pescosolido [4] noted that groups rating high in group efficacy tend to set higher goals and achieve higher performance. Group efficacy is a group's collective estimate of its ability to achieve a task. Informal leaders play a key role in creating group efficacy, especially in the early life of the group. Informal leaders seem to support group efficacy by creating and mediating meaning. This ability can be particularly important in navigating the ambiguity that is characteristic of the early life of a long-term team. Thus, the quality of informal leadership is a key factor in a team's success.

Understanding the characteristics of, and being able to interact with, informal leaders thus becomes basic to helping student teams succeed. When faculty become familiar with the role informal leadership plays, they will be able to recognize and support effective informal leaders and intervene with those that are failing.

The intent of this paper is to describe, using a qualitative approach, the roles and behaviors of informal leaders of student teams. Our question is: "what behaviors characterize effective informal leaders of small student teams working on in-class learning tasks?" One of the goals of our research was to offer faculty ways to recognize informal leaders' behaviors so they would have a solid context for interacting. Further, we examined literature outside of engineering education to bring diverse perspectives to our study.

Literature Review

The field of leadership studies is as old as the existence of leaders themselves. However, there is little consensus on definitions of leadership or on how to effectively train leaders. Although the existence of informal leaders is well documented, their characteristics and behaviors have not been well studied. Further the few studies on characteristics that have been done have usually examined informal leadership within work teams or within organizations. Thus, we will need to construct a definition of informal leadership that applies to informal leaders on student teams. We will be gathering perspectives from research on team leadership and informal leadership to do this.

Generally, theories of leadership are conceived in three ways: those that focus on the qualities of the leader, those that focus on the situation in which the group exists, and those that focus on the interaction between the leader and the followers. [5] Each of these perspectives has it advocates, strengths, and weaknesses. However, these perspectives tend to examine larger settings of formal leadership such as occurs within businesses. Small student design teams with informal leadership do not align well with these perspectives.

Team Leadership

Leadership on student design teams aligns more closely with perspectives *from research* on *small* team leadership. Hill [6] maintained that team leadership has two functions: to accomplish the task and to maintain group cohesiveness and function. Further, leaders interact with the teams' internal and external environments to achieve these functions. Student teams have little interaction with their environments beyond their instructor. Since they are not embedded in an organization in the same way that as a work team they have little need for interacting with their external environment. However, leaders do need to be concerned with the team's internal environment and how it meets both task and relational needs.

Hill [6] explicitly listed internal leadership functions for both task and relational needs. Since she focused on work teams, not all functions will apply to student design teams. Still, several could apply directly to informal leaders on student teams. These leadership functions are:
1. Goal focusing (task).
2. Facilitating decision making (task).
3. Maintaining standards of excellence (task).
4. Collaborating/involving (relational).
5. Managing conflict (relational).

LaFasto and Larson [4] also developed characteristics of effective team leadership. While their perspective of teamwork differs somewhat from Hill's, many of their leadership functions are similar. Again, although their research focused on work teams, several aspects easily adapt to leaders on student teams:
1. Focus on the goal.
2. Ensure a collaborative climate.
3. Demonstrate sufficient technical know-how.

Thus, from research on team leadership, we can develop a clear picture of the role of team leaders on student teams. Leaders have a clear task focus and an ability to create and maintain a collaborative climate. Further, they affect the quality of the outcome since they maintain standards of excellence and have a foundation of technical know-how. With these characteristics of team leaders in mind, we can examine the research on informal leaders.

Informal leadership

Informal leadership occurs without organizational power or authority supporting it. Instead, the leader uses forms of influence to achieve group goals. [7, 2] There has been little in-depth research on characteristics of informal leaders. Like team leadership, those available studies that have occurred have examined informal leadership within businesses.

A related area of research has involved social networks. Within organizations informal leaders exist alongside formal leaders with authority. Where formal leaders use power and authority to achieve their ends, informal leaders use influence. Thus the methods of leadership differ substantially between formal and informal leaders. [2,4,7] The effectiveness of informal leaders within organizations appears to lie in their ability to skillfully use social networks. However, in this study we did not explore social networks since each activity was bounded by the classroom.

Pielstick [7] examined the differences between authentic formal and informal leaders in organizations. As above, since the research was done within organizations, the characteristics will need to be adapted to student teams. Even so, several aspects apply. Compared to formal leaders, informal leaders were more likely to:
1. Engage in creative and reflective thinking.
2. Build teams and coalitions.
3. Be fair, humble, and altruistic as well as promote gender equity and diversity.
4. Engage in interactive dialogue and collaboration.
5. Have a sense of humor and like fun.

Like Pielstick, [7] Smart [2] researched informal leadership within organizations, so again we need to adapt it to this context. While her findings generally echo Pielstick, [7] she does add that informal leaders:
1. Exhibit competence.
2. Feel at ease using intuition.
3. Lead by character and trust, rather than through charisma or power.

Bass [1] surveyed a wide array of literature on group processes. He noted that informal leaders tend to remain consistent for similar tasks. Since design problems are similar in nature, one could expect the same person to perform as the informal leader throughout the semester. Further, he noted that some research has suggested that members who talk the most or participate the most tend to function as informal leaders. Since skilled communication is one aspect of all types of leadership, it is reasonable to expect verbal ability to be a factor with informal leaders.

So far this discussion has focused on the positive attributes of informal leadership. Yet, informal leadership can have negative aspects. Heifetz [8] used the term "creative deviant" when referring to informal leaders. He focused on the role of creative deviants in fostering large-scale social

change. Yet, his work generates some concerns about informal leadership. When informal leaders do not accept the existing power structure or its goals, they can effectively work to subvert them. Since informal leaders work by influence, this influence can also be used in a negative way, particularly if the informal leader surfaces a widespread disaffection within the group. Design instructors may notice negative influence if the informal leader believes tasks or goals to be a waste of time. Thus, while Smart [2] called informal leaders a "hidden asset," they can also function as a distinct liability since their influence can be used to undercut the instructor's stated goals.

From the literature above we developed this checklist of attributes of informal leadership that we adapted to student teams:

1. Exerts influence on group processes (task).
2. Maintains goal focus for self and group (task).
3. Creates a collaborative atmosphere (relational).
4. Exhibits technical competence (task).
5. Exhibits fairness, humility, and trust (relational).
6. Uses creativity, reflection, and intuition (both).

Methods

Since our goal was to describe the roles and behaviors of informal leaders of student teams we used a qualitative approach to develop a rich description of these students. Further, a collective case study seemed the best approach since we were examining several informal leaders. Rossman and Rallis [9] noted that "the strength of case studies is their detail, their complexity, and their use of multiple sources to obtain multiple perspectives." Each student leader represented a case. By examining all the cases we were able to more clearly understand the role of informal leaders in these teams.

We observed a semester junior mechanical engineering design class. It consisted of 24 students, of which three were female. The class was randomly divided into six teams of four by the instructor. Although teams were assigned, team members chose their roles within the team; the instructor did not assign them. Teams remained constant for the study period. In each case an informal leader emerged.

The class had two instructional goals. The first goal was for students to learn the engineering design methods and processes practiced in industry. The second goal was for students to learn teamwork skills as practiced in industry. The instructor used a teaching method advocated by Michaelsen. [10] To align with Michaelsen's method, the instructor created 30 minute design problems and a few longer-term projects that required students to use both design and teamwork skills to reach a solution. Each week the teams were to solve the assigned problem as a group in class and report their solution to the class verbally and on a large sheet of paper. Student work was begun and completed within class.

The instructor video recorded approximately 30 minutes of team interaction each week during class. A different team was randomly chosen each week. Teams quickly forgot they were being recorded and engaged in authentic behavior while being recorded. During the semester three

teams were recorded at least twice and two teams were recorded once. The unrecorded team had a team member that did not consent to recording. The recording process yielded 13 high quality DVDs of team interaction. Each DVD recorded the entire process of teamwork and design solution for the team of the week. We selected 11 of these recordings for study; the two that were excluded did not fit within the study requirements. We viewed each of the 11 DVDs twice, noting the characteristics of the team leaders.

We began coding the videos by identifying who informally controlled the group's processes. For example, we noted which team member was most frequently kept the group on task, assigned work, watched the clock, and gave positive feedback. This behavior was evident within the first few minutes of each of the 30-minute class sessions. Further, each of us easily and independently identified the informal leader within the first few minutes. Thus we had ample time even within the first viewing to note leadership behaviors. During the second viewing we took notes on the roles and behaviors of the informal leaders. There were approximately 50-100 notes per video. We frequently stopped or replayed the video to catch conversation, at times recording interactions verbatim. By studying five teams, usually in more than one session, we were able to note the behaviors that occurred consistently across the sessions and across the teams. We then compared these behaviors to the checklist developed from the literature.

Each class member signed a consent form allowing recording and participation in this research. As is typical in qualitative research pseudonyms were assigned to the informal leaders to protect their anonymity and to aid in constructing a rich description of their behaviors.

Results

In each team we identified an informal leader, sometimes with a "helper." In those teams recorded more than once, the informal leader remained consistent throughout the different recorded sessions. This finding was consistent with Bass'[1] contention that the informal leaders remain the same for similar tasks. "Design" can be understood as a similar task, even when the project varies somewhat from assignment to assignment. Each informal leader consistently managed the group's processes by assigning tasks, timekeeping, and positive feedback. To surface explicit behaviors we developed rich descriptions of the informal leaders from the data contained in the videos.

Cory
Cory is a non-traditional student in his early 30s, which is unusual in the university and department. He has worked in an engineering or factory environment and brings that experience to the group in a quiet way. He does well with his younger classmates and is good-natured, but business-like in class. Cory is not a top student, but is very conscientious and detail oriented. Further, he has excellent CAD skills and is easily able to note errors.

Cory's group was recorded three times during the semester. In each case, Cory functioned as the informal leader. Each time he was very task focused. He developed a quick understanding of the problem and knew its rules and requirements. Cory kept the group adhering to the problem description and its requirements in each instance. When he critiqued proposed solutions, he used reason and his extensive experience rather than opinion. For example, when one member proposed a behavior rule as part of a machine shop design Cory replied, "Rules like that don't fly

in a machine shop—at least the ones I've been in." Cory also functioned as the informal technical expert, yet he easily accepted input from other members, incorporating good ideas into the team's solution. Cory used some humor during the assigned work. For example, when planning a repetitive task as part of a solution, Cory said they should write "Rinse and repeat—that's what's on shampoo bottles." However, when time pressure mounted, the humor evaporated and the task became paramount. Cory also worked some with his team to build consensus and check group understanding, asking "Are we good with this [aspect of the problem]?" Further, he gave positive feedback on other members' work, noting when it was well done.

However, Cory was not very verbal, nor did he have good large scale teamwork skills. As noted above, teamwork skills can be divided into a task domain and a relational domain. Cory excelled in the task domain and the group depended on him to manage the task functions. When the group needed relational skills, another group member managed some of the relational interactions, such as initiating discussions. That group member varied from time to time. Further, Cory sometimes had a solution in mind and moved the group toward that solution without explicitly discussing the process. He would start on a solution process himself and give it to the group when it was needed rather than working on a solution method together. Cory was an excellent task leader, but could not corral the group when its focus wandered, nor could he generate a fully collaborative process if the task did not generate one by itself.

John
John is another non-traditional student in his early 30s. Like Cory, he has extensive work experience in an engineering environment. Also like Cory, he is not a top student, but has an outstanding work ethic and produces excellent work. He is assertive in class, often asking questions to improve his understanding. He does well with his younger classmates.

John's team was only recorded one time. During this session, John spent much time studying the problem and learning the task requirements. Like Cory, he kept the group on task; he became the "task expert" even though he found the task challenging. He also did error checking, noting "Ours should be like that one [in the book]." John listened to ideas proposed by the group, incorporating them when they were good. He also introduced innovative ways of thinking about the task, which the group incorporated. He defended the necessity of learning the skills involved in the task when the group complained about it.

John did have his own opinions about how to proceed. When his approach was finally proved to be correct, he gave mild "I told you so's" to the group, which were well received. Overall John did well at managing both the task and the group interaction.

Don
Don is a traditional student in his early 20s. He has a job selling a CAD program for a local provider and teaching customers how to use it. Although he is an excellent student, he is not the top academically. He shows high initiative to do well, but is not overly focused on achieving perfection. Don shows a high level of maturity and dependability.

Don was excellent at involving the entire group as well as managing the task. He easily kept the group focused on the task, but was not overbearing. He gave positive feedback to member's

suggestions. Indeed, he often functioned more as a facilitator, asking the group what they would like to do for parts of a solution. This behavior was in contrast to Cory. He consistently asked comprehension questions of the group to make sure everyone was on the same page or to confirm consensus. For example, "Do you guys all get what this will look like if we take it apart?" Or, "Is there anything you guys aren't clear about on this?" Further, as with the other leaders, Don was the technical expert. He studied the problem requirements and kept the group focused, even when he found the task challenging. Further, he used writing and drawing to enable the group to generate solutions. Don was unique in this respect. In other groups, one member became the "scribe" and essentially left the group while creating the reporting artifact. In his group, Don became the scribe and centered the group around what was happening on the paper, using it to more deeply explore solutions. Even when he struggled with spelling, the group was with him. Don was very skilled in both the relational and task domains of team leadership.

Emma
Emma is a traditional student in her early 20s and was the only female informal leader. She is highly verbal; indeed, she can be heard on some of the DVDs that did not record her team. She is an outstanding student, graduating in four years with a double major, with a goal of attending graduate school. Emma has an intense focus on whatever the problem is at hand.

Emma's team was only recorded one time during a task they found very challenging. Emma was very task focused. We questioned whether Emma was using the group to leverage her own understanding rather than create a group solution. However, the group seemed to do well with her intensity. Emma worked one-on-one with one member at a time while the other members kept smaller pieces of the task going. She easily incorporated other member's ideas into the solution and also easily assigned task pieces to group members. She was generous in her praise of other's work or participation, apparently wanting everyone to have a positive experience. However, she struggled with creating a truly collaborative process.

Team 1
Team 1 consisted of four males in their early 20s. They were recorded three times, two of which were on a two-part task. They were unable to successfully engage in and complete that task. In the third recording they are a three-person team failing at a complex task. Two leaders, Mark and Tim, held partial leadership roles in the group.

Team 1 was profoundly dysfunctional during the first two tasks. Mark seemed to function as a relational leader, but used the opportunity to constantly joke with his teammates. The rest of the team took their cues from him and showed little task focus. However, at the end of each task, Tim focused on the task and was able to get the group's attention. Unfortunately, Tim was unable to get the team's attention earlier in the process and joking prevailed. Tim seemed excluded from the process and at times was turned away from the group, involved in other tasks. Further, this team also had a very bright student who became the scribe, producing the paper reporting artifact. As scribe, he essentially checked out of the process and transcribed results, occasionally asking for information, while joking around.

During the last task, the team consisted of Mark, Tim, and a third male; the very bright student was absent. Again, Mark seemed to try to lead the group. However, he had low technical competence with the assigned task. Tim seemed to have technical competence, but would not

lead the group. The group had high engagement with a problem they found to be difficult, but they did not complete the task.

Team 1 either did not complete its assigned task or had such low quality that the task held no significant learning for them. However, they did offer an excellent example of what can happen with dysfunctional team leadership.

Discussion

We began our exploration of informal leaders' roles and behaviors on student teams by creating this attribute list from the literature:
1. Exerts influence on group processes (task).
2. Maintains goal focus for self and group (task).
3. Creates a collaborative atmosphere (relational).
4. Exhibits technical competence (task).
5. Exhibits fairness, humility, and trust (relational).
6. Uses creativity, reflection, and intuition (both).

In all successful teams, the informal leaders exerted strong influence on group processes in a low-key, friendly, collaborative fashion. They maintained a goal focus for the group. While they varied in their abilities to create a collaborative atmosphere, all made a genuine attempt at it. Indeed, these groups, even when frustrated with the task or experiencing conflict over approaches, did not turn on each other. Further, each successful leader exhibited technical competence. They also approached their group members with fairness and humility. We saw no evidence of a group being railroaded by their leader. Thus, the first five attributes appear to serve as good markers for quality informal leadership on these types of teams.

The sixth attribute of creativity, reflection, and intuition was far more difficult to assess. Successful informal leaders seemed to spend much time studying the problem and its requirements. Rather than taking a cursory look at the problem and diving in, they spent time reading the problem, sometimes even as the rest of the team began without them. This effort reaped rewards for the entire team since the informal leaders knew the task and kept the team focused. Informal leaders also maintained quality by keeping the team adhering to the rules of the task and asking deeper questions about the task. Leaders occasionally seemed creative in their approaches, but not notably more than their teammates. The same would be true for intuition. While these attributes may indeed be valuable, we were unable to assess their presence and importance. They may be more evident in long-term teams.

There were also some surprises about which students were not strong informal leaders. Interestingly, the highest academic performers or the most gifted by the instructor's assessment were not necessarily the informal leaders. While technical competence was clearly a requirement, academic excellence was not. Nor was strong verbal ability. Bass [1] had suggested that members who talk the most or participate the most tend to function as informal leaders. Yet, several of our leaders were more quiet than their teammates. Those with strong verbal abilities did tend to function as relational support, but they were not necessarily the informal leader.

Further, we did not observe any explicit negotiating during the recorded sessions about who would lead the team. What we observed was that the informal leader began leading and the group followed without comment. Team 1 struggled with leadership the entire time. Other teams had a clearly defined leader, but not one that was explicitly selected. This pattern is understandable in the later sessions, but a surprise early on. This pattern may be due to how well the students knew each other prior to the class. All of these students have been in many classes together, study together, and know each other's strengths. There may be a type of unspoken agreement about who leads the group that forms during out-of-class interaction. An interesting line of research would be to understand how these informal student leaders are placed in their leadership role.

Recommendations

Based on our results we offer the following recommendations.

As Hill [6] noted, team leaders have relational and task functions to maintain. Every successful informal leader of student design teams excelled in the task arena. They understood the problem, its requirements, and kept the team focused on the task. They often functioned as technical experts even as they struggled with a difficult assignment. Technical competence appears to be complex; it is not necessarily linked to academic performance. Team 1, which was dysfunctional, was missing a strong task leader and generally struggled with technical competence overall. Thus, the first step for faculty wishing to improve group performance is to assess whether the informal leader has a strong task focus and is technically competent.

The informal leaders varied in their ability to manage the relational tasks. Some, like Don and John, did quite well. Others, like Cory and Emma, struggled more. For these short-lived teams, the relational functions seemed to be less important. The teams were either able to roll with their leaders' shortcomings or other members provided relational support. For these short-lived teams, the relational component appears secondary, although if relationships go poorly, it can become primary. For semester-long or year-long teams dealing with complex tasks such as capstone projects, the relational function may become more critical. Thus, another area for faculty to assess, particularly in long-lived teams is the quality of the relational leadership. Further, we noted instances where the task leader functioned in tandem with a relational leader. While the relational tasks seemed to take a distant second, they were still necessary. Thus, observing the quality of the task leader coupled with the relational leader may prove important.

Relational leadership cannot be ignored entirely even in these short-lived teams, though. Team 1 had a dysfunctional relational leader in charge. Mahoney [11] noted that some teams experience "self-centric" leadership. Self-centric leaders' goals are group control, self-aggrandizement, and personal success. In short, these leaders are focused on meeting their needs rather than the needs of the group or the project. He noted that teams with self-centric leaders "experienced the most problems and had the least to show for their efforts by the end." Mahoney also noted the existence of team-centered leadership that focused on the needs of the team. Team 1 appeared to have a self-centric leader at the helm. The rest of the observed leaders functioned as team-centered leaders and these teams were generally successful. Thus, if a team appears to be performing poorly, faculty could examine whether the informal leader is self-centric. Discussing

with these students their understanding of their role in the group may help. Another tactic may be to install forms of extrinsic motivation, in the form of grades or peer assessment, for these leaders or teams since self-centric leaders are focused on their own status.

Limitations

This qualitative study focused on a one-semester junior level design class. As such we had a limited sample to work with. Further research will be needed to determine whether these characteristics hold across a larger sample of small design teams. However, their behaviors aligned with those identified in the team and informal leadership literature.

Further, qualitative research, like quantitative, has strengths and weaknesses. A major strength is that it is very effective in studying nuances of behavior and creating a rich picture of roles and actions. [12] A weakness is that qualitative research, by its very nature, is not generalizable. Nor does it give a statistical description of large populations.

Conclusion

Informal leaders on student teams have to manage the task and relationships. Successful informal leaders manage the task component by a) taking time to understand the task, b) being technically competent, c) maintaining quality through questioning and informal assessment, d) keeping the group focused on the task.

The observed informal leaders also managed team relationships, although they were less effective at it. At times other team members assisted in managing the relational component. Managing the relational aspect of teamwork involves a) creating and maintaining a collaborative environment, b) exhibiting fairness and humility toward teammates, and c) using creativity and intuition.

In these student teams sometimes the leadership was shared, with the task leader dominating. The secondary, relational leader would manage some of the discussion. When a relational leader dominated and the task leader was secondary, the team was less effective in accomplishing its task.

Since teamwork is widely used in design curricula, understanding the roles and behaviors of informal leaders is key to supporting successful teamwork. When team performance is low, recognizing the behaviors of informal leaders gives faculty a more solid context on which to base interactions.

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