DEVELOPING LEADERSHIP SKILLS FOR
WOMEN IN ENGINEERING AND SCIENCE

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ABSTRACT

Leaders are required to set direction and achieve results. Leaders should not be confused with managers. Leaders and managers, both have a distinct but complimentary roles. Each role has its own set of characteristics, duties and responsibilities. Both leadership and management abilities are required within an enterprise in order for it to succeed in today's highly complex and competitive global environment. Management is primarily about dealing with complexity while leadership is concerned with change. The potential for an organization's success is greatly enhanced when both strong leadership and strong management capabilities are combined in a balanced yet synergistic manner within the organization. Technologies, such as computers, software tools, and global networking, have contributed to the globalization of business and have created the potential for unprecedented volatility and change. Trying to cope with increasing change always generates an increasing demand for more leadership. The need for leadership skills is not confined to only a few executive officers. It is possible for many persons to play an important leaderships role within an organization. Many organizations do not simply wait for leaders to come along but actively try to develop them by seeking out persons with leadership potential and exposing them to career experiences that are designed to develop their leadership skills. With a proper program of providing leadership learning opportunities combined with a nurturing and mentoring environment many persons can develop and exercise leadership skills effectively within the organization. Obviously if students were given a chance to develop leadership skills as part of their education they would have a competitive advantage after graduation. This paper attempts to summarize the characteristics of leaders together with the styles of leadership that have proven to be most effective. The authors have found that the most difficult problem in designing a program that will develop leadership skills for women in Engineering and Science is to ensure that they will have equal access to the learning opportunities that can foster leadership. The problem is compounded since women are usually a minority in Engineering and Science classes and their participation in leadership building opportunities can thus not be left to chance, but must be an integral part of the design of the leadership enhancing experience.

INTRODUCTION

Leadership is currently a popular topic, [1], [2], [3], [4], [5], [6], yet the development of leadership skills in the context of a an undergraduate Engineering or Science program needs further elaboration. There are many definitions of leadership [2], but the most common elements that appear in leadership definitions are to show direction and achieve results in a changing environment. Showing direction in the context of leadership means creating a Vision. A Vision is a short concise, often heroic, statement that infuses people with a sense of purpose by providing long-term direction and forms the basis for a more expansive mission statement. A mission statement is a more comprehensive than the vision statement in stating what to do and become. An excellent mission statement will challenge and inspire every one to personal dedication and effort by generating enthusiasm for the future. While achieving results is dependent upon many factors, a mission statement that is elaborated in terms of a formal set of objectives can enhance the potential to get results by guarding against internal confusion, drift and status quo performance. Measurable events or goals must be associated with the objectives. Goals serve as milestones or strategic targets for tracking an individual's or an organization's performance and progress in realizing their

objectives. Achieving results also requires that a strategy, or commitment to undertake one set of actions as opposed to another, is necessary to achieve targeted performance goals and produce successful organizational performance. Crafting a strategy is an entrepreneurial action as some degree of venture and risk taking is inherent in choosing among alternate approaches. The strategies proposed must be consistent with the realization of the goals and they must be realizable with available resources. Statements of the vision, mission, objectives and goals are usually found in a strategic plan. Not surprisingly, strong leadership is at the core of the formulation and implementation of any robust strategic plan. If we can agree that the primary tasks of leadership are to set direction and to get results, then it is possible to try to determine the characteristics of leaders together with the styles or methods of leadership, so as to ultimately create a learning environment that provides the opportunity for the development of leadership skills. While leadership is most often analyzed in terms of leading an organization, it really means developing a better and stronger person. All undergraduate students in Engineering and Science can develop and enhance their leadership skills. Leaders have self-esteem, initiative, a commitment to excellence and empathy skills that can be advantageous in not only a business context, but also in all personal aspects of life. The authors encourage their students to formulate a personal strategic plan that will help them in providing a course of action that will enhance the probability that they will realize their dreams and aspirations.

CHARACTERISTICS OF LEADERS

There is often a debate as to whether leaders are born or made. In either case it is advantageous to identify those properties or characteristics that seem to be common to many persons that have demonstrated an effective leadership role. A number of personal characteristics, attributes and skills have been identified [1] for those persons who typically perform in a leadership role. These traits do not appear to be gender-specific and have been summarized in the following three categories.

1. Personal Characteristics

Leaders have the type of self confidence that is usually derived from a positive sense of self-esteem and worth. They have the ability to exercise self-control over potentially counterproductive emotional volatility and related actions. Leaders can sense the emotions and feelings of others and act accordingly to achieve results.

2. Attributes

Leaders are able: To have the initiative to take advantage of windows of opportunity; To be performance oriented and understanding of the importance of establishing performance metrics in the evaluation of goals and objectives; To be adaptable as it is in a rapidly changing environment that leadership are in the highest demand; To have the ability to sense an other person's emotions and to react in an appropriate manner; To be able to adopt a client focus to ensure that the needs of the "customers' are being meet. Leaders understand that without a proper reward system in place the chances for success are greatly diminished

3. Skills

Leaders have developed and used the following abilities and skills:

- Abilities to take charge and create a compelling vision that leads people in a new direction by inspiring confidence and commitment
- Communication skills that let a leader both listen and send inspiring and well-defined messages with a purpose
- Skills to create and maintain a support network of persons
- Conflict management and resolution skills that lead to a negotiated consensus among adversarial parties
- Abilities to develop the full potential of others by means of coaching and mentoring skills
- Abilities to reduce people's fear and uncertainty while concurrently increasing their hope for a better future

In a very real and fundamental context leadership is about reducing fear and uncertainty while increasing hope for a better future. People see risk, uncertainty and volatility all around themselves. This leads to fears, [2], of losing their jobs, their fiscal savings, status, friendships and other aspects of life that they have come to value and depend

upon. A leader's contribution is most significant when they are leading people, not just an organization, through a difficult and changing environment to a more secure and beneficial future.

STYLES OF LEADERSHIP

A number of studies [1] have conducted on identifying leadership styles and the type of environments where they work the best. It becomes evident that a women in an effective leadership role must be able to utilize a number, if not all of these styles of leadership during the course of their tenure as a leader. The most commonly identified leadership styles [1], include:

(a) Dictatorial Leadership

This type of leadership style is based on demanding immediate compliance with the leader's instructions. There is no opportunity for discussion, the leader expects you to do what you are told instantly. This type of leadership style can usually be initiated by persons with a very high degree of self-motivation to succeed coupled with initiative and self-control. This type of style can usually only be sustained for short periods of time and is generally unfavourable to an organization's working environment. However, during a crisis, or to force an immediate turn around, or to deal with problem employees this type of style may have to be employed, at least in the short term.

(b) Authoritative Leadership

This type of leadership style is based on creating a compelling vision that will mobilize people into action so as to realize the vision. A culture of ownership for the vision is established throughout the organization. This type of leadership style can usually be initiated by persons with a very high degree of self-confidence, empathy for stakeholders and who see themselves as catalysts for change. This type of leadership has the potential to have the most positive influence on the organization's working environment. This style is especially appropriate when a changing environment imposes the need for a new vision or when very clear direction is necessary to remove uncertainty about an organization's objectives. The Authoritative leadership style derives much of its power from the knowledge base of the leader. This approach would thus fail when the leader is working with a team of experts or peers that may see the leader as not having current knowledge or as one who is only interested in self-grandisement.

(c) Affiliative Leadership

This type of leadership style values people and their emotional state more than specific tasks or goals. This type of leader believes that people come first builds strong emotional bonds with individuals throughout the organization and then is able to take advantage of the high degree of loyalty. This type of leader offers recognition and reward for work well done and provides a great deal of positive feedback to individuals. This type of leadership style can usually be initiated by persons with empathy for others and who have the necessary interpersonal and communication skills to build loyal relationships. This type of leadership can have a positive influence on the organization's working environment. This style is especially appropriate to motivate individuals during difficult circumstances or to resolve conflicts among team members.

(d) Democratic Leadership

This type of leadership style forges consensus by asking questions and allowing participation on a democratic basis. By letting individuals have a voice in the decisions that set goals and how they work a higher level of commitment and responsibility may evolve. Persons in an organization with a democratic leadership style tend to establish realistic, if not too conservative, expectations as to what can be accomplished. This type of leadership style can usually be initiated by persons with collaborative, team building and communication skills. This type of leadership does not, in general have as positive influence on the organization's working environment as other positive styles. A totally democratic style could lead to endless meetings with the effect that people feel confused and leaderless. This type of leadership style works best when the leader is uncertain about the best direction to take and needs advice from knowledgeable employees.

(e) Pacesetting Leadership

This type of leadership style sets high performance standards by example. The leader is driven by doing things better and faster and asks the same of all subordinates. Those who can not maintain the pace are replaced. This type of leadership style requires a person with initiative and highly developed drive to achieve. This pacesetting leadership style is not sustainable and has an overall negative influence on the organization's working environment as many employees are resentful of the continuing demand for excellence and increased output when they perceive that they do not have the same reward system as the leader. This type of leadership style can work effectively in special circumstances, such as where a highly skilled and self-motivated research and development team is in place and the competitive individuals feel they can outperform the leader. This can lead to very important results being available in a short time period.

(f) Coaching Leadership

This type of leadership style is used to develop an individual or team's performance to their full potential to contribute to organizational goals. This type of leader is always asking others to try new approaches and often acts more like a counselor than a traditional leader by motivating rather than instilling fear or apathy. This coaching leadership style requires a person with empathy, self-awareness and a desire to develop others. Coaching leaders delegate authority so as to emphasize long-term learning over immediate enhanced results. While having a positive impact on the organization's working environment, the coaching leadership style is used the least due to the pressure for leaders to produce immediate bottom-line results. The style can be very important when individuals are being groomed for important longer-term roles in the organization and the level of commitment necessary to support the mentoring and nurturing associated with coaching is justifiable.

AN ORGANIZATION'S WORKING ENVIRONMENT

The type of leadership style works best in a given situation depends upon the working atmosphere or environment in the organization. Research [1] has been carried out in an attempt to characterize the factors that influence the nature of an organization's working environment. These factors [1], include: *Flexibility* - how free employees feel to innovate; *Responsibility* - peoples feeling of responsibility to the organization; *Standards* - the level of standards people set; *Reward* - is the reward system appropriate; *Clarity* - is there a clear understanding of the organization's mission and values; *Commitment* - the level of commitment within the organization.

Research has found [1] that a Coercive style of management usually acts most positively (0.01) on the level of standards people set and has an overall impact of (-0.26) on the working environment; An Authoritative style of management acts most positively (0.54) on the rewards aspect of the organizational environment and has an overall impact of (0.54) on the working environment; The Affiliative style of leadership acts most positively (0.48) on the rewards aspect of the organizational environment and has an overall impact of (0.46) on the working environment; The Democratic style of leadership acts most positively (0.48) on the rewards aspect of the organizational environment and has an overall impact of (0.46) on the working environment; The Pacesetting style of leadership acts most positively (0.04) on the responsibilities aspect of the organizational environment and has an overall impact of (-0.25) on the working environment; The Coaching style of leadership acts most positively (0.04) on the responsibilities aspect of the organizational environment and has an overall impact of (-0.42) on the working environment. Interestingly the leadership styles [Authoritative (0.54), Affiliative (0.46), Democratic (0.43), and Coaching (0.42)] that have the greatest positive effect on the overall working environment all have their highest impact in the in the area dealing with peoples perception of performance feedback and the corresponding appropriateness of the rewards. A person taking on a leadership role must thus ensure the an appropriate reward system is in place if they expect their leadership abilities to make a large difference on an organization's direction and performance.

While attempting to quantify the effectiveness of many aspects of leadership it still important to understand that leaders must ultimately replace people's fears of risk and uncertainty with a hope for a better future if they expect to provide leadership on a basis that is sustainable with time. The development of leadership is not an exact science due to the many complex factors that affect leadership performance, yet persons recognize and are greatly influenced by even the image of, if not actual leadership performance.

LEADERS

An outstanding leader can provide the leadership style best suited to the needs of the organization. Those leaders who have mastered the Authoritative, Democratic, Affiliative and Coaching styles of leadership have the potential to make the greatest positive impact on both the organization's working environment and the organization's performance. Outstanding leaders can sense their impact on people and the organization and can make a seamless transition from one leadership style to another in order to get the best results. For a leader to expand their repertoire of leadership styles it is important that they know what underlying characteristics are associated with the various styles and then first develop and/or enhance the necessary personal attributes and skills. Leadership deals with change, so obviously the leader with the widest range of leadership skills has the best potential to provide the right style at the right time, with the right intensity and duration. Since leadership at its most fundamental level is about reducing people's fear and uncertainty while increasing their hope for a better future, the ability to sense how people are feeling on a continuing basis is a great advantage. The ability to respond to person in a manner that is congruent with their emotions offers the potential to build a symbiotic environment that will foster results being achieved. The authors thus believe, based on their observations, that women may actually have an advantage over men in developing as leaders, as long as they are afforded an equal opportunity to develop and practice their abilities.

A LEARNING ENVIRONMENT FOR LEADERS

Now that a number of factors have been identified that may enhance a person's leadership potential it is appropriate to attempt to determine how these factors could be developed or at least enhanced in a university based engineering learning environment. The normal class room environment where students are, for the most part, passive participants in a lecture setting does little to develop leadership skills. Leaders do not work in isolation, hence team or group environments are more conducive to fostering leadership abilities. Extensive use of multimedia based teaching, while simplifying the transfer of information to students, can foster an undemanding learning environment that is actually counterproductive to the development of leadership skills. We attempt to develop leadership skills in students in the Faculty of Engineering at the University of Windsor by integrating University driven learning opportunities with those that flow from participating in a co-operative education program with Industry. Once the personal attributes and skill sets are identified that support or drive the various leadership styles specific learning opportunities can be designed so as to maximize the potential for students to develop leadership skills and the. Unfortunately, there can be some obstacles to creating the best environment for developing leadership skills.

For example, giving some initial course requirements and then changing them during the term creates learning opportunities that enable students to deal with change, the essential leadership quality, however, this quite often contravenes University Senate regulations or maybe characterized as bad teaching. There seems to be a growing tendency to set out all the requirements in advance in exhausting detail, in a manner that isolates students artificially from any form of change and the associated risk and uncertainty that exists in the real world. Students working by themselves do not have the necessary opportunities for leadership development. Thus, learning opportunities that allow a student to assume a leadership role and then interact with other students afford the student to the best potential to develop the skills necessary for successful leadership. Class or team projects can be used as excellent vehicles to develop leadership abilities. The manner in which teams are formed can be as critical as the nature of the project used to create the opportunity to develop leadership skills. In the workplace engineers and scientist usually do not work in isolation. Often they may be members of a multidisciplinary team and excellent interpersonal skills are necessary to form a strong cohesive team that can take advantage of symbiosis.

(a) Formation of Teams

Teams can be formed with students selected from the point of gender, cultural diversity and record of academic achievement so as to generate the potential for the broadest possible spectrum of experiences. Certain leadership requirements are specified for each of the teams. An attempt is made to set conditions that will afford an opportunity to develop the various leadership styles. The leaders are chosen from a group of volunteers or seconded from the class in such a manner so as to ensure an equal opportunity for women to participate in leadership developmental activities.

(b) Nature of Projects

A number of sequential shorter length team projects can be assigned so as to afford all interested students an opportunity to act in the capacity as a leader and gain leadership experience. Special projects can be developed to enhance the Coaching type of leadership style. In this instance an important aspect of the project is to develop the abilities and potential of student colleagues. For example in an electrical engineering course a class project was

assigned to develop a reference and tutorial manual for a circuit analysis program (SPICE). The class was divided into teams that were responsible for the compilation of each chapter. Each team was mandated to have a leadership structure consisting of one man and woman.

(c)   Co-operative Education

A co-operative education program that gives students meaningful real-world experience during their work terms can offer many opportunities to develop a range of skills including interpersonal and communication skills, as well as technical skills.

(d)   Other Initiatives

Encouragement and support for students that compete in such student competitions associated with the various professional and technical societies or those sponsored by Industry or Government can contribute to the development of leadership skills. Students can be encouraged to take part in attending or hosting meetings and competitions, etc. involving students from other Universities. Asking students to help judge projects and/or mentor secondary school students at local Science and Engineering Fairs also affords them an opportunity to develop their leadership skills. Students who take part in hosting meetings or events also can enhance their leadership skills. Quite often we require students to present their project results as if they were entrepreneurs making a multimedia presentation for venture capitalists or possible stakeholders. The more often a behavioral sequence is repeated the greater the chance that it becomes the brain's default option. In other words, practice makes perfect. Thus a learning environment that provides repeated opportunities for developing and enhancing leadership skills is essential for the student to realize their full potential as early as possible.

CONCLUSIONS

Leadership is about setting a vision or direction and achieving results. It is unlikely that persons with low self-esteem and poor interpersonal skills will rise to positions of leadership. The climate of the formative years is thus very critical in enhancing leadership potential. The normal classroom learning environment in an undergraduate Engineering or Science is not sufficient to develop leadership abilities. A diverse range of learning opportunities that involve interacting with people in a team setting can be used to develop leadership abilities effectively. Leadership at its most fundamental level is about reducing people's fear and uncertainty while increasing their hope for a better future, the ability to sense how people are feeling on a continuing basis is a great advantage. As women in Engineering and Science programs or often a minority, their participation in leadership building opportunities can not be left to chance. All the programs developed to foster leadership abilities must be designed to ensure that women have equal opportunities to participate in a leadership role.

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