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Abstract (Summary)

Leadership is an area of intense interest and need particularly among research and development, scientific, technology, engineering and mathematic (S.T.E.M.) organizations. S.T.E.M. leaders face cultural challenges unique from those of mainstream businesses and have development needs not adequately addressed in the organizational literature. We summarize a current mainstream leadership development program design, focus on the unique needs of S.T.E.M. organizations and their leaders, and recommend five design elements for the S.T.E.M. leadership development program. [PUBLICATION ABSTRACT]

Full Text

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Abstract

Leadership is an area of intense interest and need particularly among research and development, scientific, technology, engineering and mathematic (S.T.E.M.) organizations. S.T.E.M. leaders face cultural challenges unique from those of mainstream businesses and have development needs not adequately addressed in the organizational literature. We summarize a current mainstream leadership development program design, focus on the unique needs of S.T.E.M. organizations and their leaders, and recommend five design elements for the S.T.E.M. leadership development program.

Introduction

Leadership development is a foremost topic in business literature and is one of the most prolific and fastest growing areas of interest in organizational development (Sharkey, 1999). Yet there remains an acute need to develop leaders. Survey results from over 500 senior learning professionals indicate leadership and development to be the top training priority among U.S. profit, non-profit, and government organizations with experienced managers increasingly recognized as urgently in need (Hall, 2005). Even so, according to the U.S. Conference Board, businesses report a significant decline of confidence in their leadership strength, down from a high of 50% in 1997 to about one-third in 2001 (Barrett & Beeson, 2002). Ironically, although leadership development is seen as a good idea according to a recent survey of Fortune 100 level businesses, only 44% of them had formal well-defined, well-structured systems for developing high-potential employees (Giber, Carter & Goldsmith, 2000).

Professionals in science, technology, engineering and mathematics (S.T.E.M) who find themselves in positions of management have unique leadership development needs not fully addressed in organizational literature. S.T.E.M environments are similarly unique from those among mainstream business. They are "are long over due for leadership skills building and training in basic business acumen" (Hall, 2005, p. 24).

The premise of this article is that organizations require specially designed leadership development programs so that these professionals optimally contribute to the organization. S.T.E.M. organizations include scientific institutes, universities, and pharmaceutical and software development organizations. We offer recommendations for leadership program design elements to meet the unique needs of these groups. We begin by exploring what is already known about general leadership development program design, describe the needs of S.T.E.M. organizations and the characteristics of their new leaders, and conclude with five design elements essential to the success of a S.T.E.M. leadership development program.

Background

Regardless of organizational environment and despite stylistic differences and variations among curriculum, most authors agree on the core purposes and best practices for leadership development programs. Our review of organization development literature from the past decade shows that LDPs typically include: 1) formal classroom training, 2) real-world/real-time application, 3) reflection (an inward and outward focus on self, other, and beyond including the whole system), 4) 360 feedback tools with coaching, and 5) the participation and support of senior management as content expertise and mentoring.

Organizations that choose LDPs base their decisions on various organizational development considerations including leveraging favorable cultural effectiveness and transformation. They intend to create a more competitive advantage and foster greater adaptability and fortify performance capacity (Fulmer & Viceré, Fulmer, 1997; Fulmer, Gibbs & Goldsmith, 2000; Viceré & Taylor, 1994). Additionally, LDPs serve the aims of succession, building bench-strength (Tyrrell & Swain, 2000) and retention (Pernick, 2001). Organizations are investing in LDPs because they believe that homegrown leaders will fortify their organizational culture, and reinforce both their strategic agenda (Pernick) and strategic advantage (Fulmer, Gibbs & Goldsmith, 2000; Giber, Carter, & Goldsmith, 2000). They are also leveraging knowledge and learning as an important sustainable competitive advantage (Viceré, Taylor, & Freeman, 1994).

Organizations with active LDPs have moved rapidly away from the perception that leadership development is exclusively to the executive domain. They are extending their reach into all levels of management. (Fulmer, 1997; Fulmer & Viceré; Fulmer, Gibbs & Goldsmith, 2000; Viceré & Taylor, 1994). Typically education and training are delivered by a variety of external and internal sources. Specific program content may be either standardized off-the-shelf variety or customized to the specific needs of the individual participants and/or the organization as a whole (Fulmer & Viceré, 1996).

Quality LDPs include several key considerations as personality profiles that indicate

developmental opportunities, strengths and weaknesses. Psychometric-based, assessments which, when properly applied, are particularly effective to leaders' transformation and behavioral changes. Chief among them is the Myers Briggs Type Indicator (de Charon, 2003; Michael, 2003). Internal 360 instruments that capture the key behavioral success indicators are especially useful when combined with feedback and coaching. Additionally, good LDPs also have sustained emphasis on combining formal and experiential learning opportunities that result in valued change with staying power on behalf of the individual and the organization (Fulmer & Viceré, 1996; Fulmer 1997; Viceré & Taylor, 1994). Sufficient critical reflection by the participant is particularly relevant to the success of an LDP (Densten & Gray, 2001). This is often accomplished through mentorship or external coaching (Giber, Carter & Goldsmith, 2000; de Charon, 2003; Fulmer, Gibbs, & Goldsmith, 2000).

Evaluating program results on a regular basis is key to assuring that the program is working and that the organization's investment dollars are being well spent (Dalton & Hollenbeck, 1996; Pernick; Fulmer, Gibbs & Goldsmith, 2000; Sirianni & Frey, 2001). Leadership development can be effective to abut cultural change especially when joined with other levers, such as recognition and managerial support (Hyde & Patterson, 2002; Sharkey, 1999; Sirianni & Frey, 2001). However, money is unwisely spent by the organization that invests in an LDP yet remains resistant to continuous learning and development (Sharkey, 1999).

Leadership Development Programs in S.T.E.M. Organizations

With the exception of the Parke-Davis study cited below, there is little discussion in the literature about the uniqueness of S.T.E.M. cultures and their leaders.

The pharmaceutical research and development division at Parke-Davis created a program to develop leadership effectiveness of its scientific management staff engaged in leading and managing other scientists. Generally, scientists lacked formal training and had little interest in managing. Among there leadership talent was recognized as "a scarce and highly-valued asset" (Jones, Simonetti, & Vielhaber-Hermon, 2000, p. 2). Previous training and development efforts emphasized developing skills and techniques, but were fragmented leaving little room for a shared, collégial experience integral to collaboration and teamwork. However, in their second attempt, as with the other best-practice models, leadership competencies were identified; the program was customized and delivered in concert with an integrated learning model emphasizing real-world application. Shared experience was a vital part of the program. Key improvements found among the participants included personal transformation, valuable organization contribution, communication, team building and problem solving skills. The program debunked the notion that "scientists are a breed apart, to be left alone to get on with the arcane work in laboratories far from the center of corporate power" (Anonymous,2001 p. 5). Rather, they discovered that it is incumbent upon organizations to make maximum use of all their talent in order to thrive and grow in turbulent times (Jones, Simonetti, & Vielhaber-Hermon, 2000).

In contrast, U.S. Federal leadership development programs, nine altogether, including the USDA's Graduate School's New Leader Program, are stand-alone centers that function apart from the participant's own organization (Silverman & Miranda, 1997). While some of the programs involve internships, there is much less opportunity for integration of real-world experiences that fosters working and learning with others within their organization.

Examples of other successful S.T.E.M. leadership development programs are Space Systems Loral and AstraZeneca. Space Systems Loral, reported having a program for recent college graduate hires that included a mentor relationship and relies upon executive sponsorship. The purposes of the program included retention, technical skills training, and leadership development (Barbián, 2002). Astra and Zeneca merged in 1999 forming AstraZeneca one of the top five pharmaceutical companies in the world. They leveraged their newly created action-learning-based leadership development program along with other merger activities to advance cultural integration between the then merging organizations. Involving their top 200 executives,

the program achieved a whole-system, future-oriented and vision-driven perspective that embraced and utilized differences among various members of its workforce professionally, racially and by company history and affiliation (Hyde & Paterson, 2002).

Universities often underutilize the strategic advantage offered by their own potential leaders. Comprised of an atypical pool of potential organizational leaders, universities today face multitudes of unique challenges that call for leadership at all levels among faculty, staff, deans, departmental chairs, provosts, chancellors, presidents, and students. Brown's case study, at the University of Saskatchewan, found that most department heads had not initially aspired to serve in leadership roles. Pre-existing tensions between academicians and management had contributed negatively to their attitude toward formal leadership roles. To close perceptual gaps and build productive relationships an LDP was created involving participants from both administration and academics. It embraced a shared pursuit of learning and development diminishing much of the pre-existing negativism and instilling a spirit of collaboration and an appreciation for leadership (Brown, 2001).

New Leaders Within S.T.E.M. Organizations

The S.T.E.M. organization is comprised of leaders that are, in many respects, unique from those found in most other kinds of organizations. Through field experience in consulting assignments to leadership development program design and delivery at the University of Nebraska Institute of Agriculture and Natural Resources, the University of Colorado, the University Corporation for Atmospheric Research, the National Center for Atmospheric Research, and individual coaching of research scientists, university faculty and engineering managers and organization development initiatives involving over 400 LDP participants across these and several other private scientific and engineering organizations S.T.E.M. organizations the following are found in support of Brown's findings.

1. Highly educated in their specific areas of expertise, most initially express negativity and reluctance about managing and leading. They may only view it as a necessity to furthering their research or technical aspirations or organizational advancement.
2. Most S.T.E.M. professionals eventually discover opportunities for creative leadership and want to make a difference in the lives of others and their organization. They realize that leadership competencies are transferable to their individual research and to their research teams. They find their skills to be a service to their organization and the broader community, as well as their personal lives.
3. The best source of help and support is another leader with a similar background. They create and strengthen collégial relationships with counterparts across departments while sharing challenges and best practices.
4. Many express additional pressures over work/life balance and balancing their new role with their research and technical interests. Particularly in the scientific realm, the reward system has traditionally reinforced research and publishing over leading and managing others. However, this is changing due to greater emphasis on interdisciplinary science, needs of their constituents, competitive forces, and advantages of inter-departmental collaboration.
5. Leaders in S.T.E.M. organizations find relational challenges the hardest to handle. Chief among them are concerns over conflict and keeping others motivated and oriented toward developing solutions.
6. Leadership succession planning and transition planning suffer as management and leadership efforts go under-recognized and under-rewarded.

A striking example of the sixth finding is cited in the Columbia Space Shuttle accident

investigation report- that the organizational causes of the 2003 loss of the Space Shuttle Columbia and its sevenmember crew are rooted in the program's history and culture. The Gehman Report documented barriers to effective communication, lack of integrated management, and a shadow chain of command that operated outside the organization's rules (Columbia Accident Investigation Report, 2003). Among the recommendations was that, "NASA should implement an agency-wide strategy for leadership and management training that provides a more consistent and integrated approach to career development. Strategy should identify the management and leadership skills, abilities, and experiences required for each level of advancement" (p. 223).

Culture is Key

The matter of culture has much to bear when considering the design, nature, and intended outcomes of a leadership development program. Culture is emerging as the frame of reference for every leader in any organization and is intimately tied to and shaped by the leaders within. It provides the guidelines for making meaning from behavior, sets the pattern for how people function and relate to one another, determines standards of effectiveness and provides order and structure for activity (Schneider, 1994).

The S.T.E.M. culture, above all else, values: competence, knowledge and information. The need for competency predominates among these kinds of organizations that include accounting firms, think tanks, engineering, high technology companies, universities, and scientific foundations. Professionals become part of them because it reinforces their calling to achieve mastery and allows them to contribute to an inspired vision. Although somewhat true for other cultures, it is particularly true in these competency-based cultures, that hiring and promotion are based upon demonstrated achievement. Graduate degrees and professional recognition carry great weight and technical mastery is vitally important. As a result of their constant "stretching", people act more intense, more urgently, and have greater difficulty feeling satisfied with their accomplishments than in other cultures. Careful planners they value information and sound rational (Schneider, 1994).

Five Design Elements for Success

Our original premise is that the S.T.E.M. professional requires a leadership development program design that is in many respects unique. The following five design elements address the S.T.E.M. professional's needs and are essential to effective program design.

Define Organization-Specific Leadership Competencies

Leadership competencies and a leadership model must foster best practices. These should take into consideration the S.T.E.M. professional's need for both a clear and engaging vision that provides a challenge and rationale for developing new products, services, and opportunities. Technical mastery is vitally important to the S.T.E.M. professional. It is the combination of possibility with rationalism that distinguishes this culture- that is the logic for getting us there that counts. There is a high value placed on conceptual systemizaõon- a spawning ground for ingenuity and invention (Schneider, 1994). Therefore, the LDP must include problem solving, project planning, and action-learning models that engage their need to solve, or improve the novel and unique. It is important to create explicit objective measures of success relative to a standard of organizational excellence to keep them both striving and satisfied, which in turn adds value to the organization.

Apply Selection Criteria

It is vitally important to enroll participants to maximize the return on the investment. Organizational considerations should include overall corporate direction, strategy, goals, and need for leadership succession. Individual considerations include desire, confidence,

assertiveness, readiness, self-awareness, energy, and experience.

As noted, in the scientific and scholarly realm the reward system predominantly reinforces research and publishing over leading and managing others. Among those in engineering learning and practicing mechanical, non-human systems related principles are the primary focuses. Aside from leading a team of just a few members for a single purpose project, or research grant, it is uncommon for S.T.E.M. professionals to anticipate broader realms of management and leadership responsibilities as a part of their career. A clear, fair, simple process is needed to communicate the purpose and scope of the LDP as well as for selecting and notifying the applicants. In addition to having the desire to further their professional development, participants must demonstrate work/life balance capability, have longevity with the company, fulfill qualifications, such as tenure, and desire to build cross-functional relationships and a pursuit of leadership goals. The nomination process must reveal whether they possess key desirable traits including:

- * Sense of purpose
- * Desire to make an impact
- * Assertiveness
- * Receptivity to feedback
- * Long-range view of the organization and its purpose
- * Ability to engage others in a compelling vision
- * Propensity to architect operational systems and design effective strategies
- * Demonstrated need to continuously learn, for rigorous processes and producing substantive information
- * Internal motivation for competency
- * Some success with and an orientation toward working with others

Create Learning Partnerships with Relevant Activities

Real-world developmental activities or, action learning groups, reinforce informed change. While it is certainly true that an action-learning component contributes substantially to instilling collegial partnerships among the participants in mainstream programs, it is particularly necessary to the S.T.E.M. leadership development program.

More often than not, the engineer, scientist or, scholar will show much greater commitment and loyalty to one's own professional interests than the needs of the organization. However, the days of the solitary researcher, scientist or engineer pursuing the impulse of her or his own curiosity are quickly eroding and being replaced by participation within teams. Interdisciplinary lines of demarcation are fast eroding. Individual contributor roles are less common while joint appointments and working collaboratively within matrix reporting systems across departments and disciplines are fast becoming the norm. Participants can, and do, find that collaborative leadership improves their creativity and ingenuity; it provides focus and relevancy for professionals' work together. The role of the LDP is to create platforms for collaborative relationships while framing responsibilities in a light that illuminates the contribution to individual achievement and excellence. One prime arena is the action-learning team with an organizationally relevant shared purpose and task with an agreement to formally present their

findings to senior management at the conclusion of the program.

While often overlooked, it is advisable to place emphasis on the human dynamics that emerge within the action learning team so as to inform the members of the personal and relational developments. Team development models such as Tuckman's Five Stages of a Team are particularly useful for redirecting attention to the teams' processes. The DIET model, a proposed form of action research, blends the human systems side of teams with the rigor of empirical data analysis (Cady & Caster, 2000). Non-traditional, more humanistic, change methodologies such as appreciative inquiry can be incorporated into the S.T.E.M. organizational system to offer a balanced learning experience and effective model for program participants.

Involve Organizational Leaders and Peers

A leadership development initiative is only as good as those sponsoring it. Best practice organizations involve executive sponsorship in the form of program design, instruction, and mentorship. Senior management must drive the need for and support the establishment of a formal LDP. A clear vision and continued involvement by senior level staff is essential to success and continuation. Senior staff may support the program in a number of ways- financially, as subject matter experts teaching within the program, as mentors, and of course, for executive development, to lend credibility and place emphasis on the importance of the program as participants themselves.

As discussed earlier, given that the best source of help and support to the leader-professional is another leader of similar background and orientation, those already serving in a formal leadership role serve as excellent resources, mentors, and models for those just taking on the role. Peers should also contribute to the program design and implementation. Advisory panels are typically comprised of representatives from administrative, human resources, training and development, external consultants, and universities. An essential ingredient to the S.T.E.M. LDP are peers from among the ranks of fellow professionals most notably, those who have already completed the program. This brings a unique, first-hand perspective that contributes to peer engagement and overall collegiality. They serve as representatives from among the participant group who not only understand the developmental needs, experiences, and challenges of the participants, but models leadership as well- positive proof of what the program is about.

Customize Participant Support Structure to Match Needs

Pressures involving work/life balance arise from an LDP experience as well as the challenge of balancing new leadership roles with individual research and technical interests. Coaching is an excellent resource for fostering the critical reflection needed to integrate and balance these potentially unsettling demands of transition and change, however rewarding the demands may be (Ryan et al., 2000). The capacity to reflect can be developed. When tied directly to personal experience it provides a process for leaders to deepen their understanding and maximizes their effectiveness through the interpretation of their experience from a leadership perspective (Densten & Gray, 2001). As a reciprocal relationship, the capacity to reflect also extends participants' ability to listen deeply to others' needs, thus fostering a key leadership attribute (Kouzes & Posner, 2002).

High functioning mentor relationships for the participant during the program as a protege and beyond the program when serving as alumnae mentor not only reinforces the collegial experience but also fosters continued learning by holding accountability, inspiring reflection, sharing feedback and contributing to and building upon the organizations knowledge and collective positive history. When integrated into an action learning team, mentoring contributes the trust and recall of the positive history needed for organizational growth.

Managers throughout the organization should also be engaged at the onset to support the participants' learning. Managers, who are engaged in the process provide mentorship and create an environment for success and advancement for their employees. An individual development plan provides a structure to describe the desired learning, the competencies addressed, the actions that will be taken, target completion dates and measurable success indicators. These plans are reviewed in triad meetings involving the participant, the manager, and the participant's coach allowing the manager an opportunity to fine tune the plan and offer on-going support for the individual.

Summary

Our experience as program with design, delivery, leading, and participating in leadership development programs within S.T.E.M. organizations supports and extends the six findings by Brown. In addition, we recommend these five additional and essential components for LDPs specifically designed for S.T.E.M. organizations.

1. Define organization-specific leadership competencies;
2. Apply appropriate selection criteria;
3. Create learning partnerships with relevant activities;
4. Involve organizational leaders and peers;
5. Customize participant support structure to match needs;

While defining organization-specific leadership competencies is likely a good idea for any program, it is especially important within an R&D organization because it shifts the emphasis in the primary role from technical applications to leading others. Likewise, all programs need appropriate selection criteria as pointed out in recommendation 2. We specifically suggest seeking these traits for R&D organizations:

- * Sense of purpose
- * Confidence in making an impact
- * Assertiveness
- * Receptivity to feedback
- * Long-range view of the organization
- * Ability to engage others in a compelling vision
- * Propensity to architect operational systems and design effective strategies
- * Strong need to continuously learn; desire for rigorous processes and the production of substantive information
- * Internal motivation for competency
- * Orientation toward working with others

While these traits are indicative of leadership effectiveness, they are often not as valued in a typical S.T.E.M. environment that tends to reward subject knowledge and technical mastery over working within human systems. Similarly, the third point, creating learning partnerships is sound advice for any LDP, yet it is critical to the success of programs in S.T.E.M. organizations since it balances the polarity between individual endeavors and team-based ones in an era of increasing need to integrate science and technology. It is also important for the success of an LDP program to involve organizational leaders and peers. This is especially advantageous to the success of the program. Lastly, as stated in the last recommendation, LDP participants in S.T.E.M. organizations require unique encouragement and support throughout the program in order to balance and integrate their professional and personal changes.

Applying these five strategies should help ensure that a leadership development program within a S.T.E.M. organization produces maximum results. Participants will be positioned to succeed. They will understand the goal of the LDP, they will have the support they need to learn and grow, to exercise their new leadership skills. And, they will have addressed their uniqueness as technical professionals as they grow accustomed to and embrace their new roles as leaders. All of which results in a long-term strategic competitive advantage to the organization.

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