Mentoring in Cooperative Education and Internships: Preparing Protégés for STEM Professions

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1. Introduction

As noted in *Rising Above the Gathering Storm* (National Academy of Sciences 2007), the United States is not producing enough graduates in the fields of science, technology, engineering, and mathematics (STEM) to meet the growing demands of an increasingly competitive global economy. Despite the anticipated need for a highly skilled and technically proficient STEM workforce, this gap will continue to grow as enrollments in the STEM disciplines decline and a generation of baby boomers begins to retire over the next decade in the United States (NSF 2008).

One of the unique opportunities employers have to recruit and retain a trained STEM workforce prior to graduation is through cooperative education (co-op) and internship programs (Gold 2002; Gregory 1990; Jaeger, Eagan, & Wirt 2008). These integrated learning programs promote student involvement through productive work experiences in fields related to students' academic or career goals (NCCE n.d.). In addition to preparing students with hands-on skills and knowledge, employers view co-op and internship programs as a pipeline for full-time talent. As reported in a recent NACE survey, 35.9 % of employers reported hires from their internship programs and 23.3% from co-op programs (March 2008). According to Onley (2006), "The market for campus talent has gotten much more competition." It is suggested that increased competition for a skilled workforce will continue to drive employer demand for students with relevant work experiences, such as co-op and internships.

Previous research on co-op and internship programs has identified mentoring as an especially beneficial component for students as they transition from school to work (Fifolt & Abbott 2008; Frehill, Ketcham, & Jeser-Cannavale 2004; Gibson & Angel 1995; LaBonty & Stull 1993). The literature on mentoring in STEM co-op and internship programs, however, has focused primarily on (1) roles of mentors (LaBonty & Stull 1993; Ricks & Van Gyn 1997), (2) structure of programs (Forde 2008; Gibson & Angel 1995; Taningco, Mathew, & Pachon 2008) and (3) characteristics of participants and mentors (Payton 2004; Van Gyn, Branton, Cutt, Loken, & Ricks 1996).

The purpose of this article is to identify the key skill sets, areas of knowledge and dispositions that undergraduate students in the STEM fields need to become successful protégés within a cooperative education or internship placement. Results from this research are intended to provide information about students' experiences in a professional setting in order to inform the practice of protégé preparation for mentoring.

2. Background

2.1 Shrinking Pool of STEM Talent

Current estimates by the U.S. Bureau of Labor Statistics project that total employment in occupations classified as Science and Engineering will increase at nearly double the overall rate for all occupations over the next five years (NSF 2008). During this time, the completion rates for degrees in natural science and mathematics and engineering by undergraduate students in the United States are projected to fall further behind completion rates by students in other developed nations around the world (Ashby 2006; National Science Board 2004).

As the national STEM pipeline continues to shrink, the rates of retirement for individuals in the fields of science and engineering are on the rise. Currently, 26% of all degree holders in the science and engineering labor force are age 50 or over. By age 62, half of all bachelor's degree holders in science and engineering are expected to leave full-time employment (NSF 2008). This impending decline in the STEM workforce may suggest a looming crisis for the United States and industry.

To address this shrinking pool of STEM talent, the Committee on Prospering in the Global Economy of the 21st Century has recommended that the United States create an environment in which to retain the best and brightest students, scientists, and engineers from within the United

Abstract

This paper presents the findings of a mixed methods study regarding students' perceptions of mentoring in a cooperative education (co-op) program. Specifically, content analysis of student interviews suggested a lack of understanding of the mentoring process as characterized by unexamined assumptions and inadequate preparation for the co-op experience. It was noted that the STEM pipeline continues to shrink through decreasing student enrollment and increasing rates of retirement in industry. Cooperative education and internship programs can provide institutions and employers with a unique opportunity to recruit and retain students for a highly skilled and technically proficient workforce. This paper identifies key skill sets, knowledge and dispositions that undergraduate students in the STEM fields need to become successful protégés within a cooperative education or internship placement program.

States and throughout the world (National Academy of Sciences 2007). Mentoring in co-op and internship programs may be an appropriate strategy to help students facilitate their own learning. This, in turn, may result in higher rates of matriculation for students into the STEM workforce.

2.2 Mentoring in Co-op and Internships

Cooperative education and internships are structured educational strategies that integrate classroom-based learning with practical work experience through productive work placements in fields related to students' academic or career goals. These experience-based programs capitalize on the partnerships among students, educational institutions and employers, with specified responsibilities for each party (NCCE, n.d.).

Mentoring has been described as "an intense interpersonal exchange between a senior experienced colleague (mentor) and a less experienced junior colleague (protégé) in which the mentor provides support, direction, and feedback regarding career plans and personal development" (Russell & Adams 1991). This interpersonal exchange between the mentor and the protégé may involve counseling, psychological support, protection, promotion, sponsorship, skill-development, and involvement in professional organizations (Cargill 1989).

The overlap of mentoring and experience-based learning programs, like co-op and internships, can be seen in both theory and practice. In 1967, Piaget described a set of intentional learning experiences that would challenge the individual to resolve discrepancies between old and new ways of knowing. It was suggested that this shift in cognitive structures based on new experiences is where learning can occur. Piaget referred to this process as achieving equilibrium (Kelehear & Heid 2002). As an extension of Piaget's work on context and meaning, Vygotsky (1986) indicated that individuals who encounter challenges and overcome them with the assistance of a more experienced colleague may have a greater pool of resources and enhanced ability to anticipate and resolve problems in the future.

In their description of students' experiences with mentoring in cooperative education, Gibson and Angel (1995) reported that students in technical fields who had participated in a mentoring relationship often demonstrated an ability to integrate quickly into the work place and expressed higher rates of job satisfaction with their co-op placement. The authors suggested that mentors could help students through this period of transition from classroom to workplace by teaching them both the technical skills as well as the informal processes of the organization.

3. Methodology

This research was derived from a mixed methods study examining students' perceptions of mentoring in a university cooperative education program (Fifolt 2006). The original study was divided into two distinct phases. First, quantitative data were sought through survey results to provide a broad understanding of students' co-op experiences. Second, qualitative sampling through in-depth interviews provided a closer examination of individual accounts (Creswell 2002; Lincoln & Guba 1985; Patton 1980).

3.1 Data Collection and Sample Selection

The sample for the quantitative phase was drawn from a targeted population of 323 traditional-age (18-24) undergraduate college students participating in a cooperative education program at a four-year public institution in the southeast. As the largest co-op program in the state, the site was selected based on its outstanding reputation, long-standing history, structure, and diverse student population. A non-probability sample of 91 co-op students (n = 91) completed an online survey based on Noe's (1988) *Mentoring Functions Scales* for a return rate of 28%. Given the high rate of research requests from college students and corresponding low rate of return, a response rate of 28% is above the minimum sample size for selected small populations at the 95% level of confidence (Rea & Parker 1992).

In the qualitative phase, a purposeful sample of nine students was chosen to participate in follow-up interviews based on representative characteristics of the population and scores that reflected extreme ends of the distribution of scores. Participants included four Caucasian males, four Caucasian females, and one Hispanic female. The academic disciplines represented in the qualitative sample included Chemical Engineering, Civil Engineering, Construction Engineering & Management, Electrical Engineering, Industrial Engineering, and Mechanical Engineering.

3.2 Data Analysis

Responses to the survey instrument were downloaded into an Excel file and analyzed using analysis software SPSS 11.5 (Green & Salkind 2003). A factorial ANOVA was used to test for interaction effects between levels of the independent variables gender, race, and length of time in the co-op program. Main effects of the independent variables were tested using one-way ANOVA. Cronbach's alpha was used to measure internal consistency among the questions on the instrument.

Data collection for the qualitative interviews was comprised of individual telephone interviews which were audio-recorded and transcribed verbatim. Data were coded through an iterative review process and managed through a text-to-table application. The verification procedures of member checking, peer-review, and thick, rich description were used to ensure the rigor of the qualitative research (Creswell & Miller 2000; Patton 1980).

4. Limitations

Despite attempts to ensure the trustworthiness of this investigation, there were several key factors that may represent limitations to the generalizability of the findings. Due to the historical nature of cooperative education, gender and racial distributions were heavily skewed toward white male participants. Additionally, this study was limited to participants in one co-op program. A more diverse national sample might have produced different results.

While participation in the study was voluntary, individuals who chose to complete the web-based survey instrument may have demonstrated higher levels of motivation and commitment to cooperative education than their counterparts. The "selection" of participants for the study represented a potential threat to internal validity as participants may have been predisposed and/or more responsive to answering questions about their experiences with mentoring in co-op than those who chose not to participate. Finally, the original investigation was limited to the relationship between students and supervisors in cooperative education. This narrow view of students' experiences may have influenced students' responses in the qualitative phase of research.

5. Findings

The results of a factorial ANOVA revealed no significant interaction between the independent variables of gender, race, and length of time in the co-op program and the two dependent variables of psychosocial and career-related mentoring functions. Additional one-way ANOVA techniques were utilized to test for main effects for the three independent variables. The only statistical significance that was found was between the variables of gender and the psychosocial function of mentoring in which females scored significantly higher than males on this factor.

Since the original intent of the qualitative interviews was to illuminate the findings of the web-based survey, the interview protocol was tightly structured and therefore the corresponding themes were reflective of the questions in the interviews. Emergent themes focused on the two dependent variables of psychosocial and career-related mentoring and the three independent variables of gender, race, and length of time in the co-op program. Additional themes included time as a factor, differing experiences by race and gender, alternative explanations for scores, and others as mentors.

Throughout the interviews, students consistently identified assumptions that they had held prior to the co-op experience that did not match with the realities of their actual work assignments. While the concept of unexamined assumptions was not exclusive to any single theme of the study, it was communicated by all of the students as a significant aspect of their co-op experience. Additionally, interviews shed light on the lack of training students received prior to their co-op placement and the ways in which inadequate preparation contributed to their incomplete understanding of the mentoring process.

5.1 Unexamined Assumptions

Students described vastly different work experiences based on pre-determined assumptions about what the co-op placement would be like. Chris, for example, thought that the work environment would be more structured with a standard supervisor-subordinate line of reporting. What he found, instead, was a nurturing environment in which he could grow both professionally and personally. Chris described his female supervisor as "another mom" and his co-workers as an extended part of his family. Chris felt strongly about the sense of protection and advocacy that his supervisor had provided for him and an appreciation for her willingness to talk with him if there was ever a problem without the fear of negative consequences.

Brian, on the other hand, had high expectations

that he and his supervisor would develop a close bond with one another in addition to their professional roles. Despite his efforts, Brian expressed regret that his supervisor did not get to know him on a more personal level:

> She didn't really find out much about my life at all. She would oftentimes tell me about her family and how it was going and I'd kind of listen to her talk about that but she didn't really get to know me very well to encourage me in my life or find out how she could help me. I mean, sometimes her kids were in plays and I'd go see them but there was never any reciprocation of that like her coming to watch me get inducted into an honor society.

Neither Chris nor Brian spent time with his supervisor at the beginning of the co-op experience to discuss expectations of the placement or to discuss and clarify roles within the co-op setting. They both entered this new work environment and accepted it at face value. Chris self reported that his co-op placement was a very positive and enriching experience, but he acknowledged that it was due more to chance than design. Brian's co-op placement clearly fell short of his expectations. While he felt like the co-op experience was a worthwhile experience overall, he could not hide his disappointment and frustration with his specific placement based on his original expectations.

Courtney assumed that her co-op placement would be similar to other jobs that she had previously held. Not only was she surprised to learn that she was the only female engineer working in the plant during her co-op rotations but concerned by her co-workers initial reaction to her:

> I think a lot of the guys didn't think that I would necessarily be willing to do a lot of the work things but over time they realized that that wasn't true. So, I'm just like anyone else now. They've gotten over that. I'll climb in a manhole just like anyone else.

Courtney had not given much thought to potential stereotypes and other workplace challenges that are common for women who work in predominately male-dominated environments. She said that there were times in which she felt like she needed to "prove" herself to her co-workers in order to be treated as "an equal." Courtney and her supervisor had not discussed her expectations prior to the beginning of her co-op placement and the significance of being the only female on-site. Courtney suggested that a pre-planned discussion would have helped her to be more prepared for the realities of her co-op placement and might have assisted her employer in preparing the organization for her arrival.

5.2 Inadequate Preparation

Many of the students described their first rotation in co-op as a starting point in which they were responsible for learning the systems and processes of the organization before they could move on to larger projects. For Judy, this meant "learning the ropes" before she could move into a project management role with more responsibility. Students indicated that they spent most of their first co-op rotation doing this type of "on-the-job-training," although Courtney said that she felt like she had been given too much responsibility too quickly by her co-op employer due to staff turnover early in her placement. Conversely, in describing her co-op experience, Anna said that there were occasions where she did not have work to do. She indicated that her supervisor lacked the organizational skills necessary to oversee a co-op student and oftentimes provided her with unclear expectations for her work assignments.

On the first day of her co-op placement, Aisha was asked to complete and turn in a detailed project report. She was given no further direction than a one-page set of instructions that had been written by a previous co-op student. Aisha managed to assemble a report based on the resource binders she found in the office but said that "more direction would have definitely been helpful." In a subsequent work term, Aisha suggested to her supervisor that additional resources be made available to incoming co-op students. As a result of this recommendation, Aisha created a training manual for all incoming co-ops to help them with their transition to the workplace. She said that she would have appreciated having a resource like that when she had started.

In reflecting on their experiences, students said that their opportunities for success in co-op increased dramatically when they had access to the two essential inputs for sense-making: a) insider information, and b) organizational history/ documentation (Louis, 1980). Without these resources, students had difficulty anticipating and interpreting different situations in their work environments, many of which they described as context-specific. Understandably, students frequently sought guidance and support from individuals other than their supervisors to help them understand specific situations and to accomplish their tasks.

All of the students said that they identified strongly with at least one individual outside of their reporting lines to provide them with assistance during the course of their co-op placement. For Abbie, it was one of the contractors that she had worked with on a project. Abbie said that as another female engineer in her field, "She really supported me and we talked a lot about being a female in the industry and what you had to do to get ahead and the obstacles we face."

Jason identified an individual in his department whom he considered to be "more of a colleague and a co-worker" to help him learn about the overall operation of the organization. Tim was in a unique situation in that he had been assigned both a supervisor and a mentor. Tim differentiated the two roles by describing his mentor as the one who managed his daily activities while his supervisor managed the administrative tasks like performance evaluations and paperwork. In addition to these two individuals, Tim found it helpful to discuss industry and career-related questions with co-workers and others outside of his direct reporting lines.

Of the nine students interviewed for this study, only one, Judy, said that she intentionally sought out a mentor at the beginning of her co-op placement. Judy recognized early on that she needed a support system to help her grow and advance in the field. She contacted the local chapter of her specific engineering society and asked to be put in touch with other female engineers in her field. By expanding her pool of resources, Judy was able to talk with individuals both inside and outside of her co-op company and gather multiple perspectives to help her make informed decisions about her specific career path.

In general, students who were interviewed seemed interested in participating more fully in a mentoring relationship, but they lacked a basic understanding of how to make the most of their interactions with their supervisors and other potential mentors in their co-op placement. Therefore, we propose that co-op and internship programs incorporate intentional protégé preparation strategies so that students will be better prepared to enter into mentoring relationships and more likely to assume responsibility for their learning outside of the classroom. We contend that students who are equipped with the knowledge, skills, and dispositions of protégéship prior to their placements will have more success developing positive mentoring relationships and potentially greater success in transitioning into the STEM workforce.

6. Discussion

It has previously been established that mentoring can help students achieve success in the STEM fields (Fifolt & Abbott 2008; Frehill, Ketcham, & Jeser-Cannavale 2004; Gibson & Angel 1995; LaBonty & Stull 1993). We suggest that students' experiences with their supervisors could have been more productive and satisfying if their supervisors had received training on the basics of mentoring. Co-op and internship programs can continue to educate and inform employers of best practices for mentoring, but they ultimately have less ability to influence the behavior of supervisors than students. In the absence of mentor training, we believe that there are proactive steps that can be taken at the university level to prepare individuals entering the STEM fields for the realities of the workforce environment.

In the discussion that follows, we establish a rationale for protégé preparation in STEM undergraduate programs. In preparing students to enter the STEM workforce, it is important to equip them with a basic understanding of mentoring relationships and the necessity of seeking out multiple mentors. We also offer program directors and faculty in the STEM curricula a framework for protégé preparation that can enhance students' future mentoring relationships.

6.1 Rationale for Protégé Preparation

Mentoring for students and new graduates can provide a bridge between theory learned in college and the complex realities of the workforce environment. STEM preparation programs have the opportunity to work with students to help them cultivate the disposition of embracing mentoring as an avenue to further their professional learning goals. Mentoring should be conceived as necessary for individuals from their undergraduate experience through the first two to five years on the job (Tripses 2006). However, not all students have access to good mentorships in college, in internships and cooperative education placements, or as they enter the workforce. Therefore, it is important to prepare future graduates of STEM programs with the knowledge, skills, and dispositions of protégéship that can assist them in being successful in mentoring relationships.

We propose that it is possible to intentionally prepare pre-professionals for entering into

mentoring relationships with knowledge, skills, and dispositions that will assist them in being successful protégés. There are two clear benefits of this preparation. First of all, students who are prepared to proactively engage in mentoring relationships will understand the importance of seeking out multiple mentors throughout their careers (Zachary 2000). Secondly, students who are intentionally prepared for the role of protégé will understand when and how to back out of mentoring relationships which are nonproductive or damaging (Tripses & Searby 2008).

6.2 Understanding the Basics of Mentoring

Protégés should be knowledgeable about the basics of mentoring. One of the first things that new graduates need to understand is that they should not assume a passive role. A common preconceived notion is that mentors are either assigned or that mentors select their own protégés. Tripses and Searby (2008) contend that it is advisable for a protégé to identify a desired mentor and proactively approach that individual about establishing a mentoring relationship. Once a mentor has been secured, the relationship proceeds through predictable stages: preparing, negotiating, enabling, and closure (Zachary 2000). "Awareness of the phases is a key factor in successful mentoring relationships. When they are taken for granted, or skipped over, they can have a negative impact on the relationship" (Zachary 2000). Both the protégé and the mentor need to prepare for the relationship by discussing readiness, broad goals, and reasons for mentoring. There are several components in the negotiating stage of mentoring, of which the protégé needs to be cognizant and ready to outline with the mentor. Explicit preparation to clarify expectations, assumptions, and ground rules for the mentoring experience sets the stage for productive learning experiences.

The protégé plays an active role in setting priorities, establishing those learning goals, identifying possible resources, and taking increased responsibility to be self-directed (Johnson 2002). Ideally, as the relationship evolves, the mentoring partners begin to share responsibility for achievement of the goals of the protégé. This is the *enabling* or *implementation* phase of the relationship. Closure to the relationship has been anticipated (part of the initial mentoring agreement), and it involves "evaluating, acknowledging, and celebrating the achievement of the learning outcomes" (Zachary 2000).

Students need to be aware that despite the documented benefits of mentoring, there is a possibility that a mentoring experience will not be positive. Obstacles can present themselves from both the mentor and the protégé perspectives. A mentor may perceive a protégé as being demanding, jealous, unfocused, manipulative, or apathetic. A protégé may perceive a mentor as crossing boundaries or being an imposter, burned out, judgmental, non-disclosing, jealous, biased, prejudiced, or intimidating (Zachary 2000). It is important to acknowledge that these dangers do exist. This is a part of having a basic understanding of mentoring relationships.

6.3 Multiple Mentors.

Higgins and Kram (2001) speak of a developmental network or mentoring constellation as "the set of people a protégé names as taking an active interest in and action to advance the protégé's career by providing developmental assistance." Johnson (2007) suggests that the most successful people are those who "rely on multiple individuals for developmental support during their careers."

Network mentoring is not a new phenomenon. Swoboda and Miller (1986), identified network mentoring as a process involving a series of contacts between two or more people in which each plays the role of mentor and protégé at different times. For instance, an older individual may fulfill the traditional role of *grooming-mentor* (Levinson 1978), whereby special assistance is provided by a more experienced professional who grooms his/her protégé during a transitional period (e.g. entry into a profession) in order to enhance a quicker movement up the career ladder. But the younger protégé may play the role of mentor to the seasoned professional when it comes to learning about new tools in the workplace. This was the case for Chris in describing an experience in which the "older guys" helped him learn about the industry while he and some of the "younger guys" talked about new trends in technology with their co-workers.

Again, we propose that the skills of effective protégéship can be identified and *intentionally* taught in professional preparation programs. We suggest that the following framework be used as a guide to developing curriculum that will accomplish this task.

7. Protégéship Framework

Tripses and Searby (2008) have developed the following framework of the knowledge,

skills, and dispositions necessary for protégé development, which we have adapted here and used with permission for application to STEM preparation programs. The purpose of the framework is for program directors and faculty to consider how they can intentionally develop program components that will foster the development of protégéship that individuals will need as they enter mentoring relationships in the workforce.

7.1 Knowledge, Skills, and Dispositions of Protégéship

Explicit instruction on mentoring may not be prevalent in STEM preparation programs. However, assuming that students will somehow "pick up" knowledge about mentoring along the way may deny students rich opportunities to make connections between theoretical learning provided in coursework and application of knowledge in the "real world" under the guidance of a mentor. Without explicit instruction on mentoring, students may simply not know about different kinds of mentoring, their role in actively seeking out a mentor, or how to set learning goals.

The skills required in protégéship development (goal setting, communication skills, capacity to seek out and reflect upon feedback and reflection) may be currently included in a piecemeal fashion in some preparation programs. However, the connection of these skills to mentoring relationships may not be drawn. Zachary (2000) suggests activities which prompt the protégé to set goals based on insightful self-knowledge, reflection, and identification of personal and professional needs. Important relationship skills include seeking out and effectively using feedback, developing good communication, and taking responsibility for one's own learning.

The work placement in the STEM curriculum is another venue for protégé skill development. It is important to provide quality work experiences which are carefully planned, substantial, sustained in real settings, and guided cooperatively by university programs and professional placement sites. While some students may have limited options in the selection of their mentor for their supervisor, if they have proactively developed their knowledge, skills and dispositions for being a prepared protégé, they can significantly enhance their ability to have a successful mentoring experience.

Dispositions related to the development of effective protégés include willingness to learn, self-knowledge, initiative, confidentiality,

and ethical considerations (Daresh & Playko 1995; Mullen 2005; Portner 2002; Searby & Tripses 2006; Zachary 2000). The importance of professional dispositions cannot be overestimated in professional preparation. Many graduates are candidates for future leadership positions. Leadership requires self-knowledge based upon clarity of personal values. Leaders often fail not because of lack of technical skill, but because of dispositional, moral, or ethical issues (Heifetz & Linsky 2002). In highly effective mentoring relationships, protégés have opportunities to apply their knowledge of self, initiative, values, and ethics to highly unstructured problems under the guidance of a mentor. Indeed, a trusting mentoring relationship is likely the only way to avoid some of these leadership pitfalls.

It is clear that these programs have not only the best opportunity, but also the moral obligation to prepare undergraduate students for their roles as protégés (Tripses & Searby 2008).

8. Summary

As the supply of qualified and competent STEM professionals continues to shrink, the demand for these individuals is on the rise. Employers have a unique opportunity to recruit and retain a trained STEM workforce prior to graduation through co-op and internships, and the literature supports mentoring as positive component of these programs. In order for students to participate more fully in a mentoring relationship, we propose that they be introduced to the knowledge, skills, and dispositions of protégéship prior to their co-op or internship placement.

Including protégé development in a STEM preparation program may require additional and intentional efforts by program directors and faculty, but we suggest that it may help students assume greater responsibility for their own learning and can potentially lead to a more seamless transition for students as they matriculate into the STEM workforce. The framework provided by Tripses and Searby (2008) could serve as a guide for examining a curriculum for any program to insure that the knowledge, skills, and dispositions of protégéship become an integral part of the process.

Due to coursework requirements and limited resources for administrative and instructional tasks, it may not be feasible to integrate protégé preparation into the curricula. Despite these potential obstacles, there may be opportunities

to introduce mentoring concepts to students through a professional development series. Co-op and internship offices may find collaborative partnerships with the Office of Career Services and student societies as a way to integrate these topics into out-of-classroom learning experiences for students.

While it is beyond the scope of this investigation, consideration should also be given to employer readiness for establishing a co-op or internship program. As advocates for experience-based programs, we see the value in establishing a pipeline for future STEM talent; however, we also recognize that effective mentoring requires preparation and dedication from protégés as well as mentors. Before establishing a co-op or internship program, employers should understand their responsibilities for (a) identifying and incentivizing individuals to supervise/mentor new students, (b) preparing supervisors/mentors to provide effective guidance for students, (c) setting clear guidelines and job responsibilities for the co-op or internship position, and (d) clarifying reporting relationships and organizational structure.

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