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## Professional Development for STEM Departments

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### Abstract

Professional development is a highly organized and valuable process designed to disseminate specialized knowledge and skills, thereby enhancing workforce efficiency and institutional alignment with the organization's strategic goals and mission. Typically, most professional development resources focus on supporting student retention and career readiness. Maintaining student success and providing programs that enable students to acquire job skills is paramount. However, implementing strong science, technology, engineering, and math (STEM) faculty professional development systems is equally essential to achieving meaningful student outcomes and departmental operational success. Sustainable professional development strategies and faculty support mechanisms must be continually developed, measured, evaluated, and improved to ensure that faculty can meet the needs of STEM majors, the changing educational landscape, and the challenges facing academic institutions. A focus on increased faculty communication from department and executive administration, as well as continuing education opportunities, travel awards, occupational training, mentoring programs, and scholarship initiatives, offers beneficial opportunities to meet faculty professional development needs. The recommendations in this article are intended for STEM faculty but could be adopted for all faculty and modified for STEM department staff

**Keywords:** Adult Learning; Career Development; Skill Enhancement; Professional Engagement; Job Satisfaction

### 1. Introduction

Numerous definitions describe professional development in institutions of higher learning, as found in educational and business literature databases. The focus of this article is to discuss professional development through the lens of science, technology, engineering, and mathematics (STEM) faculty. Professional development refers to any sustainable and scalable formal or informal experience that supports faculty in acquiring and utilizing relevant information, skills, technology, training, and equipment to perform their jobs effectively in support of the educational institution's mission. Professional development activities can be composed of traditional interactions or administered online, either synchronously or asynchronously. STEM departments must develop faculty professional development techniques to achieve multiple objectives and goals that benefit students, faculty, departments, and the institution. Professional development for STEM faculty is grounded in adult learning theory, which emphasizes approaches that enhance learning outcomes for adult populations in diverse settings [1-3]. Adult learning theory or andragogy frameworks encompass relevant, rewarding, reflective, autonomous, practical, and collaborative experiences for adult learners. Typically, adult learners have a clearer understanding of the skills and knowledge they need to excel and advance to the next level. This understanding is invaluable to educators and administrators tasked with developing impactful professional development activities for students and faculty. Recently, undergraduate institutions have made a push to better prepare undergraduates for specific careers, rather than just improving student knowledge [4-6]. Moreover, the faculty experience has been studied extensively to improve faculty outcomes [7]. Professional development is critically essential for STEM college faculty for the following reasons. Among other things, professional development activities improve college faculty motivation, job satisfaction, job performance, attitude, use of research-based instructional

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strategies, and collaborative engagement [8-9]. Additional research on the impact of professional development on STEM faculty will elucidate more positive effects of professional development engagement.

Many academic institutions have a robust professional development infrastructure containing the foundational professional development philosophy and practices discussed in this article. However, many educational institutions also maintain a rudimentary or nonexistent professional development infrastructure on campus. Many small colleges, historically Black colleges or universities (HBCUs), and other minority-serving institutions (MSIs) often lack consistent professional development opportunities, resulting in poor retention of quality STEM faculty. Baker et al. [10] provided discourse that elaborates on how the COVID-19 pandemic stimulated obligatory campus actions, resulting in professional development gains that improved course delivery methods for students to mitigate the devastating impact of the quarantine and collateral damage caused by the global contagion. The primary method employed centered on a massive effort to utilize the Center for Teaching and Learning and highly skilled individuals on campus to enhance educational technology skills, facilitating course dissemination goals through distance learning tools. Professional development activity evaluation mechanisms are paramount to planning and implementing meaningful professional development events. Professional development leaders must create opportunities for both immediate feedback and long-term feedback following professional development events. Allowing faculty time to reflect on their skills and knowledge gains over a significant period will yield more effective evaluation data.

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## 2. Professional Development and STEM Faculty

There are essentially an unlimited number of professional development activities that STEM departments can develop and implement year after year to improve faculty performance and outlook. Professional development information distribution mechanisms exist in many forms, including workshops, learning communities, journal clubs, seminars, boot camps, presentations, faculty writing teams (FWT), learning management systems (e.g., Blackboard), conferences, online meetings, hybrid training sessions, and webinars. Dissemination of professional development information via immersive virtual reality may be advantageous for many institutions. Professional development should stimulate new ideas, collaboration, and professional efficacy in the areas critical to STEM faculty such as instructional development, research and scholarship, curriculum design, technology utilization, leadership and career development, community service engagement, library resource management, STEM program evaluation and assessment, accreditation, tenure and promotion, institutional fund raising, advising, grant writing, and entrepreneurship to name a few. Furthermore, a professional development event that could prove beneficial for faculty is to organize a series of free, company-sponsored demonstrations of scientific equipment, inviting company representatives to campus to showcase the operation of research instruments.

These types of face-to-face events could help augment knowledge of state-of-the-art instrumentation to address teaching and research issues. Certain companies may also allow STEM departments to rent or use specific devices, research software, and operational management platforms for a trial period to assess their utility and practicality. In general, online professional development events administered through Microsoft Teams and Zoom offer the advantage of allowing greater participant inclusion, unlike face-to-face events, which require sufficient physical space. Whether online or traditional, consider recording all professional development events for future use. Moreover, STEM departments should allocate funds to enable faculty to obtain certifications, degrees, and other relevant credentials. This type of professional development is easily accomplished, given the abundance of online, hybrid, and summer continuing education opportunities available. The specificity of the credentials sought by STEM faculty would depend on unique teaching responsibilities, research interests, or department needs.

Another potential advantage for STEM departments that may arise from strategically planned professional development programs is that faculty may gain an adequate level of competence to teach new courses that add to the STEM department's course catalog without the need to hire new employees. These courses can be standard courses or new interdisciplinary courses that merge expertise from multiple departments, including non-STEM fields (e.g., forensic science). For example, STEM faculty who acquire education credentials through certificates, certifications, or degree programs could, in addition to teaching courses in STEM departments, also teach classes in the education department. Furthermore, another approach to increasing the number of professional development activities to enhance faculty attitude and abilities is to integrate brief professional development tasks into regularly scheduled STEM department meetings. Schedule constraints may produce time conflicts that limit or eliminate viable professional development opportunities. Incorporating professional development elements into faculty meetings may help overcome inevitable scheduling problems. Ultimately, the best way to explore professional development activities to add to your comprehensive professional development framework is to dissect the research literature for data-based approaches and best practices in professional development. With the rise of artificial intelligence (AI), professional development initiatives that lead to STEM faculty receiving practical AI certificates and certifications may result in the development

of exciting, innovative courses or grant proposal ideas, ultimately leading to increased funding within the department. The National Science Foundation (NSF), along with other organizations, provides access to a speaker's bureau that connects STEM departments with experts in various areas (e.g., [www.nsf.gov/connect/speakers-bureau](http://www.nsf.gov/connect/speakers-bureau)). Develop professional development activities for STEM faculty that focus on the methods by which faculty are evaluated and promoted for advancement. Consider using student teaching evaluations, end-of-semester faculty evaluations, and tenure and promotion requirements as a method for designing professional development events. Tracking industry trends is another reliable method of selecting appropriate professional development techniques. Developing a sustainable professional development system for STEM faculty, which provides numerous significant opportunities to expand knowledge and skills is paramount.

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### **3. Conclusion**

Faculty-based professional development activities may improve faculty knowledge, understanding, and skills. Professional development can lead to credential attainment (e.g., degree, certificate, certification) or augment comprehension of the latest developments in teaching and research. Professional development can be delivered in physical settings (e.g., workshops) or online (e.g., webinars). In the planning stage, it is advisable to develop measurable professional development goals and objectives and plan unique activities that target specific faculty groups (e.g., new faculty and experienced faculty). Moreover, to enhance future professional development events, developing a mixed-methods evaluation system to capture participant perceptions and learning gains is advisable. Consider employing a two-tier evaluation system. Evaluate each professional development activity before the event concludes or immediately after it concludes. Moreover, evaluate the activity after a certain amount of time has passed and compare the evaluation data. Use evaluation data analysis to strengthen professional development opportunities. Follow up with participants after each professional development activity by disseminating supplementary materials to reinforce topics covered during the event. Campus-wide professional development may also include the establishment of a center for teaching and learning or a center for technology designed to help faculty explore and utilize diverse technology and innovative teaching methods. Furthermore, professional development events, whether a component of the regular STEM department meeting or a separate experience, can enhance the overall sense of community within the department and even lure faculty from their isolated silos.

Considerable research is needed to determine the extent to which professional development activities enhance critical factors that influence the success of STEM faculty and departmental productivity. Research endeavors would benefit from a careful study of the perceptions and outcomes resulting from faculty participation in meticulously designed professional development initiatives, as well as the perspectives of students, staff, and administrators. Relevant professional development activities reinforce an administration's commitment to faculty success and department sustainability. The utilization of a wide variety of professional development initiatives suggests that administrators appreciate and care not only about the faculty but also about students, who are the beneficiaries of STEM faculty satisfaction.

More funding must also be allocated from institutional and STEM department administrators to achieve professional development goals. Research indicates that faculty members who feel appreciated and valued tend to experience higher levels of job satisfaction and a more positive sense of collegial collaboration. The best approach for choosing professional development activities is to conduct internal qualitative investigations with STEM faculty to identify faculty-specific needs. Additionally, a review of professional development best practices literature is another approach to identifying beneficial techniques that can improve faculty experiences. Many STEM departments contain a productive mix of faculty and administrative staff to accomplish specific goals. The strategies outlined in this article will also be effective for STEM staff members. Planning meaningful professional development tasks for staff can address staffing issues and enhance student and department success.

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### **Compliance with ethical standards**

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