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Faculty Development and Support in Orthopedic Education: A Narrative Review

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Learning Point of the Article:

Structured faculty development – anchored in mentorship, technological innovation, and institutional support – is essential for advancing orthopedic education quality, overcoming systemic barriers, and fostering adaptive, skilled educators in a rapidly evolving medical landscape.

Abstract

Introduction: Faculty development and support are crucial for maintaining high-quality orthopedic education. Despite advancements in curriculum standardization, significant challenges persist in developing and supporting faculty members in orthopedic education globally. This manuscript aims to summarize the current state of faculty development in orthopedic education, highlighting its importance, challenges, and best practices to inform future educational policies and curricula.

Materials and Methods: This narrative review synthesizes current literature on faculty development in orthopedic education to provide expert interpretation and identify emerging trends. We searched multiple databases, including PubMed, MEDLINE, and Google Scholar using relevant keywords.

Results: Faculty development programs (FDPs) are essential for enhancing teaching effectiveness, promoting lifelong learning, and improving student outcomes. However, significant barriers, including time constraints, workload pressures, and resource limitations, hinder faculty participation. The review identified innovative strategies, including simulation technology, virtual reality, and structured mentorship programs, as promising approaches to overcome these challenges.

Conclusion: Standardized FDPs, comprehensive mentorship frameworks, and institutional support systems are critical for maintaining excellence in orthopedic education. Future initiatives should focus on addressing resource limitations while leveraging technological innovations to enhance educational delivery.

Keywords: Faculty development, orthopedic education, medical training, professional development, faculty support, mentorship.

Introduction

Orthopedics education has undergone a significant transformation from traditional apprentice-based learning to structured, standardized approaches [1]. Despite these advancements in curriculum development, persistent inconsistencies remain due to unequal access to resources and variations in training quality across institutions [2]. The evolution of orthopedic education, particularly in developing countries, such as India, represents a microcosm of global challenges and opportunities in medical education [3].

The Medical Council of India, now operating under the National Medical Commission, has implemented formalized guidelines

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and standardized teaching protocols to ensure consistent and comprehensive education nationwide [4]. This structured curriculum provides residents with broad exposure to the entire spectrum of orthopedic care through systematic training processes, including rotations across various subspecialties, such as trauma surgery, sports medicine, pediatric orthopedics, arthroscopy, spine surgery, and joint replacement procedures.

Modern orthopedic education encompasses multiple learning modalities, including didactic instruction through lectures and seminars, hands-on surgical exposure following the "Learning by Doing" model, research and academic development opportunities, and initiatives bridging the gap between academia and real-world clinical practice. This comprehensive approach requires faculty members who are not only clinically competent but also skilled educators capable of adapting to evolving educational paradigms.

Faculty development in medical education has become universally recognized as essential for addressing widespread changes in educational approaches, including evolving professorial roles, advances in pedagogical theory, changes in learning styles, innovative curriculum models, and evolving evaluation philosophies [5,6,7,8]. The scope of faculty responsibilities has expanded significantly, requiring educators to provide high-quality teaching and research guidance, collaborate in curriculum design, mentor students effectively, commit fully to teaching obligations, participate in institutional development, engage in scholarly activities, support public service initiatives, and generate and disseminate knowledge to diverse audiences [9,10,11,12,13].

The definition of faculty development has evolved considerably over recent decades. Initially focused on activities helping teachers improve teaching skills and design better curricula, the concept has expanded to encompass the personal and professional development of professors, clinicians, researchers, and managers to meet institutional goals, visions, and missions while maintaining social responsibility to the community [12]. This narrative review examines orthopedic education-related research focusing on faculty development and support systems. Based on the review findings, recommendations for newer healthcare policies and curricula are proposed to enhance the quality and effectiveness of orthopedic education globally. Given the heterogeneous nature of faculty development programs (FDPs) across different cultural, institutional, and resource contexts, a narrative review approach was selected to provide comprehensive coverage of this multifaceted topic. While systematic reviews excel at answering specific research questions with rigid inclusion criteria, narrative reviews are particularly valuable for exploring broad themes, synthesizing diverse approaches, and providing expert interpretation of complex educational phenomena. This methodology enables us to examine faculty development from multiple perspectives: Technological, pedagogical, institutional, and cultural, while acknowledging the contextual factors that influence program implementation and success.

Materials and Methods

This narrative review examined the current literature on faculty development and support in orthopedic education. We conducted a comprehensive search of PubMed, MEDLINE, Google Scholar, ProQuest, EBSCO, JAMA, and Cochrane databases using terms, including "Faculty Development," "Orthopedic Education," "Medical Training," and "Professional Development." Studies published in English through April 2025 were included. As a narrative review, this study synthesizes existing knowledge to provide a broad overview of the field rather than conducting a systematic quality assessment or meta-analysis. The focus is on identifying key themes, emerging trends, and providing expert interpretation of the literature to inform future directions in orthopedic faculty development. The literature on faculty development in orthopedic education reveals several dominant themes, though it should be noted that studies vary significantly in methodology, setting, and outcome measures. This heterogeneity, while limiting direct comparison, provides valuable insights into the diverse approaches and contexts of faculty development globally.

Current State of Faculty Development

Overview of existing programs

FDPs play a pivotal role in enhancing teaching, research, and counseling abilities of faculty members. These programs are designed to improve faculty skills and knowledge, ensuring adaptation to evolving academic demands. FDPs provide essential expertise while fostering continuous improvement in strategies and competencies, creating positive and respectful workplace environments that benefit both individual faculty members and broader academic communities [9,10].

Faculty members must demonstrate adaptability, particularly in course design and student assessment, to meet international academic standards. This adaptability becomes increasingly important as medical education continues to evolve with technological advances and changing healthcare delivery models.

Regional and institutional variations

The literature reveals diverse approaches to faculty development across different regions, though reporting

remains limited from low- and middle-income countries. Available studies suggest that cultural and economic contexts significantly influence program design and implementation. For instance, hierarchical medical education systems in some Asian countries emphasize formal mentorship structures, while resource-constrained settings often rely on innovative low-cost solutions, such as peer mentoring and technology-mediated learning.

Comparison of faculty support initiatives across different regions and institutions reveals significant variations in approaches to faculty development [9]. There exists a pressing need for standardized FDPs in orthopedic education, particularly in developing countries [1]. Mentorship and feedback mechanisms have been identified as crucial components for effective faculty development and support [8]. In addition, adequate resources and infrastructure support remain essential requirements for successful faculty development initiatives [2].

Recognition and reward systems for faculty development are fundamental for motivating faculty participation in professional development programs [10]. The goal of residency programs in orthopedic surgery is to provide sufficient exposure in both scope and breadth to enable graduating residents to practice safely and independently upon completion of their education [11].

International comparisons reveal that countries, such as India, the United Kingdom, and Germany have developed different approaches to achieve orthopedic surgery education goals while maintaining core similarities. Recent structural changes in UK and German residency programs have created more streamlined educational processes, reducing total training years [3,11,12,13,14,15]. German educators have implemented extended 3-year fellowships following residency to enhance educational outcomes [16].

Methodological considerations and evidence quality

The body of literature examining faculty development in orthopedic education is marked by notable methodological heterogeneity. Studies span a broad spectrum, from single-institution descriptive accounts to multi-center comparative evaluations. These investigations differ widely in their outcome measures and follow-up durations. While such diversity mirrors the inherently complex and context-sensitive character of educational interventions, it also complicates efforts to derive definitive best practices across settings. Most existing studies in this domain utilize either descriptive or quasi-experimental designs. Randomized controlled trials remain rare, in large part due to the logistical and ethical constraints associated with introducing randomized protocols into educational environments. Outcome assessment strategies vary substantially; some studies rely on immediate participant feedback, whereas others attempt to gauge longer-term professional outcomes. This inconsistency hampers meaningful comparison across different programs and limits generalizability. Cultural and contextual variability further contributes to the heterogeneity seen in the literature. Faculty development strategies diverge across regions. In many Western settings, there is a strong emphasis on individualized professional growth and the integration of technological tools. Conversely, educational systems in more hierarchical cultures may place greater value on structured mentorship and institutionalized forms of support. Factors, such as cultural norms surrounding authority, availability of institutional resources, and expectations for mentorship heavily influence how programs are structured and received. There is a notable publication and reporting gap. A considerable proportion of faculty development efforts are not disseminated through peer-reviewed channels and instead exist as institutional documentation or grey literature. This creates a skew in the published record, with formal, well-funded initiatives receiving disproportionate attention while potentially effective approaches from under-resourced environments remain underrepresented.

Challenges and Barriers

Common implementation challenges

Faculty members face numerous challenges in accessing and participating in development programs. Time constraints represent the most frequently cited barrier, compounded by excessive workload and limited resource availability. Mentorship programs, while vital for nurturing orthopedic talent, encounter significant implementation challenges [8,9,10,17,18].

Effective mentorship provides several critical benefits, including clinical skill development that enhances technical abilities and proficiency in performing procedures and managing clinical situations [11]. Career guidance and leadership training prepare mentees for higher responsibilities [12,16], while mentorship programs promote diversity and innovation by fostering inclusive cultures and inspiring engagement in research and evidence-based practice [19,20].

Specific barriers and solutions

Time constraints significantly impact mentor availability and reduce opportunities for guidance. Structured mentorship scheduling during work hours and virtual session options can

address these limitations. Mentor-mentee mismatches often result in unproductive relationships and frustration, which can be mitigated through careful matching based on goals, communication styles, and personality compatibility.

Building trust between mentors and mentees requires transparent and consistent communication to facilitate meaningful progress. Diverse learning needs present challenges in tailoring teaching approaches, necessitating adaptable mentorship styles to suit individual mentees. Insufficient feedback mechanisms can stagnant mentee development, requiring implementation of routine evaluation and feedback sessions.

Mismatched expectations between mentors and mentees often lead to dissatisfaction and disengagement, which can be prevented by clarifying objectives, roles, and timelines early in the relationship. Ethical boundaries must be established to prevent personal-professional conflicts through clear codes of conduct. Low mentor motivation reduces program effectiveness and can be addressed through recognition of contributions and provision of appropriate incentives.

Balancing clinical duties creates dual role strain for mentors, requiring institutional support through dedicated time allocations for mentoring activities. Lack of diversity in mentorship programs represents missed opportunities for inclusive growth, necessitating targeted programs for underrepresented groups. Research limitations and restricted access to learning materials can be addressed by leveraging digital platforms and external resources.

Resistance to mentorship programs often stems from negative perceptions, which can be overcome by highlighting success stories and mentorship benefits. Peer mentoring challenges may result in ineffective guidance due to similar experience levels, requiring structured frameworks to enhance effectiveness. Emotional burnout decreases mentor engagement and should be addressed through mental health support and wellness programs.

Program evaluation gaps make success measurement difficult, necessitating the establishment of measurable objectives and regular assessment protocols [21,22].

Strategic solutions

Strategies to overcome these challenges include providing protected time for faculty development activities, offering flexible scheduling options and online resources, implementing mentorship programs with clear goals and expectations, and recognizing and rewarding faculty participation in development programs [8]. Institutional support and comprehensive mentorship programs are essential for creating frameworks that effectively support professional development [21]. Regular evaluation of these programs ensures they meet evolving needs in medical education [22].

Innovations and Best Practices

Technological advancements

Recent innovations in faculty development initiatives include simulation technology [23], virtual reality (VR) applications, and online learning platforms. Simulation-based surgical skills training is widely recognized as valuable for improving trainee performance and represents an essential component of comprehensive surgical education curricula. VR offers genuinely immersive experiences that surpass traditional simulation methods [24,25,26].

Teaching methodologies

Faculty members typically teach residents in three primary settings: Didactic lectures or seminars, operating room instruction, and patient encounters in hospital or clinic environments [7,11]. Each setting presents unique opportunities and challenges for effective educational delivery.

- Lectures and seminars: Faculty members frequently cite time constraints as the primary barrier to enhanced resident and faculty participation. Orthopedic surgery residency review committees stipulate that programs must provide four hours of didactic sessions weekly [9].
- Operating room education: Programs have explored alternative surgical simulations, including cadaver skills laboratories and sophisticated simulators, such as arthroscopy knee simulators, which utilize computer-generated arthroscopy fields and tactile feedback (haptic feedback) to replicate authentic arthroscopic procedures [23,24].
- Bedside and clinic teaching: Demonstrating clinical signs and radiographic features remains crucial when evaluating patients in floor or outpatient settings. The "One Minute Preceptor" model provides a learner-focused, structured approach for discussing patients seen in clinical settings [21].

Regional and Cultural Perspectives in Faculty Development

Faculty development in orthopedic education exhibits considerable variation across global regions, shaped by differences in cultural norms, resource availability, and institutional frameworks. These variations reflect distinct educational priorities and operational realities, which influence how programs are structured and implemented. In North America and Europe, faculty development frequently centers

on individualized professional growth. Institutions in these regions often provide protected time and dedicated resources, supporting structured programs that incorporate simulation-based learning and formalized assessment methods. These approaches are underpinned by a broader cultural commitment to standardization, quantifiable outcomes, and technological integration. In contrast, faculty development in countries, such as India, Japan, and South Korea tends to operate within more hierarchical mentorship systems. These environments often favor traditional apprenticeship models where senior faculty plays a central role in guiding junior colleagues. While such systems may offer sustainability in settings with constrained resources, they may also reinforce rigid power dynamics and limit opportunities for more egalitarian collaboration or innovation. Evidence from low- and middle-income countries remains limited, revealing a substantial gap in the global understanding of faculty development practices. However, the available reports indicate the use of innovative strategies, including peer-led mentoring, community-based collaboration, and digitally mediated teaching solutions. Despite their potential, these models are rarely examined in the formal research literature, which continues to favor initiatives from more resourced institutions. Cultural differences further complicate the generalizability of faculty development strategies. Concepts, such as effective mentorship, professional boundaries, and feedback mechanisms are deeply influenced by cultural expectations. For instance, Western approaches that rely on direct critique and individual performance goals may be misaligned with educational cultures that emphasize indirect communication and collective harmony. A persistent limitation across the literature is the absence of standardized outcome metrics and insufficient long-term evaluation. Most studies focus on immediate feedback, typically capturing participant satisfaction, with few assessing lasting changes in teaching practices or student learning outcomes. This lack of robust, longitudinal data undermines the ability to draw conclusions about the relative efficacy or cost-effectiveness of specific interventions, particularly when applied across diverse institutional and cultural settings.

Assessment and Feedback Systems

Written assessment and constructive feedback delivery represent areas of significant concern in many residency programs. Orthopedic surgery residency review committees require all programs to provide timely resident assessment and feedback [10]. Each rotation incorporates formal assessment and feedback cycles using Rotation-Specific Objectives (RSOs), which are employed across broad ranges of medical specialties to provide residents with clear educational goals and objectives.

Assessment of resident performance should align with RSOs, incorporating mid-rotation and end-of-rotation evaluations. RSOs require annual review and adjustment to reflect actual rotation content. However, common problems include inadequate RSO adherence, insufficient formal feedback provision, grade inflation, and incomplete evaluation processes. Successful development of orthopedic surgery skills programs requires creative utilization of available institutional and regional resources, often involving inter-group exchanges and collaborative activities [27,28].

Evaluation and Impact Assessment

Assessment methods

Evaluation and impact assessment of FDPs are crucial for ensuring effectiveness. Methods for assessing program effectiveness include pre- and post-program surveys, participant feedback collection, observations and peer reviews, self-assessment and reflection exercises, student feedback analysis, follow-up assessments, institutional metrics evaluation, teaching portfolio development, focus groups or interviews, and benchmarking against established goals [29,30].

The role of feedback and continuous improvement

Feedback, evaluation, and continuous improvement are central to ensuring the effectiveness and sustainability of FDPs. Feedback provides real-time insights into participant experiences, understanding, and engagement levels. Sources include participants, peers, students, and administrators, serving to identify strengths and improvement areas, encourage reflective teaching practices, promote bidirectional communication between facilitators and participants, and enhance program relevance and responsiveness.

Evaluation systematically measures program impact and outcomes through formative evaluation during implementation for ongoing improvement and summative evaluation at program completion for overall effectiveness assessment. Evaluation determines achievement of learning objectives, supports data-driven decision-making, justifies resource allocation and program continuation, and informs stakeholders about return on investment.

Continuous improvement creates cycles of planning, implementation, assessment, and refinement using insights from feedback and evaluation to adapt and evolve programs. This approach encourages innovation and responsiveness to changing faculty needs while aligning programs with institutional goals and academic trends, ensuring long-term

relevance and effectiveness, building excellence cultures in teaching and professional growth, and promoting faculty engagement and satisfaction.

Impact on teaching and learning

FDPs significantly improve teaching practices through enhanced pedagogical skills, increased technology utilization, improved confidence and motivation, reflective practice development, and evidence-based teaching approaches [29]. By improving teaching quality, these programs indirectly but meaningfully impact student learning through enhanced engagement, improved academic performance, increased retention and success rates, positive learning environments, and development of higher-order thinking skills [29].

Future Trends and Directions

Technological integration

While simulation technology and VR show promise in orthopedic education, it is important to note that much of the supporting evidence comes from feasibility studies and small-scale pilots rather than large-scale comparative trials. The enthusiasm for these technologies should be tempered by considerations of cost-effectiveness, scalability, and evidence of improved learning outcomes compared to traditional methods [30].

- Simulation technology applications: Simulation-based surgical skills training is widely recognized for improving trainee performance and serving as essential components of comprehensive surgical education curricula. Simulators enable trainees to practice surgical operations and refine decision-making abilities in safe, controlled environments that replicate real-world circumstances with high fidelity. This approach maintains patient safety while enabling learning from mistakes [31-33].
- VR implementation: Understanding anatomical orientation of complex joints, such as shoulders, knees, and ankles presents significant challenges for residents. VR offers genuinely immersive experiences, surpassing traditional simulation methods. In risk-free environments, trainees can enter virtual operating rooms, practice complex surgical procedures on three-dimensional models, and encounter unexpected complications. Various orthopedic subspecialties, including arthroplasty, arthroscopy, foot and ankle surgery, require exposure during residency training, which many residents fail to experience due to various constraints. VR can bridge these gaps by providing subspecialty orientation, helping residents make informed specialty choices. Arthroscopic simulators, such as the Knee Arthroscopy Surgical Trainer developed by the American Academy of Orthopaedic Surgeons and the Simbionix Arthromentor provide haptic feedback on simulated cartilage and tendon while mimicking surgical instruments. VR enables practice and proficiency development before operating room entry. Consequently, VR simulations offer unique advantages compared to traditional simulators and conventional educational methods [31-33].

Limitations and Scope

This narrative review offers a broad synthesis of existing literature on faculty development in orthopedic education, prioritizing thematic exploration over systematic appraisal of evidence quality. Its design allows for integration of diverse perspectives and contextual insights, enabling identification of trends, innovations, and recurring challenges across different institutional and cultural settings. Unlike systematic reviews, which adhere to narrowly defined research questions and strict inclusion criteria, this approach facilitates a more expansive examination of the field, accommodating variability in program structure, implementation, and evaluation. However, several limitations must be acknowledged when interpreting the findings. Methodologically, the review does not incorporate formal assessments of study quality, risk of bias, or quantitative synthesis. The selection process was purposive rather than exhaustive, introducing potential bias in the inclusion of sources. The restriction to English-language publications further narrows the scope, potentially excluding relevant studies from non-English speaking regions and underrepresenting alternative faculty development models from culturally distinct environments.

The literature included in the review displays considerable heterogeneity in study design, institutional context, and outcome measures. This variability precludes meaningful cross-study comparisons and limits the ability to draw definitive conclusions about program effectiveness or best practices. Moreover, publication bias likely influences the evidence base, as institutional reports and grey literature from less resourced settings are often omitted from major databases. As a result, the findings may disproportionately reflect formal, well-funded initiatives while overlooking informal or innovative approaches in underrepresented regions. The predominance of literature from developed countries raises concerns about generalizability. Faculty development challenges and solutions in low-resource settings may differ significantly, and these contexts remain insufficiently captured in the existing evidence base. Despite these limitations, the narrative approach remains valuable for highlighting key themes, generating hypotheses, and framing future research directions in orthopedic faculty development.

Knowledge Gaps and Future Research Priorities

This narrative review highlights several substantive gaps within the current literature on faculty development in orthopedic education. These deficiencies span methodological, contextual, and content-related domains, collectively underscoring the need for a more rigorous and inclusive research agenda. From a methodological standpoint, the absence of randomized controlled trials remains a significant limitation, with most existing studies relying on descriptive or quasi-experimental designs. Standardized outcome measures are lacking, which impairs the ability to compare interventions across institutions or regions. In addition, very few studies include long-term follow-up, leaving uncertainty regarding the sustained impact of FDPs. Cost-effectiveness data are similarly sparse, limiting the practical guidance available to program designers working within constrained budgets. Contextually, the literature remains heavily skewed toward high-income, Western academic centers. There is a marked underrepresentation of faculty development experiences from low- and middle-income countries, despite these settings facing unique and pressing challenges. Cultural influences on program design and implementation are insufficiently examined, as are issues related to scalability and sustainability. Furthermore, the perspectives of diverse stakeholders – particularly junior faculty and trainees are rarely incorporated into study designs, resulting in a limited understanding of how these programs are perceived and experienced by those directly involved. In terms of content, several key areas remain underexplored. There is limited evidence to guide the selection of mentorship models tailored to specific institutional or cultural contexts. Research on the actual effectiveness of technology-enhanced faculty development strategies is minimal, and few comparative studies evaluate different educational approaches. In addition, little is known about the organizational or individual factors that contribute to the long-term sustainability of development efforts. Addressing these gaps will require a coordinated research agenda that prioritizes standardization of outcomes, robust comparative designs across multiple sites, and culturally responsive frameworks. Future investigations should place emphasis on cost-effective models suitable for resource-constrained environments, while incorporating long-term assessment strategies that capture enduring changes in teaching practices, faculty advancement, and learner outcomes.

Conclusion

This narrative review synthesizes current knowledge on faculty development in orthopedic education, highlighting both promising practices and persistent gaps. Key themes include the value of structured mentorship, institutional support, and technology-enhanced learning. However, the literature remains methodologically limited, relying heavily on descriptive, single-institution studies with few rigorous comparative trials. Cultural context, resource availability, and institutional infrastructure are critical factors influencing program success. For practice, the evidence underscores the importance of protected time, formal mentorship structures, and adaptable implementation tailored to local needs. For research, future efforts should prioritize standardized outcomes, robust study designs, and exploration of culturally responsive, cost-effective models, particularly in underrepresented and resource-limited settings. While faculty development is vital to improving orthopedic education, its long-term impact and scalability remain poorly understood. Strengthening the evidence base through more rigorous and inclusive research is essential to inform effective, sustainable program design and optimize educational outcomes globally.

Clinical Message

Formal mentorship, protected teaching time, and cutting-edge simulation technologies boost faculty teaching skills and drive better resident performance in orthopedics. Strong institutional support through allocated resources, recognition programs, and continuous program evaluation is vital to overcome barriers and maintain excellence in surgical education.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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