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Development of an Instrument to Measure Student Leadership Competencies for Undergraduate Medical Programs in Yunnan, China

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Abstract

Medical students play a crucial role in shaping the future of healthcare delivery. Although clinical skills are essential, leadership abilities should be introduced early and reinforced throughout training to help students adapt to rapid changes in education and health systems and to ease their transition into professional practice. This study aimed to identify the leadership competencies relevant to medical students and to develop and validate an instrument for assessing these competencies. Using a theoretical empirical framework, a systematic literature review and content analysis was conducted, and content validity was confirmed to generate a 49-item questionnaire covering seven areas: ethics and social awareness; personal qualities; teamwork and collaboration; patient service management; patient focused; strategic leadership and adaptability; and medical knowledge and skills. The instrument was piloted with 103 undergraduate medical students at a university in Yunnan, China. Confirmatory factor analysis (CFA) and Cronbach's alpha were applied to evaluate its validity and reliability. The results indicated that the instrument demonstrated strong convergent validity and high internal consistency, with Cronbach's alpha values exceeding 0.80 for all constructs, indicating high internal consistency. Recommendations include further refinement and testing with larger, more diverse samples to enhance the instrument.

Keywords: Student Leadership Competencies, Medical Students, Instrument Development

Introduction

While advanced technologies have expanded medicine's diagnostic and therapeutic capabilities, the growing complexity of diseases and patients' demand for high-quality care underscore the need for doctors to possess strong leadership competencies. The World Health Organization(WHO) has called for 21st-century physicians to combine clinical expertise with management, teamwork, and ethical practice (WHO, 2016), alongside a commitment to health promotion, public-health problem-solving, scientific reasoning, and technological literacy (Jia et al., 2021; Thibault, 2020). Physicians equipped with these leadership skills can identify and analyze problems, plan strategically, manage teams and themselves, collaborate effectively with colleagues, communicate clearly with patients and families, and coordinate care to improve outcomes and overall healthcare quality (James et al., 2021; Lin et al., 2023).

Because medical students are the future healthcare workforce, they must develop leadership competencies that extend beyond core clinical skills (Lucas & Venckutė, 2020). Higher-education institutions bear the responsibility of cultivating graduates who meet evolving healthcare demands. China's Education Modernization 2035 and the Guiding Opinions on Accelerating Innovative Development of Medical Education prioritize medical-education reform, emphasize education-practice integration (Song et al., 2017), and call for strengthening students' leadership and management capabilities to support the Healthy China 2030 initiative (Chen et al., 2023; Zhang & Zhang, 2021).

However, leadership education in Chinese universities remains uneven. A survey of medical students revealed significant gaps in leadership quality and ability (Chen et al., 2021), and many students have never engaged in structured leadership training or regard it as unnecessary (Huang, 2024). Existing programs often import foreign models without local adaptation (Luo et al., 2016), lack standardized curricula (Wang, 2021), and offer short-term, narrowly focused interventions with limited impact (Wang & Wang, 2023). Heavy coursework also limits students' participation in leadership roles and activities (Long et al., 2020), highlighting the urgent need for context-appropriate leadership development in medical education.

At the provincial level, Ma et al. (2022) found that Yunnan's hospitals face shortages of young talent and that trainees lack research experience and management skills. To address this, our study seeks to identify the specific leadership competencies required by Yunnan medical students and develop a validated instrument for assessing these needs among five-year undergraduate cohorts. The findings may directly enhance understanding of leadership competencies in medical education and contribute to localized research and improved measurement tools. Researchers can use this instrument to expand studies to other medical institutions and student groups or continue to explore more specifically how the instrument can be used to address relevant challenges in leadership training and assessment.

Research Objectives

1. To determine the leadership competencies needed for medical students.
2. To develop a validated instrument to assess student leadership competencies needed for five-year undergraduate medical programs in Yunnan Province, China.

Literature Review

The concept of competence has long been recognized as vital for enhancing performance across industries (Zimnyaya, 2004). McClelland (1973) originally defined competence as the combination of knowledge and skills directly linked to job performance, which can be developed through training and assessed against established standards; he also noted that personal attributes, motivation, and experience distinguish high performers from average ones. This idea has evolved into a multidimensional model comprising medical

knowledge, technical skills, character traits, and other elements in medical education. Frank et al. (2010) describe competencies as learnable, observable capabilities that can be measured to ensure mastery, forming a cohesive trajectory from undergraduate through postgraduate and continuing medical education (Aschenbrener et al., 2015). The present study focuses specifically on leadership competencies to explore how medical students mobilize their knowledge, skills, attitudes, and values to influence their behavior, enhance learning outcomes, and shape their professional identity.

Global Medical Competency Frameworks

In 1996, the Royal College of Physicians and Surgeons of Canada(RCPSC) introduced the CanMEDS framework, defining seven physician roles—professional, communicator, collaborator, medical expert, scholar, manager, and health advocate—to guide competency development from training through practice (Frank & Danoff, 2007; RCPSC, 1996). Three years later, the Institute for International Medical Education published the Global Minimum Essential Requirements (GMER) for undergraduates, specifying 60 competencies across seven domains: professional values and attitudes; medical science foundation; clinical skills; communication; population and health systems; information management; and critical thinking and research (Core Committee, 2002; Schwarz & Wojtczak, 2002). In the United States, the A ccreditation Council for Graduate Medical Education (ACGME) framework delineates 41 competencies in six areas—medical knowledge; patient care; professionalism; system-based practice; practice-based learning and improvement; and interpersonal and communication skills—to standardize graduate medical education (Caverzagie et al., 2013). Whitcomb (2004) cautions that such frameworks must be tailored for medical students since their expected performance differs from that of residents; competency-based education, therefore, requires clear, level-specific descriptions of the knowledge, skills, and attitudes students must achieve.

Chinese Adaptations and Gaps

China's unique healthcare context has led scholars to adapt and refine foreign competency frameworks rather than adopt them wholesale. For example, Zhang et al. (2002) surveyed Chinese medical students' attitudes toward the GMER and, using factor analysis, condensed its 60 competencies into 23, with professional values and attitudes, medical science foundation, clinical skills, and critical thinking and research ranking highest. Zheng and Peng (2005) argued that students' "SuZhi JiaoYu" (general education) should be strengthened. They proposed an eight-aspect framework—morality, personality, psychological quality, interpersonal coordination and communication, innovation, learning ability, executive ability, and physical health. More recently, Liu et al. (2016) conducted a cross-sectional survey grounded in Good Medical Practice (Palmer et al., 2002), ACGME, and CanMEDS, identifying eight core dimensions for Chinese clinicians: professionalism and values; patient care and clinical skills; medical knowledge and lifelong learning; information management; health promotion and disease prevention; research skills; teamwork; and interpersonal communication.

In 2022, China's Standards for Basic Medical Education (Ministry of Education of The People's Republic of China [CMOE] &Working Committee for the Accreditation of Medical Education [WCAME], 2022) defined four undergraduate domains—scientific and academic (theoretical knowledge and research ability), clinical competence (efficient, innovative patient care), health and society (public-health perspective), and professionalism and quality (self-awareness, values, and ethics). That same year, the China Consortium of Elite Teaching Hospitals for Residency Education released a six-domain framework for residents—professionalism; medical knowledge and skills; patient care; communication and collaboration; teaching; and lifelong learning—which now guides postgraduate training (China Consortium of Elite Teaching Hospitals for Residency Education [CCETHRE], 2022). While these models establish clear post-graduation standards, a comparably detailed competency framework for undergraduate medical leadership has yet to be articulated.

Western countries pioneered competency-based medical education with globally influential frameworks (CanMEDS: Frank & Danoff, 2007; GMER: Core Committee, 2002; ACGME: Caverzagie et al., 2013). However, no national framework for undergraduate medical competencies exists in China, as current standards focus on postgraduate training and practice (CMOE & WACME, 2022). Despite contextual differences, most frameworks share five features: clearly defined competencies; development via literature review, critical-incident techniques, and Delphi; alignment with educational and professional standards; adaptability to clinical settings and learner characteristics; and core domains of professionalism, communication, and collaboration, and medical knowledge and clinical skills. To establish leadership competencies for Chinese medical undergraduates, programs should adopt these general domains and identify additional, context-specific leadership areas. Table 1 details the competencies across the five major frameworks.

Table 1

Competencies in the Frameworks

Can MEDS Framework (1996, 2007)	**The Global Minimum Essential Requirements (2002)**	**ACGME Framework (2013)**	**Chinese Basic Medical Education Standards (CMOE & WACME, 2022)**	**Chinese Core Competencies Framework of Residents (CCETHRE, 2022)**
-Professional -Communicator -Collaborator -Leader -Medical expert -Scholar -Health advocate	-Professional values and attitudes -Critical thinking and research -Communication -Medical Science Foundation -Clinical skills -Information management Population and health systems,	-Professionalism -Personal and professional development -Interpersonal and communication skills -Medical knowledge -Patient care -System-based practice -Practice-based	- Scientific and academic - Clinical competence - Health and society - Professionalism and quality	-Professionalism -Lifelong learning -Communication and collaboration, -Medical knowledge and skills -Patient care -Teaching

Can MEDS Framework (1996, 2007)	The Global Minimum Essential Requirements (2002)	ACGME Framework (2013)	Chinese Basic Medical Education Standards (CMOE & WACME, 2022)	Chinese Core Competencies Framework of Residents (CCETHRE, 2022)
		learning and improvement -Interprofessional collaboration		

Conceptual Foundations: MLCF and SLC Frameworks

The Medical Leadership Competency Framework (MLCF), developed by the National Health Service (NHS) Institute for Innovation and Improvement and the Academy of Medical Royal Colleges (NHS, 2010), integrates leadership with clinical practice by defining 20 competencies across five clusters—Demonstrating Personal Qualities; Working with Others; Managing Services; Improving Services; and Setting Direction—each comprising four elements and further competency outcomes (Chen, 2018). Although the framework applies to all medical students and qualified doctors, the competencies acquired at various stages vary. Medical students' level of leadership competencies will improve over time through education, training, and practice. Ogurek and Harendza (2024) adapted MLCF into a six-domain self-assessment for medical students—covering responsible behavior, relationship building, personal development, quality improvement, self-management, and systemic thinking—and demonstrated strong content validity, though with some overlap between domains. While the MLCF provides a clear theoretical model for medical leadership, it may lack detailed, actionable implementation guidelines. In particular, difficulties may arise in how to apply the framework to specific curriculum design, training programs, or development processes within the organization.

Seemiller and Whitney's (2020) Student Leadership Competencies Framework (SLCs) is widely used in higher education to identify and cultivate the leadership skills students value most. Responding to Seemiller's call to streamline the original 60-competency list (Seemiller, 2016), they employed a Delphi process to organize these competencies into five tiers and consolidate eight initial clusters (Seemiller, 2013) into four dimensions: Intrapersonal (self-awareness and personal development), Interpersonal (group dynamics and communication), Societal (civic responsibility), and Strategic (learning, reasoning, and planning). While SLCs can be paired with other leadership models to optimize outcomes for specific contexts, their broad design may require adaptation for different disciplines, majors, or institutional environments.

Alongside MLCF, the Student Leadership Competencies (SLC) framework (Seemiller & Whitney, 2020) emphasizes the personal, social, and methodological dimensions essential for student leaders. This study draws on both frameworks to ground its instrument design: MLCF provides a detailed map of medical leadership in practice, while SLC ensures attention to the developmental needs of learners. On the one hand, MLCF was used to strengthen the cognition of medical students on the complexity of the healthcare system, such as hierarchical

diagnosis and treatment doctor-patient relationship; on the other hand, SLCs was used to cultivate their problem-solving and teamwork through student associations, volunteer service and other ways at university stage. By combining MLCF's depth and SLC's student-focused perspective, our instrument aims to offer both a rigorous and tailored approach to evaluating leadership competencies in Yunnan's medical undergraduates.

Key Domains of Leadership Competency for Medical Students

Medical students must build a strong knowledge base that aligns with China's educational standards. According to the Standards for Basic Medical Education in China (CMOE & WACME, 2022), this includes foundational biomedical sciences (e.g., physiology, pathology, immunology, anatomy, medical psychology), core clinical disciplines (internal medicine, surgery, obstetrics-gynecology, pediatrics), humanities (literature, philosophy, ethics, law), and natural sciences (physics, chemistry, biology, mathematics, logic) (Huikko-Tarvainen et al., 2024; Zhang et al., 2022). Increasingly, public-health content—such as epidemiology, emergency management, and ethics—is deemed essential to equip graduates for disaster and epidemic response (Lan et al., 2023; Wu et al., 2022). However, many students report low confidence in these areas, highlighting the need for targeted instructional efforts (Kannaiyan & Jaiganesh, 2016; Markenson et al., 2013).

Effective communication lies at the heart of both clinical care and leadership. Medical students must master patient-centered dialogue, interprofessional communication, feedback delivery, and breaking bad news (Behling et al., 2024; Taveira-Gomes et al., 2016). Qualitative studies show that negotiation, conflict resolution, and decision-making are highly valued in leadership curricula, although students often lack training in service improvement and risk management (Quince et al., 2014). Poor communication skills can manifest as reduced empathy, diminished patient trust, and suboptimal teamwork (Xie et al., 2015).

Teamwork and collaboration underpin high-quality care. In clinical settings—whether among colleagues or doctor-patient relationships—mutual respect and empathy foster effective information exchange and cooperative problem-solving (Huikko-Tarvainen et al., 2024). Training that emphasizes these interpersonal competencies helps students function seamlessly within multidisciplinary teams. Beyond soft skills, medical students need strong clinical and analytic capabilities. Key competencies include clinical reasoning, evidence-based practice, ICT proficiency, research methods, and critical thinking (Ten Cate et al., 2024). These skills enable accurate history-taking, physical examination, data interpretation, and informed decision-making to ensure safe, efficient, and patient-centered care (Li et al., 2022). Scholars recommend embedding patient-safety and patient-centered modules in the curriculum and exploring new approaches to strengthen students' critical-thinking and problem-solving aptitudes (Cabell et al., 2023; Sharma et al., 2024).

Leadership and management skills—such as change management, strategic planning, career appraisal, analytical problem solving, goal setting, and decision-making—are vital for future physician-leaders (Chen et al., 2021; Ross et al., 2021). Yet, students often lack formal leadership programs, practical experience, and opportunities to lead, leaving them feeling

unprepared for managerial roles (Lerman & Jameson, 2018; Onyura et al., 2019).

Personal qualities, including self-awareness, resilience, ethical commitment, and lifelong-learning orientation, form the backbone of professional identity (Zhou et al., 2023). Time-management skills are crucial for navigating China's intensive medical curriculum (Tian et al., 2022). Furthermore, active engagement in social-responsibility projects—whether public-health campaigns or disaster relief—cultivates fairness, justice, and a service ethos (Li et al., 2023).

Given medicine's multidisciplinary nature, leadership competency development must span these domains—knowledge, skills, attitudes, and values—in an integrated, iterative process. Despite cultural and contextual variations, certain competencies recur universally: effective communication, teamwork, personal integrity, patient focus, and strategic planning. Focusing on these core areas will prepare medical students for dynamic healthcare environments in China and beyond (Zhang et al., 2022).

Research Methodology

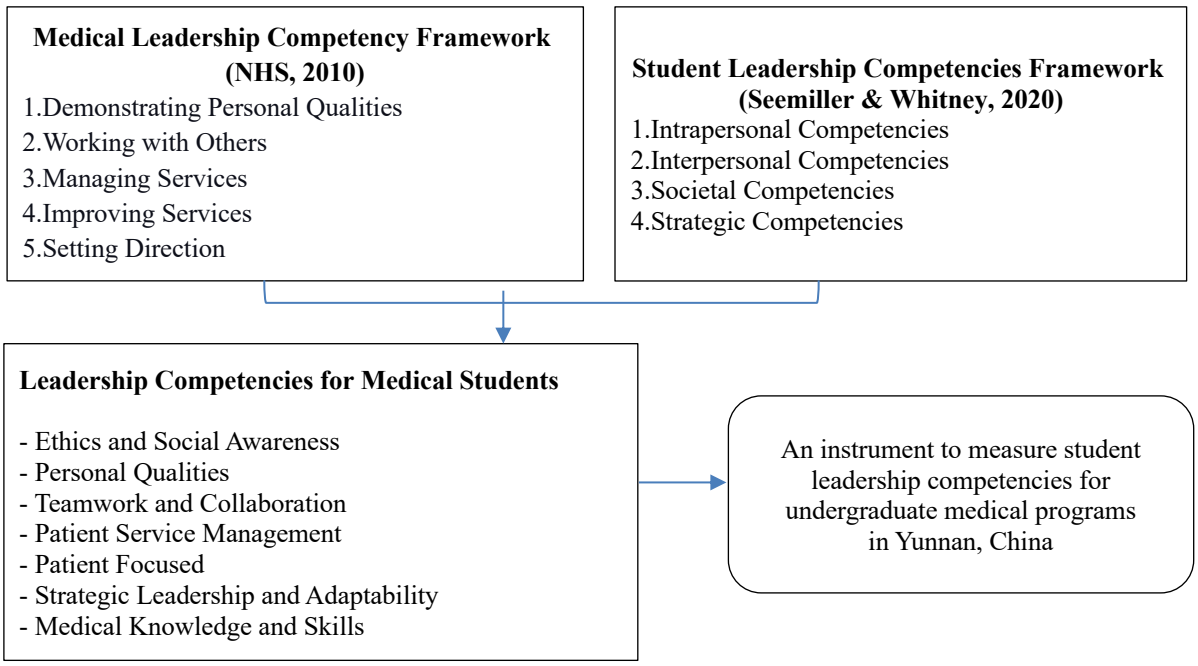
This study used a two-stage, mixed-methods approach to develop and validate an instrument measuring medical student leadership competency in Yunnan, China. It provided a quantitative data description of medical students' perceptions through a theory-oriented empirical research paradigm (Creswell & Creswell, 2017), promoted grounded and reliable results and reasonings (Creswell et al., 2011), which had advantages not available through the deployment of the quantitative or qualitative method alone (Benoit & Holbert, 2008).

Conceptual Framework

This study applies two theoretical frameworks central to its design. Based on the MLCF and SLCs, the researcher integrated relevant, high-quality literature through a systematic literature review, used the framework as search parameters and coding methods to identify the seven leadership competencies domains needed by medical students, and developed constructs accordingly. Then, a validated needs assessment instrument was designed.

Figure 1

Conceptual Framework of the Study



Instrument Development

The instrument development phase focused on item generation and validation through a systematic literature review and pilot test. In this respect, theoretical framework comparison as part of the content validation process, a systematic literature review ensures that relevant dimensions were covered, and experts' opinions and feedback might be useful to confirm the definition of competencies and items relevance of the seven-category model (Polit & Beck, 2006).

Stage 1 – Item Generation: Guided by the MLCF (NHS, 2010) and SLCs (Seemiller & Whitney, 2020), the current study conducted a PRISMA-compliant review of English and Chinese literature mainly from 2014 to 2024 across Web of Science, ERIC, CNKI, and PubMed. Competency domains were identified via content analysis, and items were drafted and refined using the Content Validity Index.

The content analysis of this study did not follow a strict deductive or inductive approach and had elements of both. It is deductive in that it is informed by existing leadership competencies theories and models from research carried out in other countries, particularly MLCF, GMER, and SLCs. At the same time, it is also inductive in that it allows for new information about competencies to arise from the data due to a new context: the Chinese medical students. Thus, the coding and analytic induction process was also informed by the broader framework of the Global Minimum Essential Requirements, the Chinese Basic Education Standards, and the Chinese Core Competencies of Residents. Considering that there may be some overlapping parts between the various competency frameworks, for example, demonstrating personal qualities in MLCF may be similar to intrapersonal competencies in

SLCs, and working with others may correspond to interpersonal competencies, these parts need to be noted in the process, and it is necessary to ensure that each code is clearly defined. Table 2 shows a preliminary competency coding framework.

Table 2

Deductive Coding Framework

Deductive Coding	Example	Explanations	Theoretical Source
Demonstrating p ersonal qualities / Intrapersonal competencies	Self-awareness. Self-management. Continuing professional development. Integrity	The values, morals, and ethics of medical students for personal development and sustainable work performance. Able to recognize their strengths and weaknesses.	MLCF-1; SLCs-1; The GMER of Chinese medical students
Working with others / Interpersonal competencies	Communication; Interdisciplinary collaboration; Relationship building	Refers to effective communication and teamwork between medical students and their peers, patients, and others at different organizational levels	MLCF-2; SLCs-2; The Chinese medical education standards
Managing services.	Planning. Managing Resources	Planning, resource management, hu man management, performance, and other management capabilities to ensure the quality and sustainability of services.	MLCF-3; The GMER of Chinese medical students
Improving services	Critically Evaluating and ensuring patient safety.	This includes ensuring patient safety by assessing risk and balancing economic and patient needs to improve the quality of services.	MLCF-4; The GMER of Chinese medical students
Setting direction / Strategic competencies	Strategic planning; Decision-making; Adaptability	Emphasized the ability of medical students to identify the contexts for change, promote innovation, decision-making, and strategic planning.	MLCF-5; SLCs-4; The GMER of Chinese medical students
Societal competencies	Social responsibility; so cial awareness	Demonstrated a commitment to social responsibility in terms of community and society.	SLCs-3; The Chinese Education standards. The GMER of Chinese medical students
Medical knowledge and clinical skills	Fundamental Medical Knowledge; Clinical judgment	Represents the ability of medical students in theoretical knowledge, practical skills, clinical decision-making, etc.	The GMER of Chinese medical students. The Chinese medical education standards

The researcher identified 79 leadership-related terms from 41 screened documents, then grouped and renamed similar terms and calculated their frequencies (Table 3). Based on this, keywords were converted or combined according to the Chinese context: (1) The leadership competencies for medical students with exactly consistent meanings mentioned between Chinese and international studies do not need to be processed. (2) Leadership competencies mentioned in Chinese studies that are similar meanings to those in other countries should distinguished and transferred in meaning. (3) Other leadership competencies mentioned in literatures but not included in the theoretical framework are added. (4) And makes a comprehensive table to summarize the leadership competencies desired for medical students.

These formed seven competency categories: Ethics and Social Awareness (ESA), Personal Qualities (PQ), Teamwork and Collaboration (TC), Patient Service Management (PSM), Patient Focused (PF), Strategic Leadership and Adaptability (SLA), and Medical Knowledge and Skills (MKS). Based on these categories, a 65-item instrument was drafted.

Table 3

Medical Students' Leadership Competencies Category in Study Synthesis

Original extracted key terms and frequencies (79 key terms/ N=510)	**Regrouping of key terms**	**Total frequency of key terms grouped**	**MLCF domains**	**SLCs domains**	**Leadership competencies categories**
Communication(31), Teamwork(29), Core medical knowledge(18), Clinical skills and experiences(16), Critical thinking(13), Self-reflection (13), Compassion(13), Interpersonal relationship (13),	Social responsibility (11), Professional ethics (11), Professionalism (8), Professional identity (4), Prevent disease (2), Social awareness (1)	37		Societal competencies	Ethics and Social Awareness
Conflict resolution skills (12), Honesty and integrity (12), Problem-solving (11), Professional ethics(11), Social responsibility (11), Change management (10), Humanities knowledge (10), Patient-centered(10), Basic medical knowledge(9), Decision-making (9), ICT management skills (9), Inspire(9), Lifelong	Self-reflection (13), Honesty and integrity (12), Lifelong learning (9), Responsibility (9), Time management (9), Self-awareness (8), Stress management (8), Self-determination (5), Confidence (5), Dedication (4),	113	Demonstrat-ing personal qualities.	Intrapersonal competencies	Personal Qualities

Original extracted key terms and frequencies (79 key terms/ N=510)	Regrouping of key terms	Total frequency of key terms grouped	MLCF domains	SLCs domains	Leadership competencies categories
learning(9),Resource allocation (9), Responsibility(9),Scientific research(9), Time management (9), Self-awareness (8), Stress management (8), Performance orientation (8), Public health knowledge(8),Professionalism(8),Quality improvement(7), Innovation(7), Patient safety (7), Organizational skills(7), Negotiating skills(6),	Self- management (3), Human l iteracy (3), Attention to detail (3), Enterprising (3), Emotional intelligence (3), Resilience (3), Justice (3), Self-development (3), Commitment (2), Openness (1), Self-discover (1), Selfless service (1), Courage (1), Self-identity (1)				
Adaptability(5),Clinical thinking and judgement (6),Leadership and management (6),Self-determination (5),Analytical skills(5), Confidence(5), Executive force(5),Financial management(4), Professional identity(4), Dedication(4), Goal setting(4), Managing others (4), Self-management (3),Attention to	Communication (31), Teamwork (29), Compassion (13), Interpersonal relationship (13), Conflict resolution skills (12), Inspire (9), Organizational skills (7), Negotiating skills (6), Patience (2), Knowledge sharing (1), Congruence (1)	124	Working with others.	Interpersonal competencies	Teamwork and Collaboration
detail(3),Career planning and management (3), Enterprising (3), Emotional intelligence(3), Human literacy(3), Justice(3), Natural science knowledge(3), Resilience(3), Risk management (3), Self-development(3), Teaching ability(3),Vision(3),Com	Resource allocation (9), Performance orientation (8), Financial management (4), Managing others (4), Risk management (3), Crisis management (2), Planning (2), Human resource	33	Managing services		Patient Service Management

Original extracted key terms and frequencies (79 key terms/ N=510)	Regrouping of key terms	Total frequency of key terms grouped	MLCF domains	SLCs domains	Leadership competencies categories
mitment(2),Crisis management (2), Evidence based practice(2), Patience(2), Planning(2), Prevent disease(2),Strategic planning(2), Congruence (1),Courage(1), Disaster management(1), Human resource management(1), Knowledge management(1), Knowledge sharing(1), Occupational quality(1), Openness(1),Self-discover(1), Self-identity(1), Selfless service (1), Social-awareness (1)	management (1)				
	Critical thinking (13), Problem solving (12), Patient-centered (10), Patient safety (7), Quality improvement (7), Evidence based practice (2)	51	Improving services		Patient Focused
	Change management (10), Decision-making (9), Innovation (7), Leadership and management (6), Adaptability (5), Analytical skills (5), Executive force (5), Goal setting (4), Career planning and management (3), Vision (3), Strategic planning (2), Disaster management (1),	60	Setting direction.	Strategic competencies	Strategic Leadership and Adaptability
	Core medical knowledge (18), Clinical skills and experiences (16), Humanities knowledge (10), ICT management skills (9), Basic medical knowledge (9), Scientific research (9), Public health knowledge (8), Clinical thinking and judgement (6), Natural	93			Medical Knowledge and Skills

Original extracted key terms and frequencies (79 key terms/ N=510)	Regrouping of key terms	Total frequency of key terms grouped	MLCF domains	SLCs domains	Leadership competencies categories
	science knowledge (3), Teaching ability (3), Knowledge management (1), Occupational quality (1)				

Stage 2 – Validation: The draft instrument was tested with undergraduate medical students and subjected to confirmatory factor analysis and Cronbach's alpha. The researcher evaluated factor loadings (λ), composite reliability (CR), and average variance extracted (AVE) to confirm convergent validity and internal consistency.

The Content Validity Index (CVI) is a standard method for evaluating and refining survey instruments. As recommended by Yusoff (2019), six medical-education experts reviewed the initial draft. Four of the selected experts possess more than 15 years working experience in Chinese medical institutions, as well as actively involved in medical student education and continuing education, where three of them hold the position of Professor or Assistant Professor (academics). The other two experts were from the field of higher education in Thailand and with many years of teaching experience. Although the CVI relies on the subjective judgment of experts on items or constructs, the expert panel, which is usually experienced, can consider issues from multiple perspectives, ensuring that different ideas can be considered, thereby contributing to identifying and correcting potential gaps or inconsistencies in the instrument (Lynn, 1986).

Item-level CVI (I-CVI) scores ranged from 0.50 to 1.00, and scale-level CVI/UA (S-CVI/UA) values for the seven competency domains were: Ethics and Social Awareness 0.759, Personal Qualities 0.833, Teamwork and Collaboration 0.889, Patient Focus 0.762, Patient Service Management 0.952, Strategic Leadership and Adaptability 0.782, and Medical Knowledge and Skills 0.875. Experts recommended phrasing adjustments for mainland Chinese respondents and adding items on current medical challenges. Incorporating their feedback produced a 49-item instrument spanning the same seven domains, with each item rated on a five-point Likert scale (1 = Not Important to 5 = Very Important). Table 4 shows the final item breakdown by dimension.

Table 4

Constructs and Number of Items Developed for Instrument

Description	Construct	Number of items
Leadership Competencies Instrument	Ethics and Social Awareness	5
	Personal Qualities	8

Description	Construct	Number of items
	Teamwork and Collaboration	7
	Patient Service Management	4
	Patient Focused	8
	Strategic Leadership and Adaptability	7
	Medical Knowledge and Skills	10
	Total	**49**

Instrument Pilot Testing

Johanson and Brooks (2010) recommended the minimum sample size for a pilot study (an interval estimate of 24-36), ideally recruiting 100 participants (Crocker & Algina, 1986, as cited in Johanson & Brooks ,2010). The researcher piloted the instrument with 103 randomly selected undergraduate medical students. Following established guidelines, items with factor loadings below 0.50 were earmarked for revision. Convergent validity and reliability thresholds were set at AVE ≥ 0.50, CR ≥ 0.70, and Cronbach's $\alpha \geq 0.70$ (with $\alpha \geq 0.90$ considered excellent). Our results showed AVE values from 0.593 to 0.686, CR above 0.70 for all constructs, and α exceeding 0.80. Table 5 shows these results.

Table 5

Cronbach's Alpha, CR and AVE

Leadership Competencies	Cronbach's Alpha	CR	AVE
Ethics and Social Awareness	0.885	0.8825	0.6032
Personal Qualities	0.930	0.9331	0.6372
Teamwork and Collaboration	0.91	0.9105	0.593
Patient Service Management	0.893	0.8974	0.6863
Patient Focused	0.923	0.9272	0.6149
Strategic Leadership and Adaptability	0.935	0.9365	0.6789
Medical Knowledge and Skills	0.948	0.9507	0.6597

Results and Conclusion

This study produced and validated a 49-item instrument to measure leadership competencies among medical students in Yunnan, China. Grounded in the NHS Medical Leadership Competency Framework and Seemiller and Whitney's Student Leadership Competencies, the researcher conducted a PRISMA-guided systematic review (2014–2024) across Web of Science, ERIC, CNKI, and PubMed, followed by content analysis to define seven domains: ethics and social awareness; personal qualities; teamwork and collaboration; patient service management; patient focused; strategic leadership and adaptability; and medical knowledge and skills. An expert panel (n=6) applied the Content Validity Index to refine 65 draft items down to 49.

The researcher then piloted this instrument with 103 undergraduate students, using confirmatory factor analysis (CFA) to assess construct validity and Cronbach's α for reliability. All domains met convergent-validity thresholds (AVE ≥ 0.59, CR ≥ 0.70) and showed strong internal consistency (α ≥ 0.80). Discriminant validity was weaker, reflecting some overlap among competencies—a finding consistent with Ogurek and Harendza (2024)—but we retained all items to preserve the framework's comprehensiveness.

The resulting tool demonstrates acceptable psychometric properties and can guide leadership training integration into crowded medical curricula. Educators can use this instrument to assess leadership readiness at key stages of the curriculum and tailor interventions to individual or cohort-level needs. Future work should expand to larger, more diverse samples, incorporate qualitative methods (e.g., interviews, focus groups), and further refine discriminant validity to ensure each competency is measured distinctly.

Discussion and Recommendation

The 49-item leadership competency instrument offers a structured way to assess and develop the leadership potential of undergraduate medical students in Yunnan Province. By organizing competencies into seven domains—Ethics and Social Awareness; Personal Qualities; Teamwork & Collaboration; Patient Service Management; Patient Focus; Strategic Leadership and Adaptability; and Medical Knowledge and Skills—educators can pinpoint both strengths and gaps in students' leadership profiles. In the Yunnan context, where healthcare delivery often must balance modern techniques with rural outreach, the Ethics and Social Awareness and Patient Focus scales are especially relevant: they help ensure graduates not only master clinical care but also understand local health disparities and community needs. Likewise, the Teamwork and Collaboration, and Strategic Leadership and Adaptability domains support students' readiness to work in interdisciplinary teams across diverse settings—from large hospitals in Kunming to village clinics in remote areas. This aligns with the MLCF emphasis on 'Setting Direction' and the SLC's 'Strategic' dimension, highlighting the relevance of leadership adaptability in varied health contexts. Also aligns with the principles and cultural background of medical education in China.

Because discriminant validity was modest, instructors should interpret closely related domains (for example, Patient Service Management and Patient Focus) together, using follow-up discussions or reflective activities to clarify subtle differences. The high internal consistency of each scale, however, confirms that the instrument reliably measures its intended constructs. As a self-assessment tool, it encourages students to reflect on their leadership development; as a diagnostic tool for faculty, it highlights where curriculum enhancements or targeted workshops may be most needed.

To maximize the instrument's value, medical programs in Yunnan could first integrate it into foundational courses by administering the survey at the start of Year 1 and again at the end of Year 2. This early and mid-curriculum assessment will reveal lower-scoring domains—such as Strategic Leadership and Adaptability—so that decision-making and

change-management workshops can be scheduled promptly and tailored to the province's unique healthcare challenges. Following each administration, mixed-cohort small-group workshops should be convened, enabling students to compare their domain scores, share lessons from urban and rural clinical rotations, and co-create action plans for developing weaker competencies.

Annually, faculty can aggregate cohort data to pinpoint common gaps—for instance, low Personal Quality scores—and use these insights to inform curriculum design, such as adding professionalism and resilience modules within existing ethics courses using Yunnan-specific case studies. In parallel, mentorship pairs should be formed, matching students strong in Teamwork and Collaboration with peers who need improvement; mentors can then model effective communication and conflict-resolution skills through interprofessional simulations that mirror Yunnan's health-system structure. Finally, every two years, the instrument should undergo re-validation with a diverse sample of students and educators across Yunnan medical schools. Supplementing quantitative results with focus groups will ensure that item wording and examples remain culturally appropriate and enhance the tool's discriminant validity. By embedding these practices—orientation, coursework, workshops, mentorship, and ongoing evaluation—Yunnan's medical educators can systematically cultivate the leadership competencies their students need to serve urban hospitals and rural communities. These research findings provide a scientific leadership development assessment plan and a replicable path for training medical talents in similar healthcare contexts in low- and middle-income countries. It includes leadership needs identification in the medical education process, the assessment of students' individual growth, and effectiveness tracking before and after teaching interventions, thereby supporting more targeted competencies development and education resource allocation.

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