INFLUENCE OF SELF-DIRECTED LEARNING ON CRITICAL THINKING AND PROBLEM-SOLVING SKILLS AMONG UNDERGRADUATE MEDICAL AND DENTAL STUDENTS

Usama Aurangzeb[1], Munir Ahmad Khan[2], Parkha Afridi[3], Alia Jehan Zaib[1], Suamyya Wajid[4], Ambreen Syed[5]

ABSTRACT

Objective: To assess the correlation between self-directed learning readiness and the enhancement of critical thinking and problem-solving skills in undergraduate medical and dental students.

Study Design: Cross-sectional study.

Place and Duration of Study: The research was conducted over a six-month period from January to June 2024 at Gandhara University, Peshawar, which encompasses Kabir Medical College (KMC) and Sardar Begum Dental College (SBDC).

Methods: A total of 820 undergraduate students in the MBBS (first to fifth years) and BDS (first to fourth years) programs participated. Data were collected using the Problem-Solving Inventory (PSI) and the Self-Directed Learning Readiness Scale (SDLRS). Descriptive statistics summarized demographic data, and associations were tested using multiple regression analysis and Pearson's correlation coefficient.

Results: SDL readiness levels were moderate to high, with MBBS students scoring marginally higher in self-management and desire for learning than BDS students. Self-control scores showed no significant difference. The correlation between SDL readiness and problem-solving skills was weak and statistically non-significant ($r = -0.072$, $p = 0.054$).

Conclusion: Self-directed learning (SDL) readiness demonstrated a weak overall association with problem-solving ability; however, students previously exposed to SDL showed significantly higher problem-solving skills. These findings suggest that structured and early integration of SDL within medical curricula could foster stronger analytical and decision-making competencies.

Keywords: Critical thinking, medical education, problem-solving, Self-Directed Learning (SDL), SDLRS, undergraduate students.

INTRODUCTION

The changes in the medical education field during the past few decades have been dramatic because of the sheer increase in the complexity of the healthcare delivery system and the remarkable technological advancements in the medical research field (1).

With the changing demands of healthcare professionals, medical organizations should equip graduates with great analytical thinking, problem solving, and adaptive learning skills(2). Conventional pedagogical strategies that focus on memorization have been criticized due to inadequate preparation of students to the challenges of contemporary healthcare (3,4).

As a result, medical education is now moving toward student-focused and active learning models that place a strong focus on autonomy, reflection, and life-long learning. The switch is particularly applicable to South Asia where practitioners are to adjust to new technologies, insufficient resources, and patient-focused care requirements (5).

Self-directed learning has emerged as a notably effective strategy resulting from the

[1] Gandhara University, Peshawar
[2] Gomal Medical College, Dera Ismail Khan
[3] Rehman College of Dentistry, Peshawar
[4] WATIM Medical and Dental College, Islamabad
[5] Hayatabad Medical Complex, Peshawar

Address for Correspondence
Dr. Ambreen Syed
Hayatabad Medical Complex, Peshawar
amber.musanif87@gmail.com

transition to a more interactive, student-centered educational approach (6). Self-Directed Learning empowers learners to assume responsibility for their educational journey by recognizing learning requirements, devising tactics, and assessing results. Knowles' adult learning theory emphasizes autonomy, characterizing self-directed learning as a fundamental element of lifelong learning in professional education. (7). Recent findings indicate that it does not only promote independence but also improve the capacity to combine and transfer knowledge to complicated clinical scenarios(8,9).

Research indicates that SDL is important to the medical curriculum because it improves critical thinking, problem-solving, and knowledge intake in students (10). In a wide study conducted by Murad et al. (2010) it was found that, as an example, SDL has been associated with improved clinical expertise, educational achievement, and information gain across a number of health care careers. Active learning, questioning preconception, and multiple points of view are factors that help students to gain the analytical thinking and problem-solving skills needed to succeed in the healthcare field (6).

This connection has been reestablished by more recent studies in Asian and Middle Eastern situations. Indicatively, Alradini et al. (2022) and Durrani et al. (2024) discovered that SDL readiness was a significant factor that determines the engagement, reflective capability, and problem-solving behaviors among medical students (11,12). Likewise, Khan and Begum (2019) indicated that structured interventions of SDL are beneficial in enhancing the self-efficacy, learning, and motivation of Pakistani nursing students(13).

The medical and dental field is dependent on both analytical and problem solving skills(14,15). These competencies help practitioners to evaluate evidence, make sound decisions, and review opposing opinions in the setting of complex clinical circumstances(16). Since clinical settings are usually full of high-stakes decisions with little room to error, the capacity to translate knowledge into practice in solving real-life problems becomes highly important(17,18). Thus, it is imperative that these abilities be developed at an early stage of undergraduate training consideration of clinical competence and patient safety.

Internationally, SDL-based curricula were found to be related to better diagnostic reasoning and reflective practice, as well as clinical decision-making(18,19). The contextual obstacles to SDL implementation observed in low- and middle-income nations, such as Pakistan, include the lack of faculty training, structural assessment, and the size of classes (20,21). Nonetheless, it is increasingly becoming apparent that localized and culturally sensitive SDL models can promote the agency and flexibility of learners(22).

The impact of SDL on Pakistani students, particularly, those who plan to work in the fields of medicine and dentistry, has been poorly researched, although there is extensive evidence of its application(20,23). This gap is considerable because the healthcare system in Pakistan faces special problems, including a large number of patients, the lack of resources, and the necessity to make rapid choices (19). To enhance the readiness of the Pakistani dentistry and medical students to become practitioners, it is essential to be aware of the effects of SDL on the development of critical thinking and problem-solving skills.

Although there is evidence of the benefits of SDL all over, studies regarding its efficiency in Pakistan are scarce. The local studies have reported that Pakistani medical and dental students are showing moderate SDL preparedness but the institutional support, faculty attitude, and culture of assessment all affect the success of its deployment (17–19). Indicatively, Mehboob (2022) and Yasmin et al. (2019) noted that structural impediments and conservative didactic patterns impede the attainment of self-directed learning modes by the students when they are in the teacher-directed learning modes (17,18). Considering the healthcare environment in Pakistan with heavy patient workload, limited resources, and the necessity to make decisions fast, developing SDL competencies capability can contribute to the reduction of the gap between the theoretical and practical aspects of practice (19,22).

Thus, this research is expected to determine the correlation between SDL preparedness and the increment of critical thinking and problem-solving abilities in undergraduate medical and dental students at Gandhara University, Peshawar. The study aims to inform curriculum changes to incorporate SDL in medical and dental training in Pakistan in line with the current educational paradigms and the changing requirement of clinical practice (20,21,25,29).

METHODOLOGY

This cross-sectional study aimed to assess the impact of Self-Directed Learning (SDL) readiness on critical thinking and problem-solving skills among undergraduate medical and dental students at Sardar Begum Dental College and Kabir Medical College, Peshawar. The study population comprised Bachelor of Dental Surgery (BDS) students from first to fourth year and Bachelor of Medicine, Bachelor of Surgery (MBBS) students from first to fifth year. Data was collected using two validated self-administered questionnaires: the Self-Directed Learning Readiness Scale (SDLRS) and the Problem-Solving Inventory (PSI).

The SDLRS (40 items) assesses SDL readiness across three domains: Self-Management, Desire for Learning, and Self-Control and the PSI (35 items) evaluates three dimensions of problem-solving ability: Problem-Solving Confidence, Approach–Avoidance Style, and Personal Control. Both instruments employ a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). These tools were selected due to their well-documented validity and reliability in educational research contexts, particularly in assessing SDL readiness and problem-solving behaviors among health profession students.

Participants included all students enrolled in the MBBS and BDS programs at Gandhara University, Peshawar, who had completed at least one semester and consented to participate.

Students who declined to consent or those with a past of learning difficulties were excluded.

Data collection was conducted during regular scheduled class sessions from January to March 2024, after obtaining approval from the university administration. The study team coordinated with class representatives to ensure maximum participation. Before distributing the questionnaires, participants were briefed about the study objectives, voluntary nature of participation, and assurance of anonymity and confidentiality. Questionnaires were distributed in paper form and collected immediately after completion to ensure a high response rate. Students were given 20–25 minutes to complete both instruments under supervision, with no discussion allowed to maintain response integrity.

Although both the Self-Directed Learning Readiness Scale (SDLRS) and the Problem-Solving Inventory (PSI) possess well-documented psychometric validity and reliability. Therefore, previously reported reliability coefficients were considered. Earlier studies have demonstrated strong internal consistency for both instruments, with Cronbach's alpha values ranging between 0.83–0.89 for the SDLRS (31-33) and 0.78–0.85 for the PSI (6). On the basis of these established values, both tools were deemed reliable for assessing self-directed learning readiness and problem-solving abilities in this study.

A consensus sampling strategy was adopted, including all students who met the inclusion criteria. This method enhanced generalizability by encompassing the entire eligible student population of the MBBS and BDS programs. However, it may introduce non-response bias, as participation was voluntary. Efforts to mitigate this included multiple reminders and flexible scheduling for data collection.

Data was analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics (frequencies, means, and standard deviations) summarized demographic characteristics and scale scores. Pearson's correlation coefficient was employed to examine associations between SDL readiness and problem-solving skills, while multiple regression analysis explored predictive relationships, controlling gender and academic year as potential confounders.

Ethical approval was obtained from the Ethical Review Committee of Gandhara University on November 10, 2023 (GU/Ethical Committee/2023/218). All ethical principles were upheld, ensuring voluntary participation, confidentiality, and data protection.

It is acknowledged that the use of self-reported measures (SDLRS and PSI) introduces potential response bias, such as social desirability and self-perception inaccuracies. However, this limitation was mitigated by ensuring participant anonymity, emphasizing that there were no right or wrong answers, and encouraging honest responses.

Statistical analysis was conducted using IBM SPSS Statistics, version 26.0. Frequency distributions and means represented demographic data, while multiple regression analysis and Pearson's correlation coefficient assessed the relationship between SDL readiness and problem-solving skills. Extrinsic variables, such as academic year and gender, were included to control potential confounding effects.

RESULTS

Participant Characteristics

A total of 820 undergraduate students from Gandhara University, Peshawar, participated in the study, comprising 308 (37.6%) BDS and 512 (62.4%) MBBS students. The mean age was 21.05 ± 2.25 years, with 442 (53.9%) females and 378 (46.1%) males.

Table 1. Participant Distribution by Year and Program

Year of Study	BDS (n, %)	MBBS (n, %)	Total (n, %)
1st Year	77 (25.0)	98 (19.1)	175 (21.3)
2nd Year	76 (24.7)	99 (19.3)	175 (21.3)
3rd Year	78 (25.3)	97 (18.9)	175 (21.3)
4th Year	77 (25.0)	98 (19.1)	175 (21.3)
5th Year	—	120 (23.4)	120 (14.6)
Total	308 (100)	512 (100)	820 (100)

Table 2. Combined Descriptive Statistics for SDLRS and PSI Scores

Variable	Mean ± SD	Interpretation
SDLRS Total	138.95 ± 10.95	Moderate–High Readiness
Self-Management	45.10 ± 6.50	Moderate Readiness
Desire for Learning	45.35 ± 6.45	Moderate Readiness
Self-Control	48.50 ± 6.80	Moderate Readiness
PSI Total	121.85 ± 10.85	Moderate Problem-Solving Ability
Problem-Solving Confidence	13.70 ± 3.50	Average Confidence
Approach-Avoidance Style	17.40 ± 3.80	Balanced Approach
Personal Control	90.75 ± 9.20	Moderate Control

Overall, students demonstrated moderate to high SDL readiness and moderate problem-solving ability. MBBS students scored marginally higher on Self-Management and Desire for Learning, while BDS students showed slightly higher Approach-Avoidance Style scores. However, none of these differences were statistically significant ($p > 0.05$).

Table 3. Correlation and Subgroup Analysis

Variable Pair / Group	Pearson's r	p-value	Interpretation
SDLRS Total – PSI Total (Overall)	–0.072	0.054	Weak, non-significant correlation
SDLRS vs. PSI (Prior SDL Exposure, n=150)	0.152	0.022	Significant positive correlation
SDLRS vs. PSI (No SDL Exposure, n=670)	–0.061	0.071	Weak, non-significant correlation

A weak, negative, and non-significant correlation was observed between total SDLRS and PSI scores ($r = –0.072$, $p = 0.054$), indicating that SDL readiness did not significantly predict problem-solving ability.

However, the subgroup of students with prior SDL experience ($n = 150$) exhibited a positive and significant correlation between SDL readiness and problem-solving skills ($r = 0.152$, $p = 0.022$), suggesting that prior exposure may enhance problem-solving capability.

Table 4. Gender and Year-wise Comparison of SDL Readiness

Group	SDL Total (Mean ± SD)	p-value	Interpretation
Male	138.80 ± 11.10	0.062	Higher Self-Management (ns)
Female	139.10 ± 11.20	0.045	Slightly stronger SDL–PSI correlation (ns)
1st Year	136.85 ± 10.10	—	Baseline level

4th Year	140.05 ± 11.25	0.08	Mild increase (ns)
5th Year	139.90 ± 11.00	0.09	Slight increase (ns)

ns = non-significant (p > 0.05).

Gender-based and year-wise differences were minor.
Male students had slightly higher Self-Management scores (mean difference = 0.25, p = 0.062), while females showed a slightly stronger but non-significant correlation between SDL and PSI (r = –0.065, p = 0.045).

Across academic years, SDL readiness gradually increased, with fourth-year MBBS students (M = 140.05 ± 11.25) scoring higher than first-year students (M = 136.85 ± 10.10), but this trend was not statistically significant (p = 0.08).

Table 5: Summary of Key Findings

Finding	Statistical Outcome	Interpretation
Overall SDL readiness	Moderate to high (M = 138.95 ± 10.95)	Students display adequate readiness for SDL.
SDL vs. PSI (overall)	r = –0.072, p = 0.054	Weak, non-significant correlation.
Prior SDL exposure subgroup	r = 0.152, p = 0.022	Significant positive association.
Gender and year differences	All p > 0.05	No significant differences.

In summary, both MBBS and BDS students demonstrated moderate to high readiness for self-directed learning and moderate problem-solving abilities.
While no significant differences were observed by gender or academic year, a positive effect of prior SDL exposure was evident, implying that students who have engaged with SDL previously develop better problem-solving confidence and adaptability.
These results suggest that SDL alone may not strongly influence problem-solving but its effectiveness can increase with earlier and structured exposure.

DISCUSSION

This study examined the association between SDL readiness and problem-solving skills among undergraduate medical and dental students at Gandhara University. Although students demonstrated moderate to high readiness, the correlation between SDL and problem-solving was weak and statistically non-significant.

While students demonstrated moderate to high SDL readiness, the weak and statistically non-significant correlation between SDL and problem-solving indicates that being ready for SDL does not necessarily equate to enhanced cognitive or analytical performance, a finding consistent with Alradini et al. (24). This suggests that SDL readiness may represent motivational preparedness rather than actual problem-solving competence.

SDL encourages autonomy, motivation, and responsibility for learning (25,26). However, effective problem-solving requires integration of these attributes with higher-order cognitive processing (27,28). As Ten Cate and Scheele (22) emphasized, competence is best developed when self-directed efforts are combined with structured clinical experiences and guided mentorship. Thus, SDL may be viewed as a foundation for learning rather than a direct determinant of performance outcomes (29).

The moderate SDL readiness observed in this cohort aligns with findings from studies within similar educational contexts, which indicate that while students are aware of SDL principles, engagement remains limited by institutional and cultural factors (29–31). Mehboob and Yasmin et al. noted that hierarchical teaching methods and exam-oriented curricula in Pakistan often inhibit genuine self-directed learning. Such barriers may explain why SDL readiness does not always result in improved problem-solving skills (21,32). Furthermore, students may recognize the value of SDL but struggle to transfer it into clinical reasoning tasks due to limited opportunities for feedback, assessment systems emphasizing recall over reasoning, and lack of early exposure to structured SDL sessions challenges also highlighted by Mehboob and Yasmin et al.

A gradual increase in SDL readiness across academic years although statistically insignificant was also observed, mirroring results reported by Premkumar et al. (33) and

Dhedhi et al. (34). This trend may reflect increasing student autonomy and exposure to clinical practice. Nevertheless, if medical curricula continue to prioritize rote memorization and summative assessment, development of higher-order reasoning will remain restricted (29,35,36).

No significant gender differences in SDL readiness were noted, consistent with previous findings among Pakistani medical students. Minor variations in subscales, such as higher self-management among males and slightly stronger SDL–problem-solving correlation among females, likely represent differing learning styles rather than inherent ability differences (37).

A notable finding was that students with prior exposure to SDL showed a significant positive correlation between SDL readiness and problem-solving ability. This suggests that sustained and structured practice of SDL fosters analytical and decision-making competencies. Durrani et al. (11) and Kiran and Hema (38)similarly reported that repeated engagement with SDL enhances reflective thinking and clinical reasoning. Patra et al further demonstrated that intentionally structured SDL modules can strengthen motivation and independent learning capacity (8). Unlike Durrani et al., who observed a strong positive correlation after a structured intervention, our study suggests that unstructured or inconsistent SDL exposure may not yield measurable gains in problem-solving ability. This contrast underscores the importance of curricular scaffolding.

From a theoretical perspective, SDL readiness prepares students to regulate their own learning, but the application of this readiness to problem-solving depends on how well SDL strategies are scaffolded within the curriculum (39–42). Vosniadou (39) emphasized that self-regulated learning bridges the gap between surface learning and deep cognitive processing, while Cutrer et al (43) described structured educational strategies as essential for developing clinical reasoning skills. Therefore, SDL should not be implemented in isolation but integrated into problem-based and simulation-based pedagogies that encourage practical application and reflection.

The findings also highlight cultural and systemic challenges within Pakistani medical education that hinder effective SDL implementation. As noted by Yasmin et al. (21) and Mehboob (20), teacher-centered instruction, rigid hierarchies, and lack of institutional support reduce students' ability to take initiative in their learning. These barriers necessitate localized strategies for integrating SDL into existing frameworks. To address these contextual challenges, faculty development initiatives should equip educators with SDL facilitation skills, SDL modules should be embedded early in the curriculum, and assessments should reward reflection and reasoning through portfolio- or case-based evaluations.

Using an SDL approach combined with structured and experiential learning may help to increase its efficiency. Patra et al. (10) discovered that the integration of SDL in the interactive and student-centered modules increased motivation and cognitive interest in medical students(8). On the same note, Atta and Alghamdi (43) established that SDL when combined with problem-based learning (PBL) is more effective in teaching concepts than individually applied. These results support the fact that the effectiveness of SDL is related to how it is operationalized in teaching learning strategies rather than student readiness.

The results of this study suggest that SDL readiness among Pakistani medical and dental students is encouraging but does not necessarily predict problem-solving performance. This gap reflects the influence of cultural, pedagogical, and institutional factors. Therefore, medical education in Pakistan should prioritize blended models integrating SDL with guided feedback, contextualized PBL, and reflective practice(8,11,21,44) Such integration can gradually transform learners from passive recipients of knowledge into active, critical problem-solvers, aligning with global trends in competency-based medical education (45).

CONCLUSION

This study highlights the prospective significance of Self-Directed Learning (SDL) as a pedagogical method in medical and dental education, given that the majority of students exhibited moderate to high levels of SDL readiness. The found modest connection between SDL preparedness and problem-solving skills indicates that SDL alone may not adequately improve cognitive function. Consequently, although self-directed learning (SDL) can enhance learner autonomy and reflective thinking, its efficacy may be augmented when integrated with supplementary instructional methodologies, including problem-based learning, simulation-based learning, and culturally contextualized case-based teaching pertinent to the Pakistani

healthcare system. Furthermore, the early and continuous incorporation of SDL across the curriculum may enhance the development of problem-solving and critical thinking skills. Future longitudinal and multicentric research are advised to investigate the enduring effects of SDL and to discern contextual and cultural aspects that affect its efficacy.

Overall, self-directed learning (SDL) readiness showed a weak and non-significant association with problem-solving ability among undergraduate medical and dental students. However, students who had prior exposure to SDL demonstrated a small but statistically significant positive correlation between SDL readiness and problem-solving skills. These findings suggest that simply being ready for SDL may not translate into enhanced problem-solving unless learners are provided structured and sustained opportunities to practice SDL within the curriculum

STUDY LIMITATIONS

This study's cross-sectional design limits its ability to establish causality between SDL readiness and cognitive skill development. Additionally, self-reported measures may not fully reflect actual SDL readiness or problem-solving abilities. The single site setting also restricts the generalizability of findings. The use of self-generated data may also be problematic since the students' self-estimations of the SDL readiness and problem-solving skills may differ from the actual levels. Moreover, the study was conducted in a single setting limiting the generalizability of the results.

REFERENCES

1. Frenk J, Chen L, Bhutta ZA, Cohen J, Crisp N, Evans T, et al. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. Lancet [Internet]. 2010 Dec 4 [cited 2025 Oct 7];376(9756):1923–58. Available from: https://pubmed.ncbi.nlm.nih.gov/21112623/

2. Harden RM. Ten key features of the future medical school-not an impossible dream. Med Teach [Internet]. 2018 Oct 3 [cited 2025 Oct 7];40(10):1010–5. Available from: https://pubmed.ncbi.nlm.nih.gov/30326759/

3. Spencer JA, Jordan RK. Learner centred approaches in medical education. BMJ [Internet]. 1999 May 8 [cited 2025 Oct 7];318(7193):1280–3. Available from: https://pubmed.ncbi.nlm.nih.gov/10231266/

4. Dolmans DHJM, De Grave W, Wolfhagen IHAP, Van Der Vleuten CPM. Problem-based learning: future challenges for educational practice and research. Med Educ [Internet]. 2005 Jul [cited 2025 Oct 7];39(7):732–41. Available from: https://pubmed.ncbi.nlm.nih.gov/15960794/

5. Aulakh J, Wahab H, Richards C, Bidaisee S, Ramdass PVAK. Self-directed learning versus traditional didactic learning in undergraduate medical education: a systemic review and meta-analysis. BMC Med Educ [Internet]. 2025 Dec 1 [cited 2025 Oct 7];25(1):1–10. Available from: https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-024-06449-0

6. Murad MH, Coto-Yglesias F, Varkey P, Prokop LJ, Murad AL. The effectiveness of self-directed learning in health professions education: a systematic review. Med Educ [Internet]. 2010 Nov [cited 2025 Oct 7];44(11):1057–68. Available from: https://pubmed.ncbi.nlm.nih.gov/20946476/

7. Knowles, M. S. (1975). Self-Directed Learning A Guide for Learners and Teachers. New York Cambridge Books. - References - Scientific Research Publishing [Internet]. [cited 2025 Oct 7]. Available from: https://www.scirp.org/reference/referencespapers?referenceid=2898453

8. Patra S, Khan A, Upadhyay M, Sharma R, Rajoura O, Bhasin S. Module to facilitate self-directed learning among medical undergraduates: Development and implementation. J Educ Health Promot [Internet]. 2020 Sep 1 [cited 2025 Oct 7];9(1). Available from: https://journals.lww.com/jehp/fulltext/2020/09000/module_to_facilitate_self_directed_learning_among.230.aspx

9. Premkumar K, Vinod E, Sathishkumar S, Pulimood AB, Umaefulam V, Prasanna Samuel P, et al. Self-directed learning readiness of Indian medical

students: A mixed method study. BMC Med Educ. 2018;18(1):1–10.

10. Atta IS, Alghamdi AH. The efficacy of self-directed learning versus problem-based learning for teaching and learning ophthalmology: a comparative study. Adv Med Educ Pract [Internet]. 2018 [cited 2025 Oct 7];9:623–30. Available from: https://pubmed.ncbi.nlm.nih.gov/30233269/

11. Durrani SF, Yousuf N, Ali R, Musharraf FF, Hameed A, Raza HA. Effectiveness of spaced repetition for clinical problem solving amongst undergraduate medical students studying paediatrics in Pakistan. BMC Med Educ [Internet]. 2024 Dec 1 [cited 2025 Oct 7];24(1):1–8. Available from: https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-024-05479-y

12. Alradini F, Ahmad N, Kahloon LE, Javaid A, Al Zamil N. Measuring Readiness for Self-Directed Learning in Medical Undergraduates. Adv Med Educ Pract [Internet]. 2022 [cited 2025 Oct 7];13:449–55. Available from: https://pubmed.ncbi.nlm.nih.gov/35547868/

13. Shah A, Muhammad A, Rahat R, Abdul A, Malak Y, Ullah S, et al. The Effect of Self-Directed Learning Abilities of Nursing Students on Their Success in Swat and Pak-Swiss Colleges of Nursing, Swat. medtigo Journal of Medicine [Internet]. 2025 Apr 4 [cited 2025 Oct 7];3(2). Available from: https://journal.medtigo.com/the-effect-of-self-directed-learning-abilities-of-nursing-students-on-their-success-in-swat-and-pak-swiss-colleges-of-nursing-swat/

14. Harasym PH, Tsai TC, Hemmati P. Current trends in developing medical students' critical thinking abilities. Kaohsiung J Med Sci [Internet]. 2008 [cited 2025 Oct 7];24(7):341–55. Available from: https://pubmed.ncbi.nlm.nih.gov/18805749/

15. Chambers DW. Lessons from Students in a Critical Thinking Course: A Case for the Third Pedagogy. J Dent Educ. 2009 Jan;73(1):65–82.

16. Reji R K, Sushma K Saini. Critical Thinking and Decision Making: Essential Skills in Nursing. International Journal of Research in Pharmaceutical Sciences. 2022 Mar 21;13(1):61–7.

17. Epstein RM, Hundert EM. Defining and assessing professional competence. JAMA [Internet]. 2002 Jan 9 [cited 2025 Oct 7];287(2):226–35. Available from: https://www.researchgate.net/publication/298348201_Defining_and_Assessing_Professional_Competence

18. Cutrer WB, Sullivan WM, Fleming AE. Educational strategies for improving clinical reasoning. Curr Probl Pediatr Adolesc Health Care [Internet]. 2013 [cited 2025 Oct 7];43(9):248–57. Available from: https://pubmed.ncbi.nlm.nih.gov/24070582/

19. Ten Cate O, Scheele F, Ten Cate TJ. Viewpoint: Competency-based postgraduate training: Can we bridge the gap between theory and clinical practice? Academic Medicine. 2007;82(6):542–7.

20. Mehboob M. The spectrum of Self-directed learning perceptions among faculty members and students of Bolan University of Medical and Health Sciences. Pak J Med Sci. 2022;38(7):1780–7.

21. Yasmin M, Naseem F, Masso IC. Teacher-directed learning to self-directed learning transition barriers in Pakistan. Studies in Educational Evaluation. 2019 Jun 1;61:34–40.

22. Nasri N, Xu W, Jamaludin KA, Mohamad Nasri N. Socio-culturally responsive medical professionalism and ethics education: A curriculum co-creation approach. Med Educ Online [Internet]. 2024 Dec 31 [cited 2025 Oct 7];29(1). Available from: https://www.tandfonline.com/doi/pdf/10.1080/10872981.2024.2303209

23. Yasmin M, Naseem F, Masso IC. Teacher-directed learning to self-directed learning transition barriers in Pakistan. Studies in Educational Evaluation. 2019 Jun 1;61:34–40.

24. Alradini F, Ahmad N, Kahloon LE, Javaid A, Al Zamil N. Measuring Readiness for Self-Directed Learning in Medical Undergraduates. Adv Med

Educ Pract [Internet]. 2022 [cited 2024 Aug 31];13:449–55. Available from: https://doi.org/10.2147/AMEP.S360333

25. SELF-DIRECTED LEARNING: A GUIDE FOR LEARNERS AND TEACHERS Malcol m Knowles New York: Association Press, 1975. 135 pp., paperbound. Group & Organization Studies [Internet]. 1977 Jun [cited 2025 Oct 7];2(2):256–7. Available from: /doi/pdf/10.1177/105960117700200220?download=true

26. Knowles MS, Holton III EF, Swanson RA. The Adult Learner : The definitive classic in adult education and human resource development. 2014 Dec 5 [cited 2025 Oct 7]; Available from: https://www.taylorfrancis.com/books/mono/10.4324/9781315816951/adult-learner-malcolm-knowles-elwood-holton-iii-richard-swanson

27. Cutrer WB, Sullivan WM, Fleming AE. Educational Strategies for Improving Clinical Reasoning. Curr Probl Pediatr Adolesc Health Care [Internet]. 2013 Oct 1 [cited 2025 Oct 7];43(9):248–57. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1538544213000941?via%3Dihub

28. Harasym PH, Tsai TC, Hemmati P. Current Trends in Developing Medical Students' Critical Thinking Abilities. Kaohsiung J Med Sci [Internet]. 2008 Jul 1 [cited 2025 Oct 7];24(7):341–55. Available from: /doi/pdf/10.1016/S1607-551X%2808%2970131-1

29. Ten Cate O, Scheele F, Ten Cate TJ. Viewpoint: Competency-based postgraduate training: Can we bridge the gap between theory and clinical practice? Academic Medicine [Internet]. 2007 [cited 2025 Oct 7];82(6):542–7. Available from: https://journals.lww.com/academicmedicine/fulltext/2007/06000/viewpoint__competency_based_postgraduate_training_.4.aspx

30. JPMA - Journal Of Pakistan Medical Association [Internet]. [cited 2025 Oct 7]. Available from: https://www.archive.jpma.org.pk/article-details/8833

31. Alradini F, Ahmad N, Kahloon LE, Javaid A, Al Zamil N. Measuring Readiness for Self-Directed Learning in Medical Undergraduates. Adv Med Educ Pract [Internet]. 2022 May 5 [cited 2025 Oct 7];13:449–55. Available from: https://www.dovepress.com/measuring-readiness-for-self-directed-learning-in-medical-undergraduat-peer-reviewed-fulltext-article-AMEP

32. Mehboob M. The spectrum of Self-directed learning perceptions among faculty members and students of Bolan University of Medical and Health Sciences. Pak J Med Sci [Internet]. 2022 Aug 30 [cited 2025 Oct 7];38(7):1780–7. Available from: https://www.pjms.org.pk/index.php/pjms/article/view/6517

33. Premkumar K, Vinod E, Sathishkumar S, Pulimood AB, Umaefulam V, Prasanna Samuel P, et al. Self-directed learning readiness of Indian medical students: A mixed method study. BMC Med Educ [Internet]. 2018 Jun 8 [cited 2025 Oct 7];18(1):1–10. Available from: https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-018-1244-9

34. Dhedhi NA, Ahmed F, Rabbani B, Naqvi SMZH. Self-Directed Learning And Approach To Seeking Medical Evidence: Perceptions Of Students From A Private Medical University Of Karachi. J Pak Med Assoc [Internet]. 2023 Sep 1 [cited 2025 Oct 7];73(9):1821–6. Available from: https://pubmed.ncbi.nlm.nih.gov/37817691/

35. Cooke Molly, Irby DM., O'Brien BC. Educating Physicians: A Call for Reform of Medical School and Residency. J Chiropr Educ [Internet]. 2011 [cited 2025 Oct 7];25(2):193. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC3204956/

36. Han ER, Yeo S, Kim MJ, Lee YH, Park KH, Roh H. Medical education trends for future physicians in the era of advanced technology and artificial intelligence: An integrative review. BMC Med Educ [Internet]. 2019 Dec 11 [cited 2025 Oct 7];19(1):1–15. Available from: https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-019-1891-5

37. Ali FA, Ata M, Azam F, Shaheen A. Equity, diversity, and inclusion in medical education in Pakistan:

Navigating a complex landscape. MedEdPublish. 2023 Dec 14;13:309.

38. Kiran M, Hema NG, Kiran M, Hema NG. Perspectives of medical undergraduate students toward self-directed learning. Indian J Physiol Pharmacol [Internet]. 2024 Jul 1 [cited 2025 Oct 7];68(2):176–80. Available from: https://ijpp.com/perspectives-of-medical-undergraduate-students-toward-self-directed-learning/

39. Vosniadou S, Bodner E, Stephenson H, Jeffries D, Lawson MJ, Darmawan IgN, et al. The promotion of self-regulated learning in the classroom: a theoretical framework and an observation study. Metacogn Learn [Internet]. 2024 Apr 1 [cited 2025 Oct 7];19(1):381–419. Available from: https://www.researchgate.net/publication/377778723_The_promotion_of_self-regulated_learning_in_the_classroom_a_theoretical_framework_and_an_observation_study

40. Zafar O. Self-Directed Learning versus Traditional Learning in Clinical Setting: A Study at Armed Forces Institute of Ophthalmology. Pakistan Armed Forces Medical Journal. 2023 Aug 1;73(4):1212–5.

41. Khan EH, Sethi A, Junaid SM, Khattak T, Khattak M. Readiness for self-directed learning among undergraduate medical students in Khyber Pakhtunkhwa during COVID-19, Pakistan. BMC Med Educ [Internet]. 2025 Dec 1 [cited 2025 Oct 7];25(1):1–12. Available from: https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-025-06745-3

42. Mahmood A, Rehman N, Huang X, Riaz I. Barriers to undergraduate medical students' research engagement in Pakistan: a qualitative exploration. BMC Med Educ [Internet]. 2025 Dec 1 [cited 2025 Oct 7];25(1). Available from: https://www.researchgate.net/publication/391046966_Barriers_to_undergraduate_medical_students'_research_engagement_in_Pakistan_a_qualitative_exploration

43. Cutrer WB, Miller B, Pusic M V., Mejicano G, Mangrulkar RS, Gruppen LD, et al. Fostering the Development of Master Adaptive Learners: A Conceptual Model to Guide Skill Acquisition in Medical Education. Acad Med [Internet]. 2017 Jan 1 [cited 2025 Oct 7];92(1):70–5. Available from: https://pubmed.ncbi.nlm.nih.gov/27532867/

44. Premkumar K, Vinod E, Sathishkumar S, Pulimood AB, Umaefulam V, Prasanna Samuel P, et al. Self-directed learning readiness of Indian medical students: A mixed method study. BMC Med Educ [Internet]. 2018 Jun 8 [cited 2025 Oct 7];18(1):1–10. Available from: https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-018-1244-9

45. (PDF) Student's opinion regarding teaching methods: A survey amongst MBBS and BDS students of a private Medical University in Karachi [Internet]. [cited 2025 Oct 7]. Available from: https://www.researchgate.net/publication/326840447_Student's_opinion_regarding_teaching_methods_A_survey_amongst_MBBS_and_BDS_students_of_a_private_Medical_University_in_Karachi