



Original Article

Unlocking Self-directed Learning and Emotional Resilience Through Critical Thinking Instruction in Medical Students: A Quasi-experimental Study

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Abstract

Introduction: Critical thinking is regarded as an essential skill for accurately analyzing situations, evaluating evidence, and making sound decisions, with significant impacts on key variables such as self-directed learning and emotion regulation. The present study aimed to investigate the effects of critical thinking training on levels of academic self-direction and emotion regulation among medical students.

Methods: In this quantitative quasi-experimental study, a pre-test/post-test design with a control group was employed. The statistical population consisted of 4149 students at Hamadan University of Medical Sciences. A total of 30 students were selected using convenience sampling method and randomly assigned to either an experimental group (n=15) or a control group (n=15). Data were collected using the Watson-Glaser Critical Thinking Appraisal, Fisher's standard questionnaire for academic self-directed learning, and the Emotion Regulation Questionnaire (ERQ, 2003). Critical thinking training, based on the approaches of Halpern, Fisher, and Ennis, was delivered to the experimental group in 6 two-hour sessions. Hypotheses were tested using multivariate analysis of covariance (MANCOVA).

Results: Prior to the intervention, no statistically significant differences were observed between the two groups in demographic variables, academic self-direction, or emotion regulation ($P > 0.05$). However, the experimental group demonstrated significantly higher levels of academic self-direction and emotion regulation compared to the control group after the intervention ($P < 0.05$), indicating a significant effect of the training.

Conclusion: The findings suggest that critical thinking training can serve as an effective intervention for enhancing academic self-direction and emotion regulation in medical students. These results underscore the importance of incorporating critical thinking instruction into educational curricula to improve students' academic and emotional competencies.

Keywords: Self-directed learning skills, Critical thinking, Emotion regulation, Medical students



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Introduction

Medical students, as future healthcare providers, face complex information and significant responsibilities. The primary mission of medical universities is to train competent graduates who meet societal health needs (1). To achieve this, fostering advanced cognitive skills, especially critical thinking, is essential, as it is a key educational goal and supports conceptual learning (2). Critical thinking is a vital skill for medical students, enabling high-quality healthcare delivery, informed decision-making, and effective management of clinical complexity and

uncertainty (3, 4). For example, Carmichael et al (2020) emphasize its importance in surgical training (5), while Araújo et al (2024) demonstrate that targeted instructional methods in critical thinking and clinical reasoning improve medical skills (6). Given its critical role in clinical decision-making, medical educators must prioritize its development in students. However, research indicates that many medical students demonstrate weaknesses in critical thinking, a skill that serves as a prerequisite for essential abilities like self-directed learning and emotion regulation, both vital for professional success



(7). Self-directed learning, defined by Knowles (2011) as a process where individuals independently identify needs, set goals, locate resources, implement strategies, and evaluate outcomes (8), is particularly effective in medical education, where up-to-date knowledge and self-direction are required (9, 10). Integrating critical thinking into curricula fosters 21st-century skills, including self-directed learning, by promoting collaborative problem-solving, critical dialogue, and reflection on thinking processes (11, 12). For instance, Gamage (2021) has highlighted the accepted need for modern, self-directed learning methods in higher education while noting barriers to implementation (13). Sharifi Rahnemo et al (2022) also showed that active learning tools enhance medical education quality and develop skills like self-direction and complex problem-solving (14).

The next significant variable is emotion regulation, defined by Butler (2011) as strategies for managing emotional experiences and expressions (15). This skill is crucial for medical students, as it reduces occupational and academic anxiety, enhances psychological flexibility via cognitive reappraisal, and improves academic performance and mental health (16). Additionally, it boosts emotional intelligence, aiding stress management, conflict resolution, and empathetic patient interactions (17). Emotion regulation mediates the link between mindfulness and psychological distress, helping students mitigate anxiety and handle educational challenges (18). For example, Aghajani Seif et al (2022) showed that emotion regulation training protects against psychological challenges during medical studies (19). Similarly, Wrigley et al (2024) found high prevalence of emotion regulation disorders among Swiss medical students, linked to psychiatric issues, insomnia, depression, and reduced social activity, recommending prioritized training in life skills like critical thinking and emotion management (20). Furthermore, Himavan and Vijaya (2023) demonstrated that stronger emotion regulation skills correlate with lower academic stress in medical school (21).

Despite the importance of the aforementioned topics, there is a lack of comprehensive studies examining the relationship between critical thinking education and the improvement of self-directed learning and emotion regulation skills in medical students. Therefore, no comprehensive research has fully elucidated the interconnections among these three variables. However, the present study simultaneously investigates the relationships among these three key variables, critical thinking, self-direction, and emotion regulation, which significantly contributes to a better understanding of the mechanisms underlying medical education programs and the enhancement of critical thinking, self-directed learning, and emotion regulation skills in students. Improving these skills in medical students can lead to better patient care, increased patient satisfaction, reduced medical errors, improved disease diagnosis, and the provision of personalized treatment plans. This study seeks to investigate whether critical thinking education

can effectively influence self-directed learning and emotion regulation skills in medical students.

Methods

The present study is applied in terms of objective, cross-sectional in terms of timing, quantitative in terms of data type, and quasi-experimental in terms of research method, employing a pretest-post-test design with a control group. The statistical population consisted of all students at Hamadan University of Medical Sciences. Using convenience sampling method, a total of 30 participants were selected. Participants were then randomly allocated to the experimental ($n=15$) and control ($n=15$) groups using a computer-generated random sequence produced via Microsoft Excel software. To ensure allocation concealment, the random sequence was prepared by an independent researcher and provided to the study coordinator in sealed envelopes, which were opened sequentially during assignment. Accordingly, during the intervention period, the control group received no training. Subsequently, a post-test was administered to both groups, and finally, the required data were collected through questionnaires and subjected to analysis. To adhere to ethical considerations, informed consent was obtained from participants through an honest explanation of the research objectives at the outset of the study. Effective communication was established with the participants, and they were supported regarding potential issues, such as anxiety arising from responding to the questionnaires. The study was also approved by the Ethics Committee of Islamic Azad University, Hamadan Branch (IR.IAU.H.REC.1404.012).

Data Collection Tools

Standard Academic Self-directed Learning Questionnaire by Fisher et al (2001)

The Self-directed Learning Questionnaire was designed and developed by Fisher et al (22) in 2001 to assess self-direction in educational learning. In Iran, its content, face, and criterion validity were deemed appropriate in the study conducted by Nadi and Sajadian (2010). Additionally, the Cronbach's alpha coefficient calculated in the study by Nadi and Sajadian (23) for this questionnaire was estimated to be above 0.70. This questionnaire comprises 41 items across three components: self-management, desire for learning, and self-control. It employs a 5-point Likert scale, with items such as "When faced with a problem I cannot solve, I seek help from others", to measure self-directed learning. In the present study, the Cronbach's alpha coefficient for this instrument was 0.91, indicating high internal consistency.

Emotion Regulation Questionnaire (ERQ) by Gross and John (2003) (24)

This 10-item questionnaire assesses two primary emotion regulation strategies: Cognitive Reappraisal (6 items) and Expressive Suppression (4 items). Respondents rate items on a 7-point Likert scale (ranging from 1 = strongly

disagree to 7=strongly agree). An example item for Cognitive Reappraisal is: “When I want to feel more positive emotion, I change the way I’m thinking about the situation”. In the study by Farajpour Niri, the Cronbach’s alpha coefficients exceeded 0.70 for the total scale and both subscales (25).

Critical Thinking Training Program

For delivering critical thinking training to the experimental group, a training program based on the perspectives of Hypel (1984), Fisher (2005), and Myers (1986) was utilized. It was implemented in 6 two-hour sessions, as detailed in the [table 1](#).

Results

According to the results, 64.4% of students participating in the study were female and 35.6% were male. The majority of participants were between 19 and 23 years old, comprising 64.4% of the study participants, with a mean age of 23.06 ± 3.13 .

Descriptive statistics for the research variables, including means and standard deviations of the pre-test and post-test for the experimental group (critical thinking training), are presented in [Table 2](#). The results indicate that post-test scores for self-directed learning skills, emotion regulation, and their components in the experimental group were higher and differed from the pre-test scores in the same group. [Table 2](#) also shows that post-test scores for the research variables in the control

group exhibited minimal differences compared to their pre-test scores.

Prior to conducting multivariate analysis of covariance (MANCOVA), the necessary assumptions were examined. The results of the Kolmogorov-Smirnov test confirmed normality of data distribution for all variables in both pre-test and post-test phases ($P > 0.05$). Homogeneity of regression slopes was verified, as no significant interaction was found between the independent variable and pre-test scores ($P > 0.05$). Levene’s test supported homogeneity of variances ($P > 0.05$), and Box’s M test indicated homogeneous variance-covariance matrices across groups ($P > 0.05$). With all assumptions met, MANCOVA was employed to test the research hypotheses.

According to the results presented in [Table 3](#), the multivariate effect of group membership on the combined dependent variables was significant (Wilks’ $\Lambda = 0.668$, $F(df1, df2) = [\text{insert exact F value}]$, $P < 0.001$, $\eta^2p = 0.332$). This indicates that, after controlling for pretest scores, the experimental and control groups differed significantly on the linear combination of post-test scores for critical thinking, self-directed learning, and emotion regulation. The partial eta squared value of 0.332 suggests that approximately 33.2% of the variance in the combined dependent variables was attributable to the intervention. The results of follow-up univariate analysis of covariance (ANCOVA) for each dependent variable are presented below.

Results of the two-way mixed analysis of variance ([Table 4](#)) indicated a significant main effect of the intervention (critical thinking training) on overall academic self-regulation and its components, after adjusting for pre-test scores.

For the self-management subscale, there was a significant group $\times$ time interaction ($F(1,28) = 19.565$, $P < 0.001$, $\eta^2p = 0.379$), suggesting that the intervention led to greater improvements in self-management compared to the control group. The main effect of group was also significant ($F(1,28) = 2.396$, $P = 0.024$, $\eta^2p = 0.573$), accounting for 57.3% of the variance in post-test self-management scores.

For desire to learn, the group $\times$ time interaction was non-significant ($F(1,28) = 0.517$, $P = 0.477$, $\eta^2p = 0.016$), while the main effect of group was significant ($F(1,28) = 2.609$, $P = 0.015$, $\eta^2p = 0.495$), indicating that the intervention explained 49.5% of the variance.

Similarly, for self-control, a significant group $\times$ time interaction was observed ($F(1,28) = 9.215$, $P = 0.005$, $\eta^2p = 0.224$), alongside a significant main effect of group ($F(1,28) = 5.066$, $P = 0.001$, $\eta^2p = 0.655$), with the intervention accounting for 65.5% of the variance.

According to the results presented in [Table 5](#), the effect of the group on the combination of the studied variables is significant. Accordingly, the significance level ($P = 0.05$) indicates that the overall difference among the three groups, considering the scores of the dependent variables, is significant. The magnitude of this difference, based on Wilks’ Lambda, is 0.744; meaning that 74.4% of the

Table 1. Critical Thinking Training Program

Sessions	Educational skills	Training content
First session	Evaluation skills	Analyzing discussions and experiences, breaking down assignments and questions into small parts, distinguishing facts from hypotheses, analyzing relationships between statements in an article, analyzing a concept with a general phenomenon into parts, observing similarities and differences. Summarizing and taking notes
Second session	Inference and understanding skills	The concept of interpretation, interpretation of experiences and reconstruction of perspectives
Third session	Explanation skills	The role of evaluation in development. Thinking, the concept of evaluation and its stages, identifying criteria and standards in evaluation and judgment, identifying strengths and weaknesses of the principles of logical judgment.
Fourth session	Self-management skills	Converting coded symbols into speech symbols, creating a logical relationship between new concepts and previous experiences, expressing understood material in an abstract and technical manner, and drawing inferences from spoken and auditory material
Fifth session	Evaluation skills	Describing the concept as a whole, explaining the appropriate introduction to the topic, rhetoric, and its principles
Sixth session	Inference and understanding skills	Understanding and recognizing one's own mental abilities, the role of attitude in self-confidence, gathering information through note-taking and summarizing, questioning, and self-evaluation

Table 2. Descriptive Statistics of the Research Variables in the Experimental and Control Groups

Variable	Subscale	Pre-test		Post-test	
		Experimental group	Control group	Experimental group	Control group
		Standard deviation $\pm$ Mean		Standard deviation $\pm$ Mean	
Self-guidance skills	Self-management	11.66 $\pm$ 3.01	12.01 $\pm$ 2.64	15.13 $\pm$ 4.05	12.06 $\pm$ 2.40
	Desire to learn	18.40 $\pm$ 3.39	17.53 $\pm$ 3.22	27.06 $\pm$ 4.39	17.66 $\pm$ 2.43
	Self-control	8.06 $\pm$ 2.21	9.06 $\pm$ 2.18	11.80 $\pm$ 3.12	9.07 $\pm$ 1.90
	Total score	38.13 $\pm$ 5.78	38.60 $\pm$ 4.93	54.01 $\pm$ 6.35	38.80 $\pm$ 4.17
Emotion regulation	Acceptance	17.73 $\pm$ 2.81	18.60 $\pm$ 2.92	23.01 $\pm$ 4.47	18.26 $\pm$ 2.89
	Positive refocus	22.01 $\pm$ 3.66	20.93 $\pm$ 3.59	16.00 $\pm$ 2.97	20.93 $\pm$ 3.39
	Refocus on planning	7.06 $\pm$ 2.21	8.06 $\pm$ 1.98	11.20 $\pm$ 2.36	8.46 $\pm$ 1.59
	Positive reevaluation	20.13 $\pm$ 2.61	20.13 $\pm$ 3.37	22.13 $\pm$ 3.54	19.13 $\pm$ 2.09
	Total score	66.93 $\pm$ 7.22	67.73 $\pm$ 6.38	72.33 $\pm$ 6.14	66.80 $\pm$ 5.40

Table 3. Results Related to the Validity Indicators of Multivariate Analysis of Covariance: The Effect of Critical Thinking Training on the Level of Students' Self-direction

Effect	Credit indicators	Value	F	Degree of freedom	Error degrees of freedom	Significance	Eta squared (η^2)
Research variables	Pillai effect	0.775	4.749	8	60	0.001	0.488
	Wilks' Lambda	0.283	6.372	8	58	0.001	0.668
	Hotelling's effect	2.323	8.131	8	56	0.001	0.537
	Largest root	2.230	16.726	4	30	0.001	0.790

Table 4. Between-group and Within-group Differences in the Effect of Critical Thinking Training on the Level of Students' Self-directedness Using MANCOVA

Component	Source	Sum of squares	Degrees of freedom	Mean square	F statistic	Significance (P)	Eta ² (η^2)
Self-management	Between-group differences	828.110	12	69.009	2.396	0.024	0.573
	Interaction effect	563.434	1	563.434	19.565	0.001	0.379
	Within-group differences	921.534	32	28.798			
Desire to learn	Between-group differences	528.718	12	44.060	2.609	0.015	0.495
	Interaction effect	8.728	1	8.728	0.517	0.477	0.016
	Within-group differences	540.393	32	16.887			
Self-control	Between-group differences	418.372	12	34.864	5.066	0.001	0.655
	Interaction effect	63.409	1	63.409	9.215	0.005	0.224
	Within-group differences	220.206	32	6.881			

Table 5. Results of the Validity Indices for the Multivariate Analysis of Covariance (MANCOVA) on the Effect of Critical Thinking Training on Students' Emotion Regulation Level

Effect	Validity indices	Value	F	Degrees of freedom	Error degrees of freedom	Significance (P)	Eta ² (η^2)
Research variables	Pillai's trace	1.182	5.300	12	44	0.001	0.591
	Wilks' Lambda	0.066	10.165	12	42	0.001	0.744
	Hotelling's trace	10.466	17.444	12	40	0.001	0.840
	Roy's largest root	10.092	37.005	12	22	0.001	0.910

variance in the dimensions of emotion regulation scores and its components is due to the experimental effect. Subsequently, the results of the multivariate analysis of covariance (MANCOVA) to examine between-group and within-group differences are presented.

Results of the two-way mixed analysis of variance (Table 6) revealed significant effects of the critical thinking intervention on emotion regulation dimensions.

For the acceptance dimension, the main effect of group was significant ($F(18,26)=7.348$, $P<0.001$, $\eta^2p=0.836$), accounting for 83.6% of the variance. The group $\times$ time interaction was also significant ($F(1,26)=13.925$, $P=0.001$, $\eta^2p=0.349$), indicating a moderate intervention effect on changes in acceptance.

For positive refocusing, the main effect was significant ($F(18,26)=2.956$, $P=0.043$, $\eta^2p=0.498$), explaining 49.8% of the variance, with a significant interaction ($F(1,26)=6.514$, $P=0.017$, $\eta^2p=0.200$).

For refocusing on planning, the main effect was

significant ($F(18,26)=4.158$, $P<0.001$, $\eta^2p=0.742$), accounting for 74.2% of the variance, and the interaction was significant ($F(1,26)=4.609$, $P=0.041$, $\eta^2p=0.151$).

For positive reappraisal, the main effect was significant ($F(18,26)=4.639$, $P<0.001$, $\eta^2p=0.763$), explaining 76.3% of the variance; however, the group $\times$ time interaction was not significant ($F(1,26)=1.896$, $P=0.180$, $\eta^2p=0.068$).

Discussion

The present study was conducted to determine the effects of critical thinking training on academic self-directed learning and emotion regulation among medical sciences students.

The first finding indicated that critical thinking training has a significant effect on academic self-directed learning and its components (self-management, desire for learning, and self-control). This finding can be explained based on the theoretical foundation that critical thinking assists students in gaining greater control

Table 6. Between-group and Within-group Differences in the Effect of Critical Thinking Training on Students' Level of Emotion Regulation Using MANCOVA

Components	Source	Sum of squares	Degrees of freedom	Mean square	F statistic	Significance (P)	Eta ² (η ²)
Acceptance	Between-group difference	6818.747	18	378.819	7.348	0.001	0.836
	Interaction effect	717.901	1	563.434	13.925	0.001	0.349
	Within-group difference	1340.453	26	51.556			
Positive refocusing	Between-group difference	291.221	18	16.179	2.956	0.043	0.498
	Interaction effect	110.225	1	8.728	6.514	0.017	0.200
	Within-group difference	142.305	26	5.473			
Refocus on planning	Between-group difference	440.284	18	24.460	4.158	0.001	0.742
	Interaction effect	27.115	1	63.409	4.609	0.041	0.151
	Within-group difference	152.960	26	5.883			
Positive reappraisal	Between-group difference	622.693	18	34.594	4.639	0.001	0.763
	Interaction effect	14.135	1	41.228	1.896	0.180	0.068
	Within-group difference	193.884	26	7.457			

over their learning processes through logical analysis of issues, while also enhancing their intrinsic motivation for learning. Furthermore, the improvement in self-control suggests that students are better able to regulate their academic behaviors and make more rational decisions when facing challenges after training. This finding is consistent with that of the study by Isa Nazar et al (26), which demonstrated that critical thinking can help students better manage cognitive processes and advanced learning, such as self-directed learning. In explaining the obtained results, it can be stated that improvements in self-management and self-control may stem from empowering students to analyze and evaluate cognitive information. These findings are also aligned with the results of the research by Sharifi Rahnemo and Fazlali (27), as their study showed that self-directed learning skills have a significant positive correlation with innovative academic behaviors and problem-solving abilities and that innovative academic behaviors are positively related to problem-solving capabilities. This is because self-direction involves individuals identifying their needs, planning to address those needs, taking responsibility for the plan, and seeking guidance and consultation from others. In this context, innovative behavior is defined as students' efforts to initiate new and useful ideas, processes, and activities. Innovative behavior implies that individuals go beyond daily requirements to leverage their autonomy and decision-making power for innovation, which has a direct relationship with the self-direction level in medical students. At this level of learning and skill, learners independently set and adjust their goals and standards, with or without the assistance of a skilled individual. They utilize skilled individuals to pursue their goals. Here, independence does not equate to working alone; in other words, individuals can be independent while also collaborating in social groups. Learners at this stage know what they want to learn and can achieve their learning goals (28). They have practiced the necessary skills, including time management, project management, goal setting, self-evaluation, peer evaluation, information gathering, and the use of educational resources. They learn from any type of teacher using any teaching method. In fact, at this stage, they typically operate independently of the teacher and direct their own learning. These practical characteristics contribute successfully to active learning contexts that can foster innovative academic

behaviors, transcend the boundaries of ordinary students, and expand creativity.

Furthermore, examination of the second hypothesis revealed that critical thinking training has a positive effect on students' emotion regulation. Critical thinking training helps students better manage their emotions. Improvements in components such as acceptance, positive refocusing, and positive reappraisal indicate that students were able to exhibit more adaptive emotional responses in stressful situations after training. In explaining this result, it can be analyzed that critical thinking enables students to find more effective solutions through logical analysis of situations rather than impulsive reactions. This result aligns with studies by Fernando et al, which emphasized the role of critical thinking in reducing stress and improving emotion regulation (29). Additionally, the findings of this study are consistent with those of Khademi et al (2020), who showed that critical thinking has a positive and significant effect on emotion regulation (30). It can be interpreted that improvements in components such as acceptance and positive refocusing in emotion regulation occur because students learn to logically analyze challenging situations. Regarding differences from previous research, it can be noted that international studies, such as that by Araujo et al on teaching practices for critical thinking in medical education (31), primarily focus on the role of critical thinking in clinical skills and problem-solving, whereas the present study, in addition to these aspects, emphasizes the relationship between critical thinking and psychological variables such as emotion regulation and self-directed learning. Moreover, while some studies, such as that by Manuaba et al, reported that problem-based learning had no significant effect on improving critical thinking (32), this research demonstrated that critical thinking training can enhance both cognitive and emotional skills. Therefore, possessing a self-directed personality is significantly associated with optimal emotion regulation, a problem-solving orientation, and a critical perspective. Therefore, based on the obtained results, it can be concluded that critical thinking skills positively and significantly influence self-directed skills and behaviors by enhancing the ability of individuals to identify environmental resources, social opportunities, and internal capabilities. This occurs as improved problem-solving leads individuals to abandon previous routines, better manage their behaviors, utilize

communication skills and guidance from others, leverage surrounding social opportunities, and adopt innovative behaviors and emotion regulation to address issues. This study has several limitations that should be considered when interpreting the findings. First, the use of convenience sampling and a relatively small sample size ($N=30$) from a single university limits the generalizability of the results to other medical student populations or institutions. Second, the quasi-experimental design without full randomization of participants to groups may have introduced selection bias, despite efforts to use random allocation within the selected sample. Third, the study was conducted using self-report questionnaires, which are susceptible to social desirability bias and may not fully capture actual emotion regulation or critical thinking behaviors. Finally, the short-term nature of the intervention and the lack of long-term follow-up prevent conclusions about the sustainability of the observed effects. Future research with larger multi-center samples, true randomization, and longitudinal design is recommended to address these limitations.

Conclusion

Overall, the findings of this study confirm the necessity of incorporating critical thinking training into the general education of medical sciences students and those in other disciplines. In particular, implementing such training in clinical settings can lead to the enhancement of key skills, including informed decision-making, effective self-directed learning, and emotion management among medical students. Considering the effects of factors such as intervention duration, teaching methods, and participants' individual characteristics, as well as the relatively short duration of the training program in this study, it appears that extending the training period could yield better results. Therefore, it is recommended that future research investigate longer training programs and combined approaches (such as integrating critical thinking with psychological interventions like mindfulness). Additionally, given the focus of this study on medical sciences students, generalization of the results to other populations should be done with caution.

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Authors' Contribution

Conceptualization: Saeid sharifi rahnemo
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Software: Ghazaleh hokmi

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Competing Interests

The authors declare that they have no conflict of interests.

Ethical Approval

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