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Trend of tendency to critical thinking among medical students in Tehran University of Medical Sciences, 2010–2015: A longitudinal study

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Abstract:

BACKGROUND: Critical thinking is one of the goals of education. It is a criterion for academic accreditation in medical education by concentration on students' soft skills. Due to lack of basic information on critical thinking tendency in undergraduate medical program, this study aimed to determine the trend of tendency toward critical thinking of medical students in two phases: basic science (year 1) and preinternship (year 5) at Tehran University of Medical Sciences.

MATERIALS AND METHODS: This longitudinal descriptive–analytic study has been conducted in two phases (2010 and 2015); all 105 medical students were selected by accessible sampling method. Years of entrance to college was the inclusion criterion. The psychometric properties of The California Critical Thinking Dispositions Inventory (CCTDI) were confirmed, and then, the instrument was completed twice by participants. Data were analyzed by SPSS: 16 using student t-test, and paired t-tests.

RESULTS: There was a significant difference between genders of students ($P < 0.05$). Males were more disposed toward critical thinking than females. The significant increase was found between mean of truth-seeking in the second test compared to the first test; instead, the mean of inquisitiveness, analyticity and self-confidence and inquisitiveness was significantly decreased ($P < 0.05$). However, in other subscales, there were no significant differences between the 1st and the 5th year students ($P > 0.05$). The total score of the test in the second phase was lower than the first phase, which was not significant.

CONCLUSION: According to the findings, there is necessary to consider the critical thinking dispositions in medical students training programs and break down the barriers. Tendency toward critical thinking seems to be as prerequisite of critical thinking skills in undergraduate medical program.

Keywords:

California critical thinking dispositions inventory, critical thinking, longitudinal, medical student

Introduction

Critical thinking promotion of university students has been regarded as one of the purposes of higher education, especially in medical sciences. It is also one of the crucial elements of universities' accreditation criteria, which seems to be more important in medical sciences education that faces

to uncertain and stressful atmosphere of clinical situations.^[1]

Critical thinking skills and attitude have been paid more attention in medical sciences. Healthcare is an uncertain domain and prone to diagnostic and management errors.^[2] Improving the diagnostic skills and critical thinking abilities of physicians

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in undergraduate and postgraduate programs could be a part of the solution.^[3] As medical problem-solving and medical learning environments are complex, uncertain, and difficult to understand, undoubtedly, it could be challenging. Medical students' motivation, the acquisition and evolution of declarative and conditional knowledge, problem-solving strategies, curricular models, teaching strategies, the presented learning opportunities, and the nature of the learning environment are of the interactive variables.^[4]

It is more important when a person faces to information explosion in which he/she needs some competencies for appraising and analyzing the most relevant information in complex situations.^[5] Critical thinking is a professional prerequisite for clinical expertise. A physician uses problem-solving strategy based on his/her structure of knowledge.^[6]

When learners have no tendency for applying critical thinking, teaching any framework for analysis and appraisal is useless; hence, to better understanding of critical thinking and relationship between attitude and skills, presenting its operational definition seems to be necessary. The disposition toward critical thinking has been described as having strong internal motivation for solving problems and making decisions by critical thinking.^[7]

As to an Iranian study, 98.6% of medical students had no inclination to critical thinking.^[8] Similar study showed uncertain attitude toward critical thinking in nursing students.^[9] In the other study, 81.8% of nursing students showed uncertain attitude.^[10] Most of the students with uncertain attitude showed poor interpersonal communication, i.e., a more positive attitude is conducive to better interpersonal communication.^[11] Some evidence reported normal critical thinking among medical students,^[11] while the others reported it in the weak range,^[12] which could be resulted from educational system. Some studies showed significant difference between critical thinking attitude from first- to last-year students' academic study on one side, and positive relationship between critical thinking attitude and students' mental health from the other side, indicated to this fact that improving critical thinking could promote students' mental health.^[13]

Furthermore, as most clinical situations are uncertain and stressful, and individuals with lower level of stress and anxiety showed higher level of critical thinking, not only the stress management should be integrated in clinical part of medical sciences disciplines curricula, but also stressful situations should be modified.^[14] Knowledge translation skill is the other influential factor on critical thinking which has been reported as

poor,^[15] and most clinical learners showed uncertainty in their critical thinking inclination.^[10] Helping people with lower academic achievement should be the main purpose for training healthcare personnel for acquiring self-directedness.^[16]

Critical thinking promotion faces some facilitators and inhibitors which should be considered by teachers, curriculum developers, and instructors and educational leaders.^[17] Continuous monitoring of them leads to promote critical thinking in the long term^[18] as well as critical thinking attitude which could be manifested by personality characteristics of psychoneurosis, flexibility, and conscientiousness, as well as abstract construction of cognitive learning approaches.^[19] Educational and professional success requires thinking skills and internal motivation development to apply them.^[20] Strong positive correlation between critical thinking skills and critical thinking dispositions actually can weaken the task at hand. Students' willingness and ability to involving in critical thinking should be considered in school and professional development curricula, instructional assignments, and educational outcomes assessments.^[21] It should be noted that skillfulness is not a guarantee for critical thinking disposition for its application, and being disposed toward critical thinking does not assure that a person is skilled.^[6]

Despite importance of critical thinking, little research has been done in this field in Iran. The target groups in the previous conducted studies were students, especially university students, and nurses, and most studied focused on surveys using questionnaire.^[22] Little studies have referred to critical thinking differences between Asian students and their non-Asian counterparts. The role of culture and its relation to critical thinking is currently neglected. As critical thinking tendency of Asian countries' students is different from others, it seems to be associated with cultural and contextual issues.^[2]

Due to lack of study about critical thinking attitude in undergraduate medical education to promote critical thinking skills by planning organized interventions, this longitudinal study aimed to seek the trend of disposition toward critical thinking in medical students of University of Medical Sciences from basic sciences to internship, it has also investigated critical thinking attitude in both genders.

Materials and Methods

Study design and setting

The current study is a longitudinal descriptive-analytic study which was conducted on 105 medical students studying at Tehran University of Medical Sciences (TUMS).

Study participants and sampling

Participants were medical students, either male or female, who were studying in the 1st year and 5th year of medicine and were accepted in TUMS undergraduate program. If they met the inclusion criteria, they were included in the study. Students who came from other universities as a guest were excluded. Finally, 165 questionnaires were completed and returned by students.

All 105 medical students were selected to complete the California Critical Thinking Dispositions Inventory (CCTDI) two times. Hence, the sample size was calculated as 210.

Data collection and technique

All 105 participants (50% were males and 50% were females) completed the CCTDI two times: First, when they passed basic science course (1st year), and the second time, when they were in preinternship (5th year). Therefore, the expected completed questionnaires were 210; however, 165 questionnaires were completed, returned and analyzed. The response rate was 78.5%. The dropout was related to the students who either were not progressed with their group or transferred to other universities. Some students took a semester off and some students did not return their questionnaires.

Facione developed the original copy of the questionnaire as 75 items in different subscales of open-mindedness, inquisitiveness, cognitive maturity, systematicity, truth-seeking, analyticity, and self-confidence following a Delphi study in American Philosophy Association in 1990.

To contextualize the questionnaire in the present study, the process of translation and back translation was performed,^[23] in which at first the instrument was translated by two bilingual expert translators separately. Two translation copies were merged to form the final Persian copy. Then, the expert panel checked the accuracy of translation. Qualitative Delphi process was run three times in which faculty members were commented on the questionnaire for face and content validity. Construct validity was also assessed through confirmatory factor analysis. Reliability of questionnaire was calculated by Cronbach's alpha.

Data were analyzed using paired *t*-test and independent *t*-test. Level of significance was regarded as $P = 0.05$. The mean of total score and each subscale including open-mindedness, analyticity, cognitive maturity, truth-seeking, systematicity, inquisitiveness, and self-confidence was lower when compared first with the second time. All analyses were repeated by age. The scores of 1st and 5th year participants were also compared in both genders using independent *t*-test. All data were

analyzed by Statistical Package for the Social Sciences version 16 (SPSS, Inc., Chicago, IL, USA).

Ethical consideration

After TUMS approval process for research proposal (code: 90-01-76-13693), participants were taken informed consent and the objectives of study were explained for them. They were also assured that their data would be kept confidential and reported anonymously in research analysis section.

Results

Out of 165 participants, 105 (50% males and 50% females) completed the instrument two times in 1st and 5th year of their academic program.

Psychometric properties of validity and reliability of the instrument were assessed at first. To confirm content and face validity, qualitative Delphi process was run three rounds in which faculty members were commented on the questionnaire. Their comments were considered in preparing final copy. For construct validity, based on the fitness statistical indexes of MFI, GFI, X²/df, all subscales showed acceptable fitness except for curiosity and confidence to inference which showed significant *P* value [Table 1]. Reliability of the questionnaire was calculated by Cronbach's alpha as 0.80. The results showed that the questionnaire instrument was valid and reliable for using in the current study.

Participants completed the instrument. According to the data, significant difference was found between first and second test in subscales of inquisitiveness, truth-seeking, analyticity, and self-confidence ($P < 0.05$), but no significant difference was found in the rest of subscales. It should be noted that a significant increase was found just in truth-seeking subscale and the rest showed significant decrease. Table 2 demonstrates that the total score of the test in the second phase was lower than the first phase, which was not significant ($P = 0.17$).

There was a significant difference between subscales of inquisitiveness, truth-seeking, and self-confidence among males in two times ($P < 0.05$). However, no significant difference was found for the other subscales. A noteworthy point is significant increase in truth-seeking and significant decrease in inquisitiveness, and self-confidence in second time compared to the first time.

Among females, there was significant difference between two for subscales of inquisitiveness, analysis, and self-confidence ($P < 0.05$); however, no significant difference was found for others. Interestingly, not only total score but also subscales of inquisitiveness,

Table 1: California Critical Thinking Dispositions Inventory subscales goodness of fit

Construct	MFI ^d	GFI ^c	χ^2/df^b	P	df	χ^2	RMSEA ^a (95% CI)
Open-mindedness	0.93	0.9	1.23	0.12	54	66.3	0.05 (0.086-0)
Inquisitiveness	0.90	0.9	1.60	0.01	35	56.1	0.07 (0.11-0.04)
Cognitive maturity	0.099	0.91	1.01	0.45	35	35.39	0.011 (0.076-0)
Systematicity	0.99	0.9	1.03	0.42	54	55.41	0.017 (0.067-0)
Truth-seeking	0.95	0.9	1.16	0.19	54	62.67	0.041 (0.041-0)
Analyticity	0.94	0.9	1.27	0.11	44	55.83	0.054 (0.093-0)
Self-confidence	0.93	0.9	1.51	0.04	27	40.86	0.073 (0.12-0.014)

^aMFI, ^bGFI, ^cChi-Square Goodness of Fit Test, ^dRMSEA. MFI=McDonald fit index, GFI=Goodness of fit index, RMSEA=Root mean square error of approximation, CI=Confidence interval

Table 2: Comparing total score and subscale of California Critical Thinking Dispositions Inventory in first and second step

Construct	Mean±SD		Mean difference	T	P
	First step	Second step			
Open-mindedness	35.62±4.52	36.70±4.04	0.08	0.116	0.91
Inquisitiveness	46.77±6.93	43.78±6.64	-2.99	3.99	0.001
Cognitive maturity	37.89±5.42	37.45±4.77	-0.44	0.618	0.538
Systematicity	39.07±5.69	39.67±5.70	0.60	1.08	0.284
Truth-seeking	32.71±5.88	35.77±5.16	3.06	4.09	<0.001
Analyticity	45.56±3.98	43.3±25.07	-2.24	3.55	0.001
Self-confidence	46.73±5.10	43.73±5.74	-3	4.74	<0.001
Total	286.53±21.12	280.6327.62	-5.90	1.59	0.17

SD=Standard deviation

analyticity, and self-confidence showed significant decrease.

Significant difference was found between males and females subscale scores of systematicity in the first time ($P < 0.05$), but they showed no difference for others. In the first time, the total score of the questionnaire for males and females also showed no difference. There was significant difference between males and females subscales score of systematicity and truth-seeking in the second time ($P < 0.05$), but for the other subscales, males and females showed no difference. The total score of males was significantly higher than females in the second time ($P = 0.019$).

Discussion

In the present study, trend of medical students' disposition toward critical thinking from 1st to 5th year has been studied through a longitudinal design by gender using a valid and reliable instrument, the CCTDI. Hence, psychometric properties of validity and reliability of the questionnaire were also confirmed.

The results have been discussed in two sections of confirming psychometric properties and assessing the aim of the study.

According to the result, the reliability of CCTDI was calculated as 0.80 by Cronbach's alpha which is higher than 0.7 that indicated it is a high reliable instrument.

In Asgari and Maleki's study the reliability of the test was calculated as 0.68 using Kuder-Richardson and as 0.63 using test-retest in a 4-month interval in Iranian context;^[24] furthermore, in Mehrinejad's study, reliability of test was reported as 0.78 using half-split and 0.83 using Cronbach's alpha test.^[25] Comparing to the current study, our method yielded higher index. It is likely related to using different methods of calculating reliability. Although the results are different in their studies, they concluded that the applied tool is reliable in the Iranian context. It should be noted that it seems that all studies have been conducted simultaneously, but their papers have been published earlier.

Besides approving face and content validity, the construct validity was also confirmed using factor analysis. It is in agreement with the other studies such as Facione (1998), Asgari and Maleki (2011), and Mehrinejad (2011) which applied either the original or the validated copy of the questionnaire. It should be noted that just fitness statistical index of Chi-square and P value are under the influence of sample size, which were not acceptable in two subscales statistically. Therefore, it sounds that despite significant results, it is preferred that the related subscales are not applied. In the present study, the sample size, participants who were selected by accessible sampling method, was the students admitted to School of Medicine in TUMS in 2010; they introduced to study and followed to 2015. On the other side, no study was found in the Iranian context in which the constructs of instrument have been confirmed by factor analysis. The

results of the present study in this field could be also helpful for its application in future studies which will be conducted +9 on medical sciences students.

According to the findings, males showed more inclination to critical thinking than females ($P < 0.05$). The study conducted on faculty members' critical thinking in Mazandaran University of Medical Sciences using California Critical Thinking Skills test (CCTST) reported higher critical thinking of medical school faculty members compared to the others; however, no significant difference was found between critical thinking scores of males and females.^[26] This finding is not in agreement with the present study. It seems that it could be justified by considering different subjects; in the present study, participants were medical students.

Present study also showed nonsignificant descending trend from 1st to 5th year; therefore, it sounds academic study could influence on critical thinking disposition. In the other study, critical thinking attitudes and skills were studied among students of first and last year of healthcare management at University of Medical Sciences using CCTDI as well as CCTST. It showed that the students' critical thinking is in the normal range, and they expressed positive attitude toward critical thinking. Regarding the reports from other universities, the authorities and faculties paid more attention to fostering critical thinking.^[27] The present study has been conducted longitudinally using CCTDI questionnaire which is different from the mentioned research in which students were tested through a cross-sectional design; the other point is different disciplines of students. It seems that all of them could be influence on the results.

According to a study conducted in Ferdowsi University using Watson-Glaser Critical Thinking Appraisal (WGCTA), significant difference was found between critical thinking scores of 1st- and 4th-year students, which is in consistent with the findings of the present study. Based on the standards, the mean of critical thinking scores has been categorized in the weak range. Although females were better at inference and males in interpretation, no significant difference was found between them in terms of total score of critical thinking which is in disagreement with the findings of the present study. Based on the reports, no significant difference was reported between critical thinking of humanity sciences students and other disciplines except in interpretation domain.^[28] Although the findings are similar in some extents, the results could be affected by different fields of studies as well as learning atmosphere of the present study.

Relationship between critical thinking with mother tongue, gender, and age, which was studied on 30

participants using CCTST Form B, showed no correlation between age and gender and critical thinking.^[29] The findings are different from the findings of the present study which could be associated with diversity in research population and research environment.

Significant relationship was found between elements of critical thinking tested by CCTDI and mean score of students' academic performance tested by self-directed learning readiness scale. It showed no difference between males and females.^[30] It seems that different subjects and applying different instruments could justify these differences in the results.

We studied just the trend of attitude toward critical thinking and did not classify its type. Another study among nursing students of BSc program using CCTDI showed around 81.1% uncertain attitude of participants.^[7] Through a longitudinal descriptive design using CCTDI, among nursing students from the Sophomore II to Senior II semester in the Midwestern United States, significantly higher CCTDI scores in the Junior I and Junior II semesters were observed, but no significant differences were found between the Sophomore II and Senior II semesters.^[31] This can indicate that changes in critical thinking occur in the early years; it would be better if the first phase of our study was conducted in the 1st year of education.

Our results showed nonsignificant decrease of critical thinking. The generic critical thinking ability of pharmacy students at the College of Pharmacy of North Dakota State University seems to be increased over the course during a 4-year professional pharmacy program; however, their motivation to think critically did not show to increase. CCTST and CCTDI were applied to gathering data.^[32] Results could be affected by different curricula as well as learning atmosphere of the present study.

A study entitled "Assessing critical thinking in medical sciences students in two sequential semesters: Does it improve?" was conducted by Athari *et al.* (2020) in Isfahan University of Medical Sciences. They discovered the medical sciences' critical thinking change using CCTST through a longitudinal design in two-sequential semester. The results showed no significant change.

Compared to the current study, they have measured critical thinking skills, but we tried to follow attitude toward critical thinking than skill. Both studies have applied California critical thinking test. On the other side, in the current study, all students studying in the first and last year of medicine were selected via census rather than random sampling in Athari *et al.*, which indicated to stronger statistical power. It seems in the current study that the sample are the input and output of an

undergraduate program which could be representative of all students who enrolled in undergraduate medical program, some revisions for improvement could be possible.

On the minus side, changing attitude could facilitate skill improvement; thus, it seems readiness to change and attitude toward critical thinking have been ignored in Athari *et al.*'s (2020) study.^[33]

Construct validity of questionnaire was also confirmed which is in agreement with the other studies such as Facione (1998), Asgari and Maleki (2011), and Mehrinejad (2011) which applied either the original or the validated copy of the questionnaire. The results of the present study in this field could also be helpful for its application in future studies which will be conducted on medical sciences students.

Limitations and recommendations

The psychosocial status of participants while completing the questionnaire was out of control of researchers. It can influence on students concentration, readiness, as well as the way of answering the questions.

It is recommended to provide learning opportunities for medical students to foster their critical thinking in professional situations and acquire positive attitude toward it as a core of decision-making in uncertain situations. Several factors involved with critical thinking should be considered, it seems not only cognitive and psychomotor sections of curricula, but also affective domain should be carefully developed and revised to better results for promoting critical thinking skills and attitude. Undoubtedly, it can indirectly lead to higher level of self-efficacy, mental health, and stress management and can improve quality of care and patient safety which is the final consequence of medical education.

Conclusion

Trend of medical students' disposition toward critical thinking from 1st to 5th year has been studied through a longitudinal design by gender using a valid and reliable instrument, the CCTDI in which males showed higher inclination to critical thinking than females, on the other side, nonsignificant descending trend was found from 1st to 5th year of the study. In the present study, psychometric properties of validity and reliability of the CCTDI questionnaire were also confirmed.

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Conflicts of interest

There are no conflicts of interest.

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