ORIGINAL ARTICLE

A Survey on Critical Thinking Skills of Medical Students in Mashhad Medical School (2017-18 academic year)

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Background: critical thinking plays an important role in clinical decision making and is acknowledged as a standard in medical education. This study was designed to evaluate critical thinking skills of medical students of Mashhad University of Medical Sciences, Mashhad, Iran.

Methods: this observational-analytical study included the students of three stages of basic sciences and physiopathology, externs, and clinical interns. Form B of California Critical Thinking Skill Test (CCTST) was used to evaluate critical thinking skills. The questionnaire included 34 multiple choice questions to evaluate five areas of inductive reasoning, comparative reasoning, analysis, evaluation, and inference.

Results: 112 students with an average age of 24.22 ± 2.78 years were enrolled in the study. 53.4% were female. An average of 4.46 ± 15.89 was considered as normal by the test developers while the average score of the participants was 15.89 ± 4.46 with a minimum score of 8 and a maximum of 34; which was statistically different from the desired score. Using one-way analysis of variance, we found no statistically significant difference between critical thinking scores of students of different academic stages (P = 0.746 (F (3,108) = 0.411)).

Conclusion: The findings showed that critical thinking skills of the participants are similar to some of the universities of the country; however, lacking compared with the students of the universities of other countries. Thus, educating and teaching critical thinking skills should be included in the educational curriculum.

Keywords: Student, Critical thinking, Medicine

استبيان حول مهارات التفكير النقدي لطلبة الطب في كلية الطب مشهد (٢٠١٧-١٨ العام الدراسي)

الخلفية: يلعب التفكير النقدي دوراً مهماً في اتخاذ القرار السريري و هو معترف به كمعيار في التعليم الطبي. صُممت هذه الدراسة لتقييم مهارات التفكير النقدي لدى طلاب الطب بجامعة مشهد للعلوم الطبية فى إيران.

المنهجية: تضمنت هذه الدراسة التحليلية القائمة على الملاحظة طلاب المراحل الثلاث للعلوم الأساسية و علم وظائف الأعضاء و الأطباء الخارجيين و المتدربين الإكلينيكيين. تم استخدام النموذج B من اختبار كاليفورنيا لمهارات التفكير النقدي (CCTST) لتقييم مهارات التفكير النقدي. تضمن الاستبيان ٣٤ سؤالاً من متعدد الخيارات لتقييم خمسة مجالات للاستدلال الاستقرائي و الاستدلال المقارن و التحليل و التقييم و الاستدلال.

النتائج: تم تسجيل ١١٢ طالباً بمتوسط عمر 2.78 ± 24.22 سنة في الدراسة حينما كان ٥٣,٤٪ من الإناث. اعتبر مطورو الاختبار متوسط ٤,٤٦ ± ١٥,٨٩ كالمعتاد بينما كان متوسط درجات المشاركين ٤,٤٦ ± ١٤,٧٥ بحد أدنى ٨ درجات و بحد أقصى ٣٤ التي كانت مختلفة إحصائياً عن الدرجة المرغوبة (- = (111) t 3.16، P <0.002). باستخدام تحليل التباين أحادي الاتجاه ، لم نجد فرقًا ذا دلالة إحصائية بين درجات التفكير النقدي لطلاب المراحل الأكاديمية المختلفة (P = 0.746 (F (3,108) = 0.411)).

الخلاصة: أظهرت النتائج أن مهارات التفكير النقدي لدى المشاركين متشابهة مع بعض جامعات الدولة و إن كانت تفتقر إلى ذلك مقارنة مع طلاب جامعات الدول الأخرى. و بالتالي ، يجب تضمين تعليم وتعليم مهارات التفكير النقدي في المناهج التعليمية.

الكلمات المفتاحية: الطالب ، التفكير النقدي ، الطب

بررسی مهارت های تفکر انتقادی دانشجویان پزشکی دانشکده پزشکی مشهد در سال تحصیلی ۹۷-۱۳۹۶

زمینه و هدف: تفکر انتقادی یکی از مهارت های حائز اهمیت در تصمیم گیری بالینی است و یکی از استانداردهای آموزش پزشکی برشمرده می شود. هدف این مطالعه تعیین میزان مهارت های تفکر انتقادی دانشجویان پزشکی دانشکده پزشکی مشهد بوده است.

روش: در این پژوهش توصیفی- تحلیلی، جامعه مورد پژوهش دانشجویان پزشکی سه مقطع علوم پایه- فیزیوپاتولوژی، کارآموزی و کارورزی بود. برای ارزیابی از فرم «ب» آزمون مهارت های تفکر انتقادی کالیفرنیا(CCTST) استفاده شد. ابزار جمع آوری شامل ۳۴ سؤال چند گزینه ای در پنج حیطه استدلال استقرایی، استدلال قیاسی، تجزیه و تحلیل، ارزشیابی و استنباط بود.

یافته‌ها: تعداد ۱۱۲ دانشجو با میانگین سنی ۲/۷۸ ± ۲۴/۲۲ در مطالعه حضور داشتند. از شرکت کنندگان ۵۳.۶ درصد زن بودند. میانگین نمره کلی تفکر انتقادی دانشجویان مورد بررسی (M=14.75, SD=3.81) بود. کمترین نمره ۸ و بیشترین ۳۴ بود. نمره میانگین (M= ۴/۴۶ , SD =۱۵/۸۹) از طرف سازندگان آزمون و موسسه تفکر انتقادی کالیفرنیا به عنوان نرم تعیین شده است که با میانگین کسب شده تفاوت معناداری دارد. درتحلیل واریانس یک طرفه، تفاوتی بین نمرات تفکر انتقادی در مقاطع مختلف تحصیلی وجود نداشت (F (3, 108) = 0.411, P = 0.746).

نتیجه‌گیری: میانگین نمرات تفکر انتقادی دانشجویان در این مطالعه مشابه برخی دانشگاههای داخل کشور است، ولی در مقایسه با سایر کشورها از میانگین کمتری برخوردار است. در نتیجه آموزش مبانی تفکر انتقادی به دانشجویان از طرق مختلف می بایست در دستور کار مسئولین آموزشی دانشگاه قرار گیرد.

واژه های کلیدی : دانشجو، تفکر انتقادی، رشته پزشکی

تعلیمی سال ۲۰۱۶_۲۰۱۷ میں مشہد میڈیکل کالج (college) کے طلباء کی تنقیدی فکر کا مطالعہ

بیک گراونڈ: تنقیدی فکر طبی فیصلہ سازی میں اہم مہارتوں میں سے ہے اور طبی تعلیم کے معیارات میں سے ہے۔ اس مطالعے کا مقصد مشہد میڈیکل کالج کےطلباء کی تنقیدی فکر کی مہارت کی سطح کا مشخص کرنا تھا۔

روش: اس وضاحتی تجزیاتی مطالعہ میں، مطالعہ تین درجوں کے طبی طالب علموں پر مشتمل تھا - فزیو پیتھولوجی، انٹرن شپ اور انٹرن شپ۔ کیلیفورنیا کریٹیکل تھنکنگ سکلز ٹیسٹ (سی سی ٹی ایس ٹی) کا فارم بی جانچنے کے لیے استعمال کیا گیا ۔ جمع کرنے والے ٹول میں ۳۴ متعدد انتخابی سوالات شامل تھے جن میں پانچ شعبوں میں استدلال، استنباطی استدلال، تجزیہ، تشخیص اور تخمینہ شامل تھا۔

نتیجے: ۲۲٫۲۴ ۲٫۷۸ کی وسطی عمر کے کل ۱۱۲ طلباء میں تھے۔ شرکاء میں ۵۳٫۶ فیصد لڑکیاں تھیں۔ مطالعہ کرنے والے طلباء کی تنقیدی فکر کا اوسط اسکور تھا (M = 75.14، SD = 81.3). سب سے کم اسکور ۸ اور سب سے زیادہ ۳۴ تھا۔ اوسط سکور ۴٫۴۶ (= M = 15.89 SD)ٹیسٹ بنانے والوں اور کیلیفورنیا انسٹی ٹیوٹ آف کریٹیکل تھنکنگ نے طے کیا تھا، جو حاصل کردہ اوسط t (111) = -3.16 p (0.002>سے نمایاں طور پر مختلف ہے۔ تغیر کے یک طرفہ تجزیے میں، تعلیم کی مختلف سطحوں میں تنقیدی فکر کے اسکور کے درمیان کوئی فرق نہیں تھا0 = P

سفارش: اس مطالعے میں طلباء کی تنقیدی فکر کے درمیانی اسکور ملک کی کچھ یونیورسٹیوں سے ملتے جلتے ہیں، لیکن دوسرے ممالک کے مقابلے میں اس کا مطلب کم ہے۔ نتیجے کے طور پر، طلباء کو تنقیدی فکر کی بنیادی باتیں مختلف طریقوں سے سکھانا یونیورسٹی کے تعلیمی سرگروہ کے میں شامل ہونا چاہیے۔

کلیدی الفاظ: طالب علم، تنقیدی سوچ، طب

INTRODUCTION

Thinking is defined as rearrangement, recreation, or change of the information obtained from environment using symbols and information stored in the long-term memory. Thinking itself is classified into different categories such as creative thinking, critical thinking, and problem solving thinking (1). Problem solving thinking or critical thinking is one of trending topics of education centers. The importance of designing and solving problems in education systems is rooted in the importance of this aspect of thinking. Although formation of critical thinking dates back to the era of civilized human, it has not been mentioned in scientific literature until the beginning of twentieth century.

Anis et al. defined critical thinking as a form of sharp thinking which is based on evidence about what should be believed and done (1). Another definition which is provided by Woolfolk et al. is evaluating the decisions made through logical assessment of available evidence (1, 2).

Critical thinking is an important skill in clinical decision making. It is a kind of cognitive process by which we understand and evaluate our findings according to reasoning and analysis (3). It helps the physician in making the best possible clinical decision for the patients and thus providing them with the best available care (4).

One of the most important missions of higher education in the 21st century is to train the students for facing the increasingly complex and rapidly changing society in the era of information explosion (5).

Experts of the field state that the key elements of critical thinking are analysis, evaluation, inference, interpretation, clarification, and self-regulation (6).

Critical thinking is a combination of knowledge, attitude, and performance of an individual and can be categorized into 5 skills of inference, recognition of hypotheses and data, deduction, interpretation, and evaluation of logical reasonings. Critical thinking enables people to process and evaluate new information compared with existing information, and is the junction of inductive reasoning and comparative reasoning working together in the process of problem solving. Critical thinking is one of the more important factors of clinical decision making and indicates the clinical performance of physicians and nurses, and is a major factor in improving professional independence (7).

International federation of medical education has cited critical thinking as one of the standards of medical education. In addition, it is of great importance in evaluation and assessment of the performance of medical faculties (8). The importance of addressing critical thinking in medical education especially regarding the rapidly changing practices has been emphasized throughout the literature. One of the main missions of any educational institution is to not only developing the professional qualities of students, but also to develop decision making, problem solving and self-efficiency which is influenced by training to think critically and logically (9, 10).

Without doubt, human of 21st century is bombarded with loads of information every day and the enthusiasm towards collecting the information in many cases leads to dismiss of critical thinking about the gathered information. The third international study in Iran reported the state of critical thinking skills of Iranian university students as undesirable (11).

In recent years, to evaluate critical thinking, several tests were developed with their most famous one being California Critical Thinking Skill Test (1). Some authors believed that evaluating the general critical thinking skills of people is not of great value, and that critical thinking skills could be evaluated in relation with the field of each person's field of knowledge and expertise (12, 13).

Abdehagh et al. in their study regarding critical thinking abilities of first semester and last semester students of bachelors and masters of midwifery across the universities of Tehran pointed out that there is a need to use more modern exam systems and active learning approaches (14).

In a study aimed to assess the critical thinking skills of students in Isfahan, Athari et al. reported that the average score of the students was 12.48 ± 3.23. They also reported that there was no association found between the critical thinking score and the ranking of the student in the university entrance exam (15). The only part in which there was an association between students of different educational stages was comparative reasoning (15). These findings were also reported in another study conducted by Gharib et al. comparing critical thinking skills of first-year students and last-year students their course on management of health care providers. Although there were no significant differences found between the skills of the two groups, students who were about to finish their course had a much more positive attitude towards critical thinking (16).

The importance of critical thinking in medical education in response to the rapidly changing health care environment has been emphasized because the main and primary task of any medical educational institution, in addition to developing students' professional competencies, is to develop decision making skills. Problem-solving and self-efficacy themselves are overshadowed by the ability to practice thinking critically and with a logical routine (17, 18).

The aim of this study was to determine the level of critical thinking skills of medical students of Mashhad University of Medical Sciences and the relevant critical thinking sub-skills.

METHODS

This cross sectional, observational-analytical study was carried out among medical students of three academic stages of basic sciences and physiopathology, externs, and clinical interns.

To evaluate clinical thinking skills of the students, form B of CCTST (California Critical Thinking Skill Test) was used as it is more comprehensive than other tools of critical thinking assessment. The first part of the questionnaire was consisted of demographic information such as age, gender, and academic stage of the student. The second part consisted of 34 multiple choice questions with only one correct answer. These questions evaluated skills of five areas of inductive reasoning (14 questions), comparative reasoning(14 questions), analysis (9 questions), evaluation (14 questions), and inference (16 questions). It is worth mentioning that

some of the questions covered more than one single area. The validity and reliability of the Persian version of the tool was confirmed in several studies in Iran. In one study carried out on 1000 college students in Iran, validity of the test was confirmed and its reliability was shown with a calculated Cronbach's alpha of 0.79 (19).

In this questionnaire, one point was awarded for each correct answer and the total critical thinking score of each participant was calculated as the total sum of their obtained points. Thus, the minimum possible score was 0 and the maximum achievable score was 34. In addition, a separate score was calculated for each of the five areas of critical thinking skills and their maximum was considered as 9, 11, 14, 16, 14 for analysis, inference, evaluation, comparative reasoning, and inductive reasoning accordingly (20).

A total time of 45 minutes was given to each participant to complete the test. The participants provided the authors with their informed consents prior to completing the questionnaire. In compliance with the instructions of the test, one point was dedicated to each right answer, and for analysis, the total score of the test was used. The sample size needed for the study was calculated as 125 people. To enroll the desired number of participants especially those of the clinical stages of the academic curriculum, the authors described the study thoroughly to externs and interns and the questionnaires were completed as self-administered tests. Regarding students of basic sciences and physiopathology stage, some classes were randomly selected and were provided with the questionnaires. After the authors briefed the students about the study, questionnaires were completed as self-administered tests.

The participants were assured that the data would be presented collectively at the end of the study and no personal data would be published. This study was approved by the research committee of Mashhad University of Medical Sciences with study number of 961333. Data analysis was carried out using version 16 of SPSS software. Descriptive analysis indices (frequency, mean, standard deviation, minimum and maximum score), Kolmogorov–Smirnov test for assessing normality of the data, Levin test to assess the equality of variances, and one-sample T-test, independent T-test, and one-way ANOVA were used to analyze the data. A P-value of less than 0.05 was considered as statistically significant throughout the study.

Table 1. Total scores of critical thinking and critical thinking sub-skills

Critical thinking sub-skill	Mean ± SD	Maximum	Minimum
Analysis	3.46 ± 1.51	7	**1**
Evaluation	5.22 ± 1.51	10	**1**
Inference	4.86 ± 1.76	9	**1**
Deductive reasoning	6.80 ± 1.92	12	**4**
Comparative reasoning	5.25 ± 1.96	10	**1**
Total score	14.75 ± 3.81	34	**8**

RESULTS

A total of 112 students were enrolled in the study, 60 (53.6%) of which were female. The average age of the participants was 22.24 ± 2.75, and the youngest and oldest were 18 and 33 years old, respectively. The majority of the participants were in basic sciences and physiopathology stage (34 participants), and the least were chosen from clinical interns (20 subjects). The mean score of the subjects' critical thinking skills was 14.75 ± 3.81 with a minimum of 8 and maximum of 43 points. Table 1 represents the mean, standard deviation, minimum and maximum score of the participants in each area of analysis, evaluation, inference, inductive reasoning and comparative reasoning.

According to the instructions of the developers of the test, California Critical Thinking Institution, an average score of 15.89 ± 4.46 was considered as normal. We observed that the average score of the participants was significantly lower than the anticipated score (t (111) = -3.16, P-value = 0.002) (table 2).

To compare the skills of students of different academic stages, one way ANOVA was used (table 3). Firstly, the normal distribution of the data was proven using Kolmogorov–Smirnov test, then to assess the equality of variances, Levine test was applied (P = 0.411, S = 0.968). One way ANOVA showed no significant difference between skills of students of different academic stages (F (3,108) = 0.411, P-value = 0.746). As shown in table 3, the average skill score of the participants of physiopathology stage was the highest among the participants (15.29 ± 5.02).

ANOVA test was used to compare the mean of each of the sub-skills of students' critical thinking skills of different educational levels. In the analysis sub-skill, the highest mean score was obtained among the physiopathology students (3.90 ± 1.42) and the lowest was seen among interns (2.90 ± 1.70). However, the difference was not statistically significant (P = 0.12).

In the evaluation sub-skill, the lowest score belonged to basic sciences (M = 4.63, S = 1.85) and the highest score belonged to externs (5.96 ± 1.53). In this sub-skill, there was a significant difference between the educational levels that belonged to the group of interns. (P = 0.04)

Regarding the sub-skills of inference, comparative reasoning and deductive reasoning no significant difference was observed between students of different educational stages (Table 4).

Table 2. One-sample T test to compare desired and actual mean of Critical thinking score

Variable	Desired mean	Actual mean	Difference of the means	P-value
Critical thinking score	15.89	14.75	-1.14	0.002

Table 3. Results of ANOVA test comparing critical thinking score according to educational stage

Critical thinking score	Descriptive analysis indices			
	Frequency	Mean ± SD	Minimum score	Maximum score
Basic Sciences	34	14.24 ± 3.34	9	20
Physiopathology	31	15.29 ± 5.02	8	34
Externship	27	14.81 ± 3.21	8	21
Internship	20	14.70 ± 3.26	8	21
P-Value		0.746		

Table 4. Results of ANOVA test comparing critical thinking sub-skills between different educational stages

	Basic sciences	Physiopathology	Externship	Internship	P-value
Analysis	3.32 ± 1.55*	3.90 ± 1.42	3.52 ± 1.34	2.90 ± 1.70	0.127
Evaluation	4.62 ± 1.85	5.29 ± 2.20	5.96 ± 1.53	5.15 ± 1.42	0.046
Inference	4.74 ± 1.56	4.77 ± 2.04	4.70 ± 1.77	5.40 ± 1.60	0.510
Deductive reasoning	6.26 ± 1.62	7.19 ± 2.16	6.96 ± 1.93	6.90 ± 1.94	0.245
Comparative reasoning	4.94 ± 1.93	5.19 ± 2.07	5.58 ± 2.08	5.15 ± 1.66	0.418

* Scores are reported as mean ± standard deviation

Figure 1 shows a comparison of critical thinking between the two sexes in various educational levels. The gap between this level of thinking in men and women seems to increase over the years of education. So that over time, education in men is better. The results of independent t-test did not show a significant difference in the total score and sub-skills between the two sexes.

Figure 2 compares the confidence limits for critical thinking scores and sub-skills at different levels of education. As can be seen, however, the point estimate of the critical thinking score at all points is lower than the expected average. But with the exception of the basic sciences course, where the limits of trust could not exceed the expected average, in other sections, it has been cut, which indicates the achievement of the expected level in critical thinking in these sections.

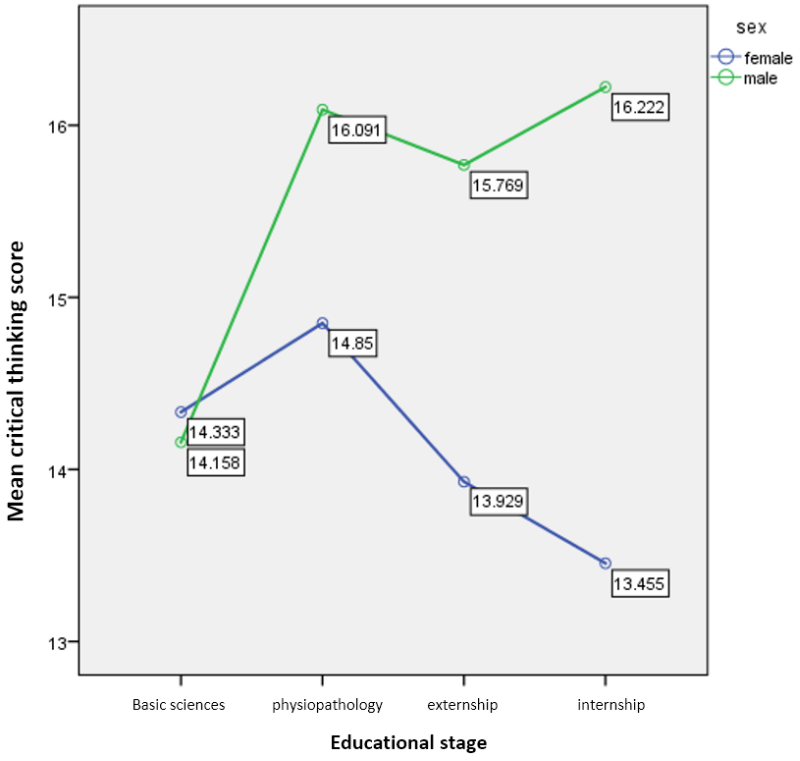

Figure 1. Comparison of critical thinking skill scores in students of different genders

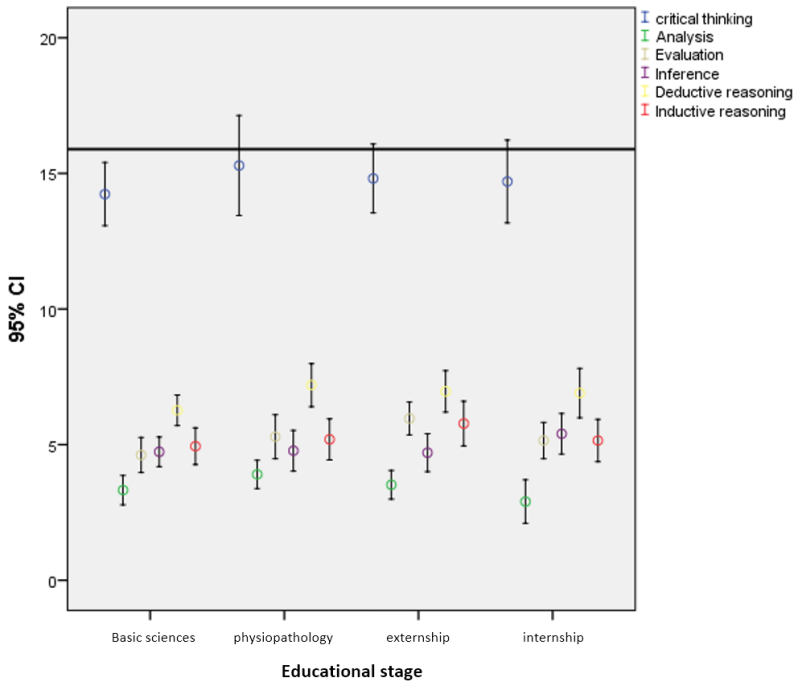

Figure 2. Confidence interval of critical thinking scores in students of different stages of medical education and its comparison with the desired score

DISCUSSION

Current study was carried out among 112 medical students in 4 stages of basic sciences, physiopathology, externship, and internship. In this study, the mean total score of critical thinking of the students was 14.75, which was significantly less than the mean expected by the questionnaire designers (15.89). The comparison of students' critical thinking skills in different educational levels did not show a significant difference. In the analysis skill among the sub-skills, the highest and lowest mean score was observed in physiopathology and internship, respectively. In the evaluation skills, the lowest and highest score belonged to the students of basic sciences and to the externs, respectively. In this sub-skill, there was a significant difference between the educational levels, with the interns having the highest score among participants. No significant difference was observed among students in different educational stages regarding comparative reasoning, deductive reasoning, and inference. There was no significant difference between men and women in the total score and sub-skills.

Very limited studies assess critical thinking skills, especially among medical students; therefore, there is no specific criterion for measuring the norm or abnormality of the critical thinking score of medical students. However, the findings showed that the mean critical thinking scores of medical students affiliated to Mashhad University of Medical Sciences is similar to students of some universities in the country, but lower than other countries.

In a study conducted in the United States on students' critical thinking status, mean score was 16.4 (21). In another study in theUnited States, this mean was 18.2 (22). In a study conducted on midwifery students at Tehran University of Medical Sciences, the score was below 14 in all universities (23). The mean total score of critical thinking of medical students in Isfahan and Bushehr in 2009 was 13.36 and 11.94 out of 34 respectively (24). Cisneros, reported the overall critical thinking score of pharmacy students of Campbell University of United States of America at their entrance to the university at 20.25 (25).

The same holds true for the sub-skills of critical thinking, so that the mean scores of the sub-skills of critical thinking of medical students of Bushehr and Isfahan University of Medical Sciences in the sub-skills of analysis, evaluation, inference, inductive reasoning, and reasoning deductions of 3.1 and 4.3 out of 9, 5.05 and 4.5 out of 14, 4.52 and 4.2 out of 11, 4.94 and 6 out of 16, and 6.84 and 2.9 out of 14, respectively, are consistent with our findings (24).

In general, the findings indicated that the average scores of critical thinking and its sub-skills in medical students in the country have a lower average compared to the results of other countries. Therefore, it seems that critical thinking skills are not sufficiently developed in the Iranian educational system.

The study of Amini et al. in Shiraz showed that medical students of Shiraz were weak in using their critical thinking skills, which is consistent with the results of the present study (26). During the study of Amini et al., only the inference ability of interns was significantly higher than other two groups. Also, in the present study, the inference skills of interns with a score of 5.4 was higher than the overall average of 4.86 and also higher than other educational levels. This can be due to the involvement of interns in the clinical decision-making process.

Regarding the relationship between critical thinking skills and gender, the results also showed that the total score was not related to gender and only analysis subskill score was higher in male students. Similar to some other studies, the present study found no association between total test score and gender. In the study of Amini et al., the inference ability of men was slightly higher than women (26).

Examining the relationship between critical thinking skills and students educational level showed that there is no statistically significant difference between the total score of critical thinking and students' educational level. Most studies in the past reported that students' critical thinking skills do not change significantly during the school years. This could be due to the lack of proper and adequate use of active learning methods by professors, students' lack of motivation to use these methods due to the convenience of the lecture method, the use of traditional methods of student evaluation

such as multiple-choice tests, the lack of new methods of evidence-based education, and the use of conventional methods in clinical settings instead of the care process.

However, in the field of inference, intern students performed significantly better than the other three groups. According to Bulls' research, there was a relationship between critical thinking and clinical decision making; however, this relationship was related to inductive reasoning and inference skills (27).

In the research of Mirmolaei et al., an increase in inference ability was observed in final year nursing students in three medical universities of Tehran province (23).

It seems that in the present study, although medical students obtained a higher average score than nursing and midwifery students, this average was lower than the average of critical thinking in foreign countries.

The cause can be traced to the teaching methods and educational models. Since on one hand educational centers and educational models merely as repositories of information and on the other hand professors as merely speakers and transmitters of information do not provide the necessary skills for thinking and reasoning, so the correct and appropriate use of critical thinking skills in different situations and studying in the way of critical thinking is enough to just read textbooks and memorize information and take exams as well.

Because the inference section of California Critical Thinking Test assesses the participant's ability to determine the probability of correctness and inaccuracy of the inferences made, it seems that student education in the clinical years has to some extent been able to correlate the interns' ability to evaluate whether his or others' inference is right or wrong. However, the mean of the overall score in all research samples is weak in the field of inference.

In some studies, the change of curricula and educational methods to new methods and their comparison with students trained with traditional methods has been done and the results showed that the use of new educational methods such as problem-based education reinforces thinking process (28).

However, the reality is that in medical students' curricula, large classrooms, limited class time, as well as dense and complex curriculum content are the main obstacles for creating learning environments and using the new methods to reinforce critical thinking. It seems that with proper planning and application of special strategies and the use of new educational methods, critical thinking skills can be strengthened.

The results of this study are surprising. Medical students of Iran have entered the university in a very difficult competition, and there is certainly no doubt about their intelligence and excellence. But their poor performance in applying critical thinking is questionable. It may be important to note that being intelligent is inherent, and passing the university entrance exam requires perseverance and memorizing a huge volume of data. Critical and thoughtful approach to scientific issues and other issues of life requires special education, which has been neglected in our educational system.

One of the most important limitations of the present study was the large number of questions in the Critical Thinking Questionnaire and how students responded to questions that were beyond the control of the researcher.

Teaching the basics of critical thinking to students through a course; in-service training for university professors to teach using critical thinking strategies; avoiding passive teaching methods, and evaluating students in the classroom and exams based on thought-provoking processes for problem-solving is recommended for promoting these skills in medical sciences.

Ethical considerations

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors. The ethics committee of Mashhad University of Medical Sciences approved this research, ethics code IR.MUMS.fm.REC.1396.820.

ACKNOWLEDGEMENT

We hereby would like to appreciate the support of the Department of Public Health and Family Medicine and its valuable professors, without whom this research would not have been possible. Also, we would like to thank the Vice Chancellor of MUMS General Medicine and the Dean of the Faculty, and the experts of the Department of Public Health Medicine who provided the necessary arrangements for this research, and all students who showed their exemplary cooperation.

Financial Support: This research is approved and financially supported by the research committee of Mashhad University of Medical Sciences, grant number 961333.

Conflict of Interest: None.

REFERENCES

1. Saif A. Modern educational psychology: psychology of learining and teaching: Dowran publishing company; 2020. Persian.
2. Marzano RJ. Dimensions of thinking: A framework for curriculum and instruction: ERIC; 1988.
3. Windish DM. Teaching medical students clinical reasoning skills. Acad Med. 2000;75(1):90.
4. RN ES, RN MC. Critical thinking in nursing education: Literature review. Int J Nurs Pract. 2002;8(2):89-98.
5. Mehr Mohammadi M. Education training of teacher and administrators. Tehran: Madreseh Publisher.1379:43-50. Persian.
6. Yousefi; A, Gardanshekan M. Critical Thinking. Iranian Journal of Education in Medical Sciences. 2012;11(9):1120-8. Persian.
7. Distler JW. Critical thinking and clinical competence: results of the implementation of student-centered teaching strategies in an advanced practice nurse curriculum. Nurse Educ Pract. 2007;7(1):53-9.
8. MacCarrick G. A practical guide to using the World Federation for Medical Education standards. WFME 2: educational program.
Ir J Med Sci. 2010;179(4):489-91.

9. Hunt B. Developing critical thinking skills at the university of Phoenix-Nevada campus. 2010.
10. Hasanpour M, Mohammadi R, Dabbaghi F, Oskouie F, Nikravesh MY, Salsali M, et al. The need for change in medical sciences education: A step towards developing critical thinking. Iran Journal of nursing. 2006;18(44):39-49. Persian.
11. Kiamanesh A. Intended and Attained curriculum in primary school years. Journal of Educational Sciences. 1997;3(2):13-37. Persian.
12. Meyers C. Teaching Students to Think Critically. A Guide for Faculty in All Disciplines. Jossey-Bass Higher Education Series: ERIC; 1986.
13. McPeck JE. Teaching critical thinking: Dialogue and dialectic: Routledge; 2016.
14. Abdehagh Z. Comparing critical thinking of master and bachelor Midwifery students, Tehran University of Medical Sciences: MSc Dissertation. Tehran: Tehran University of Medical Sciences; 2004. Persian.
15. Athari Z, Sharif M, Nematbakhsh M, Babamohammadi H. Evaluation of Critical Thinking Skills in Isfahan University of Medical Sciences' Students and Its Relationship with Their Rank in University Entrance Exam Rank. Iranian Journal of Medical Education. 2009;9(1). Persian.
16. Gharib M, Rabieian M, Salsali M, Hadjizadeh E, Sabouri Kashani A, Khalkhali H. Critical thinking skills and critical thinking dispositions in freshmen and senior students of health care management. Iranian journal of medical education. 2009;9(2):125-35. Persian.
17. Clynes MP. A novice teacher's reflections on lecturing as a teaching strategy: Covering the content or uncovering the meaning. Nurse Educ Pract. 2009;9(1):22-7.
18. Khalili H, Babamohammady H, Hajiaghajani S. The effects of two educational methods, classic and critical thinking strategies, on the stable learning of nursing students. Koomesh. 2004;5(2):53-62.
19. Mehrinejad A. Adaptation and Normalization of California Critical Thinking Skills Test. Advances in Cognitive Sciences. 2007;9(3):63-72. Persian.
20. Assessment I. California critical thinking skills test manual. Millbrae, CA. 2011.
21. Bauwens EE, Gerhard GG. The use of the Watson-Glaser Critical Thinking Appraisal to predict success in a baccalaureate nursing program. SLACK Incorporated Thorofare, NJ; 1987.
22. Bowles K. The relationship of critical-thinking skills and the clinical-judgment skills of baccalaureate nursing students. SLACK Incorporated Thorofare, NJ; 2000.
23. Mirmolaei T, Shabani H, Babaei G, Abdehagh Z. Comparison of critical thinking among first and last trimester baccalaureate midwifery students. Journal of hayat. 2004;10(3):69-77. Persian.
24. Azodi P, Jahanpoor F, Sharif F. Critical thinking skills of students in Bushehr University of Medical Sciences. Interdisciplinary Journal of Virtual Learning in Medical Sciences. 2020;1(2):10-6. Persian.
25. Cisneros RM. Assessment of critical thinking in pharmacy students. Am J Pharm Educ. 2009;73(4).
26. Amini M, Fazlinejad N. Critical Thinking Skill in Shiraz University of Medcial Sciences Students. Medical Journal of Hormozgan University. 2010;14(3):214-9. Persian.
27. Vaughan-Wrobel BC, O'Sullivan P, Smith L. Evaluating critical thinking skills of baccalaureate nursing students. SLACK Incorporated Thorofare, NJ; 1997.
28. Tiwari A, Lai P, So M, Yuen K. A comparison of the effects of problem-based learning and lecturing on the development of students' critical thinking. Med educ. 2006;40(6):547-54.