

ANALYSIS OF CRITICAL THINKING TENDENCY OF CHINESE UNDERGRADUATES MAJOR IN SOFTWARE

Wanyi Du

Foreign Language Educational Centre, Dalian University of Technology, Liaoning, China

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ABSTRACT: UNESCO has been defining critical thinking ability as the training goal of higher education since 1998. However, in China, the research of critical thinking ability is still at primary stage. Few courses were designed to cultivate students' critical thinking ability and innovation ability. In this paper, the author investigates the critical thinking tendency of college students majoring in software in the school, and finds that the critical thinking ability of college students majoring in software in our university is not only lower than the average standard specified by international measurement, but also at a disadvantage compared with the existing survey results in other regions of China. Therefore, it is suggested that teachers must change the inherent thought and method in traditional teaching, and actively develop new teaching mode, infusing the cultivation of thinking ability into the subject education.

Keywords: Critical Thinking; Critical Thinking Tendency; Software Major.

1. INTRODUCTION

Critical thinking has great significance in the world we live in. As early as October 1998 in the "World Conference on Higher Education" held by UNESCO in Paris, France, cultivating critical thinking of university students had been listed as an important goal of higher education in the future, and this goal was written in one of the important documents of the conference-*Declaration On Higher Education For The 21st Century: Ideas and Actions*. The first article of the declaration states clearly that: the mission of education and training is to develop students' critical and independent attitudes. In the United States, Drew Faust, the first female President of Harvard and the 28th President of Harvard University, publicly and explicitly pointed out the essence and goal of American education at the graduation ceremony of Harvard University: that is develop students' critical thinking and innovative spirit. Iowa department of education in United States has proposed a three-way structure model, which includes basic thinking (conventional thinking), critical thinking and creative thinking. Foundational thinking depends on the knowledge received from the course teaching, which is available to most students; critical thinking relies on foundational knowledge and can reorganize knowledge; Creative thinking will rely on fundamental and critical thinking for producing new knowledge for human society. The integration of these three kinds of thinking forms a compound thinking process and has great potential for innovation.

In China, although the critical thinking has not yet been listed in one of the goals of education and training, in 1999, the document of *The Central Committee Of The Communist Party Of China And the State Council On Deepening The Education Reform And Comprehensively Promoting Quality Education* pointed out: quality education should has the consensus to cultivate spirit of innovation and practical ability. Therefore, the essence of innovative education is to cultivate talents with creative thinking, creative personality and creative skills. Lu Yuxiang, president of the Chinese academy of sciences, once pointed out: "A country with sustained innovation capacity and a large number of high-quality human resources will have great potential to develop the knowledge economy, while a country lacking scientific reserves and innovation capacity will miss the opportunities presented by the knowledge-based economy". Innovation ability certainly will take thinking ability as the core. Only by improving learners' thinking ability, especially the advanced thinking ability (HOTS) including critical thinking ability, can they correctly propose, analyze and solve problems in the construction and development.

In network information age, critical thinking has its specific significance. Roberson (2006) pointed out: "The lack of information in the middle ages and the flood of information today collide" which would lead to the so-called "The chaos of the modern university curriculum". In the chaos, educators are "Forced to input more and more information, but students learn less and less". The description of this phenomenon is also coincided with the current situation of higher education in China. If the higher education system

can change direction and strengthen the development and training of critical thinking, the students' study will have different effects. At the same time, in information age, lifelong learning is already a basic skill for social workers. Critical thinking is an integral part of lifelong learning skills. No matter you turn on TV, or read newspaper, or surf the internet, only the person who has critical thinking ability, can distinguish right from wrong, correctly understand and judge, analyze and organize vast amount of network information. Critical thinking skills can help learners to tackle the complex and changing world and improve the humanistic spirit of modern social life. [Qingxu \(2000\)](#) proposed that cultivating students' critical thinking has the following meaning: it is helpful to cultivate students' innovative spirit and ability, and it is helpful for the survival and development of students in the information age, and to eliminate the superstition and blind faith of students.

2. CRITICAL THINKING SKILLS AND PERSONALITY TRAITS

For the critical thinking concepts, scholars at home and abroad have many different views. [Ennis \(1987\)](#) thinks that critical thinking is a rational reflective thinking which is on the basis of objective experience. [Paul \(1990\)](#) thinks that critical thinking consists of reasoning elements, intelligence criteria and intelligence features. He thinks that the thinks are proficient to control the internal structure of their thoughts and applying knowledge standards to evaluate them in the individual mind. [Brookfield \(1987\)](#) summarizes several elements that critical thinkers should have:

1. Identifying and challenging assumptions is a core of critical thinking
2. The importance of challenging the environment is significant to critical thinking.
3. Critical thinkers should imagine and explore more possibilities.
4. Through imagination and exploration for further rethinking and doubt.

Chinese scholar [\(Zhong, 2002\)](#) thinks that critical thinking is a deliberate, skeptical thinking activity, which obtains information that guides its beliefs and actions by observing, reflecting, reasoning, and communicating mental processes. [Hongzhi \(2004\)](#) summarizes the critical meaning as "Critical thinking refers to skills and mental attitudes, without disciplinary boundaries, and any topic involving intelligence or imagination can be reviewed from the perspective of critical thinking. Critical thinking is not only a thinking skill, but also a personality or temperament, which not only can reflect the level of thinking, but also highlight the modern humanistic spirit." Although different researchers have made different discussions on the connotation of approving thinking, the general structure of critical thinking has been basically agreed. That is, they think that in addition to critical thinking skills, critical thinking must also consist of the personality traits of critical thinking.

[Foong \(2000\)](#) Prepared a scale which is suitable for testing college students' critical thinking skills and thinking tendency (i.e. personality trait) CCTST and CCTDI, according to the framework of critical thinking theory formed by the [American Philosophical Association Critical thinking \(1990\)](#). Critical thinking in the scale includes interpretation, analysis, interference, evaluation, explanation and self-regulation six sub-skills. Critical thinking tendency includes seven dimensions such as truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and maturity. Since in this paper, we mainly investigate the critical thinking tendency of college students majoring in software, the seven dimensions are further explained as follows:

- Truth-seeking means you should have sincere and objective in your search for knowledge. If you find the answer that is not consistent with the original views of the individual, or even run in the opposite direction with personal beliefs, or affect your own interests, it is not considered.
- Open mindedness means you should have tolerant of different opinions and guard against the possibility of personal prejudice
- Analyticity means learners can identify the problem and understand crux of the problem and anticipate the consequences with reasons and evidence.
- Systematicity will ask learners should work hard to deal with problems in an organized and purposeful way.
- Self-confidence will ask learners to be sure of their ability of rational analysis.
- Thirst for knowledge means to have curiosity and passion for knowledge, and attempts to learn and understand, even if the practical value of that knowledge is not immediately apparent.
- Cognitive maturity means learners can make judgments prudently, or not make judgments temporarily, or modify existing judgments, and receive multiple solutions with alertness. Even

in the absence of comprehensive knowledge, one can understand that even an expedient decision is sometimes needed.

Tishman (1994) pointed out that features of critical thinking tendency of learners describes learners' knowledge system. If the target of higher education is to cultivate learners more productive and effective in their personal and professional lives, then the most important content of a successful college curriculum should guide learners to solve problems objectively, open-mindedly, systematically, analytically and decisively.

3. SURVEY OBJECTIVE AND SURVEY OBJECT DESCRIPTION

The main purpose of this survey is to fully understand the overall situation of critical thinking tendency and subentry ability of college students of Science and engineering in our university. The strengths and weaknesses of students' critical thinking tendency are found, through investigation, analysis and comparative analysis, so as to target in teaching and research, which provide strong data support and teaching reform help for the author and other teachers.

This investigation includes 133 undergraduate students majoring in software in freshman students and sophomore students of Dalian university of technology, wherein there are male students 104 and female students 29. In the freshman year, there are 78 respondents, including female 20, and in the sophomore year, there are 55 respondents, including female 9. The overall average score of the respondents are 588, with English average score 125. The respondents' age is between 17 and 20.

4. SURVEY TOOLS AND EVALUATION CRITERIA

California Critical Thinking Tendencies Inventory (CCTDI) is adopted for this survey. The inventory is widely used at home and abroad for college students, and has been tested for reliability and validity for many years. Most of scholars in China also adopt the inventory for measuring students' critical thinking tendency. For example, Shiguo (2009) adopted the inventory for inspecting 300 students' critical thinking tendency. Qingxu and Xinhui (2001) also made a further revision and verification for the Chinese class of the questionnaire through the test survey and analysis. MeiCi *et al.* (2004) not only revised the questionnaire in Chinese and tested its reliability, but also surveyed seven critical thinking tendencies of more than 2,000 students. Meici Peng's revised edition is adopted for this survey.

The Chinese edition CCTDI has a total of 70 entries, which respectively test respondents from seven dimensions of critical thinking tendencies. Each dimensions subscale contains 10 entries, which requires respondents to express whether they agree or not according to the statement of the entries, and to choose 1-6 points according to the degree of agreement. 1 point indicates strongly agree, and 6 points indicates strongly disagree. The score interval of each subscale is 10-60. The possible score range of the total score is 70-420. For each subscale, 40 is recommended as a positive or negative boundary, and the recommended target score is 50. A score above 50 on a subscale which means that temperament is strong. From 40 to 50 score, means stronger; a score below 40 is considered weak in the temperament. A score below 30 points indicates that the mental temperament of the respondents deviates from some critical thinking tendency temperament which is reflected in the scale. The total score is between 210-280, which indicates critical thinking tendency is neutral in temperament; If the total score below 210 indicates a remarkable conflict with critical thinking tendency; If the score is above 350, indicates a strong critical thinking tendency.

All the respondents complete the questionnaire in class under the guidance and supervision of teachers in written answers method.

5. SURVEY RESULTS AND DATA ANALYSIS

5.1. Overall Scoring Data

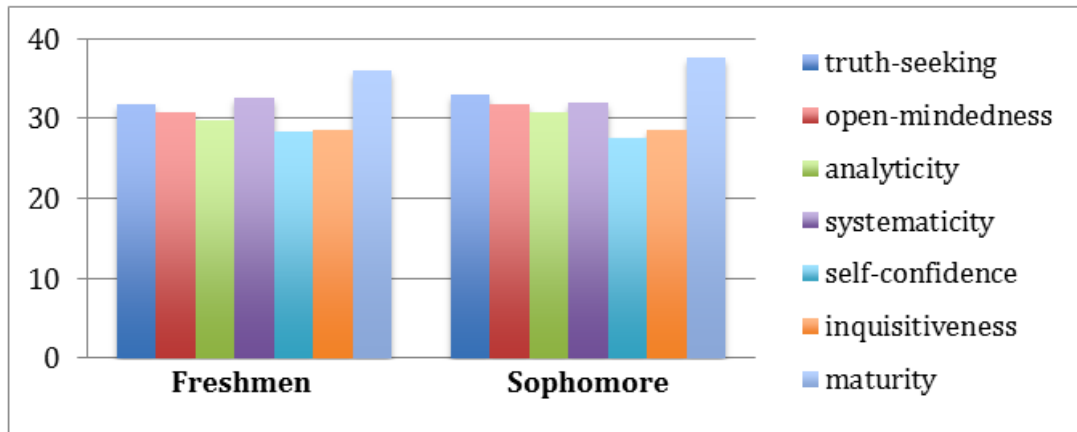
The survey results show that the average score of college students majoring in software in our school is 220, among which the average score of the freshman year students is 218.3, and the average score of the sophomore students is 221.73, which is slightly higher than that of freshman students. Although the total score is between 210 and 280, which indicates that the critical thinking temperament of the respondents is neutral, the total score is close to the minimum standard, which indicates that the overall level is relatively low (Table 1). In all respondents, there are 44 respondents whose total score is less than 210, including 27 respondents in freshman year (20.3% of the total number of respondents in freshman year) and 17 respondents in sophomore year (30.9% of the total number of respondents in sophomore year).

Table 1. Overall Score for Critical Thinking Tendency in Both Grades

Score	Freshman Respondents	Sophomore Respondents	Grand Average
Seven Overall Average Scores	218.3	221.73	220
Truth-seeking	31.75	33.05	32.4
Open mindedness	30.9	31.78	31.34
Analyticity	29.75	30.91	30.33
Systematicity	32.65	32.00	32.33
Self-confidence	28.45	27.69	28.07
Inquisitiveness	28.65	28.58	28.62
Maturity	36.15	37.71	36.93

Source: data collected from survey designed in this paper

From the total score of each item, total score of each item of software majors in our school is less than 40 points (Table 1), which indicates that students in our school show lower temperament performance in all dimensions. Students' self-confidence (28.07) and inquisitiveness (28.62) are even lower than 30 points. Only in maturity (36.93), the students' total average score is close to 40 points. Meanwhile, sophomore students also show a decrease in systematicity and self-confidence (Figure 1).

Figure 1. The Overall Trend of the Seven Sub-dimensions

Source: data collected from survey designed in this paper

5.2. Compared with the Survey Results of Other Universities in China

The author thinks it is necessary to compare this result with the survey results of some other universities in China, so as to better measure the critical thinking status of software students in our school. The author select the results of survey on the critical thinking tendency of 180 English majors in a comprehensive university, Jin Luzhen's survey on four universities (500 students) in Nanjing region, and Jiyong (2012) survey on three universities in Shanghai area (500 students) for comparison. Therefore, the objects of comparison cover students from different regions and universities of different majors. The comparison results can better indicate the current situation of critical thinking tendency of software major students in our university.

Table 2. Compare the Data with Other Survey Results

	English Major in University	Universities in Nanjing	Universities in Shanghai	Students in Software major of Our University
Total Points	287.5	283.7	268.32	220
Truth-seeking	40.75	36.72	42.65	32.4
Open mindedness	40.62	40.25	41.91	31.34
Analyticity	42.12	43.8	39.59	30.33
Systematicity	41.52	38.3	39.25	32.33
Self-confidence	35.65	40.14	34.5	28.07
Inquisitiveness	44.67	43.74	32.97	28.62
Maturity	41.77	40.76	32.79	36.93

Source: data collected from the paper of Jiyong (2012), and survey designed in this paper:

From [table 2](#), it can be seen that the overall level of software students in our school is lower than that of other areas. Among the seven sub-dimensions, the differences are obvious in systematicity and inquisitiveness. Students in Shanghai region and students in our university are stronger in systematicity than inquisitiveness. English major students in a certain school and students in Nanjing region have strong inquisitiveness, and low systematicity. However, from the table comparison, it can be seen that self-confidence in one of the seven dimensions of all surveys is at a relatively low level. In the other three survey reports, at the same time, the positive correlation between grade level and students' critical thinking tendency and ability was also shown.

5.3. Results Analysis

Data survey shows that the overall critical thinking temperament of college students in the school of software is low, and students not only lack the desire and confidence for pursuing and exploring new knowledge, but also lack the rational thinking for looking at what they have learned fairly and objectively. The lack of critical thinking temperament often leads that student's behavior shows:

1) Lack of analysis will make students block in the inherent learning methods and leaning thinking, and it is impossible for carrying out creative thinking and transformation. Most students' learning habits are from passive cramming which formed in primary and secondary schools. In exam-oriented education, unique and creative thinking and methods are not accepted, with the lapse of time, students are used to listening to the teacher mechanically, and they will remember what the teacher says without any analyzing, sorting, synthesizing, reflecting, questioning or thinking again. Hence, the knowledge they learned is simple, and the memory time is very short. In college classes, the amount of information increases dramatically, and teachers ask students to use suitable learning methods for enhancing their independent learning ability, which will lead to many students at a loss and don't know what to do. Therefore, many college students, especially freshmen, they are stressed out, and the college life is far from the free-spirited college life they imagined.

2) Lack of inquisitiveness leads to students' lack of thorough understanding of knowledge, and their inability to digest and absorb knowledge which is reflected in the fact that classroom discussions are often meaningless and homework content is perfunctory. The college students who are lack of inquisitiveness and open-mindedness are often reluctant to use their brain in college-style classroom discussions. No matter answering questions or in group discussions, most students are passive listeners and superficial. For example, when discussing prejudice, most students keep silent and show that they have no any interest. Part of students who are willing to discuss also can answer "because people hold different views". If the teacher asks further "why?" then there will be more people show silent and confused. When we are writing homework, for open essay questions, only a few students learn to think carefully and express their views. Most students copy other people's content or plagiarize online resources. When they are doing their homework, most of the students are just forming, and will not check and modify.

3) Lack of open-mindedness will lead to subjects cannot be integrated and research ability is low. Critical thinking and learning not only strengthens learners' ability to think in literature and philosophy, but the most important is that it is an ability to improve learning and cognition that is interwoven into all knowledge systems without disciplinary boundaries. Lack of critical thinking skills and desires will lead to the decline of learners' overall quality at last. After the students enter into college, they change their learning style and shift the focus of learning to learner-centered extracurricular autonomous learning. Many students complain that they don't understand professional knowledge, basic courses are unnecessary, and their mind cultivation is too boring. If the learners can use critical thinking methods and skills to integrate the knowledge and abilities of different subject, it will get twice the result with half the effort. For example, when the students in software major learn English, the topic discussed in class are information technology and software design. Teachers ask students as software designers to think about new software design methods and concepts, which requires students to integrated disciplines. However, most students only take this task as an assignment for a language course, they are not able to fully investigate and analyze the current and needs of the software industry, nor will they ask teachers of specialized courses for relevant knowledge. As a result, they neither learn to design new and useful software, nor study the relevant English expressions.

4) Lack of self-confidence is also demonstrated in students' imperfect knowledge system, and they don't dare to express their opinions and question teachers and textbooks. In their characters, they are a yes-man, and they are timid and overcautious, and they always stay in dormitories and study rooms and are reluctant to go out to face the society. For example, in class, occasionally there are obvious typographical and spelling errors in textbooks, and the writer makes mistakes or slips of the tongue when writing on the blackboard once in a while. Most students keep silent and let things slide even if they have found the mistake. Even when they disagree with the teacher, they don't stand up and discuss it with the teacher, either because the teacher is more right or because they are silent. For example, the teacher leave students with the tasks of social survey and practice, only a few students actually go out of the campus to interview passers-by, and most students only choose to solve problems on campus or even in class or dormitory.

6. STRENGTHEN CRITICAL THINKING EDUCATION IS URGENT

This survey results are worrying which fully explains the importance and necessity of strengthening critical thinking education in our university. Although we are lack of the condition of offering special courses on logical thinking for students, "injection" type teaching method can also help strengthen critical thinking skills. The "Injection" type critical teaching in the existing teaching asks a significant change in our existing teaching model. This change is reflected in three aspects:

1. The subject of study is no longer the teacher standing in the middle of the classroom, but the students sitting in classroom. Student-centered classroom participation is the key to the growth of critical thinking skills. Teachers in class should support students to express their views openly, and emphasize students' active and regular participation in thinking and practice, at the same time, teachers can provide effective thinking process modeling, develop thinking skills, and stimulate students' interest in learning. The role orientation of teachers and students in class and the way of asking questions put forwarded by Alison (2011) can be referred to practice. (Table 3).

Table 3. Reasonable Classroom Role Positioning of Teachers and Students and the Way to Ask Questions

	Intention	Teachers' classroom role	Students' classroom role	Questions
Analyze	to decompose information for better understanding	<ul style="list-style-type: none"> • explore • induce • observe • evaluate • be as a resource • questioning • organize 	<ul style="list-style-type: none"> • discuss • discover • debate • deep thinking • test • examine • questioning • calculate • investigate • inquiry • participate actively 	What is impossible to happen? If...happen, what will happen? What are the similarities between...and ... What else might happen? What will happen next if...? What are the problems of...? Can you tell the difference between ... and ...? What are motives behind...? What is the turning point? What is the question?
Evaluate	to make decisions based on thorough reflection, criticism and evaluation	<ul style="list-style-type: none"> • explain • accept • instruct 	<ul style="list-style-type: none"> • judge • argue • compare • criticize • question • debate • evaluate • decide • choose • prove • participate actively 	Is there a better solution? How do you consider the value of? Can you justify...? Do you think it a good or bad thing? How do you deal with? What will change? Do you believe...? How do you feel? What are the effects of...? What are the advantages and disadvantages of...? Why... is important? What is the backup plan?

				Who gain and who lose?
Create	to create new information and form new understanding based on previous understanding	<ul style="list-style-type: none"> • promote • extend • reflect • analyze • evaluate 	<ul style="list-style-type: none"> • design • elaborate • plan • adventure • modify • generate • recommend • make 	Can you design...? Can you find a possible solution? What would you do if you get the resources? What would happen if...? How many solutions do you have? Can you create new ways to...? Can you offer a suggestion for...?

Source: From paper of Alison (2011)

2. The focus of teaching is no longer on taking indoctrinate knowledge as importance, but on teaching the learning process and learning methods. Classroom teaching should pay attention to the transfer and mastery of knowledge results to the understanding of the learning process and meaning. Focus of teaching should be positioned in teaching students reasoning, teaching students to think. Foong (2000) pointed out that: the classroom that focuses on the teaching of higher-order thinking and the learning process has three features that can be observed.: students can be heard explaining, speculating, describing models or exchanging their ideas (Direct teaching of problem solving and reasoning strategies); the question that the teachers ask students why, what and how can be heard---these questions are not questions that can be answered in a single word, but require students to elaborate (Teacher emphasis on meaning and understanding is existing); you can observe students to make the following choice for contents: what procedures are used? How can knowledge be integrated into new and unconventional tasks to oversee development and evaluate solutions (There is a classroom atmosphere that encourages students to think independently, consistently and independently)

3. Most of the classroom teaching is dominated by open questions. Questions are core of critical thinking. Finding problems, questioning problems and solving problems are necessary processes of thinking. Open questions can break through isolated knowledge or problems, and present students with paradigm, and cultivate students' analyzing ability, evaluating ability and creating ability. In a broad sense, open questions have three basic standards Foong (2000): (1) To give all students the opportunity to demonstrate some knowledge, skills and understanding; (2) Can promote the students beyond the scope of reasoning, and thinking; (3) Allow students to use a wide range of solutions and strategies.

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