International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

The Critical-Thinking Effectiveness of College Students in Taiwan - Examining Students of Human Resource Development Departments

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Abstract: ***In recent years, the influence and educational environments in Asian countries have attracted attention around the world. However, students from Eastern and Western countries differ in their level of active class participation. Higher education institutions hope to establish a learning environment that promotes high-level thinking to assist students entering the workplace after graduation. Therefore, we examined college students of human resource development departments to investigate their critical thinking performance. We adopted a one-group pretest-posttest experiment design and a teaching approach that involved questioning, brainstorming, and cooperative learning methods. The results of this study indicate that these teaching strategies can effectively enhance students' critical-thinking skills. On the attitude, the abilities to identify, analyze, and consider problems improved significantly.***

Keywords: critical, thinking, college students, Asian, experiment design

1. Introduction

Thinking is the primary aspect of any education system, and critical thinking is a necessary skill for enhancing students' cognition [1]. Higher education has been traditionally considered an environment where students participate in activities that cultivate higher-order thinking skills, including critical-thinking, transformational-learning, and life long-learning skills [2]. College courses are the first step in a student's development of critical, reading, thinking, and writing skills [3]. In recent years, higher education institutions have hoped to establish learning environments that promote high-level thinking [4].

The cultivation of critical thinking is considered an important objective of tertiary education [5], particularly in modern learning environments where students are exposed to tremendous amounts of information that require effective cognitive strategies to process [6]. Education systems throughout the world are increasingly focusing on teaching thinking skills [7]. A number of scholars have indicated that Asian students participate less in classroom discussions [8]. Thus, the classroom performance of Asian students often lacks critical thinking. Critical thinking has attracted substantial attention from the fields of psychology and education (e.g., [9]; [10]). Therefore, the objective of current education is not only to teach the course contents but also to train and encourage students to develop critical-thinking skills [7].

Numerous educators and scholars believe that critical-thinking skills should be developed through participatory, practical, and problem-based activities [11], [12] Therefore, in this study, we examined Taiwanese college students to investigate their critical-thinking skills. We conducted critical-thinking training and examined the students' learning outcomes.

2. Literature Review

2.1 What is critical thinking?

Critical thinking is a higher-order reasoning skill associated with an ability to think rationally, evaluate actions and beliefs according to certain criteria, and correct actions or beliefs based on these evaluations [13], [14].

Critical thinking involves identifying and discussing critical implications, and plays a crucial role in the initiation of problem-solving and decision-making processes [15]. Critical thinking is a constructivist analysis process for examining occurrences in our environments [16]. Additionally, literature widely acknowledges that critical thinking is a crucial to the process of learning, cognitive development [17], and effective information seeking [18].

Through continuous exploration, questioning, and careful consideration, conclusions can be slowly developed. Critical thinking also involves a willingness to consider and treat matters sequentially and with caution, and not being biased by old or new external factors. In other words, critical thinking is the general skill of effectively employing the available evidence and perspectives in an argument. Critical thinking has also been defined as the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication to guide one's beliefs and actions [19]. Therefore, critical thinking training enables students to formulate questions, recognize their personal assumptions, evaluate evidence, and derive appropriate conclusions.

When challenging an argument, critical thinking incorporates more dimensions of a problem compared to general problem solving [20]. In addition, knowledge and experience influence both critical thinking and decision making. Among the critical thinking competencies identified in the Secretary's

Commission on Achieving Necessary Skills (SCANS) [21] were creative thinking, decision making, problem solving, and reasoning. If critical thinking is conducted without creativity, doubt and denial will be absent [22]. If creativity lacks critical ideas, novelty will be absent. The development of rationality and criticism skills simultaneously develops creativity. The development of creativity also develops criticism skills. They are two aspects of the same process. Additionally, critical thinking is often linked, compared, and used interchangeably with problem solving [23], [24] and higher-order thinking [7], [25].

Critical-thinking skills are important because they enable students to effectively manage social, scientific, and practical problems [26]. Synthesizing known critical thinking abilities is not merely a skill or personality trait, but rather a high-level thinking process associated with specific learning experiences. In this study, we contend that critical thinking is a type of thinking process that uses subjective criteria to resolve problems and obtain answers. Logical analysis and reasoning processes are combined with objective ideas to assess matters and suggest improvement methods. Critical-thinking, problem-solving, and creative-thinking skills are inseparable. When problems occur, critical-thinking skills and attitudes are necessary to conduct judgments, analyses, and reflection. Creative thinking is a higher-level psychological process that requires critical-thinking skills as a foundation. Therefore, the importance of critical-thinking skills in life and education is even more significant.

2.2 Critical-Thinking Teaching Strategies

A teacher must be able to employ key teaching strategies, such as higher-level questioning and problem-based tasks, and create a learning environment that encourages the development of thinking strategies, including critical-thinking, analysis, reflection, evaluation, problem-solving, judging, justifying and interpretation methods.

Critical-thinking teaching strategies could be divided into four types [27]. First, direct strategies: teachers demand that students emulate their behavior to acquire useful information, knowledge, and skills. The teaching process for these strategies is as follows: (1) Teachers introduce critical-thinking techniques; (2) students review the techniques, procedures, rules, and related knowledge; and (3) the students recall their impressions when performing the techniques and the reasons for their impressions. The teaching content for these strategies includes the following: (1) Using critical-thinking skills to solve problems and achieve goals; (2) combining the procedures and rules used to apply the techniques; (3) predicting the results of using the techniques; (4) evaluating the procedures for employing the techniques; and (5) evaluating the results of the techniques and how to use the results. Second, indirect strategies: teachers present problems to stimulate students' intellectual curiosity, allowing students to derive conclusions and test themselves. Students use concepts they suggest and consider various theories and explanations to examine different solutions. Teachers do not make value judgments regarding students' thinking; instead, they allow the students to assess their own ideas. After students obtain essential information, they can organize their knowledge and develop their own concepts. These types of strategies allow students to evaluate different perspectives in a debate while respecting others' beliefs and opinions. Students also employ various problem-solving techniques, such as (1) concept formation techniques; (2) open discussion techniques; and (3) exploration techniques. Third, productive strategies: commonly employed to enhance students' thinking when writing, developing solutions to extraordinary problems, and creative expression. Students are then given designed assignments or activities to increase their creativity using new materials. Students can also employ a more metaphorically descriptive vocabulary. Fourth, cooperation strategies: these strategies involve placing students in heterogeneous groups to consider and solve problems together. Teaching evaluations are also focused on small groups to achieve goals. Cooperation strategies can enable students to boost their learning achievements and improve their interpersonal relationships with peers and teachers.

The test content was divided based on degrees of reasoning proficiency, with each item including a type of classification relationship. The California critical-thinking skills test aimed at college and gifted high school students [25]. The test content comprised explanatory reasoning, argument analysis and evaluation, interpretation, mental games, and induction. Also employed the California Critical-Thinking Skills Test Form B for students from high school to college [28]. The questions were multiple-choice questions. The test content comprised explanation, analysis, inference, and interpretation. Attitude or tendency scales include the California Critical-Thinking Tendency Scale developed by [28]. The subjects of this test were students in high school and college. The test content assessed the students' ability to locate truth, maintain an open mind, analytical and systematic behavior, self-confidence, inquisitive behavior, and maturity. Suggested using verbal reasoning, argument analysis, and thinking to test hypotheses and applying likelihood and uncertainty as well as decision making and problem solving [29]. Employed 10 indicators to assess college students' critical-thinking skills [30]. These indicators were identifying and explaining issues, distinguishing types of claims, recognizing stakeholders and contests, considering methodology, framing personal responses and acknowledging other perspectives, reconstructing arguments, interpreting content, evaluating assumptions, evaluating evidence, and evaluating inferences.

Critical-thinking testing tools can be divided into two categories, that is, ability and attitude scales. Most of these tools focus on cognitive skills and personality attitudes and cover a wide participant age range. Although the majority employs multiple-choice questions, a few of the tools employ open-ended, situational questions. The content is primarily focused on confirming hypotheses, interpretation, and evaluation. However, students in higher education require ability indices that contain higher-level critical thinking. Therefore, we referenced the index developed by Northern Illinois University and Haplern et al. for higher education to design a scale for critical-thinking skills in Taiwan.

The essay test criteria suggested by the International Center for the Assessment of Higher Order Thinking (ICAT) comprised eight rating dimensions [30]. These dimensions were clarity of terminology, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness. The participants' performance on standardized instruments was frequently influenced by their empirical beliefs and personal backgrounds, their assumptions of the topics, and their political and religious ideology. If the participants' modes of thinking differed from those of the test preparers regarding "assumptions and judgments," the participants' scores would be incorrect. Therefore, when scoring critical-thinking skills, teachers should be skilled in the scoring criteria described previously and dismiss their personal beliefs regarding the students' background to provide impartial assessments.

Instruction that supports critical thinking involves questioning techniques that require the students analyze, synthesize, and evaluate information to solve problems and make decisions (think) rather than merely repeat information (memorize) [31]. The current education trend of standardizing curricula and emphasizing test scores undermines the instructors' ability to cultivate critical thinking in the classroom [32]. College students, and even adult learners, are not initially capable of critical thinking and must develop these analytical skills through college classes [33]

3. Methodology

3.1 Qualitative research

To comprehensively describe the nature and implications of critical-thinking skills, we conducted further interviews to obtain the views of critical-thinking experts and scholars and business representatives. These interviews were used as the foundation for developing our questionnaire. Each interview was conducted face-to-face, and lasted between 1 and half hours and 1 hour. If questions remained after this interview, telephone calls and e-mail messages were used to conduct follow-up and confirmation. Purposive sampling was employed to select the interviewees. We selected two academic representatives and three industry representatives. Table 1 shows the interviewees' introductions and interview times. We adopted the qualitative analysis software NVivo used by [34] to analyze the interview results, as shown in Table 2. These results were then used to determine the essential connotations of critical-thinking skills that applied to Taiwanese college students. These skills can be classified into the following categories: (1) Identifying problems: identification and recognition; (2) analyzing problems: identification, analysis, and interpretation; (3) considering problems: thinking and hypothesizing; (4) assessing problems: assessment, judgment, and evaluation; and (5) clarifying problems: deduction, induction, and clarification.

Table 1: Interviewee profiles

Code	Respondent Introductions
A	Teaches and serves as the head of research and development at a technological and vocational institute.
B	Taught at higher vocational schools and colleges. Currently managing a technology company.
C	Retired from the Industrial Technology Research Institute. Currently employed as a supervisor at a science and technology company.
D	Serves as a group leader at the Industrial Technology Research Institute. Simultaneously teaches at a college.
E	Teaches and serves as a dean at a technological and vocational institute.

3.2 Sample and Experimental Design

During this study, because of issues related to testing the participants, the instructors could not provide experimental teaching to two classes as a comparison group and a control group in the same year. Therefore, we employed a one-group pretest-posttest design. We recruited 30 sophomores studying in the human resources development department of a technical college. Immersive teaching materials were adopted in a human resource development class to provide experimental teaching of critical-thinking skills. The experiment total of 8 weeks. We conducted a "critical-thinking skills achievement test" and a "critical-thinking skills attitude test" during the first week as pretests. We conducted a mid-test in the fifth week and posttest in the eighth week to assess the students' learning outcomes.

During the experimental process, the teachers employed brainstorming, questioning, and grouping techniques as cooperative learning strategies. Additionally, debate competitions were held during the fifth week. This allowed students to consider the various questions raised by teachers, hear the opinions of their classmates, and engage in analysis, reflection, and judgment based on their life experience.

3.3 Instrument

The course and teaching were designed to promote excellent performance, as shown in Table 2. The training of critical-thinking skills was integrated into the teaching process without influencing the course content. Students used the classroom learning process to develop thinking skills and participate in identifying, analyzing, considering, assessing, and clarifying the problems and situations presented by their teachers.

Table 2: Teaching procedures for the experimental group

Instructional procedure	Instructional focus
Enhance motivation	• Analyze what is to be learned • Increase interest using novel, surprising, incongruous, and conflicting events • Illustrate how the learning result will have positive value for them
Maintain a positive learning environment	• Establish a learning organization • Encourage students to actively participate in classroom activities

	• Enable students to work productively and cooperate with each other • Encourage students to engage their critical-thinking skills and problem-solving abilities
Recall prior knowledge	• Confirm students' prior knowledge • Explain how students' prior knowledge influences their learning • Explain how new knowledge and skills can be incorporated in real-life
Conduct process evaluation	• Perform critical thinking tests • Engage in discussions with individuals or groups • Perform classroom observations
Provide feedback and implement modifications	• Monitor and adjust learner feedback • Adjust teaching according to learners' learning situations • Modify teaching to satisfy students' needs
Conduct summative evaluation	• Identify appropriate teaching resources for students • Encourage students to establish personal learning goals and develop personal knowledge and skills • Evaluate learning outcomes and reassess learning needs

3.4 Expert Validity

In this study, we tested the students using two scales. These scales were a "critical-thinking achievement scale for students in higher technical education" and a "critical-thinking attitude scale for students in higher technical education." When designing these scales, we employed the essential connotations of critical-thinking skills developed by Chao, Cheng, Lin, and Yang (2010) as a foundation for preliminary preparations. We then invited six experts to provide written reviews and removed inappropriate items from the scales. Table 3 shows the expert reviewers' introductions. The reviewers comprised service personnel for education authorities, instructors at technological institutes, and industry executives.

Table 3: Expert reviewers' introductions

Code	Introduction
A	Teaches and serves as the head of research and development at a technological and vocational institute.
B	Former Vice Minister of the Ministry of Education. Currently serving as a chair professor at a college.
C	Serves at the Industrial Technology Research Institute and also teaches at a college.
D	Serves as the general manager of a science and technology stock company.
E	Teaches at a college.
F	Teaches at a college and serves as the director of a general education center.

4. Results

1. Analysis of the College Student Critical-Thinking Achievement Scale

We participated in a discussion with the experimental teachers before the critical-thinking education was conducted to develop critical-thinking scales based on the class content for pre-, mid-, and posttest assessments. For the pre- and mid-tests, the average scores, standard deviations, and t-test results were employed to assess the students' performance before and during the critical-thinking education. The results of the pre- and mid-tests differed significantly (t = 10.76***), the mid- and posttest results differed significantly (t = 8.47***), and the pre- and posttest results also differed significantly (t = 14.44***). That is, differences were observed in the students' performances before and after the critical-thinking education. After completing the critical-thinking education, the students' critical-thinking skills improved significantly. Their scores were evaluated by three raters. Using the Pearson's correlation coefficient, the raters' scores were .58**, .62**, and .91**, which indicated that the scale evaluations had rater reliability.

2. Analysis of the College Student Critical-Thinking Attitude Scale

A. The Pre- and Mid-Test for Each Dimension on the Critical-Thinking Attitude Scale

(1) The Pre- and Mid-Test for Each Dimension on the Critical-Thinking Attitude Scale

Table 1 shows the pretest and mid-test average scores, standard deviations, and t-test results for each dimension on the College Student Critical-Thinking Attitude Scale. After the critical-thinking education was implemented, the students' pre- and mid-test scores did not differ significantly in any dimension. That is, after completing critical-thinking education, the students' critical-thinking attitudes did not differ in any dimension.

Table 1: Pre- and mid-test t-test summary of the College Student Critical-Thinking Attitude Scale

Dimension	Pre- and Mid-test	M	SD	t
Identifying Problems	Pretest (N = 30)	3.69	0.40	1.59
	Mid-test (N = 30)	3.85	0.38	
Analyzing Problems	Pretest (N = 30)	3.64	0.34	0.81
	Mid-test (N = 30)	3.71	0.37	
Considering Problems	Pretest (N = 30)	3.56	0.38	1.60
	Mid-test (N = 30)	3.73	0.46	
Assessing Problems	Pretest (N = 30)	3.81	0.38	0.07
	Mid-test (N = 30)	3.81	0.34	
Clarifying Problems	Pretest (N = 30)	3.66	0.40	-0.60
	Mid-test (N = 30)	3.59	0.46	
Overall	Pretest (N = 30)	3.67	0.61	0.21
	Mid-test (N = 30)	3.70	0.60	

(2) Posttest for Each Dimension of the Critical-Thinking Attitude Scale

Table 2 shows the average pretest and posttest scores, standard deviations, and t-test results for each dimension of the College Student Critical-Thinking Attitude Scale. After the critical-thinking education was implemented, the students' performances on the pre- and posttests differed significantly in the dimensions of identifying problems, analyzing problems, and considering problems. That is, after completing critical-thinking education, the students' critical-thinking attitudes differed in identifying problems, analyzing

problems, and considering problems. Their scores for the posttest were higher than those for the pretest.

Table 2: Pre- and posttest t-test summary of the College Student Critical-Thinking Attitude Scale

Dimension	Pre- and Posttest	M	SD	t
Identifying Problems	Pretest (N = 30)	3.69	0.40	2.61*
	Posttest (N = 30)	3.96	0.41	
Analyzing Problems	Pretest (N = 30)	3.64	0.34	2.82**
	Posttest (N = 30)	3.90	0.37	
Considering Problems	Pretest (N = 30)	3.56	0.38	3.02**
	Posttest (N = 30)	3.88	0.44	
Assessing Problems	Pretest (N = 30)	3.81	0.38	1.55
	Posttest (N = 30)	3.95	0.35	
Clarifying Problems	Pretest (N = 30)	3.66	0.40	0.58
	Posttest (N = 30)	3.72	0.43	
Overall	Pretest (N = 30)	3.67	0.61	1.90
	Posttest (N = 30)	4.00	0.74	

(3) College Student Critical-Thinking Experimental Teaching Observations

To understand the classroom interactions of the instructors and the tested students, we used participant observations to record the classroom conditions.

During classes, the teacher would move between various groups seeking different answers (1004-1422).

When students participated by answering questions and speaking, the teacher awarded them with "point cards"(1004-1430).

We could ask questions. The teachers asked each group whether any improvements had occurred and encouraged the students to stand and speak. The students who stood and spoke received three reward cards (1011-1430).

We formed groups for discussions (each group comprised approximately 8 to 10 people). The teacher distributed blank paper with the following question: Q. Assuming you are members of a company, please select a deputy general manager, a production manager, a business manager, a research and development manager, a human resources manager, and several employees…write your choices on the paper and then raise your hand to be counted (1018-1636).

During classes, the teachers asked the students questions and provided reward cards to encourage the students to think for themselves and express their views. Under this teaching method, the college students in the immersive critical-thinking skills development program were more likely to ask questions and express their opinions after receiving training in critical-thinking, and cooperative-learning, and questioning methods than they were before the experimental education. This shows that the students could actively consider others' opinions and their own self-awareness in the classroom. They could also offer their opinions for reference to foster a learning atmosphere in the classroom.

5. Discussion

In this study, we used critical-thinking education and assessment strategies in industry-oriented higher technical education to develop two assessment tools. These tools were an "industry-oriented higher technical education integrated with critical-thinking skills attitude scale" and an "industry-oriented higher technical education integrated with critical-thinking skills human resource development course learning achievement scale." These scales were used for conducting self-reports and situational and teacher assessments.

Critical thinking requires training, practice, and patience [31]. However, by encouraging students throughout the development process and modeling their thinking behaviors, students' critical-thinking skills can be improved. Experimental education indicates that immersive critical-thinking education strategies are suitable for cooperative learning. Group cooperative learning can be used to develop thinking abilities and promote interpersonal and group relationships [35], [36] and also facilitates the inclusion of the question-and-answer teaching method in courses. Presenting students with open-ended questions could improve their high-level thinking skills [37]. Group thinking activities can be used for brainstorming to allow students to become accustomed to thinking. Additionally, debate competitions can be held to enable students to practice their independent critical-thinking skills. Peer coaching can provide students with active learning and critical-thinking opportunities [38]. Therefore, in the critical-thinking learning process, teachers act as guides. Peer cooperative learning methods can be employed to prevent students from fearing the teacher and being unwilling to pose questions. Peer strength can be used to encourage students to access their personal experiences and inspire thinking among their peers. However, [39] highlighted that critical-thinking classrooms typically have the following attributes: frequent questions, developmental tension, and a fascination with the contingency of conclusions, and active learning. In this study, we used questioning methods, brainstorming, and cooperative education in classroom learning to stimulate student thinking. During the experimental process, greater effort was focused on discussion and analysis of the problems, which caused the progress of the course to somewhat fall behind. Therefore, course progress and the development of students' critical-thinking skills must be considered further.

In this study, we administered pre-, mid-, and posttests three times to the students receiving the experimental education using an industry-oriented higher technical education integrated with critical-thinking skills human resource development course learning achievement scale. The results were scored by three raters. The test results indicated that the students' critical-thinking skills increased significantly between the three achievements tests, particularly in the aspects of writing, identifying the crux of problems, and presenting their opinions. The business education students also showed significant increases in critical thinking after

completing the critical-thinking education activities [26], [40], [41], [42].

These results are identical to those of this study. [43] Employed collaborative learning activities to develop students' critical-thinking skills. Additionally, through the classroom observations and instructor feedback, we found that the students expressed their opinions more frequently in class during the experimental education. Therefore, the immersive critical-thinking teaching activities employed in this study improved students' critical-thinking skills.

Results from the three pre-, mid-, and posttests performed on the students who received the experimental education using the industry-oriented higher technical education integrated with critical-thinking skills attitude scale indicate that although no significant differences were between the pre- and mid-test results were observed during statistical analysis, the pre- and posttest scores differed significantly. Additionally, the students' acceptance of their identifying, analyzing, and considering skills increased significantly. The cultivation of critical thinking requires careful attention to design and evaluation of the environment [44]. Therefore, in the teaching field, merely planning the teaching content and processes in advance is insufficient. An atmosphere that facilitates the development of critical-thinking skills in the classroom must be created.

Conclusion and pedagogical implications

Critical thinking is an essential competency in today's information age [45]. The promotion of students' critical-thinking skills is a challenge faced by educators worldwide [45]. Stated that to achieve quality education and the ideal of developing learners into competent thinkers who can identify and solve problems and make decisions using creative and critical thinking, qualitative improvements to educator training must be conducted [46]. In this study, we performed grouping using cooperative learning. We integrated critical-thinking training into teaching activities to develop students' higher-level thinking abilities during the learning process. Recommended emphasizing environmental and task motivations during cooperative learning [47]. To promote cooperative learning quality, active learning environments should be created [48]. Therefore, before the deployment of the cooperative learning methods, students' learning motivations must be established in the critical-thinking education process to maintain the students' positive beliefs, attitudes toward learning, and concentration. Designing reasonable and challenging tasks can assist students in reaching their education goals through cooperative learning. Teachers should also compliment the words and work produced by each group, thereby encouraging students to participate in activities and brainstorming more frequently.

The results of the attitude scale indicate that the students' abilities to identify, analyze, and consider problems improved significantly. However, no significant differences were observed in their assessing and clarifying performance. This indicates that the students examined in this study still require active training in higher-level thinking skills. However, in the field of teaching, students accept the education provided by teachers. Additionally, teachers play an important part in increasing students' interest through the teaching process to achieve the learning objectives. Educators must recognize that not only teaching thinking skills is important and possible, but they must also personally develop effective critical thinking skills. They must understand how to teach thinking skills before they can assist learners in becoming effective thinkers [46]. That problem-based learning environments increased students' thinking skills and acquisition of knowledge [49]. Creating a classroom environment that facilitates thinking can increase the frequency of students' engagement in critical thinking. This environment encourages students to not only accept new knowledge during the teaching process but to also absorb, transform, and apply this knowledge.

Limitations and future research

This study was limited to a one-group pretest-posttest design because of the experimental education participants. Therefore, experimental education must be conducted with control groups in future studies to verify the immersive teaching materials and strategies established in this study. Additionally, in this study, we examined only sophomores of a human resource management department at a technical college. Therefore, the research results and interpretations can only be applied to similar learning conditions. Researchers wishing to apply the results of this study to various demographic groups and national conditions should carefully assess the similarities in the research background and participants. Various teaching strategies for developing students' critical-thinking skills can be examined in future studies. Furthermore, the teaching strategies developed in this study can also be applied to various levels of education in the future.

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