An Exploration into Research on Critical Thinking and Its Cultivation: An Overview

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Abstract—The intellectual root of critical thinking can trace back to Socratics in ancient Greece. Since then, a variety of conceptions and models have been proposed, which constitute the theoretic core of critical thinking. They place different weights on different aspects of critical thinking. In the meantime, the cultivation of critical thinking commenced when Socrates attempted to apply theories of critical thinking into the instruction. Consequently, a variety of instruction approaches and strategies and assessment of critical thinking have been developed. However, there is still a dispute on whether critical thinking can be developed independently of subject content. The paper attempts to review research on critical thinking with the aim to discover commonalities and clarify the subtle differences among diversities of conceptions, models, instruction approaches and strategies, and assessment. The discovery and clarification could be significant for the instruction of critical thinking, especially, conducted in non-western countries.

Index Terms—critical thinking, theoretic core, critical thinking instruction, critical thinking assessment

The research on critical thinking can date back to Socratic time in ancient Greece. Since then, a variety of definitions, models and theories on critical thinking have been developed. The intellectual development of critical thinking is in parallel with its instruction which commenced when Socrates attempted to instruct people how to justify their confident claims to knowledge. The variation of definitions, models and theories which leads to a variety of the instruction approaches and strategies, and assessment of critical thinking requires the discovery of the threads among them. The paper aims to explore the commonalities and clarify differences among the various conceptions, models, instruction approaches and strategies for the purpose to facilitate the development of critical thinking in non-western culture. The discovery and clarification would be significant for the instruction of critical thinking conducted in non-western countries, in particular, Confucian culture. It includes two general topics: theoretical background of critical thinking and critical thinking instruction.

I. THEORETICAL BACKGROUND: CRITICAL THINKING

It is essential for the instruction of critical thinking to find out the thread among various conceptions and models which have been produced since critical thinking was initially drawn attention in pedagogical practice. This section attempts to clarify critical thinking definitions and models. It includes the discussion on the alternatives to the concept of critical thinking, the conceptions of critical thinking and critical thinking models.

A. Alternative Labels for Critical Thinking

In the discourse on critical thinking, three professional terms--higher order thinking, creative thinking, and problem solving are found to be often interchangeable with critical thinking (Lewis & Smith, 1993). However, there are some subtle differences among these labels. Clarification of similarities and differences among them can contribute to the deep understandings of critical thinking.

First, higher order thinking, as an umbrella concept, includes critical thinking and creative thinking, as well as problem solving (Lewis & Smith, 1993). Newmann (1991) explained that higher order thinking is a broad conception rather than a specific conception as critical thinking. It can be easily recognized when it manifests itself in solving a problem in practice (Lewis & Smith, 1993; Resnick, 1987). To solve a complicated problem, Resnick (1987) argued, higher order thinking is required in considering the cost and benefit of multiple solutions, and developing a novel one. Newmann, Voss, Perkins, and Segal (1991) stated that higher order thinking involves such skills as scrutinizing arguments for logical consistency, distinguishing between relevant and irrelevant information, using metaphor and analogy in solving problems and developing solutions, asking for clarification in a conversion, pressing people to stay with an issue, and summarizing the progress. These skills overlap those concerning critical and creative thinking. Problem solving can be seen as "arenas where critical and creative thinking take place" (Bailin, Case, Coombs, & Daniels, 1999b, p.288).

Second, there are some differences between critical and creative thinking. Paul and Elder (2008b) claimed that critical thinking is a process of evaluating, while creative thinking is a process of creating. Scholars tend to discuss creative thinking in comparison with critical thinking. They view critical and creative thinking as two distinctive concepts. Critical thinking is analytic and evaluative within a given framework, while creative thinking is imaginative

and inventive, and involves generating and inventing new ideas or solutions by transcending framework (De Bono, 1976; Glaser, 1985).

Although there are some differences between critical thinking and creative thinking, they are closely connected. Harris (1998) pointed out that in problem-solving, two kinds of thinking work together and are not really independent of each other. In solving a problem, "first, we must analyze the problem; then we must generate possible solutions; next we must choose and implement the best solution; and finally, we must evaluate the effectiveness of the solution" (Harris, 1998, p.2). It is a cyclical process from critical thinking to creative thinking, and then from creative thinking to critical thinking. As Paul and Elder (2008b) stated, although critical thinking and creative thinking can be separated artificially, in practical context, they are interwoven and connected into one. The relationship among the labels is illustrated in Figure 1.
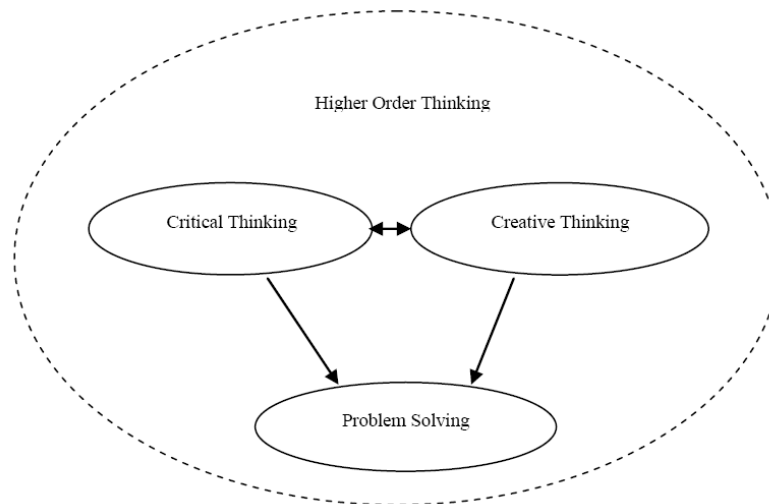

Figure 1. Relationship among Labels

B. Conceptualization of Critical Thinking

Due to a long history of research on critical thinking, it is a hardship for researchers and theorists to reach a consensus on its conception. There are as many definitions of critical thinking as contemporary scholars who attempt to seek the clarification of definitions. However, continuous endeavor to explicate the concept of critical thinking is undertaken under the assumption that it is conducive to the effective instruction of critical thinking in educational settings. There is agreement among scholars on three approaches to conceptions of critical thinking: philosophy, psychology and education (Bailin, 1998; Cohen, Salas, & Riedel, 2002; Lewis & Smith, 1993; Sternberg, 1986). The next sub-sections mainly discuss them.

Philosophical tradition: Philosophical inquiry into critical thinking extends from the ancient time of Socrates, Plato and Aristotle to the contemporary of Dewey, Ennis and Paul. These scholars have turned their attention to the nature of critical thinking and devoted much attention to the requirements of formal logical systems rather than the requirements of critical thinking within the educational conditions (Sternberg, 1986). Dewey, an American philosopher, psychologist and educator, is widely considered as the founder of the modern critical thinking movement (Fisher, 2001). He viewed critical thinking as reflective thinking and defined it as "active, persistent and careful consideration of a belief or supposed form of knowledge in light of the grounds that support it, and the further conclusions to which it tends" (Dewey, 1961, p.4). Dewey stressed that belief is established upon a firm basis of reasons. He explained that what is believed or disbelieved depends on something which stands as reasons of belief. If suggested knowledge that occurs is at once accepted, there is no or minimum of reflection. Reflective thinking involves consistent doubt and systematic and perpetuated inquiry in overcoming the inertia that inclines people to accept the suggested form of knowledge at its face value.

Ennis (1962), whose definition is widely accepted in the field, defined critical thinking as "reasonable reflective thinking that is focused on deciding what to believe or do" (Ennis, 1991, p.6). The definition emphasizes the reasonable and reflective nature of critical thinking. Goal of thinking critically is to decide what to believe or do. Ennis' definition stresses application of reasonable and reflective thinking in decisions. The thrust of critical thinking is propelled from the dimension of thought into that of action (Whitaker, 2002). Scriven and Paul (2008) elaborated critical thinking as:

"Critical thinking is 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, as a guide to belief and action" (Scriven & Paul, 2008, p. 1).

The definition regards critical thinking as a process which consists of five skills from "conceptualizing" to "evaluating". The content which is processed within critical thinking is information obtained by observation, experience,

or communication. Similar to Ennis' definition, Scriven and Paul's definition emphasizes the purpose of critical thinking as a guide to belief and action.

The philosophical approach to the concept of critical thinking features in enumerating the characteristics of a critical thinker, attaching importance to reasoning skills and processes, and highlighting purposes of critical thinking. In the emphasis of reasoning and logical system, the philosophical definitions imply the qualities of the ideal critical thinker under ideal circumstances in which the limitations on human thought are not in place (Sternberg, 1986).

Psychological tradition: In contrast with the philosophical approach, psychological approach is mainly concerned with the processes and skills of critical thinking in practical context (Moon, 2008). The emphasis of processes and skills of critical thinking aims to make the idea more comprehensible, more usable and more relevant to practice. Moreover, psychological tradition pays attention to the behaviors and actions of critical thinkers within personal and contextual constraints, because behaviors and actions are overt indicators of a person's covert internal unobservable processes.

Psychologist Robert Sternberg (1986) thought that critical thinking consists of "mental processes and strategies" which are utilized to "solve problems, make decisions and learn new concepts" (p.3). He considered the processes and skills as the integral elements of critical thinking, and stressed the importance of problem-solving practice rather than an ideal context. The similar accentuation can be found in Halpern's definition of critical thinking as "the use of cognitive skills or strategies that increase the probability of a desirable outcome" (Halpern, 1999, p.70). Halpern accorded emphasis to desirable outcomes when using skills or strategies to solve problems. In conceptualizing critical thinking, psychological researchers highlight the importance of context and the limitation it can impose on performance of component processes and skills. The practical discipline or professional contexts determine appropriate application of particular component skills of critical thinking.

Educational tradition: Educational tradition to critical thinking is a combination of philosophic and psychological approaches (Sternberg, 1986). Educators are primarily concerned with how to develop students into critical thinkers rather than the process or skill itself (Moon, 2008). Therefore, educational conceptions of critical thinking mainly emerge from the way in which students are guided into critical thinkers. Processes and skills, which are necessary in the classroom for problem-solving, decision-making, and concept learning, can be taken as components of guidance in nurturing critical thinkers.

Pascarella and Terenzini (1991, cited in Rudd & Baker, 2000) argued that critical thinking can be defined in a number of ways,

"but typically involves the individual's ability to do some or all of the following: identify central issues and assumptions in an argument, recognize important relationships, make correct inferences from data, deduce conclusions from the information or data provided, interpret whether conclusions are warranted on the basis of the data given, and evaluate evidence or authority" (p.118).

The definition indicates that critical thinking, as reasoning ability, is composed of a variety of skills. It centers on the individual development of reasoning ability, instantiated in specific skills. Pascarella and Terenini (1991, cited in Rudd & Baker, 2000) also stressed that postsecondary education should foster these skills. Tsui (2002) corroborated the reasoning ability in her definition. She defined critical thinking as "students' abilities to identify issues and assumptions, recognize important relationships, make correct inferences, evaluate evidence or authority, and deduce conclusions" (p.743). The preference for individual development of critical thinking is ascertained in Papastephanou and Angeli's (2007) definition which interpreted critical thinking as individual's reflective thinking when involved in problematic situations in any discipline. Reflective thinking that characterizes the individual critical thinker is conceived of as a necessary capability in solving problems.

Educational theories of critical thinking are developed from class observation and experience (Sternberg, 1986). Educational conceptions of critical thinking are generalized from instructional experiences of cultivating critical thinkers. Critical thinking is primarily conceptualized as an individual's logical and reasoning ability which can be developed with undergraduates and graduates in academic institutions. Educators stress the importance of reasoning ability as a component of critical thinking in the case that students need to be cultivated into critical thinkers in higher education.

The relationship among three approaches to conceptualization of critical thinking is illustrated in Figure 2 below. Philosophical researchers tend to conceptualize critical thinking in an abstract way and emphasize the characteristics and processes of critical thinking which are concerned with ideal critical thinkers under ideal contexts (Sternberg, 1986). In contrast, educational conceptualization of critical thinking focuses on how to effectively develop students into critical thinkers in the class, which is crystallized into the development of specific critical thinking skills. Psychological conceptualization of critical thinking emphasizes the importance of skills and their utilization in problem-solving in practice. It stresses the limits imposed by practical constraints. Therefore, to a certain degree, the educational conception of critical thinking is an instructional substantiation of the abstract philosophical conception, and the psychological conception is its practical substantiation.
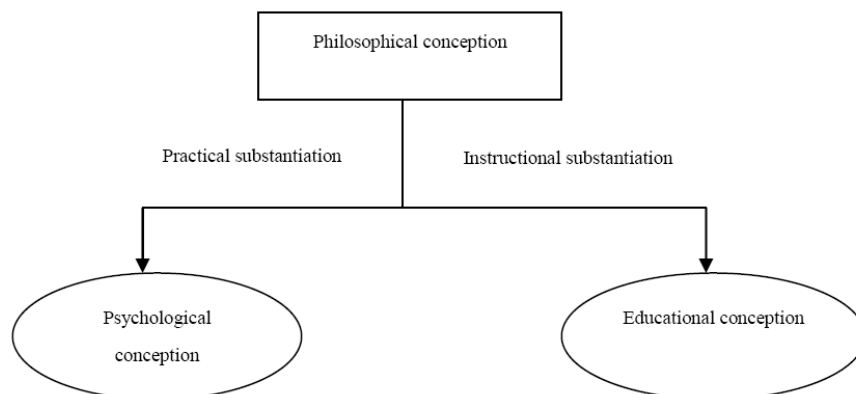
Figure 2. Relationship among different conceptions of critical thinking

The philosophical conception has a preferred weight on the theoretic aspect of critical thinking; the psychological conception on the practical aspect; the educational concept on the instructional aspect. From three different aspects, they attempt to elaborate the concept of critical thinking. Perfect critical thinking by an ideal critical thinker under the ideal context emphasized in philosophical conceptualization can be not easily obtained in an actual educational setting, and therefore, the teaching and learning of such perfect critical thinking might not be implemented successfully. Development of critical thinking for undergraduates in educational institutions has to consider the limitations imposed by personal traits and environmental contexts with the ultimate objective of cultivating critical thinkers who can apply critical thinking skills into solving a problem in reality.

Convergence of conceptions of critical thinking: The variations in definitions of critical thinking constitute a barrier to critical thinking instruction and assessment. Efforts to explore core commonalities of critical thinking conceptions intensified in a Delphi study in which a cross-disciplinary panel of 46 experts completed a multi-round, method-strict research project under the sponsorship of the American Philosophical Association (Facione, 1990b). The Delphi study articulated the conception of critical thinking as follows:

"We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990b, p. 2).

The agreed definition conceives the outcome of critical thinking as judgment, rather than solutions and decisions. Lipman (1988) held that outcomes of critical thinking such as solutions and decisions are too narrow, and that judgment includes solving problems, making decisions and learning new concepts. "All aspects of critical thinking centrally involve judgment" (Bailin, Case, Coombs, & Daniels, 1999a, p.280). The experts in the Delphi study agreed that critical thinking includes five core skills: interpretation, analysis, evaluation, inference and explanation.

Differences between critical thinking ability and skill: It is often found that two terms, 'critical thinking ability and critical thinking skill', are often used interchangeably in the literature of critical thinking research. Such interchangeable use of two terms is due to double connotations of 'skill'. As Smith (2002b) argued, 'skill', on the one hand, refers to "skilled performance of tasks", and on the other hand, refers to "acquired ability or capacity" (p.661). The double connotations of 'skill', more or less, mask the differences between ability and skill. There are some subtle differences between the two concepts that need to be clarified. If elucidation of differences between ability and skill is achieved, consequently, differences between critical thinking ability and skill can become clear.

Skill is often defined as a capacity or ability to do something well, to perform competently a task (Bailin, 1998; Bailin et al., 1999a; Smith, 2002a, 2002b). The definition emphasizes something inner in individuals' mind, inner ability, and at the same time, it also focuses on the external manifestation of skill by the competent performance of tasks. Two main points of the definition are confusing and problematic for skill teaching. It is necessary to make a choice among two focuses of the definition: whether skill refers to only inner ability or only performance of tasks. If the choice is made for inner ability, that is, skill and ability can be interchangeable. However, some researchers claim that skill is not equated with ability. Barrow (1984, cited in Griffiths, 1987) disagreed with such a broad sense of skill, and believed that skill is not synonymous with ability but is a sub-class of ability. It is ability that underlies skill and brings out or makes up the skill of an individual.

Therefore, critical thinking skill refers to task-related competent performance, while critical thinking ability focuses on the ideal competence or capability of the ideal thinker. Critical thinking ability is macro while elemental skill of critical thinking is micro (Paul, 1993). Micro-skill can be orchestrated into macro-ability of critical thinking. Critical thinking is a stable and enduring ability developed from the integration of a variety of elemental skills. If learners acquire a mastery of critical thinking skills, they consequently acquire an enduring critical thinking ability.

Proposed concept of critical thinking in non-western culture: For facilitation of critical thinking development in non-western culture, the concept of critical thinking possibly includes defining characteristics, such as "reflective, reasonable and intellectually disciplined", and the process of interpreting, analyzing, synthesizing, and evaluating arguments and the purpose "as a guide to making judgments". The defining characteristics can be employed to

distinguish critical thinking from any other kind of thinking. Critical thinking is reflective in that "it involves thinking about a problem at several different levels or from several different angles all at once" (Hunter, 2009, p.5). By being reasonable, critical thinkers would not hurry to draw a conclusion that cannot be supported by evidence and rationality or make a decision to accept a belief without the support of good reasons. Critical thinking is intellectually disciplined in the sense that it involves systematically analyzing questions and problems, carefully assessing needed evidence, and holding to critical thinking standards (Paul & Elder, 2002).

Critical thinking is regarded as a process that "helps us to arrive at the most likely destinations when evaluating claims" (Braithwaite, 2006, p.1). Process is a journey to the accomplishment of purpose. The purpose of critical thinking is to make judgments (Lipman, 1988).

Operationally, critical thinking, as the ability, consists of skills of interpreting, analyzing, synthesizing and evaluating. Each skill subsumes sub-skills. These skills are used to achieve ultimate end, i.e., judgment on belief or action. The following is a detailed discussion of these skills (see TABLE 1).

TABLE 1
SPECIFIC CRITICAL THINKING SKILLS AND SUB-SKILLS

Skill	Sub-skills
Interpretation	• Identifying arguments and recognizing explicit premises, reasons and conclusions
	• Distinguishing argument from description, explanation, and summary
	• Paraphrasing arguments to others, distinguishing deductive argument from inductive argument
Analysis	• Making inferences about implicit premises, assumptions and conclusions
	• Detecting flaws in the argument
Synthesis	• Discovering hierarchical interrelations among arguments in support of the main position or view
	• Diagramming arguments
Evaluation	• Evaluating global structure of thought by using elements of reasoning and criteria of thought
	• Evaluating local arguments and their relationships by using criteria of thought

Interpretation, as one of critical thinking skills, refers to understanding and interpreting arguments. It encompasses such sub-skills as: identification, categorization and expression. Identification refers to the skill to identify argument and its components: premise and conclusion, and distinguish argument from non-argument such as description, explanation, and summary. Categorization requires learners to understand and appropriately formulate different types of arguments, and describe and characterize these arguments such as deductive argument and inductive argument. Expression refers to the skill to paraphrase arguments explicitly or implicitly presented.

Analysis focuses on breaking down arguments into constituents and recognizing the constituents. It includes inference and detection. Although some arguments have explicitly stated premises and conclusions, some still use implicit assumptions as reasons. Some just jump to conclusions and leave premises implicitly unstated or explicitly state premises and leave conclusions unstated. Inference refers to the skill to make inferences about implicit premises, assumptions and conclusions. Detection refers to the skill to detect flaws in an argument. Flaws include false premises and the flawed reasoning that takes coincidence as causal argument and confuse necessary conditions with sufficient conditions, etc.

In contrast to the skill of analysis, synthesis functions in recombining the analyzed constituents into the whole. However, such recombination is not a simple process of adding parts together into a whole. It emphasizes the uniqueness and originality of the whole. Its first sub-skill is to detect the main position or point of view. It subsumes discovering hierarchical interrelations among the arguments, and how the different types of argument are combined to support the main position or point of view. The second sub-skill is to diagram arguments based on detailed analysis, which makes clear the process of the author's reasoning.

Evaluation refers to the assessment of arguments. The assessment of arguments involves judgment on acceptability and strength of premises and conclusions of a given argument, on whether a given argument is based on doubtful assumptions or presuppositions, and on confirmable strength of a given argument's consequences. It also includes judgment on the globe structure of the whole thought. The assessment and judgment requires criteria, which could be adapted from Paul's model, including elements and standards of thought. Elements of reasoning is only used to evaluate the completion of structure of the whole global thought, while the standards functions in evaluation of both local arguments and global thought.

C.   Critical Thinking Model

Generally, there are three traditional approaches to critical thinking models, which are in consistence with three approaches to conceptions of critical thinking. These academic traditions have developed their own specific models with variant concerns and purposes. The philosophical approach to the critical thinking model articulates reasoning elements and thought standards used to evaluate the elements. The psychological model of critical thinking is concerned with the skills or components in problem-solving. The educational model evaluates thought in educational settings (Irish, 1999). Richard Paul's model, Robert Sternberg's componental model and Bloom taxonomy are among the typical models of three traditions.

Richard Paul's model: Richard Paul's model has been evolved and improved since it was proposed in 1993. The purpose of Paul's model has always been to develop a flexible theory of critical thinking that can be contextualized

across various disciplines. As depicted in Figure 3, it consists of three parts: elements of reasoning, standards of thought, and intellectual traits (Paul & Elder, 2008a). Critical thinkers habitually employ the standards to assess the elements of reasoning in order to develop intellectual traits.

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│            Standards of Thought               │
│  Clarity   Accuracy   Precise   Relevance   Depth │
│  Breadth   Logicalness   Significance   Fairness   │
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┌─────────────────────────────────────────────┐
│             Elements of Reasoning             │
│  Purpose   Point of view   Concept   Question │
│  Information   Assumption   Inference   Implication │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│             Intellectual Traits               │
│  Courage   Empathy  Perseverance  Humility  Autonomy │
│  Integrity      Confidence in reason      Fair-mindedness │
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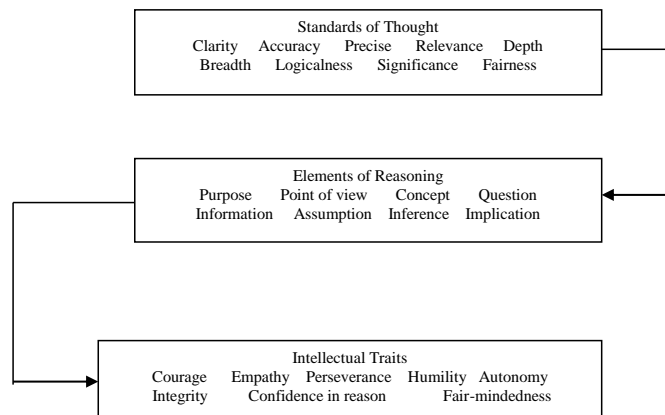
Figure 3. Paul's model (Paul & Elder, 2008a, p.19)

There are eight elements of reasoning: purpose, point of view, concept, question, information, assumption, inference, and implication. The elements are referred to as the fundamental structure of human thought and are always present in human thought consciously and subconsciously whenever and wherever reasoning is taking place. The ability to identify the elements of reasoning is essential to critical thinking. A person, who is adept at the identification of the elements, can be in a better position to recognize the flaw in this or that part, and thus, can be in a better position to analyze the mistakes in their thinking or in the thinking of others (Paul & Elder, 2002).

Paul and Elder summarized the interrelations among the eight elements of reasoning in the following statements:

"Whenever you are reasoning, you are trying to accomplish some purpose, within a point of view, using concepts or ideas. You are focused on some question, issue or problem, using information to come to conclusions, based on assumptions, all of which have implications" (Paul & Elder, 2002, p. 53).

The elements of reasoning function in interdependent fashion, and the way one element functions can influence the manner in which the other element functions. These elements constitute an interrelated system which can be used to analyze the completion of thought whenever and wherever it occurs in any context.

There are a range of intellectual standards from which we can choose to evaluate the quality of statements. However, the most fundamental are nine standards as the inclusion of Paul's model, which we routinely use in assessing statements—clarity, accuracy, precision, relevance, depth, breadth, logicalness, significance, and fairness. Good critical thinking necessitates a command of standards of thought. Paul stressed that these fundamental standards require being infused in all thinking as the guide to better reasoning (Paul & Elder, 2008a).

Critical thinking can be employed to serve two incompatible objectives: selfishness and fair-mindedness. Critical thinking in fair-minded fashion requires intellectual virtues which constitute the third dimension of Paul's model. As required, fair-minded critical thinkers strive to develop eight essential intellectual habits that lead to a disciplined mind: intellectual courage, intellectual empathy, intellectual perseverance, intellectual humility, intellectual automaticity, intellectual integrity, confidence in reason, and fair-mindedness. These eight traits of mind are interdependent. The interrelations among the virtues of strong-sense thinking are explicated as follows:

"To become aware of the limits of our knowledge, we need the intellectual courage to face our own prejudices and ignorance. To discover our own prejudices, in turn, we often must intellectually empathize with and reason within points of view with which we fundamentally disagree. To achieve this end, we typically must engage in intellectual perseverance, as learning to empathically enter a point of view against which we are biased takes time and significant effort. That effort will not seem justified unless we have the necessary confidence in reason to believe we will not be tainted or "taken in" by whatever is false or misleading in the opposing viewpoint" (Paul & Elder, 2002, p. 56).

To actualize fair-mindedness in critical thinking, it demands critical thinkers to be intellectually modest, intellectually courageous, intellectually honest, intellectually determined, intellectually empathetic, and have strong confidence in reason, and intellectually automatic, even though it is challenging and cannot be overtly taught (Paul & Elder, 2002).

Paul's model of critical thinking exemplifies perfections of strong and fair-minded thinking. Elements of reasoning and standards of thought constitute what is essential to critical thinking, while intellectual traits emphasizes what a critical thinker is disposed to be. It is concept-based, not composed of rules, procedures, and steps to follow. As a result, it is extremely flexible and applicable to any discipline and any level of thinking (Moseley et al., 2005).

Robert Sternberg's componential model: Robert Sternberg, a distinguished psychological and educational theorist, developed a well-know triarchic theory of intelligence of which componential model is one of three subtheories. Componential model consists of three kinds of components: metacomponents, performance components, and knowledge-acquisition components, which are considered as academic problem-solving skills (Sternberg, 1986). Analytic intelligence is the joint operations of three kinds of components.

Metacomponents are higher order processes executed in solving problems. They are used to recognize an existing problem, analyze the problem, and make a decision about which strategy is picked up. Metacomponents includes planning what steps are used, how to organize these steps into coherent strategies, and what resources are used; monitoring what has been done, what is currently doing, and what needs to be done in problem-solving; evaluating the results by using feedback when a problem is solved completely. They decide what performance components actually do.

Performance components, lower-order cognitive processes, play a role in the execution of instructions of metacomponents. Actually, strategies and steps decided by metacomponents need to be put into practice in solving problems by performance components. They are applicable in task solution and organize themselves into three stages: encoding stimuli, comparing and integrating stimuli, and response (Kaufman & Grigorenko, 2009).

In contrast to the first two sets of component which attach importance to problem-solving, the third set, knowledge-acquisition components, is thought as a mental processes involved in gaining knowledge. It includes three subprocesses: selective decoding, which refers to the task to sift out relevant information from irrelevant information; selective combination, which refers to the task to combine selectively encoded information into a plausible whole; and selective comparison, which refers to the task to compare and relate new acquired information to the previously gained information.

The componential subtheory, as one important part of Sternberg's triarchic theory of intelligence, highlights mental processes and a mechanism that underlies intelligent behaviors, i.e. how intelligent behaviors are generated, regardless of specific behavior contents. Three kinds of component are actually skills included in problem solving ability (Sternberg, 1986).

Benjamin Bloom's model: Benjamin Bloom's model--the Taxonomy of Educational Objectives aims to classify goals in the educational system, promoting research on problems and issues related to assessment of learning and on the relationship between assessment and education (Moseley et al., 2005). It intended to be helpful for teachers, administrators, and specialists who cope with curriculum and evaluation problems, not to provide insights into educational philosophy and teaching methods. Although it is not originally designed to enhance critical thinking instruction, its sections on analysis, synthesis and evaluation, contains a wealth of useful information about the instruction (Paul, 1985a).

Bloom's taxonomy consists of six hierarchical levels: knowledge, comprehension, application, analysis, synthesis, and evaluation, from the simple to the complex as the representation of thought. Six categories in the Taxonomy are interconnected in a stepwise manner from lower level 'knowledge' to the higher level 'evaluation'. As the foundation for higher levels, knowledge involves the recall of specific and isolable information and facts, of ways of organizing, judging, and criticizing facts and information, and of patterns, schemes, and structures by which information and facts are systemized (Bloom, 1956). As a precondition, knowledge requires one to comprehend what they remember about facts and information. After one knows and understands something, the next level is to apply them in particular and concrete situations.

The next higher level is to analyze material we understand and apply, breaking down the material into its componential parts and discerning the relationships among the parts and the way they are organized (Bloom, 1956). Still higher up is to synthesize the analyzed constitutes so as to form a whole and discover the patterns or structures not clear before. The highest level is evaluation, which is defined as making judgments about the quality of ideas, works, material, knowledge, and so forth (Bloom, 1956). It involves the utilization of internal criteria such as logic accuracy or consistency, and external standards for appraising the judgments. Bloom's taxonomy is a cumulative hierarchy in which six levels are ordered on a single dimension from simple to complex and from concrete to abstract. There is no overlap among these levels and mastery of lower levels is a prerequisite for mastery of higher ones (Krathwohl, 2002).

Bloom's taxonomy is a well-known framework for classifying a number of educational objectives into clear structures and a coherent framework for classifying thinking according to levels of complexity. Bloom (1956) intended the Taxonomy to "be a classification of the student behaviors which represent the intended outcomes of the educational processes" (p.12). By depicting differences between the intended behaviors specified by instructional objectives and the actual behaviors as the result of students' participation in the unit of classroom instruction, one can verify whether instructional objectives have been achieved, and whether a particular intended skill has been learned. Therefore, Bloom's taxonomy is significantly valuable in education and can be applicable to all the subject-matter content at different levels of education in different schools (Bloom, 1956). Nevertheless, it notes that the Taxonomy is one-sided hierarchy that limits our understanding of nature of critical thinking (Paul, 1985a). Paul pointed out that gaining knowledge simultaneously entails comprehension, analysis, synthesis, and evaluation.

Implication for the model utilized in non-western culture: Three types of models as represented in three traditions to critical thinking have their significance in building the model used for the instruction of critical thinking in non-western

learners. The proposed model would include the elements of reasoning and standards used for evaluating these elements in Paul's model to evaluate the whole thought and specific arguments and the higher levels of the Taxonomy which correspond to the levels of critical thinking skills. However, the model would not include components, employed in Sternberg's componential model, because, according to the definition of component as "an elementary information process that operates on internal representations of objects or symbols" (Kaufman & Grigorenko, 2009, p. 6), metacomponents can be regarded as equivalent to metacognition. It has two aspects: ability to reflect on cognition, which involves understanding of cognitive resources and operational processes in the facilitation of comprehension; and ability to control cognition, which involves mental mechanism in monitoring comprehension and regulating efforts to improve comprehension (Koda, 2005). Performance components also bear similarities to cognitive processes. Therefore, Sternberg's componential model is not so much a critical thinking model as a psychological model.

II. CRITICAL THINKING INSTRUCTION

Long history of critical thinking instruction has prompted a variety of arguments, and approaches and strategies, and assessment concerned with critical thinking instruction. This section mainly discusses the following topics: disputes on instruction of critical thinking, instructional approaches to critical thinking, and specific instructional strategies for critical thinking and assessment of critical thinking.

A. Controversy in Critical Thinking Education

Since Socrates practiced teaching critical thinking, a variety of principles and concepts have been proposed about instruction of critical thinking. However, no agreement has been achieved on how to teach critical thinking, though all agree that teaching students to be critical in their studies and their future life and work should be the goal of higher education (Moore, 2011). The conflicting debate has been continuing on whether critical thinking can be taught independently of subject-matter or not, which is closely related to the disputable assumption: whether there are general critical thinking skills, and whether general critical thinking skills can be transferred if there are. The assumption of general critical thinking skills hinges on the assumption of the transferability.

The controversy in critical thinking instruction is referred to as the generic vs. discipline-specific debate between the generalists and the specificists. Ennis (1989, 1990, 1997) is considered as the leading defender of the generalist movement, while McPeck (1984a, 1984b, 1985, 1990) is regarded as the leading defender of the specifist movement. McPeck criticized the trend of teaching critical thinking as a subject of study in itself and claimed that critical thinking is always about something in particular, and therefore critical thinking must be taught by embedding it into something particular in a curriculum subject. McPeck reiterated that there are no general and transferable critical thinking skills, but subject-specific skills. In contrast, Ennis and other generalists (Higgins & Baumfield, 1998; Johnson, Siegel, & Winch, 2010; Paul, 1985b; Quinn, 1994) assert that there exist indeed general and transferable critical thinking skills which can apply across disciplines and fields. These skills must be taught in a general course where they are not overshadowed by subject content.

Although the importance of subject-specific knowledge is not ignored, it is contended that there are some general critical thinking skills unrelated to subject-content. Subject-specific knowledge is not a sufficient condition for thinking critically (Ennis, 1989). Even if we accept the important role of subject-specific knowledge in thinking critically, there are still some areas within different subjects that are "sufficiently similar or overlapping as to make general thinking skills possible, especially during the process of schooling" (Higgins & Baumfield, 1998, p.396).

In essence, the debate between the generalists and the specifists is like two sides of one coin: the generalist movement focuses on the mental aspect of critical thinking, i.e. logical principles of reasoning independent of subject matter; the specifist movement emphasizes the practical aspect of critical thinking, i.e. application of reasoning principles in subject matter (Bailin, 1998; Bailin et al., 1999b). The difference between the generalist and the specificist is actually the range of application of intellectual resources rather than general and transferable critical thinking skills themselves. Intellectual resources include background knowledge and reasoning principles, concepts and procedures (Bailin, 1998). The researcher believes that emphasis on one end of reasoning principles, concepts and procedures does not imply the ignorance of the other end of the application along the continuum. It is different focuses that matter. The instruction of critical thinking in non-western culture should place emphasis on both of reasoning principles, concepts and procedures and their application to professional and daily lives. The competent application of reasoning principles, concepts and procedures is an attribute of critical thinking skill. Therefore, the development of general critical thinking skills is actually to develop students' competent application of reasoning resources in various practical contexts.

B. Approaches to Critical Thinking Education

The debate on whether critical thinking can be cultivated independently or not leads to different instructional interventions in critical thinking development. In particular, dispute on whether critical thinking is subject-specific or not brings about four main types of instructional approach: general critical thinking course, infusion, immersion and mixed approach of general approach with infusion or immersion (Ennis, 1989). In addition to the instructional approaches, there is another type of instructional intervention: the whole academic degree program where effects of entire degree programs on the development of critical thinking skills are investigated (Behar-Horenstein & Niu, 2011;

Niu, Behar-Horenstein, & Garvan, 2013). Niu et al. (2013) considered whole academic degree program as "holistic approach". Due to its long duration of non-obvious and indirect instruction, holistic approach is discussed independently of the other instructional approaches.

Holistic approach: Holistic approach normally lasts for at least one year, even more than two or three years. The approach mostly uses pretest and posttest to measure the utility or efficiency of an academic program in the development of critical thinking. In a study conducted by McMullen and McMullen (2009), participants from three successive classes were drawn to explore the effect of a two-year nursing program on the improvement of participants' critical thinking skills. No direct instruction of critical thinking took place. California Critical Thinking Skills Test (CCTST) was employed to assess participants' critical thinking at program entry and three times during the program. The result indicated that the growth on participants' critical thinking skills was not linear, but quadratic, and that students at higher and median skill levels at the program entry showed a modest increase in evaluation skills, a sharp decrease in analytic skills and unchanged inference skills, while those at lower skill levels showed substantial increase in all three critical thinking skills. However, as McMullen and McMullen themselves pointed out, one independent sample without a control group restricts us to claim a causal relationship between the growth in participants' critical thinking and their participation in the two-year program.

Researchers admit that length of programmatic approach, another threat to validity, is an intervening factor which poses some confounding effects on the consequence of the program. Behar-Horenstein and Niu (2011) pointed out that, among these studies, few have made efforts to address these threats in programmatic intervention. In spite of these defects inherent in instructional program, it is undeniable that, to a certain extent, these studies suggest a positive effect of programmatic intervention in critical thinking development.

Alternative instructional approach: There are two camps of instructional approaches to critical thinking. One camp, defended by Ennis and then by Davies, advocates for explicit instruction of critical thinking under the assumption that critical thinking can be defined as a set of skills and these skills are specific, teachable through description and practicing, and that, once learned, they can be used for a variety of issues (Davies, 2006, 2011; Ennis, 1991). In compliance with this view, critical thinking can be taught explicitly as a subject of study itself (general approach), or by being infused into a subject (infusion), or combination of general approach with infusion or immersion (mixed approach). The other camp with proponents—McPeck and Moore, upholds that critical thinking can be regarded as a subject-specific skill which can be learned and practiced only in particular subject matter (McPeck, 1985; Moore, 2011). Therefore, leading figures in this camp advocate for the immersion approach to critical thinking instruction. Moore advocates that critical thinking can be developed only through prolonged immersion in the content of discipline, and that exposure to and participation in a variety of subject matter instructions can result in an automatic critical thinker.

Ennis (1989) elaborated four instructional approaches to critical thinking. General approach is that critical thinking can be taught in separation from the presentation of content of existing subject matter; infusion refers to an approach that instruction of critical thinking abilities is embedded into existing subject matter in which general principles of critical thinking are made explicit; immersion is similar to infusion except that general principles are not made explicit; for the mixed approach, general principles of critical thinking are taught in a separate course in parallel with subject-specific critical thinking instruction. Ennis claimed that views on general and transferable critical thinking skills determine what approach is chosen by researchers and the approach chosen implies the support with the generalist or the specificist. Therefore, the author has to make it clear that a certain instructional approach chosen to be employed in this study does not imply the author's alignment with either side of the debate.

Among studies on effectiveness of instructional interventions in the improvement of critical thinking skills, the author believes that no evidence has sufficiently persuasive power than what is drawn from meta-analysis studies. Behar-Horenstein and Niu (2011) reviewed 61 empirical studies published from 1994 to 2009, which focused on the improvement of college students' critical thinking skills through instructional interventions, and found that the first frequently used approach (52% of the studies reviewed) is immersion; the second one is holistic approach (19%), and the other three approaches have an equal rank as the third (each 9.5%). Immersion is reported to yield lowest growth of students' critical thinking out of all the approaches. Abrami et al. (2008) conducted a meta-analysis of instructional interventions affecting critical thinking skills with 117 empirical studies published from 1960s through 2005 and found that the mixed approach outperforms and the immersion underperforms the other three instructional approaches significantly. General approach and infusion are found to have moderate effects. Infusion and immersion are employed more frequently than the other two approaches. In another meta-analysis of effects of instructional interventions on college students' critical thinking skills, in which immersion is the first frequently used approach and holistic approach is second, Niu et al. (2013) found that a single intervention longer than 12 weeks is more effective than single interventions shorter than 12 weeks or the holistic approach. It can be inferred from such findings that the effect of a single intervention is confounded with length of exposure to that intervention. The longer exposure to a single intervention, the more effective such single intervention is.

The aforementioned research reviews indicate that, among five instructional approaches to critical thinking, immersion which is used most frequently has the smallest effect. Holistic approach also has a small effect, though better than immersion. Mixed approach is reported to be most effective in improving students' critical thinking ability. General approach and infusion both have a moderate effect. Another finding is that effect of a particular approach is

influenced by length of exposure to the approach. The longer the exposure is to one single approach, the more effective the approach is found to be. Although, the duration of 12 weeks was found to be a determinant of effects of a single approach, it is not reasonable to make a conclusion that the length of exposure of at least 12 weeks is a threshold for effects of a single approach.

C. Teaching Strategies for Critical Thinking

In addition to teaching approaches, educators and researchers attempt to deploy a variety of specific teaching strategies to develop critical thinking. Among the most frequently used strategies are group discussion, concept mapping, and questioning (Lee et al., 2012; Qatipi, 2011; Savage, 1998; Walker, 2003). These three teaching strategies were used in the development of critical thinking skills in this study. This section mainly discusses them.

Group discussion: Many studies have been conducted to examine the effects of group discussion on critical thinking development. It has been found to be an effective teaching strategy for the development of critical thinking. Some studies discussed and elaborated group discussion used in their courses (Bucy, 2006; Sionti, Ai, Ros é, & Resnick, 2011); some conducted empirical studies to investigate effects of group discussion (Chiu, 2009; Pena & Almaguer, 2012; Yang, 2008), which could provide more persuasive evidence.

Hudgins and Edelman (1986) conducted a study with the duration of six weeks to examine the effect of group discussion on critical thinking development. Ten classes in five primary schools were chosen as a sample and in each class students were assigned into two groups: experimental group and control group. The instrument 'Test of Critical Thinking' developed by the researchers was employed in pretest and posttest to assess participants' critical thinking. The results showed that there is no significant increase in children's critical thinking ability in the experimental group compared to the control group. The difference is negligible. Hudgins and Edelman explained that no significant increase is due to a short period of six weeks, and that more lessons and longer discussion could bring about significant improvement of critical thinking.

Hayes and Devitt (2008) conducted a study with the duration of sixteen weeks in a college. The ACT-CAAP critical thinking test was administered in pretest and posttest to measure participants' critical thinking skills in two groups. The results showed that group discussion in small classes can significantly improve critical thinking skills more than in large classes. Another important finding is that non-native English speakers acquired a significant improvement of their critical thinking skills, which was not found for native English speakers, though native English speakers have higher scores of critical thinking skills in both pretest and posttest than non-native English speakers. Hayes and Devitt explained that native English speakers have higher scores because of their higher reading ability. In addition, the reason why non-native English speakers obtained significant improvement of critical thinking skills while native English speakers did not is that familiarity with new terminology and frequently practicing of group discussion contributes to the development of critical thinking skills.

The empirical evidence indicates that group discussion is more effective for college students than for the students in the primary school. That is, it can impose greater influence on the improvement of critical thinking with learners who have grown up intellectually and cognitively. Its positive effects on development of critical thinking also depend on the length of discussion treatment.

Concept mapping: In addition to group discussion, a concept map has been found to be also effective in the development of critical thinking. Vacek (2009) introduced concept mapping as a teaching tool to facilitate critical thinking. He believed it would improve the use of various critical thinking skills. However, Vacek provided no experimental evidence to support such an assertion, and no description of how to use concept mapping in a particular context. The empirical evidence for the effect of concept mapping on improvement of critical thinking can be found in the study conducted by Wilgis & McConnell (2008). There is a small convenience sample of fourteen 'Novice Graduate Nurses' and a two-day treatment intervention in the study with only one treatment group. Concept mapping was employed as both a teaching strategy and evaluation of critical thinking. Concept mapping was found to be effective in accelerating participants' critical thinking ability to synthesize and prioritize information, make appropriate plans and make judicious decisions. However we can still cast some doubts on the findings because of short-time treatment, no control group, and implausible instruments.

The convincing and persuasive empirical evidence is offered in the study by Lee et al. (2012). The study used quasi-experimental design in a two-year registered nurse baccalaureate program. The results showed that, although there is non-significant decease of critical thinking in both groups, participants in the experimental group significantly outperformed the control group in inference and deduction among five critical thinking abilities and have higher growth rates of these two skills. Lee explained that the decrease of critical thinking for participants in both groups is due to regression effects with higher initial scores. As mentioned earlier, it is actually long duration of the holistic approach that confounds the effect of concept mapping.

The above studies are conducted on the basis of the content of nursing training, and thus, it may be effective only in the nursing educational setting. It needs to some studies conducted in an EFL educational situation to justify whether concept mapping is similarly plausible for EFL learners' development of critical thinking. For that reason, Khodadady & Ghanizadeh (2011) conducted a study with the aim to investigate the influence of concept mapping on the development of critical thinking ability with EFL learners. Thirty-six students at upper intermediate and advanced levels were chosen and randomly assigned to treatment and control groups. Treatment intervention consists of concept

mapping after reading each text and formulation of required post-reading activities during the three-month session. "Watson-Glaser Critical Thinking Appraisal" (CTA) was employed to measure participants' critical thinking ability. The results showed that concept maps significantly foster EFL learners' critical thinking ability in the reading class. This study suggests that concept mapping as a teaching strategy is effective across specific disciplines in improvement of critical thinking.

Questioning: Asking right and critical questions can stimulate and direct critical thinking and push us forward towards the continuous exploration of opinions, insights and judgments (Browne & Keeley, 2007). Seker & Komur (2008) investigated the relationship between critical thinking skills and in-class questioning behaviors of students. Twenty second-year students of an English language teaching department were chosen and assigned to a higher-level group and a lower-level group in terms of critical thinking ability. A reading text was used to elicit information about questions asked by participants and the "Ennis-Weir Critical Thinking Essay Test" was used to measure critical thinking ability. It was found that students with lower-level of critical thinking ability ask less questions than those with higher-level, and that students with higher-level ask more questions concerning comprehension, application, analysis, synthesis and evaluation when compared to questions concerning knowledge asked by those with lower-level. This study proved that critical thinking ability has an important influence on the types of questions asked by participants. However, it did not provide direct evidence about effects of questioning on critical thinking development.

Alexander, Commander, Greenberg, and Ward (2010) explored the effects of a 'four-question teaching technique' on the enhancement of critical thinking in online discussion. The study used the combination of two strategies: questioning and group online discussion. Twenty-four students were chosen to participate in online discussion forums. There were three asynchronous discussion forums with topics about three different cases studies on behaviorism, social cognitivism and metacognition. The first forum was conducted during the second week of the course. The second and last forums were conducted at the middle and end of the course, respectively. The participants were randomly assigned to groups of 5or 6, but they were not always in the same group for each forum. The four-question technique was employed for three forums, but completed only for the second discussion forum, not for others. The instrument 'Washington State University Critical and Integrative Thinking Scale (WSUCITS)' was used to measure critical thinking. The four-question technique was found to has a positive role in improving participants' critical thinking. The same effective results were found in another study by Barnett & Francis (2011). The difference is that written questions, not oral ones, were used in the study. It was found that the students receiving quizzes which contain written high order thinking questions performed significantly better than those receiving quizzes which do not contain such questions.

The evidence provided in the above studies proves that there is a close correlation between learners' critical thinking ability and the type of question. Students with higher critical thinking ability tend to ask more questions than those which lower critical thinking ability. Questioning plays a significant role in developing critical thinking.

D.   Assessment of Critical Thinking Skills

Among the most commonly used tests of critical thinking skills are California Critical Thinking Skills Test, Watson-Glaser Critical Thinking Appraisal, and the Cornell Critical Thinking Test (Abrami et al., 2008; Fawkes, O'meara, Weber, & Flage, 2005; Niu et al., 2013). The California Critical Thinking Skills Test (CCTST) is a standardized, 34-item, multiple-choice test with the aim to assess three core critical thinking skills: analysis, evaluation, and inference; and two traditional reasoning skills: deduction and induction.

To examine whether the California Critical Thinking Skills Test (CCTST) measured the enhancement of critical thinking skills gained by students after they completed critical thinking courses, Facione (1990a) conducted four experiments and found that CCTST can detect the growth in critical thinking skills achieved by the students. CCTST has shown to be reliable and valid, and been widely used to assess college students critical thinking skills (Phillips, Chesnut, & Rospond, 2004). The Watson-Glaser Critical Thinking Appraisal (WGCTA) and the Cornell Critical Thinking Test (CCTT) also enjoy high popularity among researchers. Both of them are standardized, multiple-choice tests and have been proved to have high reliability and validity. However, a standardized multiple-choice test has inherent weakness.

Multiple-choice tests can only reveal test-takers' recognition of knowledge, not their underlying reasoning ability (Ku, 2009). Norris (1988) cautioned that multiple-choice critical thinking tests cannot distinguish "variance in scores due to the differences in the background beliefs of examinees which are not part of ability to thinking critically from variance due to differences in critical thinking ability" (p. 2). The reason is that alternative solutions to a problem and alternative approaches to reaching a solution which are the nature of critical thinking bring about difficulties for the multiple-choice tests. This type of format structure, as Yeh (2001) pointed out, cannot assess respondents' ability to weigh various claims according to available evidence, and decide which claim is well supported and why alternative claims are not well supported, even though respondents can perform well.

Ennis (1993) suggested an open-ended, but focused approach to the assessment of critical thinking skills, which reiterates his earlier suggestions of viable alternatives to multiple-choice tests, such as the addition of justification requests to multiple-choice items, essay testing and performance assessment. Therefore, a test that requires test-takers to read and evaluate arguments through written essay is considered as authentic assessment of critical thinking, such as 'The Ennis-Weir Critical Thinking Essay Test' and 'the ICAT Critical Thinking Essay Test'.

It is noticeable that there are some differences between the test through reading a written essay and through writing an essay, even though they both belong to an essay test of critical thinking. The test that requires test-takers to read and evaluate arguments through written essay can be designated as a 'receptive test', while the test that requires test-takers to apply their critical thinking into writing an essay as a 'productive test' (Hinkel, 2011). Receptive tests place emphasis on application of knowledge of reasoning into recognition, analysis, synthesis, and evaluation of arguments with more weight on declarative knowledge than procedural knowledge. The range of expected responses in receptive tests is limited due to limited arguments from input texts. In contrast, productive tests focus on application of knowledge of reasoning into reasonable and logical expression of points of view with more weight on procedural knowledge than declarative knowledge. The range of expected responses in the productive test is larger than in the receptive test.

The commonly used tests-CCTST, WGCTA, and CCTT are the examples of a receptive test, while the ICAT Critical Thinking Essay Test and the Ennis-Weir Critical Thinking Essay Test is an example of a productive test. Whether receptive test or productive test, these essay tests are time-consuming and not appropriate for large-scale assessment. Therefore, to achieve cost-effect balance, it is better to combine multiple-choice and giving reasons for choice, which could be supposed to be used in non-western settings.

In empirical practice, aforementioned tests have to be translated into different versions when they are employed in non-English speaking contexts. Instrument translation poses some threats to validity of the translated instrument (Maneesriwongul & Dixon, 2004; Peña, 2007; Rode, 2005; Sripusanapan, 2001; van Widenfelt, Treffers, Beurs, Siebelink, & Koudijs, 2005). Bias is a direct threat to validity. There are some types of bias, in particular, cultural bias, which translation cannot smooth away.

There are two procedures of instrument translation in order to reduce potential threat as much as possible. One is translation-backtranslation procedure that is commonly used to guard against potential threat to validity of translated instruments. However, linguistic translation-backtranslation is not sufficient to effectively remove cultural bias. Linguistic equivalence in the translation of research instruments cannot remove potential differences which lead to different patterns of response, due to different cultural interpretations (Peña, 2007). It is the carefully crafted and culturally appropriate translations that can ensure that examinees' performance on the measure is most likely and accurately to be reflective of their critical thinking. However, given the great difference between the western and eastern culture, it is not an amiable task to achieve culturally appropriate translation. Therefore, in practice, adaptation is commonly used in conjunction with partial translation to change, or reword, even create new questions and items so that the original cultural flavor can be maintained to a greater extent.

Another procedure is 'multidisciplinary committee approach' through which a group of people from different areas prepare translation (van de Vijver & Tanzer, 2004). It can enhance quality of translation through collective efforts and, especially, in the case when they have complementary expertise of different areas. However, it is practically unfeasible to group people with different areas of expertise, such as psychological, linguistic, and cultural. Therefore, for the assessment of critical thinking in non-western culture, in particular, Confucian culture, it is necessary to develop the valuation system to assess learners' critical thinking ability which is compatible with the local culture.

III. CONCLUSION

Since the research and instruction of critical thinking commenced in ancient Greece, it is mainly conducted in western educational institutes in western countries such as the United States of America (Atkinson, 1997; Day, 2003). its essential core was built up in western society and its creation, development and instruction were based on western academic tradition. Atkinson expressed cautions against the development of critical thinking in the East. He believed that critical thinking is a social and cultural practice and therefore, is difficult for non-western learners to master. Therefore, on the basis of review of various conceptions and models of critical thinking, the researcher proposed the concept of critical thinking and suggested what models could be possibly employed in building the model suitable for non-western culture and society.

In pedagogical practice, a variety of instructional approaches and specific teaching strategies have been developed and experimented with, among which immersion and the holistic approach are found to be less effective than infusion and general approach and in turn than general approach in improving critical thinking skills, and group discussion, concept mapping and questioning are found to be among commonly-used teaching strategies. However, empirical evidence was mostly produced in experiments mainly conducted in western culture, which needs rigorous evidence from non-western context. For assessment of critical thinking, researchers and educators have developed a variety of inventories among which the commonly-used tests mostly employ multiple-choice format. Some took the format of essay. Both formats have their inner weakness, which requires the combination of them in order to achieve cost-effect balance, which is particularly practical for the assessment of critical thinking in non-western society.

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