ASSESSING UNIVERSITY STUDENTS' GENERAL AND SPECIFIC CRITICAL THINKING

Chau-Kiu Cheung, Ph.D., Elisabeth Rudowicz, Ph.D., Anna S.F. Kwan, Ph.D., Xiao Dong Yue, Ph.D.

City University of Hong Kong

Acknowledgments. This manuscript is prepared under the research project, "Teaching Students to Learn. Think Critically, and Creatively" (Grant #TG0022), funded by the City University of Hong Kong. This project, led by Dr. Graeme Lang, is part of a group of projects under the overall leadership of Prof. Edmund Ko. We appreciate the assistance of Ms. Kit-yin Chung in collection and coding of the data.

Correspondence: Chau-kiu Cheung. Department of Applied Social Studies, City University of Hong Kong, Tat Chee Avenue, Kowloon (e-mail: ssjacky@cityu.edu.hk) Assessing University Students' General and Specific Critical Thinking

The study aims at examining the validity of a measure of critical thinking and at verifying the concept of general critical thinking. Components of this concept comprise cognitive skills, motivational disposition, behavioral habit, and ideological belief. They correspond to eight measures of the critical thinking components of 577 university students. Results show that the eight measures were reliable according to latent trait models for dichotomous and graded data and reflected a common factor of general critical thinking, and had consistent relationships with a set of background characteristics, including years and fields of study. They also indicate that each of the eight components contributes significantly to general critical thinking. Furthermore, they demonstrate convergence in the predictive validity of alternative scores of general critical thinking. Students of humanities and social sciences were consistently higher on various scores of general critical thinking based on different sets of weights applied to the eight components.

Fostering students' critical thinking has been an increasingly important goal for university education (Macalister, 1999). It has received high ranking among faculty (Browne & Littwin, 1987). Obviously, assessment of students' critical thinking is essential for tracking its development. For this purpose, instruments have been available in the West (Facione et al., 1998; Watson & Gracer, 1994). However, these instruments require modification and adaptation when applied to countries where English is not the primary language and whose cultures, including values and lifestyles, are remarkably different from that of the West. It appears that an individual's reading skills, especially for a second language, interfere with assessment of critical thinking (Ennis & Norris, 1990). Areas for modification include broaden-
ing the conceptualization of critical thinking from one concentrating on skills to one also incorporating dispositions, beliefs, and habits essential for assessment in the educational setting (Ennis & Norris, 1990). This broader assessment of critical thinking necessarily raises the issue of the weighting of critical thinking components in order to identify general critical thinking. This is the task of validation and calibration for the measure of critical thinking. The present study performs such a task with a sample of university students in Hong Kong. It adapts and develops eight measures to tap a student’s critical thinking skills, dispositions, beliefs, and habits and then assesses the student’s general critical thinking with alternative weighting procedures in order to determine the validity of the measures.

The exclusive emphasis on the cognitive skill component of critical thinking has been contentious because it ignores other important components (Keeley & Browne, 1986). As such, students appear to fail in their practice of critical thinking, including identifying ambiguity and hidden values in written sources. Moreover, more critical reviews of critical thinking suggest that the assessment needs to incorporate measures of dispositions, beliefs, and behaviors that are stable and desirable to counter faulty ideologies and myths (Brookfield, 1987; Halpern, 1998; Moon, 1999). These pragmatic and critical remarks point to the need for more adequate assessment that is general enough to reflect a student’s skill, motivational disposition, habit, and belief integral to critical thinking. Further to this, it is necessary to demonstrate these different components form a coherent measure. This is the objective of the present study.

**Conceptualization of Critical Thinking**

Critical thinking suggests an integration of being critical and the thinking process. However, many previous conceptualizations tend to focus exclusively on thinking and neglect its essential qualifier, critical. Thus, they overemphasize thinking skills and downplay critical elements. An adequate conceptualization of critical thinking should combine cognitive thinking skills, motivational dispositions, behavioral habits, and ideological beliefs. A profusion of concepts has appeared to clarify skills involved in the cognitive thinking components that define critical thinking. The concepts include interpretation (categorization, decoding significance, clarifying meaning); analysis (examining ideas, identifying arguments, analyzing arguments); evaluation (assessing claims, assessing arguments); inference (querying evidence, conjecturing alternatives, drawing conclusions); explanation (stating results, justifying procedures, presenting arguments); self-regulation (self-examination, self-correction); deduction (analogic reasoning, using analogies, formulating hypotheses, extension of arguments, ability to build knowledge, modeling, prediction, adaptive reasoning); and their overall integration (Bensley & Haynes, 1995; Bourland-Davis, 1998; Dexter et al., 1997; Eljamal et al., 1998; Hynd, 1999; Taube, 1997). While many of these notions have stemmed from research and theorizing involving eminent philosophers and scholars (Eljamal et al., 1998), they become hardly distinguishable from
alternative views of thinking, including logical thinking, creative thinking, theorizing, decision making and problem solving, leading to the problem of conceptual overlap and confusion.

Emerging with the elaboration of critical thinking skills is the introduction of motivational dispositions as an essential component of critical thinking (Facione et al., 2000). The motivational component tends to include the following dispositions: inquisitiveness, concern for being well-informed, alertness to opportunities, trust in the processes of reasoned inquiry, self-confidence in own ability to reason, open-mindedness, flexibility, understanding of opinions of others, fair-mindedness, honesty in facing biases, prudence, willingness to reconsider, clarity, orderliness, diligence, reasonableness, care in focusing attention, persistence, and precision (Pascarella et al., 1996; Taube, 1997; Weinstein, 1992).

This profusion of concepts again creates the problem of conceptual overlap and confusion in relation to alternative concepts inherent in personality. It is therefore important to discern dispositions that have least overlap and confusion with major personality traits. Inquisitiveness and truth-seeking stand out as two notions central to critical thinking or being critical and absent in major personality traits, such as openness to experience, conscientiousness, and agreeableness (Soldz & Vaillant, 1999).

Critical thinking also implies action or habit—a behavioral dimension. At least, it is desirable and necessary for students to demonstrate their critical thinking in their work (Browne & Litwin, 1987). Problems have been notable in students' failure to apply their ability in real-life practice of critical thinking (Keeley & Browne, 1986). Accordingly, students appear to be sensitive and overly critical of numbers or statistics rather than words and the logic of thinking and they are unable to identify ambiguity, values, and value conflict inherent in real-life messages and therefore ask wrong questions about them (Keeley & Browne, 1986). That is, they ask questions about the computation of a statistical figure rather than the logic involved in deduction and inference. They are fond of faulting messages for not providing detailed information rather than revealing hidden assumptions and values in them. This behavior illustrates that students do not adequately apply their critical thinking skills, in spite of their importance (Chiodo & Tsai, 1995; King, 1995). Notably, the practice of critical thinking would become a habit or life style for the student to exercise skills of analysis, comparison, prediction, application, deduction, synthesis (problem solving), and perspective taking. The converse case is uncritical thinking practice in terms of compliance with others' demands and one's preexisting habits, trivializing, and superficial thinking.

Beliefs are an integral ideological component of critical thinking, but they rarely figure in assessment tools (Ennis & Norris, 1990). Their importance is notable in the emerging concern for reflective thinking and learning in education (Moon, 1999). This concern has lent support for critical beliefs that knowledge is not absolutely certain and that it serves to emancipate people from the oppression of
unreasonable structure and ideology (Habermas, 1972; Moon, 1999). On the other hand, critical beliefs would manifest in endorsement to the scientific worldview, which dictates the need for understanding how the world operates, with reference to a set of general principles for pursuing truth. This worldview is at odds with paranormal belief and absolutist belief, which constrain the individual’s pursuit of truth. As in the past relevant research (Klaczynski et al., 1997, 1998), paranormal belief refers to agreement with such statements as "it is important to avoid certain unlucky numbers when choosing where to live", "advice from a horoscope is believable", and "you have a personal possession which you think can bring you luck". Such views are not consistent with the scientific worldview. The role of critical thinking is presumably to counter paranormal belief and other beliefs at odds with the scientific worldview (Halpern, 1998). Absolutism, as in the past relevant research (Klaczynski et al., 1997, 1998), refers to agreement with statements such as "right and wrong never change", and "there is only one good solution to most problems". This kind of belief is detrimental to critical thinking to the extent that it oversimplifies reality and hinders an appreciation of the complexity of social life in a pluralistic society. Critical thinking should manifest both orientations to truth seeking and awareness of diversity (MacPhee et al., 1994).

Integrating the cognitive, motivational, behavioral, and ideological components of critical thinking provides a basis for its thorough assessment (Ennis & Norris, 1990; Klaczynski et al., 1997). The cognitive component, dealing with skills of interpretation, analysis, evaluation, and inference, would involve the student’s reading a message and making judgment about its implications. This is a task most typical in the measurement of deduction in critical thinking (Watson & Glaser, 1994). In addition to tapping students’ ability in deduction, the measure of reasoning assesses their recognition of various fallacies, including those concerning overgeneralization, slippery slopes, and faulty association (Halpern, 1994). The measure can also tap students’ knowledge about sociopolitical values, which is essential for detecting the incredibility of an argument (Browne & Litwin, 1987).

The motivational component refers to critical thinking dispositions to truth seeking and inquisitiveness (Facione et al., 1998). It taps the student’s ongoing concern about critical thinking. The behavioral component focuses on the student’s study experience or habit. It addresses questions about how often the student exercises critical thinking in the classroom and individual study (King, 1995; Shepelak et al., 1992). The ideological component tackles beliefs in absolutism and paranormal ideas (Klaczynski et al., 1997; Royalty, 1995), which are negative indicators of critical thinking.

**Purpose of the Present Study**

The primary goal of the study is to examine the validity of a measure or a procedure to identify general critical thinking that is equally applicable to students of various background characteristics. Such a measure is a form of aggregation of eight components (two for each) of the cogni-
tive, motivational, behavioral, and ideological dimensions of critical thinking. For this goal, the measure needs to demonstrate (1) internal consistency in each of its eight components, (2) convergence of the components and alternative ways of scoring, and (3) convergence of alternative ways of scoring such that they show similar relationships with such background factors as age and year of study.

A secondary goal of the study is to verify the robustness of the concept of general critical thinking against variation due to alternative ways of scoring that eliminate potential bias due to age, sex, fields and years of study, levels of GPA and interest, and fathers' employment conditions (but not mothers' employment, which has not been a common indicator of the family background [Sorensen, 1994]). This issue arises because of the likelihood of differential importance of different components in identifying the general critical thinking of students with different background characteristics. For instance, there may be differential interpretation and importance of different components between men and women (Clinchy, 1989).

Predictions

With regard to predictive validity, the measure of critical thinking should demonstrate relationships with background characteristics that agree with theory and existing research. Research has shown that a student studying humanities and social science shows better critical and logical thinking than others (Gadzella & Masten, 1998; Lehman & Nisbett, 1993). The reason is that disciplines such as sociology and psychology put greater emphasis on critical thinking (Gadzella & Masten, 1998a; Misra, 1997; Shoemaker et al., 1993; Weast, 1996). Some argue that psychologists emphasize the cognitive component of critical thinking skills and sociologists apparently neglect it (Gadzella & Masten, 1998). Sociologists seem to emphasize the ideological component of critical thinking, in pursuit of social critique, sociological imagination, and unveiling social forces. Perhaps, even though students of sociology may suffer in the cognitive skill component of critical thinking, they would have superior manifestations in other aspects of critical thinking. Altogether, social science students would show higher levels of critical thinking than students in other disciplines.

Research has indicated that students at a senior level of study are more competent and studying for a higher degree score higher on critical thinking (Spaulding & Kleiner, 1992). This finding suggests higher levels of critical thinking among students with higher GPA and a higher level of study. This expectation would be consonant with cognitive development theory that emphasizes the role of cognitive abilities in favorable academic performance (Meyers, 1987). Moreover, research has shown that cognitive abilities contribute to critical thinking (Sa et al., 1999).

Interest in completing the survey concerning critical thinking would have a positive effect on students' scores on critical thinking, as demonstrated in research on interest on knowledge and processing of information about a subject (Alexander & Murphy, 1998; Alexander et al., 1998; Tobias, 1994). This expectation would be consistent with studies which have found.
higher critical thinking among students who have higher need for cognition and more active learning (Blinde, 1995). Moreover, research also has attributed the greater development of critical thinking of adult students to their higher interest to study (Graham & Donaldson, 1999).

Some people who are self-employed would encounter more challenge that draws out their critical thinking than employees who do not have independent decisions to make. These self-employed people would be more autonomous and rely on their own thinking rather than follow conventions (Kluegel & Smith. 1986). Because of the father’s influence on his children (Grolnick et al., 1991). some of the students whose fathers are self-employed would develop higher levels of critical thinking. In sum, students of different background characteristics would exhibit differential levels of critical thinking.

The theoretical and research data lead to formulation of predictions that expect higher levels of critical thinking in a student who has higher GPA and higher interest, has studied in humanities and social sciences, and pursued a degree rather than a high diploma, and whose fathers are self-employed. Group differences that are in line with the expectations would support the predictive validity of the measure of critical thinking.

Methods
In April and May 2000, 577 students in the City University of Hong Kong completed a survey questionnaire in English. They were students attending a dozen classes selected to represent students of the three major areas of study (business, humanities and social sciences, science and technology) and the three years of study (Year 1 to Year 3). The questionnaire required about 30 minutes for a student to complete. In our sample, 54.7% (n = 316) of respondents were students of science and technology, 36.1% (n = 208) were students of humanities and social sciences, and 9.2% (n = 53) were business students. Year 1 students comprised 45.7% (n = 264) of the sample, Year 2 students, 28.0% (n = 161), and Year 3 students, 26.3% (n = 152). There were two levels of study, with 71.2% (n = 411) studying for a degree and 28.8% (n = 166) studying for a high diploma. The sample had a fair composition of students of the two sexes, with 52.3% (n = 302) being male, and 47.7% (n = 275) being female. Their average age was 21.2 years, with a standard deviation of 2.2. They also had a fair distribution of GPA (from 0 (F) to 4.3 (A+)), with 74.0% (n = 427) having GPA between 2.5 and 3.5, 21.3% (n = 123) below 2.5, and 4.7% (n = 27) having GPA of 3.5 or above. Their average GPA was 2.7, with a standard deviation of 0.5. A great majority (89.7%, n = 518) of students completed their questionnaires in class whereas 10.3% (n = 59) returned their completed questionnaires during the next few days following the class.

Measurement
Measurement of critical thinking included those assessing students’ cognitive, motivational, behavioral, and ideological components with instruments adapted from various sources (Facione et al., 1998; Halpern. 1994; King. 1995; Klaczynski et al., 1997, 1998; Shepelak et
al., 1992; Watson & Glaser, 1994). A necessary task of the questionnaire design was to re-design and adapt short questions written in simple English. Since English is the university students’ second language, the questionnaire included Chinese translation of difficult and important terms. Clearly, these procedures were inevitable because the study was to assess critical thinking, not proficiency in English. The questionnaire contained items tapping the student’s cognitive critical thinking skills, followed by items on motivational critical thinking dispositions, ideological critical thinking beliefs, and behavioral critical thinking habits. In total, the measures of critical thinking included 48 items. These items formed composite scores (by means of latent trait analysis, factor analysis, or simple averaging) that identify the following concepts.

Cognitive critical thinking skills. Measures of critical thinking skills included nine items adapted from the section of deduction in Critical Thinking Appraisal (Watson & Glaser, 1994) and eight items adapted from another suggested measurement schema (Halpern, 1994). The Critical Thinking Appraisal presented premises and conclusions and asked about the adequacy of conclusions in a true/false format. The other eight items adopted a multiple-choice format with possible fallacies in reasoning, inference, analysis, interpretation, and evaluation given as options (Halpern, 1994). The student was to choose the option that best described the fallacies in each of the eight short passages. Having no logical problems was also one of the six possible options for each question. The eight fallacies were those pertaining to social pressure, framing or leading, incredibility, wrong association, overgeneralization, hypothesis confirmation, hindsight, and entrapment or sinking cost. An example was: “Jane states that she knows that old people like to watch on TV Hit Songs and Golden Melodies because her grandmother does” (Fallacy of overgeneralization).

Motivational critical thinking dispositions. Measures of critical thinking dispositions included eight items measuring inquisitiveness and six items measuring truth seeking, both adapted from the California Critical Thinking Disposition Inventory with a five-point Likert-type scale (Facione et al., 2000). Previous studies showed that some measures of the Inventory clearly demonstrated stability or factorial validity across students of different disciplines (Walsh & Hardy, 1997).

Behavioral critical thinking habits. Measures of critical thinking habits included both positive and negative aspects. The positive aspect referred to analysis, evaluation, reasoning, application, and comparison in class and study whereas the negative aspect referred to failure to apply these critical thinking skills (King, 1995; Shepelak et al., 1992). Particularly, uncritical thinking habit involved the student’s agreement with teachers, classmates, and one’s own preexisting ideas. To contrast the positive, analytic aspect of critical thinking, this negative, uncritical component might address a habit of compliance, not just with others but also with one’s existing mindset. Measures of the positive and negative aspects of critical thinking habits also employed a five-point rating scale describing how often the student used seven positive and three negative critical thinking practices. Two examples were:
"You ask yourself 'why' about a statement or formula in the course material" (analysis) and "You agree with the course material simply because the teacher mentions it" (compliance).

Ideological critical thinking beliefs. Measures of absolutism and paranormal beliefs represented the negative aspect of critical thinking beliefs (Klaczynski et al., 1997, 1998). They employed a five-point Likert-type scale to measure a student’s agreement with seven statements indicative of the two beliefs. An example of an absolutism item was: "Right and wrong never change;" and an example of the paranormal belief was: "The advice made from the horoscope is believable."

Acquiescence, missing responses, variation, interest to answer the questions, and inconsistency in ratings and responses were other measures identified as control variables (Zagorski, 1999). They tapped a student’s vulnerability to biases of the response set. Acquiescence referred to the tendency of making high ratings for all rating items. Variation referred to the standard deviation of all rating scores. Lack of variation indicated that the student’s ratings of items were all within a narrow range. Missing responses referred to the number of nonresponses to all closed-ended questions. Inconsistency referred to the disparity of responses to questions about recent GPA, expected GPA, years of study, age, and sex, which appeared twice in the questionnaire. Interest in answering the questions was a composite scale of four five-point Likert-type scale items concerning "highly motivated for completing the questionnaire," "tried the best in answering the questions accurately," "interested in answering the questions," and "answers really reflect opinions and abilities." The reliability alpha of the composite scale was .743. For the ease of making comparison, the measure was trichotomized into one, with scores within the lowest third (0-33.3) of the scale would represent low interest, scores within the middle third (33.3-66.7) medium, and within the top third (66.7-100) high.

Approaches to Analysis

Analysis included application of (1) latent trait analysis to identify and ascertain the reliability of each of the eight measures of critical thinking, (2) factor analysis of the eight latent traits and computation of factor scores and alternative scores suggestive of general critical thinking, (3) correlation analysis of alternative scores and general critical thinking and each of its eight specific components, and (4) regression analysis of alternative scores of general critical thinking on basic background characteristics and control variables (see Figure 1).

First, latent trait analysis was used to identify and assess latent traits based on dichotomous and graded scales (Baker, 1992; Thissen, 1991). It outperforms factor analysis in incorporating three components (discrimination, difficulty, and guessing), when factor analysis only tackles discrimination and fails to differentiate items of differential difficulty and likelihood of guessing. When applied to graded responses, latent trait analysis can identify discrimination and difficulty parameters without using the restrictive assumption of equal intervals between successive grades, as in factor analysis. In all, latent trait analysis can recover latent traits under more realistic conditions.
Second, factor analysis (by the principal component method without using rotation technique because it only extracted one factor) identified scores of general critical thinking based on the same eight critical thinking components identified in latent trait analysis. The scores differed in weights applied to aggregation of the eight components. The simplest and most conventional score was the unweighted mean score of the eight components. That is, each component was equally important in identifying general critical thinking. Such a score would not suffer too much from the problem of variation in scales because each of the latent traits already followed a normal distribution, based on the marginal likelihood estimation of latent trait analysis. Nevertheless, each latent trait did not perfectly form a standard score. Thus, an alternative and common procedure was to use standard scores to compute the mean score. This second score again assumed equal weighting for each of the eight com-
ponents. The third score was the common factor score derived from factor analysis of the eight components. The associated approach attached differential weights reflective of the importance of items to identify a common factor. The fourth to ninth scores were also factor scores resulting from factor analysis, but with differential weights for different sexes, years of study, faculties, father employment conditions, levels of GPA and interest. The factor analyses involved were applicable to alternative groups of students with different characteristics, sex or others. Thus, the resultant factor scores reflected general critical thinking with different sets of weights salient in different groups. This procedure necessarily equalized factor scores of general critical thinking for different groups. For instance, the resultant scores would have the same means for both men and women. Accordingly, the procedure identified general critical thinking separately for men and women and applied different sets of weights to aggregate the eight critical thinking components for the two sexes.

The third step of analysis was to correlate among alternative scores of general critical thinking to examine their convergent validity. Fourth, regression analysis of the alternative scores served to determine the predictive validity with reference to background characteristics involving sex, years of study, faculties, levels of GPA and interest, and father employment status. The analysis also included indicators for high diploma study, acquiescence, missing responses, variation, inconsistency, and in-class completion of the survey as control variables. When different characteristics showed the same (order of) effects on different scores, these scores would tend to demonstrate their convergence in predictive validity. Regression analysis was also useful to reveal the predictors of each of the eight critical thinking components.

Results

Latent Trait Analysis

Latent trait analysis showed that each of the eight components of critical thinking was reliable according to the latent trait model: critical reasoning (marginal reliability = .58; [Thissen, 1991]), deduction (marginal reliability = .67), analysis habit (marginal reliability = .74), compliance habit (marginal reliability = .57), paranormal belief (marginal reliability = .88), absolutism (marginal reliability = .65), truth seeking (marginal reliability = .51), and inquisitiveness (marginal reliability = .75). Moreover, every constituent item manifested reliability in terms of its positive discrimination parameter estimated in the latent trait analysis. Another instance of reliability for graded items was the monotonically increasing threshold parameters estimated for the grades. That is, higher grades of critical thinking items were increasingly more difficult. This pattern verified the ordinal nature of the grading items. The reliability of the components warrants further analysis involving them.

Factor Analysis

The next step of analysis involved factor analysis of latent traits identified in the previous steps. The factor analysis also held acquiescence as a control variable to partial out effects due to the rating pattern. This step separately identified factor scores
Table 1
Factor loadings on the general critical thinking factor of students by sex and year of study

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Male</th>
<th>Female</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>649</td>
<td>298</td>
<td>271</td>
<td>261</td>
<td>159</td>
<td>149</td>
</tr>
<tr>
<td>Reasoning skill</td>
<td>.468</td>
<td>.512</td>
<td>.405</td>
<td>.475</td>
<td>.586</td>
<td>.379</td>
</tr>
<tr>
<td>Deduction skill</td>
<td>.332</td>
<td>.346</td>
<td>.230</td>
<td>.350</td>
<td>.405</td>
<td>.271</td>
</tr>
<tr>
<td>Analysis habit</td>
<td>.338</td>
<td>.434</td>
<td>.389</td>
<td>.278</td>
<td>.215</td>
<td>.454</td>
</tr>
<tr>
<td>Compliance habit</td>
<td>-.615</td>
<td>-.505</td>
<td>-.705</td>
<td>-.612</td>
<td>-.570</td>
<td>-.670</td>
</tr>
<tr>
<td>Paranormal belief</td>
<td>-.640</td>
<td>-.653</td>
<td>-.579</td>
<td>-.666</td>
<td>-.636</td>
<td>-.683</td>
</tr>
<tr>
<td>Absolutist belief</td>
<td>-.616</td>
<td>-.515</td>
<td>-.709</td>
<td>-.626</td>
<td>-.583</td>
<td>-.586</td>
</tr>
<tr>
<td>Truth seeking disposition</td>
<td>.259</td>
<td>.112</td>
<td>.510</td>
<td>.040</td>
<td>.290</td>
<td>.510</td>
</tr>
<tr>
<td>Inquisitiveness disposition</td>
<td>.538</td>
<td>.567</td>
<td>.412</td>
<td>.565</td>
<td>.492</td>
<td>.484</td>
</tr>
</tbody>
</table>

Note: Factor loadings from a factor analysis that partialed out acquiescence

Table 2
Factor loadings on the general critical thinking factor of students of different faculties and backgrounds

<table>
<thead>
<tr>
<th></th>
<th>Business</th>
<th>Humanities and social sciences</th>
<th>Science and technology</th>
<th>Father employed</th>
<th>Father as self-employed</th>
<th>Father not employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>52</td>
<td>204</td>
<td>309</td>
<td>219</td>
<td>47</td>
<td>75</td>
</tr>
<tr>
<td>Reasoning skill</td>
<td>-.072</td>
<td>.441</td>
<td>.414</td>
<td>.407</td>
<td>.381</td>
<td>.481</td>
</tr>
<tr>
<td>Deduction skill</td>
<td>.145</td>
<td>.121</td>
<td>.315</td>
<td>.440</td>
<td>.362</td>
<td>.345</td>
</tr>
<tr>
<td>Analysis habit</td>
<td>.641</td>
<td>.449</td>
<td>.408</td>
<td>.005</td>
<td>-.389</td>
<td>.651</td>
</tr>
<tr>
<td>Compliance habit</td>
<td>-.686</td>
<td>-.651</td>
<td>-.500</td>
<td>-.362</td>
<td>.452</td>
<td>-.796</td>
</tr>
<tr>
<td>Paranormal belief</td>
<td>-.211</td>
<td>-.640</td>
<td>-.619</td>
<td>-.764</td>
<td>-.526</td>
<td>-.687</td>
</tr>
<tr>
<td>Absolutist belief</td>
<td>-.509</td>
<td>-.610</td>
<td>-.584</td>
<td>-.616</td>
<td>-.743</td>
<td>-.607</td>
</tr>
<tr>
<td>Truth seeking disposition</td>
<td>.748</td>
<td>.407</td>
<td>.167</td>
<td>-.030</td>
<td>-.630</td>
<td>.467</td>
</tr>
<tr>
<td>Inquisitiveness disposition</td>
<td>-.574</td>
<td>.675</td>
<td>.597</td>
<td>.540</td>
<td>.618</td>
<td>.705</td>
</tr>
</tbody>
</table>

Note: Factor loadings from a factor analysis that partialed out acquiescence
Table 3
Factor loadings on the general critical thinking factor of students by level of interest in taking the test

<table>
<thead>
<tr>
<th>Number</th>
<th>Low interest</th>
<th>Medium interest</th>
<th>High interest</th>
<th>GPA &lt; 2.5</th>
<th>GPA 2.5-3.5</th>
<th>GPA &gt; 3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reasoning skill</td>
<td>.421</td>
<td>.479</td>
<td>.429</td>
<td>.569</td>
<td>.338</td>
<td>.236</td>
</tr>
<tr>
<td>Deduction skill</td>
<td>.148</td>
<td>.471</td>
<td>.229</td>
<td>.282</td>
<td>.232</td>
<td>.719</td>
</tr>
<tr>
<td>Analysis habit</td>
<td>.185</td>
<td>.115</td>
<td>.755</td>
<td>-.142</td>
<td>.519</td>
<td>-.247</td>
</tr>
<tr>
<td>Compliance habit</td>
<td>-.632</td>
<td>-.529</td>
<td>-.764</td>
<td>-.503</td>
<td>-.638</td>
<td>-.099</td>
</tr>
<tr>
<td>Paranormal belief</td>
<td>-.793</td>
<td>-.622</td>
<td>-.613</td>
<td>-.514</td>
<td>-.702</td>
<td>-.724</td>
</tr>
<tr>
<td>Absolutist belief</td>
<td>-.740</td>
<td>-.664</td>
<td>-.183</td>
<td>-.710</td>
<td>-.599</td>
<td>-.596</td>
</tr>
<tr>
<td>Truth seeking disposition</td>
<td>.383</td>
<td>.001</td>
<td>.555</td>
<td>-.343</td>
<td>.337</td>
<td>.889</td>
</tr>
<tr>
<td>Inquisitiveness disposition</td>
<td>.462</td>
<td>.621</td>
<td>.304</td>
<td>.694</td>
<td>.485</td>
<td>.602</td>
</tr>
</tbody>
</table>

Note: Factor loadings from a factor analysis that partialled out acquiescence

Table 4
Correlations among different scores of general critical thinking

<table>
<thead>
<tr>
<th>Unweighted mean score</th>
<th>Unweighted mean score based on standard scores</th>
<th>Factor score weighted equally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unweighted mean score based on standard scores</td>
<td>.916</td>
<td>1.000</td>
</tr>
<tr>
<td>Factor score weighted equally for all students</td>
<td>.949</td>
<td>.921</td>
</tr>
<tr>
<td>Factor score weighted differently between sexes</td>
<td>.920</td>
<td>.902</td>
</tr>
<tr>
<td>Factor score weighted differently among years of study</td>
<td>.953</td>
<td>.928</td>
</tr>
<tr>
<td>Factor score weighted differently among faculties</td>
<td>.890</td>
<td>.872</td>
</tr>
<tr>
<td>Factor score weighted differently among levels of GPAs</td>
<td>.914</td>
<td>.880</td>
</tr>
<tr>
<td>Factor score weighted differently among fathers’ employment conditions</td>
<td>.765</td>
<td>.708</td>
</tr>
<tr>
<td>Factor score weighted differently among levels of motivation</td>
<td>.812</td>
<td>.807</td>
</tr>
</tbody>
</table>
based on all students and different groups of students with different background characteristics, including sex, years of study, fields of study, GPA, interest, and the father’s employment status. Results showed that the eight components had moderate loadings on a common factor of general critical thinking in all cases. However, the loadings and therefore weights were different for different groups of students. Based on all students’ responses, factor analysis showed that loadings of paranormal belief, absolutist belief, and compliance habit were the highest (> .6) whereas that of truth seeking disposition was the lowest (.259, see Table 1). This finding illustrates the convergence of different components in identifying a common factor of general critical thinking. Notably, the three negative indicators all showed negative loadings. Nevertheless, whereas beliefs and compliance habit were more important in identifying the common critical thinking factor, truth seeking disposition, deduction skill, and analysis habit were less important.

Roughly the same pattern of factor loadings resulted from factor analysis based on different groups of students (see Tables 2 & 3). Some nuances in factor loadings occurred in different groups. It appears that reasoning, deduction skills, analysis habit, inquisitive disposition and the paranormal belief were more important or central in identifying general critical thinking among men than among women. Conversely, truth seeking disposition in a positive sense and compliance habit and absolutist belief in a negative sense were more important among women than men. The most dramatic difference was in loadings of truth seeking disposition between men and women. Accordingly, truth seeking disposition was important to differentiate female critical thinkers and uncritical thinkers but it was not useful to do so for men.

Besides, reasoning skill was particularly important to Year 2 students of all faculties in general (loading = .586) but was unimportant to business students (.072). Deduction skill was very important to students of highest GPA (.719) but was unimportant to students of unemployed fathers (.159). Analysis habit was very important to students with high interest to respond to the survey (.755) but was unimportant to students whose fathers were employers (.389). Compliance habit was particularly important as a negative indicator of critical thinking for students of business (.686), Year 3 students in general (.670), and low interest to answer the questions (.632) but was unimportant to students with high GPA (.099). The paranormal belief was very important as a negative indicator for students of low interest (.793) and whose fathers were employees (.764) but was quite unimportant to business students (.211). Absolutism was very important as a negative indicator for students of unemployed fathers (.828) but was quite unimportant to highly interested students (.183). Truth seeking disposition was very important to business students (.748) but was unimportant to students whose fathers were employers (.630), students of low GPA (.343), and students of medium interest (.001). Inquisitiveness was very important to students of self-employed fathers (.705) but was unimportant to business students (.574). Apparently, there were some nuances in the importance of different com-
ponents in identifying a common critical thinking factor for different groups of students. They just reflected unique parts of different components, which shared common features but were not identical.

**Correlation Analysis**

A result of factor analysis was creation of factor scores representing general critical thinking. These scores included those derived separately for each group of students of a particular background characteristic. The most common unweighted mean score of the eight critical thinking components clearly had very high correlations with other scores (see Table 4). Equally high correlations also appeared in relationships between the unweighted mean score based on standardized scores and the factor score weighted equally for all students and all other scores. These high correlations support the convergent validity of various scores of general critical thinking. It appeared that the scores based on universal weighting did not deviate strongly from those based on particular weighting for different groups of students. The lowest correlations (.708 & .765) were between the factor scores weighted differently for students with different father employment conditions and the two unweighted mean scores. This finding suggests that students differing in father employment conditions were quite different in their weighting of the eight components to form general critical thinking. At least, the eight components had differential weights. On the other hand, correlations involving the factor score with universal weighting and all other scores were all higher than .83. The finding indicates that the pattern of weights was very similar among different groupings of students or at least the difference would not create tremendous disparity in the scoring patterns.

**Regression Analysis**

Scores of general critical thinking demonstrated a great extent of convergence in prediction based on background characteristics. Most notably, regression analysis showed that the student with high interest to respond to the survey scored the highest, among other students, on all of the measures of general critical thinking (see Table 5). Even though some of the regression coefficients were not significant, the direction of the coefficients clearly indicated the superiority of the highly interested students. Secondly, students of humanities and social sciences were usually higher than were other students on all scores. Conversely, students of science and technology obtained the lowest scores, except the one standardized within the field of study. No doubt, the standardization artificially eliminated difference between students of different fields of study. Another instance of convergence was the consistently lower scores of high diploma students, except the score weighted differently for students of different levels of interest. Furthermore, Year 3 students tended to have the highest on all scores, except the one based of the unweighted mean of standardized scores of components. Students with high GPA were also highest on all scores except the one standardized with a level of GPA. The standardization again artificially equalized general critical thinking for students of the three levels of GPA.
Table 5
Metric regression coefficients for predicting different scores of general critical thinking

<table>
<thead>
<tr>
<th>Predictor</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.029</td>
<td>0.064</td>
<td>0.174</td>
<td>-0.291</td>
<td>0.193</td>
<td>0.064</td>
<td>0.247</td>
<td>-0.058</td>
<td>0.059</td>
</tr>
<tr>
<td>Year 2</td>
<td>0.011</td>
<td>-0.036</td>
<td>0.153</td>
<td>0.094</td>
<td>0.319*</td>
<td>0.057</td>
<td>0.171</td>
<td>-0.024</td>
<td>0.176</td>
</tr>
<tr>
<td>Year 3</td>
<td>0.006</td>
<td>-0.006</td>
<td>0.251</td>
<td>0.175</td>
<td>0.367*</td>
<td>0.194</td>
<td>0.300</td>
<td>0.059</td>
<td>0.372*</td>
</tr>
<tr>
<td>Business</td>
<td>0.097*</td>
<td>0.150</td>
<td>0.339</td>
<td>0.354</td>
<td>0.291</td>
<td>-0.077</td>
<td>0.110</td>
<td>0.299</td>
<td>0.598*</td>
</tr>
<tr>
<td>Humanities and social</td>
<td>0.062</td>
<td>0.128</td>
<td>0.482*</td>
<td>0.491*</td>
<td>0.425*</td>
<td>-0.056</td>
<td>0.349</td>
<td>0.166</td>
<td>0.694*</td>
</tr>
<tr>
<td>Medium GPA</td>
<td>0.029</td>
<td>0.080</td>
<td>-0.014</td>
<td>-0.096</td>
<td>-0.042</td>
<td>-0.094</td>
<td>-0.204</td>
<td>0.036</td>
<td>-0.033</td>
</tr>
<tr>
<td>High GPA</td>
<td>0.090</td>
<td>0.225</td>
<td>0.548</td>
<td>0.522</td>
<td>0.507</td>
<td>0.610</td>
<td>-0.241</td>
<td>0.435</td>
<td>0.849*</td>
</tr>
<tr>
<td>Father employed</td>
<td>-0.012</td>
<td>-0.017</td>
<td>0.013</td>
<td>-0.057</td>
<td>-0.003</td>
<td>0.072</td>
<td>-0.010</td>
<td>-0.140</td>
<td>0.124</td>
</tr>
<tr>
<td>Father as an employer</td>
<td>0.042</td>
<td>0.098</td>
<td>0.045</td>
<td>-0.007</td>
<td>0.127</td>
<td>0.029</td>
<td>-0.011</td>
<td>-0.078</td>
<td>0.165</td>
</tr>
<tr>
<td>Father self-employed</td>
<td>0.015</td>
<td>0.095</td>
<td>0.187</td>
<td>0.134</td>
<td>0.197</td>
<td>0.332</td>
<td>0.242</td>
<td>-0.091</td>
<td>0.467*</td>
</tr>
<tr>
<td>Medium motivation</td>
<td>0.055</td>
<td>0.081</td>
<td>0.235</td>
<td>0.112</td>
<td>0.194</td>
<td>0.021</td>
<td>0.120</td>
<td>0.117</td>
<td>0.281</td>
</tr>
<tr>
<td>High motivation</td>
<td>0.107*</td>
<td>0.172</td>
<td>0.658*</td>
<td>0.597*</td>
<td>0.595*</td>
<td>0.457</td>
<td>0.535*</td>
<td>0.790*</td>
<td>0.272</td>
</tr>
<tr>
<td>High diploma</td>
<td>-0.040</td>
<td>-0.100</td>
<td>-0.281</td>
<td>-0.209</td>
<td>-0.364*</td>
<td>-0.137</td>
<td>-0.305</td>
<td>-0.439*</td>
<td>0.033</td>
</tr>
</tbody>
</table>

\( R^2 \)                \( 0.182 \) | \( 0.216 \) | \( 0.489 \) | \( 0.292 \) | \( 0.501 \) | \( 0.250 \) | \( 0.434 \) | \( 0.380 \) | \( 0.408 \)

Notes: *: \( p < 0.05 \)
(1) Unweighted mean score
(2) Unweighted mean score based on standard scores
(3) Factor score weighted equally for all students
(4) Factor score weighted differently between sexes
(5) Factor score weighted differently among years of study
(6) Factor score weighted differently among faculties
(7) Factor score weighted differently among levels of GPAs
(8) Factor score weighted differently among fathers’ employment conditions
(9) Factor score weighted differently among levels of motivation

The regression analysis controlled for acquiescence, variation among ratings, the number of missing responses, inconsistency between factual information, and the mode of survey administration (in class versus take-home).

The reference categories were male, Year 1, science and technology, low GPA, father not employed, and low motivation.

Another consistent pattern revealed that students with self-employed fathers were the highest on most of the scores. In all, these results demonstrate consistent differences among students of various background characteristics and these dif-
ferences accord well with the hypothesized predictions.

The factor score with universal weighting for all students appeared to be a preferable measure of general critical thinking. First, it demonstrated a pattern of student differences that was very similar to those found with other scores. Notably, it indicated that students of humanities and social sciences and business had scores higher than those of students of science and technology. It also showed higher scores among students with higher interest, higher GPA, longer duration in study, and whose fathers were self-employed. Similarly to other scores, this factor score was also higher among degree students than among high diploma students. The women also scored somewhat higher on this score, as on most of the other scores. Besides prediction using the factor score attained high explaining power (.489), which was only inferior to that (.501) based on the factor score separately estimated for students of different years of study.

**Discussion and conclusion**

Results of this study illustrate that a measure of general critical thinking adapted for students in Hong Kong is valid in terms of convergent validity and the convergence of prediction. Despite its diverse components, the measure can maintain a coherent structure that integrates the components. The importance or weight identified in factor analysis for each component for identifying general critical thinking varies across the components and this variation differs considerably among students of different characteristics. However, a summary score of general critical thinking can still maintain stable prediction based on students' background characteristics (from regression analysis). That is, alternative scores of general critical thinking can indicate similar differences among students of different characteristics. What is more, the measure of general critical thinking is not merely a replica of its components. Findings from regression analysis clearly indicate that each component has its uniqueness to reflect the cognitive, behavioral, motivational, and ideological dimensions. Hence, the measure of general critical thinking would not completely replace its components and overshadow their significance.

**Conceptualization of critical thinking**

The central theme that critical thinking, in general, covers the four dimensions (cognitive, motivational, ideological, and behavioral) is valid, as shown in the study. The four dimensions are not alien or unrelated. They neatly cohere together to identify a general concept of critical thinking. The study thus upholds critical theoretical insights that cast doubt on exclusive focus on the cognitive-skill dimension (Brookfield, 1987; Klaczynski, et al., 1997; Walters, 1994; Warren, 1994). It shows that whereas the cognitive dimension is important, the other dimensions had non-negligible weights for identifying general critical thinking. More central than the cognitive dimension are the ideological and behavioral habit components, which have often been missing in past research. On the other hand, truth seeking disposition appears to be the least central component indicative of general critical thinking (based on factor analy-
sis). However, it is not entirely irrelevant to the student population because it is most salient among business or high-GPA students. At any rate, all eight components assume their significant places in contributing to general critical thinking and none seems to be irrelevant. Clearly, the cognitive component does not dominate the others in identification of the general concept. Hence, studies that rely exclusively on the cognitive component would not give a thorough picture of critical thinking. These studies may best describe the critical thinking of high performers but would miss a lot in describing business students' critical thinking. To business students, reasoning and deduction skills are not central components reflective of general critical thinking. Rather, truth seeking disposition and critical thinking habit (analysis versus compliance) are particularly important indicators of business students' critical thinking.

The newly introduced motivational dimension, including truth seeking and inquisitiveness dispositions (Facione et al., 2000), does not seem to be a dominant component of critical thinking. In the study, their weights for identifying general critical thinking fluctuate dramatically. Among business students and students whose fathers were either employees or employers, weights of the dispositions were contrary to expectation. The findings show that these dispositions are not stable indicators of critical thinking. Conceivably, they are most vulnerable to motivational biases and situational confounds. The dispositions may not register stable traits as expected. Hence, exclusive focus on the motivational dispositions would lead to an incomplete picture of critical thinking. Whereas cognitive skills and motivational dispositions seem to be philosophers' favorites in defining critical thinking, the study is in line with other social scientists in locating drawbacks in the sole concern with the two aspects (Walters, 1994; Warren, 1994).

**Variation due to Background Factors**

A conspicuous issue figures in the fairness of comparing critical thinking between men and women (Clinchy, 1989). Critics of existing measures contend about their inapplicability of using logical tests to measuring women's critical thinking. They maintain that the female adheres to a connected mindset, which is in favor of conformity and understanding as a manifestation of critical thinking. At least, women and men would have a disparate pattern of weighting in different components. Results of the present study, however, can hardly lend support to this supposition. Weights of men and women for identifying general critical thinking were very similar, despite some slight differences. The most remarkable discrepancy between men and women does not concern the cognitive components. Rather, it is truth seeking disposition that manifested the greatest difference in weighting between men and women. However, it is men that showed a low loading for truth seeking disposition. In other words, truth seeking disposition, like others, was a significant component for identifying general critical thinking for women. Overall, the eight components cohered in a similar fashion between men and women and this warrants the applicability of the critical
thinking components to both men and women.

A related argument concerning the gender difference is the lower score of women on critical thinking. Results of the present study offer no support for this contention. Scores of general critical thinking were consistently higher for the women than for the men (see Table 5).

One discernible threat to measurement of critical thinking is the effect or bias of interest to complete the task. This would be a problem if interest was not explicitly measured and held as a control variable. The present study is certainly free of this problem. Nevertheless, it is suggestive of a caveat to take precautions against the potential bias of interest. Due to the bias of interest, respondents with varied levels of interest may undermine the conclusion and generalization drawn from the study. Even in studies of people with comparably high levels of interest, critical thinking might become unreasonably high due to the motivational effect. Therefore, people with low interest in the study would generate scores of critical thinking that are probably lower than their real level. An adjustment factor for interest is necessary to identify the true level of critical thinking.

The cultural factor is inevitably of concern for studying critical thinking. It is a principal theme of the study to adapt measures to assess Hong Kong students’ critical thinking, with the underlying premise that imported measures are not fully applicable to them. The language barrier is clearly one cultural factor hindering the applicability of foreign instruments. The language and interest are decidedly factors confounding measurement of critical thinking. To circumvent these barriers, it is necessary to use questions with simpler language structure. The aim is to pool questions that are culturally applicable to university students in Hong Kong. Without this careful screening and adaptation, a survey of Hong Kong students would not adequately assess their critical thinking. The effort admittedly would result in a measure best descriptive of Hong Kong students but failing to be comparable to alternative measures used in other places. However, the developed measure is not entirely specific to Hong Kong culture. There is no reason why the same measure could not be used for other populations in other places. As such, the applicability and validity of the measure in other cultural settings is certainly a desirable research agenda for further inquiry.

Further Research

The conceptualization that critical thinking comprises various components besides those of cognitive skills and disposition is not a parochial one for Hong Kong. It stems from the literature and should apply elsewhere. These components should manifest in studies of other populations and in other places. Replication of the present study in other places is desirable to enrich discussion on the measurement of critical thinking.

Essentially, further research can examine in more detail variation in critical thinking as a consequence of different background characteristics. While the present study finds some significant
differences due to the field and level of study, GPA, father’s employment condition, and interest. A closer inspection of their effects is necessary for a better understanding of the origin of critical thinking. Apparently, the teaching and exposure involved in the field of study may explain the difference in critical thinking and the socialization or parenting process may explain father’s influence. In both cases, some sort of social learning may be relevant to explain the observed difference. Nevertheless, the socialization and learning process is not entirely transparent. For instance, whereas the father’s employment condition may influence his expectation and behavior toward his offspring (Kohn et al., 1983, 1990), the magnitude and process of the influence of the father on the child decidedly require further investigation. One common theme is the influence of employment condition on ideational flexibility, which may also be a disposition, similar to open-mindedness, of critical thinking. This may be a clue to examining the influence of the father’s employment condition on his offspring’s critical thinking. Further research should elucidate the way in which the offspring learns critical thinking from his or her father.

Further research to enhance the database is necessary. Despite the effort to collect data from a diverse sample of university students, the present study is still unable to secure a sample that perfectly represents the population of university students in Hong Kong. Essentially, the sample under study did not represent a randomly selected one. Perhaps, it might overrepresent certain subgroups and underrepresent others. Regarding subgroup variation, the study reveals that critical thinking measures scored according to weights specifically derived from different subgroups show very high correlations and the measures were predictable similarly across various background factors. These findings suggest that group variation might not create tremendous difference in assessment and prediction. Thus, the results seem to apply similarly to various groups of students and robust against variation in the grouping across samples. Nevertheless, they may not fully be generalizable to the population of university students.

References


The case for critical thinking. Teaching Sociology, 24, 189-194.

Weinstein, E.K. (1992). Questions and answers to
guide the teaching of critical thinking. Teaching English in the Two-Year College, 19,
284-288.

Zagorski, K. (1999). Egalitarianism, perception of
conflicts, and support for transformation in
Poland. In S. Svalfors & P. Taylor-Gooby
(Eds.), The End of the Welfare State? Responses to State Retrenchment (pp.190-217).
London: Routledge.