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Assessing the Dimensional Validity and Reliability of the University of Florida Critical Thinking Inventory (UFCTI) in Chinese: A Confirmatory Factor Analysis

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Abstract

The importance of assessing critical thinking has been emphasized extensively by numerous administrators and educators in higher education worldwide. In a contemporary agricultural sustainable development environment, agricultural students need to develop critical thinking to manage complex situations and to deal with controversial issues in international agriculture settings. From psychological points of view, thinking varies cross-culturally. In other words, people from different cultures think differently. With the increasing number of Chinese students studying in the U.S., educators need to be aware of the importance of supporting these Chinese students within the intercultural classroom environment. Thus, it is necessary to explore and understand the way Chinese students think to help them more easily adapt to a culturally diverse educational environment. The purpose of this study was to evaluate the validity and reliability of a Chinese version of the University of Florida Critical Thinking Inventory (UFCTI). The UFCTI measures critical thinking styles using two constructs: engagement and seeking information. Confirmatory Factor Analysis (CFA) was applied to examine the hypothesized measurement model based on the theoretical foundations of the original UFCTI (English version). The CFA findings indicated the UFCTI measurement model between the two versions is equivalent. Specifically, the results confirmed the two-factor measurement of critical thinking style: engagement and seeking information. The findings also indicated adequate validity and reliability for the UFCTI Chinese version.

Keywords: critical thinking style, Chinese students, confirmatory factor analysis, agricultural education

Introduction

Critical thinking is a purposeful, self-regulatory thinking aimed at solving problems, addressing questions, forming judgments, and making decisions (Bailin et al., 1999; Facione, 1990; Rudd et al., 2000). Critical thinking is often regarded as a core competence needed by graduates in an era of globalization (Durkin, 2008; Egege & Kutieleh, 2004). College students have been required to think critically to process a vast amount of information in today's learning environment. In such context, countries across the globe try to improve their citizens' critical thinking in order to meet the challenges of the changing world (Shaheen, 2016; Turner, 2006). Due to the increasing global population, agriculture is facing even greater challenges, such as feeding the growing world population, food safety, water conservation, biotechnology and climate change. The importance of agricultural students being able to think critically has permeated the international educational literature (Akins et al., 2019; Roberts et al., 2018) because they must be able to manage complex situations and to deal with the controversial issues impacting global agricultural development (Bisdorf-Rhoades et al., 2005; Duncan et al., 2016).

Critical thinking has been identified as a set of skills (Paul, 1992), dispositions (Facione, et al., 1994), and style (Lamm, 2015a, 2015b). Lamm (2015a, 2015b) described critical thinking style as one of the cognitive thinking preferences of calculating outcomes and solving problems by using rational or logical thoughts. Previous research has indicated that cognitive thinking style varies across individuals from different cultural backgrounds (Brown, 1998; Ten Dam & Volman, 2004; Zhang & Sternberg, 2001). Several studies have revealed that international students from Asian countries generally score lower on critical thinking assessments. For example, Yeh and Chen (2003) compared critical thinking dispositions between Chinese and American graduate nursing students, revealing Chinese students reflected lower critical thinking dispositions. Similarly, Tiwari et al. (2003) compared critical thinking dispositions of nursing students from Australia and Hong Kong. The findings indicated that students from Hong Kong scored lower than Australian students. The incongruence of cognitive thinking preference among students from different cultural backgrounds poses challenges for educators to teach critical thinking (Lun, 2010; Tan, 2017).

Thinking critically has been one of the most important academic standards in Western countries (Gu & Hayhoe, 2001; Ho, 2001). Educators observed that Asian students expressed less critical thinking because they do not frequently engage in classroom discussions (Hu & Grove, 1999; Zhang & Zhang, 2013). In particular, some faculties have found that international Chinese students have challenges when demonstrating critical thinking compared to their western counterparts (Chen, 2017; Dong et al., 2008; Durkin, 2008). These observations could be attributed to cultural differences. Cultural distinctions are inevitably manifested in educational practices in the classroom (Zhang & Zhang, 2013). Instruction in China is typically a teacher-centered environment, with Chinese students receiving direct guidance from their teachers (Watkins & Biggs, 2001). Content is delivered by instructors in a clear and information-packed structure (Chang, 2000; Gollnick & Chinn, 1998; Williams, et al., 2001). This educational environment likely leads students to be passive learners or less-critical thinkers (Facione et al., 2009). The unfamiliar academic standard and different educational environments in Western countries therefore pose challenges for Chinese students.

Although the literature has emphasized the importance of improving Chinese student critical thinking, the availability of valid instruments for measuring critical thinking within the Chinese-speaking population is lacking. Additionally, the reliability and validity of critical thinking instruments in a Chinese-language version has been questioned (Luo & Yang, 2001;

Peng et al, 2004). The California Critical Thinking Disposition Inventory (CCTDI) has been translated to Chinese and applied to compare the critical thinking dispositions among nursing students with different cultural backgrounds (Salsali et al., 2013; Tiwari et al., 2003; Yeh & Chen, 2003; Yeh, 2002). However, the internal consistency measured by Cronbach's alpha for the subscales of the Chinese version of the CCTDI ranged from .34 to .47, revealing the translated instrument is not adequately reliable.

According to Kimberlin and Winterstein (2008), using an existing instrument is more cost-effective than developing a new instrument. Researchers developed the University of Florida Critical Thinking Inventory (UFCTI) to measure critical thinking style (Lamm & Irani, 2011). The UFCTI has been used for about 10 years in agricultural fields in higher education, and it has sound psychometric properties (Lamm & Irani, 2011). Rather than developing a new instrument requiring a long and expensive development process, this study aimed to translate the UFCTI to Chinese and examine its validity and reliability. Lamm (2015a), who is one of the developers of the UFCTI original version, described critical thinking style as "the way an individual goes about thinking and reaching solutions to a problem" (p. 1). Each critical thinker has an individual style of processing information regarding a specific issue that be measured on a continuum between engagement and seeking information (Lamm & Irani, 2011). The UFCTI consists of 20 Likert-type items of which responses can range from 1= Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. Thirteen of the items are designed to measure the construct of seeking information, and seven items are used to measure engagement. Students with overall UFCTI scores 79 or higher are identified as seekers, and those with 78 or lower are identified as engagers (Lamm & Irani, 2011).

Individuals with a preference for engagement are highly engaged with their surroundings when applying thinking critically. Engagers prefer to attend to others' discussions, and look for opportunities to showcase their reasoning and problem-solving process. Engagers are confident with their communication ability and are proficient in showing how they arrive at a decision (Lamm & Irani, 2011). Individuals with a seeking information critical thinking style prefer to seek out a large amount of information. Seekers are hungry learners, and they desire to understand complex problems for which many aspects of solutions exist. Seekers pursue the truth about a subject, even if the truth conflicts with their own opinions or beliefs (Lamm & Irani, 2011). There is no right or wrong critical thinking style but an ideal critical thinker would possess qualities expressed by both preferences and choose to engage in a specific preference given the context of a situation when they are being asked to process information that requires critical thinking (Lamm & Irani, 2011).

Previous studies in agricultural disciplines have utilized the UFCTI to investigate the relationship between critical thinking style and water conservation behaviors (Gorham et al., 2014), food safety behavior (Leal et al., 2017), and opinion leader's communication behavior (Putnam et al., 2017). Akins et al. (2019) investigated the enhancement of critical thinking after integrating case studies into educational settings. These studies have reported that the overall UFCTI reliability measured by Cronbach's alpha ranged from .79 to .95. With respect to the two constructs, Cronbach's alpha for the seeker construct ranged from .87 to .92, and Cronbach's alpha for the engager construct ranged from .87 to .90. Although the UFCTI has been widely used in the U.S., there is no study that attempted to translate the UFCTI English version to Chinese.

In the U.S., Chinese students are the largest group of international students, accounting for 33% of the total international student population (Institute of International Education Open

Doors Report, 2018). Considering international Chinese students are from culturally and linguistically different backgrounds, emphasis should be placed on understanding Chinese students' critical thinking style to increase their engagement with the learning environment and cultivate their truth-seeking attitudes. Identifying an appropriate instrument to measure critical thinking style is one of the crucial prerequisites to improve critical thinking. However, the absence of appropriate instruments in Chinese makes it difficult to assess Chinese agriculture students' critical thinking style. The aim of this study was to fill the research gap by validating an instrument to assess critical thinking style for Chinese students pursuing degrees in Western countries.

Theoretical Framework

Psychometric Theory serves as a theoretical framework to guide this study. Psychometric Theory describes how psychological measurement (e.g. intelligence, attitudes, and personality traits) relate to a set of observable variables, such as items in questionnaires, assessments or tests (Nunnally,1994). Psychological measurement includes the interest variables represented as latent constructs. Psychometric measurement "consists of rules for assigning numbers to objects to represent quantities of attributes" (Nunnally, 1994, p. 2). The "rules" assign the numbers using a given scale that can be explicitly formulated to reflect the properties of the attributes (Nunnally,1994). The interpretation of the psychometric instrument scores are used to measure the validity and reliability of the instrument (Nunnally,1994). Validity is the extent to which an instrument represents the underlying concept that it purports to measure; reliability is the extent to which an instrument yields consistent result (Ary et al., 2018). When translating and/or adopting a measurement from an original language or culture to a different language, it is necessary to evaluate the psychometric properties to ensure adequate validity and reliability of the newly translated instrument (Geisinger,1994).

In this study, the overall critical thinking style score was acquired by asking participants to rate their level of agreement with observable variables representing critical thinking style: seeking information and engagement. The observable variables underlying the seeking information latent construct were represented by statements such as: "*I enjoy learning about many topics*" or "*I ask many questions when making a decision*". Likewise, the items underlying the engagement construct are represented by statements such as: "*I am able to relate to a wide variety of issues*" or "*I am interested in many issues*". These observed items reflect the concrete behavior that represent the psychological characteristics of critical thinking style. The overall critical thinking style inventory coordinates the relationship between observable items and the theorical measurement model. Thus, the two latent constructs are combined to represent a psychometric measurement of critical thinking style. In this study, identifying the psychometric stability of the instrument was viewed as an essential step ensuring the cross-cultural equivalence of measurement. In other words, this study was conducted to ensure the UFCTI Chinese version continues to measure the same constructs that were intended or expected to be measured in the original English of UFCTI.

Purpose and Objectives

The purpose of this study was to translate the UFCTI from the English (its original language) into Chinese, and to ascertain the psychometric properties (validity and reliability) of the UFCTI Chinese version for broader adoption among the Chinese speaking population.

Methods

The UFCTI was translated from English to Chinese by a panel of bilingual educators after acquiring permission from the developers of the UFCTI to use the English version inventory. Six Chinese experts from universities in China and the U.S. participated in the translation process. These six experts represented the fields of Agriculture, Education, and English to ensure content validity of the translation process. They were all fluent in both English and Chinese, knowledgeable about both cultures, and familiar with the content of critical thinking style measured by the instrument. A sample of 148 undergraduate agricultural students in China were invited to complete the Chinese version UFCTI through an online survey software, Qualtrics. Hair et al. (2019) stated that the minimum sample size for CFA is 100 if the number of constructs in a model is less than five. The measurement model UFCTI has two constructs, so the sample size for this study was determined to be adequate. Confirmatory Factor Analysis (CFA), implemented in Mplus Software (Muthén & Muthén, 2008), was used to examine the hypothesized two-factor structure measurement model derived from the UFCTI original version. Specifically, the CFA was performed to describe the associations of each item with the latent constructs as well as the correlations between the latent constructs (Milfont & Fischer, 2010).

With CFA, the researcher can test the measurement theory. The measurement theory identifies "how measured variables logically and systematically represent constructs involved in a theoretical model" (Hair et al., 2019, p. 661). Measurement theory specifies the pattern of theoretical variables loadings on prespecified constructs. CFA cannot be performed properly without a measurement theory. CFA is used to examine how well the theoretical pattern of the factors matches the actual data (Hair et al., 2019). Thus, CFA is a method that confirms or rejects the prespecified measurement theory. The measurement theory of the UFCTI Chinese version is the same as the UFCTI English version, which specifies that critical thinking style is represented by engagement and seeking information preferences. The engagement construct was measured by seven items, while the seeking information construct was measured by thirteen items.

Measurement Model-fit

CFA is used to examine the measurement theory that specifies a series of relationships between measured items and latent constructs (Hair et al., 2019). CFA allows researchers to assess the measurement model fitness based on the measurement theory. Practically, CFA is used to examine a prior number of factors or latent constructs, as well as which items load on those constructs (Hair et al., 2019). As reported in Table 1, the indices of assessing the hypothesized measurement model fitness include the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the Root Mean Squared Error of Approximation (RMSEA). CFI is an index to assess the model fit by assessing the discrepancy between the sample data and the hypothesized measurement model (Hu & Bentler,1999). A CFI value greater than .90 suggests acceptable fit to the model (Hu & Bentler,1999). Schumacker and Lomax (2004) asserted that values of TLI values above .90 are considered an acceptable fit, and values greater than .95 are deemed to an excellent fit. The RMSEA is the average of the residuals between the observed correlation/covariance from the sample and the expected model estimated for the population (Hair et al., 2019). An RMSEA is relatively independent of sample size (Browne & Cudeck, 1992). A RMSEA value of .08 or less is recognized as an acceptable fit, and a value less than .05 represents an excellent fit (Browne & Cudeck, 1992).

Table 1
Diagnostic Measurements and Cut-off Values Used to Examine Measurement Model Fit

	Measurements	**Diagnostic measurements and cut-off value**
Model-fit	CFI, TLI, RMSEA	CFI > .90 (Hu & Bentler,1999) TLI > .90, acceptable fit; TLI > .95, excellent fit (Schumacker & Lomax, 2004) RMSEA < .80 acceptable fit; RMSEA < .05, excellent fit (Browne & Cudeck, 1992).
Construct validity	Convergent validity	Factor loadings > .50, (Hair et al., 2019). AVE> .50, adequate convergent validity (Hair et al., 2019).
	Discriminant validity	Correlation among constructs < .85 (Hair et al., 2019).
Reliability	Composite reliability	Composite reliability > .60 (Awang, 2015).
	Cronbach's alpha (α)	Cronbach's alpha (α) > .80 (Cronbach, 1951).

Construct Validity

Assessing the construct validity of a hypothesized measurement model is the primary objective of CFA. Evidence of construct validity indicates good measurement model fit. Construct validity is "the extent to which a set of measured items actually reflects the theoretical latent constructs those items are designed to measure" (Hair et al., 2019, p. 675). Construct validity includes convergent validity and discriminant validity (Hair et al., 2019). Once good model fit is established, convergent validity and discriminant validity were evaluated to determine the psychometric properties of the UFCTI Chinese version.

Convergent Validity

Convergent validity refers to the fact that items underlying the same associated latent construct should "converge or share high proportion of variance in common" (Hair et al., 2019, p. 675). Factor loadings and average variance extracted (AVE) are used to estimate convergent validity (Hair et al., 2019). With regard to factor loadings, high factor loadings indicate the items that are underlying a specific latent construct converge or share a common variance (Hair et al., 2019). The rule of thumb for factor loading is standardized loading estimates "should be .5 or higher, and ideally .7 or higher" (Hair et al., 2019, p. 676). AVE is computed "as the mean variance extracted for the items loading on a construct and is a summary indicator of convergence", a value of AVE for each construct greater than .50 indicates adequate convergent validity (Hair et al., 2019, p. 619).

Discriminant Validity

Discriminant validity refers to the fact that the construct should be distinct from dissimilar, unrelated constructs (Hair et al., 2019). High discriminant validity provides evidence that a construct is unique and explains the variance that other unrelated constructs do not explain (Hair et al., 2019). Discriminant validity is tested by examining the correlation among constructs. Correlation among constructs must be less than .85 (Hair et al., 2019). Adequate discriminant validity indicates individual items only represent the corresponding latent construct (Hair et al., 2019).

Reliability

Reporting and interpreting reliability of a measurement is necessary for investigating the accuracy of measurement (Warmbrod, 2014). Cronbach's alpha (α) is commonly used in evaluating internal consistency of an instrument. With CFA, composite reliability (CR) is also used to report the reliability of latent constructs and overall reliability for the entire measurement model. CR value for each construct should be greater than .60 (Awang, 2015).

Results

The purpose of this study was to examine the validity and reliability of the Chinese version of the UFCTI using a CFA. The UFCTI consists of two constructs, with 20 items assessing critical thinking style. Table 2 presents the findings from the CFA. Overall correlations for the items had small to large positive linear relationships (r = .21- .67) (Davis, 1971). All of the relationships among the items had positive correlations and were significant at .001 alpha levels (Table 3).

Measurement Model-fit

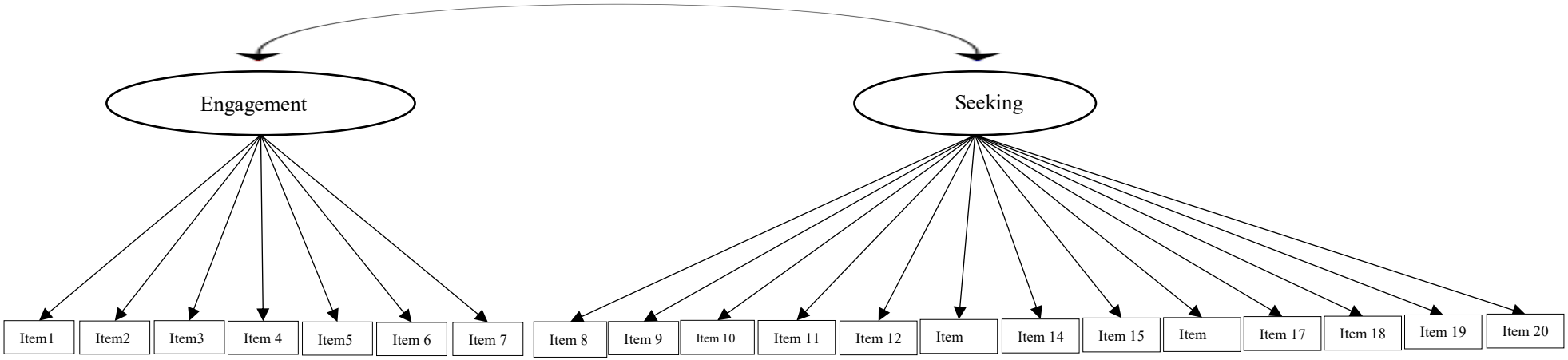
A CFA was conducted to assess the two-factor hypothesized measurement model of the UFCTI Chinese version. According to the CFA results, the two-factor hypothesized measurement model showed adequate fit (CFI = .95, TLI = .94, and RMSEA = .05). These findings indicated that the UFCTI Chinese version complies with the hypothesized measurement model of the original UFCTI English version according to the cut-off values of the CFI, TLI, and RMSEA. Therefore, the UFCTI Chinese version appears to be stable when compared to the English version. It appears that the UFCTI Chinese version and English version assess the same constructs of critical thinking style, and the scores are equally meaningful in both versions.

Construct Validity

The construct validity for the UFCTI Chinese version measurement model was evaluated using convergent validity and discriminant validity. For the convergent validity, factor loadings for each item should be greater than .50. Table 2 displays the standardized loadings. The lowest loading is .55, linking the engagement construct to item 2. Other items' factor loadings ranged from .56 to .90. The AVE value for the engagement construct was .41, and AVE for the seeker construct was .48. AVE was used to test the convergent validity that estimates the amount of variance explained by the construct related to the amount of variance attributable to error (Hair et al., 2019). The AVE values for both constructs were less than the recommended value of .05. However, based on the recommendation of Fornell and Larcker (1981), if the composite reliability is greater than .60, the convergent validity of the construct is still adequate. In this study, the composite reliability for engagement and seeking information were .89 and .92, respectively, which were higher than .60 for each construct. These findings support the establishment of convergent validity of the UFCTI Chinese version.

The way to establish discriminant validity is to examine the correlation between the engagement and seeking information constructs. The correlation between the two constructs is .78, which was less than the cut-off value of .85. Therefore, the results support the discriminant validity of the UFCTI Chinese version measurement model. Figure 1 displays 20 items and two latent constructs of the measurement model. The construct validity was support by the model fit, convergent validity and discriminant validity. Therefore, no changes need to be made to the UFCTI Chinese version based on the model fit and construct validity.

Figure 1
Hypothesized factor structure of UFCTI English Version



Note. Item 1 = Opportunities to solve problems, Item 2 = Interest in many issues, Item 3 = Relate to a wide-variety of issues, Item 4 = Finding answers to questions, Item 5 = Good problem solver, Item 6 = Confident in conclusion, Item 7 = Present issues clearly, Item 8 = listen carefully, Item 9 = Enjoy learning, Item 10 = Importance to be well-informed, Item 11 = Ask lots of questions, Item 12 = Willing to change opinion, Item 13 = Consider facts without biases, Item 14 = Enjoy learning, Item 15 = Get along with people, Item 16 = Search for truth, Item 17 = Find right answers, Item 18 = Find multiple solutions, Item 19 = Ask questions in decision-making, and Item 20 = Problems have numerous solutions.

Table 2

Factor Loadings and Reliability Measures of UFCTI English and Chinese Versions

Construct	Item	*M*	*SD*	*SFL*[1]	*AVE*[2]	*CR*[3]	*α*[4]
Engager	1. I look for opportunities to solve problems. 我会努力寻求解决问题的方案。	4.12	.82	.79			
	2. I am interested in many issues. 我对很多问题都感兴趣。	3.78	1.02	.55			
	3. I am able to relate to a wide variety of issues. 我具备处理各种问题的能力	3.46	.89	.64			
	4. I enjoy finding answers to challenging question. 我喜欢解决具有挑战性的问题。	3.65	.84	.59	.41	.89	.84
	5. I am a good problem solver. 我是解决问题的高手。	3.37	.90	.56			
	6. I am confident that I can reach a reasonable conclusion. 我相信我能得出合理的结论。	3.70	.81	.68			
	7. I present issues in a clear and precise manner. 我能清晰并准确地表述问题。	3.66	.89	.70			
Seeker	8. I listen carefully to the opinions of others even when they disagree with me. 我总是认真地听取别人的意见，即使他们的观点和我的不一致.	3.78	.94	.65			
	9. I enjoy learning about many topics. 我喜欢解决具有挑战性的问题。	3.72	.97	.70	.48	.92	.92
	10. It is important to be well informed. 消息灵通是很重要	3.57	.90	.59			
	11. I ask lots of questions in a learning environment在学习过程中，我会问很多问题。	4.22	.89	.72			

12. I am willing to change my opinion when I am given new information I find to be credible. 当我获得新的可信的信息时, 我愿意改变我的观点。	3.91	.91	.64
13. I try to consider the facts without letting my biases affect my decisions. 我尽力尊重事实，不让主观偏见影响我的判断。	3.95	.83	.72
14. I enjoy learning even when I am not in school. 即使课后，我也乐于学习。	3.61	.88	.56
15. I can get along with people who do not share my opinions. 我能跟与我观点不一致的人和睦相处。	3.67	.90	.70
16. I search for the truth even when it makes me uncomfortable. 我努力寻找真相，即使真相让我感觉不舒服。	3.77	.90	.69
17. I will go out of way to find the right answers to a problem. 我会竭尽全力寻找解决问题的正确方案。	3.84	.82	.78
18. I try to find multiple solutions to problem. 我尝试寻求多种方案去解决问题。	3.70	.81	.73
19. I ask many questions when making a decision. 在我做决定之前，我会问很多问题。	3.80	.89	.72
20. I believe that most problems have more than one solution. 我相信大多数问题都不止有一个解决方案。	4.09	.84	.75

Note. [1]SFL = standardized factor loading; [2]AVE = average variance extracted; [3]CR = composite reliability; [4]α = item reliability of each measure for Cronbach's α.

Table 3

The Correlations of the UFCTI Chinese Version Items

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7						
Item 1	1												
Item 2	.45*	1											
Item 3	.48*	.35*	1										
Item 4	.43*	.37*	.45*	1									
Item 5	.24*	.26*	.58*	.42*	1								
Item 6	.53*	.38*	.51*	.42*	.38*	1							
Item 7	.49*	.41*	.53*	.51*	.53*	.43*	1						
	Item 8	Item 9	Item10	Item11	Item12	Item13	Item14	Item15	Item16	Item17	Item18	Item19	Item20
Item 8	1												
Item 9	.42*	1											
Item10	.33*	.36*	1										
Item11	.46*	.50*	.30*	1									
Item12	.36*	.41*	.31*	.59*	1								
Item13	.50*	.45*	.41*	.67*	.61*	1							
Item14	.38*	.39*	.30*	.39*	.36*	.38*	1						
Item15	.52*	.54*	.44*	.43*	.43*	.48*	.39*	1					
Item16	.48*	.51*	.43*	.54*	.47*	.53*	.42*	.50*	1				
Item17	.49*	.47*	.48*	.59*	.48*	.56*	.44*	.46*	.56*	1			
Item18	.44*	.49*	.46*	.50*	.44*	.57*	.47*	.46*	.49*	.62*	1		
Item19	.50*	.52*	.47*	.51*	.49*	.53*	.29*	.50*	.44*	.55*	.55*	1	
Item20	50*	.49*	.32*	.64*	.54*	.60*	.45*	.52*	.46*	.62*	.60*	.59*	1

Note. * Correlation is significant at the 0.001 level (2-tailed).

Item 1 = Opportunities to solve problems, Item 2 = Interest in many issues, Item 3 = Relate to a wide-variety of issues, Item 4 = Finding answers to questions, Item 5 = Good problem solver, Item 6 = Confident in conclusion, Item 7 = Present issues clearly, Item 8 = listen carefully, Item 9 = Enjoy learning, Item 10 = Importance to be well-informed, Item 11 = Ask lots of questions, Item 12 = Willing to change opinion, Item 13 = Consider facts without biases, Item 14 = Enjoy learning, Item 15 = Get along with people, Item 16 = Search for truth, Item 17 = Find right answers, Item 18 = Find multiple solutions, Item 19 = Ask questions in decision-making, and Item 20 = Problems have numerous solutions.

Reliability

The Cronbach's α for the overall instrument was .96. The Cronbach's α for the engagement dimension was .84, indicating good internal item consistency, and the Cronbach's α for the seeking information dimension was .92, indicating excellent internal item consistency. The composite reliability value for the engagement dimension was .89, and for the seeking information dimension was .92. Both composite reliability values were greater than the recommended value (> .60), indicating good reliability (Hair et al., 2019).

Conclusions and Discussions

The diversity of students worldwide demonstrates a great need for cross-culturally validated measurements or instruments for assessing critical thinking. Therefore, researchers should ensure the translated version of an instrument continues to measure the same constructs as before the adaptation. The existing instruments for assessing Chinese students' critical thinking emphasized measurement of disposition components with little or no consideration given to critical thinking style. The UFCTI is an established instrument for assessing critical thinking style that has been used in agricultural disciplines for over a decade (Gorham et al., 2014; Leal et al., 2017; Putnam et al., 2017). This study translated the original UFCTI into Chinese and assessed the validity and reliability of the UFCTI Chinese version by using a sample of Chinese agriculture undergraduate students. According to the model fit indices (CFI = .95, TLI = .94, and RMSEA = .05), the results supported a good model fit for the UFCTI Chinese version. Thus, this study indicated the UFCTI Chinese version was valid and measures the same underlying characteristic of critical thinking style as the original English version.

A CFA was performed to examine the psychometric properties. The CFA findings indicated that the measurement model between the English version and Chinese version of the UFCTI were equivalent. Specifically, the results confirmed the two-factor measurement model of critical thinking style: engagement and seeking information. The internal consistency reliability for the engagement construct is .84, and .92 for the seeker construct. The two factor-model showed that all the items of the instrument significantly loaded ($p < .001$) on the respective two factors. All the factor loadings were greater than .50, which is considered an adequate level of construct validity. The findings supported the reliability and two-factor structure of the UFCTI Chinese version. This study provided the first evidence for the reliability and validity of the UFCTI when administered to a sample of Chinese agricultural students in China. Therefore, future critical thinking cross-cultural research becomes more feasible because of the presence of the validated UFCTI Chinese version.

Implications and Recommendations

Improving critical thinking has been a major concern for educators worldwide. It is important for researchers to have a valid instrument to explore critical thinking style for students from different cultural backgrounds. Construct validity is associated with how well a dimension measurement conforms to the original construct's theoretical definition. The establishment of construct validity allows one to use the same factorial construct between the two versions while providing meaningful interpretation and valid inferences for a future cross-cultural comparison. The results of this study indicated that the translation of the UFCTI Chinese version is appropriate for recording critical thinking skills of Chinese students.

This study would also be helpful for Chinese educators to understand students' critical thinking style. Previous studies highlighted the need for nurturing Chinese students' critical

thinking. Thus, this instrument could identify which aspect of critical thinking style needs to be improved, and then assist Chinese educators as they strive to develop their students' critical thinking. With a better understanding of the style of thinking students are expressing, educators will be able to efficiently incorporate diverse teaching strategies and methods to help students actively engage in the learning environment as well as encourage their truth-seeking attitudes. The sampling bias is a limitation of this study because the samples were collected at a single university. Further research is needed using different samples of Chinese university students to establish broader validity and reliability of the instrument. Acknowledging this limitation, the results indicate the instrument can be important to developing a deeper understanding of critical thinking style. For example, researchers and program evaluators could use the instrument in longitudinal studies that seek to explore the relationships between critical thinking style and learning performances or other cognitive factors, such as dispositions or attitudes. This is in line with the statement that investigating the attitudinal and cognitive style components is essential to providing a holistic evaluation of critical thinking performances (Ku, 2009). Additionally, this translation and validation proved the possibility of translating the original instrument into other languages and validation for broader application. The CFA method used in this study can provide a useful strategy for future studies intended to translate and adopt measurement tools. Specifically, CFA can be used to ensure a valid instrument for cross-cultural measurement equivalence.

The valid Chinese version of the UFCTI will allow researchers to conduct cross-cultural comparison studies about critical thinking style. With the increasing complexity of global agricultural issues, agricultural students are required to be more engaged in learning and utilizing professional knowledge to solve problems. By understanding how students approach complex issues, it is hoped that educators will bring different resources, perspectives, and knowledge to the internationalization of agricultural education. Future findings may provide insights about how to incorporate useful perspectives into international or multicultural agricultural education programs based on students' critical thinking style. Embedding appropriate teaching strategies into the intercultural learning environment is very important to facilitating effective international agricultural education development.

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