
Title	Development and validation of a critical thinking disposition scale
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EDUCATION RESEARCH FUNDING PROGRAMME

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FINAL REPORT



**Development and validation of a critical thinking
disposition scale / SUG 11/17 CKL**

By

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Singapore

Part II

EXECUTIVE SUMMARY

Purpose / Research Question

The purpose of the research study was to develop and validate a critical thinking disposition scale based on the definition provided by Ennis (1996). The research questions are:

1. What type of dispositions contribute towards critical thinking?
2. Is the critical thinking dispositional scale that is developed valid and reliable?

Background

At present, there are a number of conceptualizations of critical thinking dispositions that have been proposed partly due to the objectives of the different scholars. For example, some of the objectives included being commissioned to consolidate opinions across several disciplines, improvement of teaching and learning, and the inclusion of additional criteria. We subscribe to the criteria detailed by Ennis (1996) – the set of critical thinking dispositions should be simple, of value, comprehensive, comprehensible, conform to our everyday meanings in terms of language.

Although many conceptualizations of critical thinking dispositions have been proposed, the number of instruments that assess specifically critical thinking dispositions remain relatively scarce. A search of the current literature surfaced only two such instruments, namely The California Critical Thinking Disposition Inventory (CCTDI) (Facione & Facione, 1992) and Critical Thinking Disposition Scale (CTDS) (Sosu, 2013). However, there were noticeable gaps in both scales that may lead to reservations on their use. The CCTDI had several items that had cross loadings and/or poor factor loadings whilst in the CTDI, several key dispositions were clearly neglected.

Participants

The participants were 352 students (106 male, 246 females) enrolled in a postgraduate program in education. The mean age was 26.8 years, SD = 4.58.

Research Methodology / Design

In developing the scale, we followed the guidelines suggested by DeVellis (2016). An initial item pool comprising of 83 items was formed. Content validation was conducted and statements were refined such that 27 items were retained for empirical testing. Exploratory factor analysis was conducted to ascertain the factorial structure of the scale. The resulting scale was tested for measurement invariance across gender using a second order confirmatory factor analysis. Convergent validity was examined by examining the relation with the Epistemic Curiosity Scale and the Openness to Experience subscale from the HEXACO-PI-R. Internal consistency of each factor was computed using Cronbach alpha or Spearman Brown coefficient.

Findings / Results

Five factors were extracted from the exploratory factor analysis - Openness, Analyticity, Reflectiveness, Clarity and Focus. Openness refers to the tendency to be open to new ideas and possibilities, Analyticity refers to the application of reasoning and the use of evidence to support opinions and viewpoints, Reflectiveness refers to the awareness of self-beliefs and way of thinking, Clarity refers to the disposition of a person to represent his thoughts and opinions clearly to other people and Focus refers to the tendency to concentrate on the current situations. Multigroup confirmatory factor analysis supported a

second order model fit and measurement invariance across gender. The first and second order factors of the scale were all significantly correlated to epistemic curiosity and openness to experience. The internal consistency of all the factors were high. Taken together, there is sufficient evidence to support the validity and reliability of the final questionnaire.

Conclusion

This questionnaire is suitable for use in scenarios that either requires a short time for administration or the possibility of survey fatigue is high. Furthermore, as the five factors converge to a higher order factor, it is possible for users to assign an overall critical thinking disposition score to respondents, in order to facilitate quick comparisons. The main drawback of using this questionnaire is the possibility of a social desirability bias. Hence, it should not be used in high stakes situations.

Keywords

Critical thinking disposition; Critical thinking; Scale development, Exploratory factor analysis, Confirmatory factor analysis

Part III

INTRODUCTION

The past decades have seen the notion of critical thinking move from an emphasis on skills to a holistic definition that also encompasses disposition and metacognition dimensions. In essence, skills refer to a person's ability to perform critical thinking; dispositions refer to the tendency to carry out critical thinking under certain conditions whilst metacognition allows for self-corrections and self-improvements. Interactions of these three components determine the actual level of critical thinking in a person. For example, a person may have excellent critical thinking skills but lacks the inclination to use them. On the other hand, a different person may be eager to apply critical thinking but lacks the cognitive and metacognitive ability to do so.

Although all dimensions are important, there is a large disparity in the consensus arrived by researchers in terms of skills and dispositions. The general agreement on core cognitive skills is that it includes the ability to interpret, analyze, evaluate, infer, explain and self-regulate (Dwyer, Hogan, & Stewart, 2014; Ennis, 1993; P. A. Facione, 1990; Halpern, 1998; Liu, Mao, Frankel, & Xu, 2016; Watson & Glaser, 1980). However, the consensus on the critical thinking disposition aspect is less clear (Lai, 2011). Different conceptualizations proposed by various researchers have led to different dispositions being measured (e.g. Dwyer, Hogan, Harney, & Kavanagh, 2017; N. C. Facione, Facione, & Sanchez, 1994; Perkins, Jay, & Tishman, 1993; Sosu, 2013; Stupnisky, Renaud, Daniels, Haynes, & Perry, 2008; Valenzuela, Nieto, & Saiz, 2011). Moreover, some researchers have also claimed that there is one overarching thinking disposition that includes several subdispositions (Tishman & Andrade, 1996).

RESEARCH BACKGROUND

Conceptualizations of critical thinking dispositions

At present, there are a number of conceptualizations of critical thinking dispositions that have been proposed (See Table 1). The views of what constitutes critical thinking dispositions are varied partly due to the objectives of the different scholars. In the APA Delphi Report, the researchers were commissioned by the American Philosophical Association to consolidate the opinions from academics across several disciplines. A total of 46 critical thinking experts collectively proposed nineteen dispositions that critical thinkers would need to possess (P. A. Facione, 1990). Several researchers aimed to improve teaching and learning, albeit at different educational levels (Bailin, Case, Coombs, & Daniels, 1999; P. A. Facione & Facione, 1992; Halonen, 1995; Halpern, 1998; Paul & Elder, 2005) whilst others had different criteria in their propositions. For example, Perkins, Jay, and Tishman (1993) included the concept of ability in their definition of critical thinking dispositions whilst Dwyer, Hogan, Harney, and Kavanagh (2017) built a consensus model of the dispositions between students and educators. Finally, we subscribe to the criteria detailed by Ennis (1996) – the set of critical thinking dispositions should be simple, of value, comprehensive, comprehensible, conform to our everyday meanings in terms of language, and subordinates should fit under superordinates, if possible (Ennis, 1996).

Table 1: Conceptualizations of critical thinking dispositions

Author	Dispositions
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Data analysis

Exploratory factor analysis (EFA) was conducted using IBM SPSS ver 25 to ascertain the factorial structure of the scale. The factorability of the correlation matrices was assessed using Bartlett’s test of sphericity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The number of factors to be extracted was determined by the scree test (Cattell, 1966) and parallel analysis (Horn, 1965). The data was analysed using principal axis factoring with a promax rotation used on the resulting factors. The EFA was then ran iteratively with items that have poor factor loadings or substantive cross loadings being eliminated from the scale. Additionally, the internal consistency of each factor was computed using Cronbach alpha or Spearman Brown coefficient (when there are only 2 items) and reviewed at each iteration.

Subsequently, the resulting scale from EFA was tested for measurement invariance across gender using a second order confirmatory factor analysis (CFA). In testing for a second order structural model, we followed the process outlined by Byrne and Stewart (2006) in establishing baseline models, configural invariance, metric invariance and scalar invariance. The second order CFA was conducted using IBM SPSS AMOS ver 25. In evaluating model fit, we examined the χ^2 test statistic, the comparative fit index (CFI), the root mean square error of approximation (RMSEA) and the standardized root mean-square residual (SRMR). Similarly, the criteria used to determine measurement invariance are non-significant changes in χ^2 (Byrne, Shavelson, & Muthén, 1989) and a –0.1 change in CFI paired with changes of .015 in RMSEA and .030 in SRMR for metric invariance or .015 in SRMR for scalar invariance (Chen, 2007).

FINDINGS AND DISCUSSION

Exploratory factor analysis

Both the results for the KMO test, .834, and the Bartlett’s test of sphericity, $\chi^2(91) = 2209.808, p < .001$, provided support for performing the EFA (Howard, 2016). In the scree plot, it can be observed that a break in the plot exists at two points, indicating the extraction of 1 factor or 5 factors (See Figure 1). Parallel analysis supported the notion of 5 factors (See Table 3). Therefore, we decided to retain 5 factors in the final scale. The total variance explained by the five factors was 63.7%.

Figure 1. Scree plot on the number of factors to extract

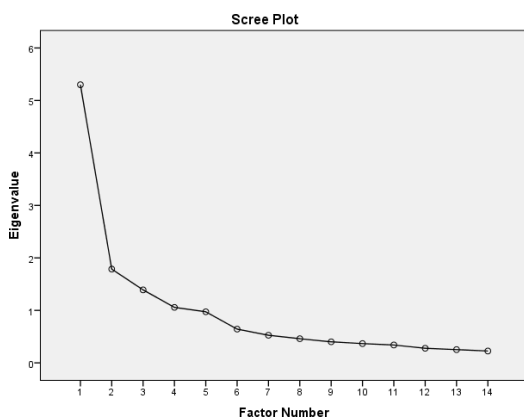


Table 3: Results from Parallel Analysis

Factor	Raw data eigenvalues	Mean random data eigenvalues	95 th percentile random data eigenvalues	Decision
1	4.820	.394	.478	Yes
2	1.272	.308	.374	Yes

3	.942	.242	.292	Yes
4	.589	.185	.229	Yes
5	.484	.134	.178	Yes
6	.066	.087	.128	No

Upon inspection of the items, we decided to label the factors as Openness (OPE), Clarity (CLA), Focus (FOC), Analyticity (ANA) and Reflectiveness (REF). The labels were decided based on two reasons: 1) the phrasing of the items themselves and 2) research literature that highlighted the importance of these factors. The final factor loadings of each item are presented in Table 4. Each factor had three relevant items with the exception of Clarity which had only two items loaded onto it. The mean, standard deviation, skewness and kurtosis of the items in each factor are presented in Table 5. The means and standard deviations ranged from 3.13 to 4.36 and .56 to .91 respectively. The skewness and kurtosis indices ranged from $-.07$ to $-.74$ and $-.60$ to 1.65 respectively. The internal consistency values are also presented in Table 5 and the indices ranged from .72 to .86, indicating an acceptable to high reliability. The Cronbach alpha value for the entire scale was .86.

Table 4: Pattern matrix for the Critical Thinking Disposition Questionnaire

Item	Factor				
	1	2	3	4	5
OPE1	.966				
OPE2	.797				
OPE3	.537				
CLA1		.903			
CLA2		.853			
FOC1			.811		
FOC2			.803		
FOC3			.413		
ANA1				.866	
ANA2				.806	
ANA3				.805	
REF1					1.096
REF2					.493
REF3					.490

Table 5: Descriptive statistics for the Critical Thinking Disposition Questionnaire.

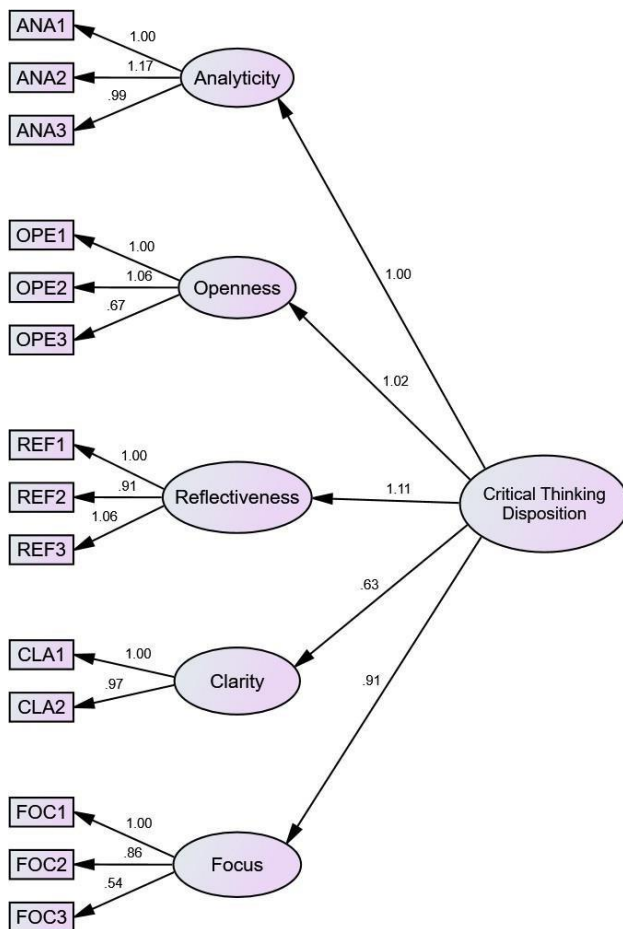
Item	Full statement	Mean	SD	Skew	Kurtosis	Internal consistency
Openness						.82
OPE1	I look for different ways of doing things.	4.13	0.68	-.50	.44	
OPE2	I look for different answers to questions.	3.98	0.76	-.52	.18	
OPE3	I think about different possibilities when making decisions.	4.36	0.60	-.57	.74	
Clarity						.86
CLA1	It is important for other people to understand what I am writing.	4.25	0.61	-.42	.54	
CLA2	It is important for other people to understand what I am saying.	4.24	0.60	-.31	.32	
Focus						.72
FOC1	I am not easily distracted by unrelated details in discussions.	3.24	0.90	-.20	-.60	
FOC2	I do not discuss irrelevant details in conversations.	3.13	0.91	-.13	-.42	
FOC3	I am able to stay focus on the main points in discussions.	3.88	0.68	-.74	1.52	
Analyticity						.84

ANA1	I offer reasons when justifying my opinions.	4.13	0.56	-.07	.45
ANA2	I think of various reasons before stating my opinions.	4.04	0.69	-.62	.85
ANA3	I offer reasons when I state my viewpoints.	4.12	0.60	-.29	.76
Reflectiveness					.80
REF1	I am clear about my beliefs.	4.14	0.63	-.53	1.65
REF2	I reflect on my beliefs when I encounter a conflict.	4.06	0.67	-.59	1.39
REF3	I am clear about my own thinking.	3.92	0.69	-.46	.77

Confirmatory factor analysis

Based on the specifications from EFA, a second order factor model was constructed and tested (See Figure 2). The fit indices suggested an acceptable fit for this model, $\chi^2(72) = 203.44, p < .001, CFI = .94, RMSEA = .072$ with 90% CI = (.061, .084), SRMR = .077. In addition, the loadings from the first order factors to the second order factor are significant and relatively high, ranging from .63 to 1.11, suggesting that the first order factors can be grouped under one overarching critical thinking disposition.

Figure 2. A second order CFA model for the Critical Thinking Disposition Questionnaire



The hypothesized model was tested for measurement invariance across gender and the results are presented in Table 6. In the baseline model for males, two error covariances were added. However, by implementing a condition of partial measurement invariance, multigroup analyses can still continue (Byrne & Stewart, 2006). The fit indices for the

baseline models indicated an acceptable fit for both males $\chi^2(70) = 121.57, p < .001, CFI = .93, RMSEA = .084$ with 90% CI = (.058, .104), SRMR = .084 and females $\chi^2(72) = 162.24, p < .001, CFI = .94, RMSEA = .072$ with 90% CI = (.057, .086), SRMR = .081.

Five hierarchically nested multigroup models were tested across gender. The configural model (Model 1), in which no equality constraints were imposed, demonstrated an acceptable fit to the data, indicating that the model structure was the same in both males and females. When all the models were compared against Model 1, the fit indices also did not change significantly, indicating that the second order critical thinking disposition structure was invariant across gender.

Table 6: Test for measurement invariance across gender

Model	Description	Model comparison	χ^2	df	CFI	RMSEA	SRMR	$\Delta\chi^2$	p	Δ CFI	Δ RMSEA	Δ SRMR
Baseline												
Male	To test model-fit for males	-	121.57	70	.929	.084	.084	-	-	-	-	-
Female	To test model-fit for females	-	162.24	72	.938	.072	.081	-	-	-	-	-
Configural												
1	No equality constraints imposed.	-	305.32	144	.926	.057	.088	-	-	-	-	-
Metric												
2	All first order factor loadings invariant	2 vs 1	315.39	153	.925	0.055	.087	10.07	n.s.	-.001	-.002	-.001
3	All first and second order factor loadings invariant	3 vs 1	318.87	157	.925	0.054	.094	13.55	n.s.	-.001	-.003	.006
Scalar												
4	All first and second order factor loadings and observed variable intercepts invariant	4 vs 1	330.56	166	.924	0.053	.093	25.24	n.s.	-.002	-.004	.005
5	All first and second order factor loadings and observed variable intercepts invariant. Latent factor intercepts constraint to zero.	5 vs 1	340.50	172	.922	0.053	.092	35.18	n.s.	-.003	-.004	.004

Convergent validity

The convergent validity of the Critical Thinking Disposition Questionnaire was analysed through computing the correlation correlations for the first and second order factors with the Epistemic Curiosity Scale and the Openness to Experience subscale of the HEXACO PI-R (See Table 7). The results showed that epistemic curiosity and openness to experience were all significantly correlated to the first and second order factors of the scale.

Table 7: Convergent validity of the Critical Thinking Disposition Questionnaire

Variables	1	2	3	4	5	6	7	8
1 Critical Thinking Disposition	1.00							
2 Openness	.75**	1.00						
3 Clarity	.64**	.26**	1.00					
4 Focus	.56**	.35**	.21**	1.00				
5 Analyticity	.81**	.50**	.38**	.39**	1.00			
6 Reflectiveness	.78**	.46**	.30**	.43**	.55**	1.00		
7 Epistemic Curiosity	.51**	.47**	.17**	.31**	.46**	.41**	1.00	
8 Openness to Experience	.34**	.36**	.17**	.13*	.26**	.24**	.41**	1.00

* $p < .05$; ** $p < .01$;

Discussion

The five extracted factors were Openness, Analyticity, Reflectiveness, Clarity and Focus. Openness refers to the tendency to be open to new ways, solutions, ideas and possibilities. Analyticity refers to the application of reasoning and the use of evidence to support opinions, viewpoints, ideas and solutions. Reflectiveness refers to the awareness of self-beliefs and way of thinking. Clarity refers to the disposition of a person to represent his thoughts and opinions clearly to other people. Focus refers to the tendency to concentrate on the current situations.

Future users of this scale would need to be aware of its advantages and potential pitfalls. The parsimonious nature of this questionnaire makes it suitable for use in scenarios that either requires a short time for administration or the possibility of survey fatigue is high. Furthermore, as the five factors converge to a higher order factor, it is possible for users to assign an overall critical thinking disposition score to respondents, in order to facilitate quick comparisons. This scale is useful for anonymous research data, self-analysis, improvement purposes and other low stakes situations. The main drawback of using this questionnaire is the possibility of a social desirability bias. Participants with high levels of cognition would be able to answer the items "correctly" to demonstrate a high critical thinking disposition. Hence, it should not be used in high stakes situations. Moreover, the questionnaire is but one measure of critical thinking dispositions. Researchers who require a comprehensive evaluation of critical thinking may need to include other measures, such as performance assessments or longitudinal observations.

CONCLUSION

The current study paves the way for future research in critical thinking. Whilst many educators have focused on developing critical thinking skills, the emphasis on teaching methods to acquire a critical thinking disposition remains relatively unexplored. The development of a critical thinking disposition questionnaire is but the first step in this area.

We conclude by noting some limitations with this study. First, the sample involved are postgraduate students and this may potentially bias the responses. However, a mitigating factor would be that the students belong to different disciplines, thus ensuring a good spread of intellectual thought. Second, we did not address any issues of domain specificity. It may be possible that critical thinking dispositions vary across different subject areas, and thus, a general instrument may be insufficient for certain domains. Lastly, we recognize that

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APPENDIX**The Critical Thinking Disposition Questionnaire**

No.	Full statement	Strongly disagree	Disagree	Neither disagree or agree	Agree	Strongly agree
1	I look for different ways of doing things.	1	2	3	4	5
2	I look for different answers to questions.	1	2	3	4	5
3	I think about different possibilities when making decisions.	1	2	3	4	5
4	It is important for other people to understand what I am writing.	1	2	3	4	5
5	It is important for other people to understand what I am saying.	1	2	3	4	5
6	I am not easily distracted by unrelated details in discussions.	1	2	3	4	5
7	I do not discuss irrelevant details in conversations.	1	2	3	4	5
8	I am able to stay focus on the main points in discussions.	1	2	3	4	5
9	I offer reasons when justifying my opinions.	1	2	3	4	5
10	I think of various reasons before stating my opinions.	1	2	3	4	5
11	I offer reasons when I state my viewpoints.	1	2	3	4	5
12	I am clear about my beliefs.	1	2	3	4	5
13	I reflect on my beliefs when I encounter a conflict.	1	2	3	4	5
14	I am clear about my own thinking.	1	2	3	4	5