

Use Importance-Performance Matrix Analysis to Understand Training Practices on ICT Literacy and Critical Thinking

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Abstract

The study aims to explore how the participants vary in their self-efficacious belief and motivation after using critical thinking online training units integrated by information and communication technologies (ICTs), abbreviated as iCT², in the both academe and industry context. Based on the quasi-experimental pre-post research design with stratified sampling, the researcher has completed the empirical validation administered to the 739 research participants with valid return of 75%. The research finding indicates that enactive master of the domain knowledge is directly influenced by vicarious modeling and sense of arousal, and indirectly by verbal persuasion. Extending the results of PLS-SEM, the importance-performance matrix analysis (IPMA) takes the performance of each construct into account, and contrasts the structural model total effects (importance) and the average values of the latent variable scores (performance) to highlight critical determinants for the improvement of management practices. The IPMA requires obtaining the total effects of the relationships of all the other constructs (i.e., AR, VM, and VP) on the target construct of EM to indicate their importance. The total effect of a relationship between two constructs is the sum of all the direct and indirect effects in the structural model; that is, the total effect equals to direct effect and indirect effect. The three determinants tend to be equally performed, however, vicarious modeling (VM) is of high importance compared to verbal persuasion (VP) and sense of arousal (AR). Related to iCT² training practices and effectiveness assessment, the research finding is aligned to the issues of training transfer and talent development in bridging the potential candidates in academe to the professionals in industries.

Key words: information and communication technologies (ICTs), critical thinking, importance-performance matrix analysis (IPMA), self-efficacious belief

Introduction

In light of modern citizenship, one of the major goals among higher education is to cultivate and train college students to become independent and reasonable thinkers [1]. Haghparast, Nasaruddin [1] elaborate that students should be competent of being identifying problems, evaluate potential evidence, distinguish information, and draw conclusions. Critical thinking is often thought as a metacognitive process consisting of a set of higher-order sub-skills, e.g., inductive and deductive, and the such increases the chances of producing a logical

conclusion to an argument or solution to a problem when used appropriately [2]. That is, critical thinking is deemed a series of purposeful self-regulatory tactics and decision-making resulting in multiple outcomes with potentials. Fell and Lukianova [3] assert that critical thinking is an essential set of competences necessary for successful completion of any degree program in higher education. Florea and Hurjui [4] define critical thinking as knowledge updating, analyzing differences, observe cause-effect relationships, extract ideas from real-case scenarios, support ideas with evidence-based metaphors, and evaluate information based on multiple perspectives. Although researchers have a different description about critical thinking, Haghparast, Nasaruddin [1] bring up as a whole that critical thinking skills include interpretation, analysis, inference, evaluation, explanation, and self-regulation.

To a sample of 2000 undergraduate students from six Malaysian public universities, Rodzalan and Saat [5] investigate students' perception on their critical thinking and problem solving. They find students perceived higher critical thinking demonstrate greater problem solving skill. More, male students are perceived to have better critical thinking and problem solving skill. Social science students appear to perform better in this skill, as compared to science and engineering students. That is, there are differences between genders and academic disciplines on the both skills. As said, college students with critical thinking skills and literacy turn to be critical in academic success and future career planning.

As the subskills of critical thinking, being capable of identifying problems is of essence. To train one individual to possess this preliminary skill of identifying a gap or critical problem within a perplexing issue, this research project also integrate the concept of design thinking to instructional-system design of the kind. According to Brown [6], design thinking is a people-centered problem-solving methodology, based on people's needs, innovative solutions are sought for a variety of issues, and this creates more possibilities. Tim Brown, CEO of IDEO Design Company, made his definition in the Harvard Business Review that design thinking is a people-oriented design spirit and approach that takes into account of people's needs, behavior, and technology or business viability [6]. Design thinking is actually a set of procedures, but the more important thing is the other set of thinking behind this. Kokotovich [7] argues that the way of design thinking can transform the way people looks at the problem, and via a specific way of thinking, the specific outline of the problem can be showed more completely. Using this method to explore the problem, the crux of the problem can be identified, when more problems are identified, there is a higher chance to

provide a clear solution on design techniques and the problem of demand [7]. Rauth, Köppen [8] point out that design thinking is a creative process that encompasses multiple methods, steps and skills, at the same time, design thinking also includes cross-domain integration. In their study of transforming entrepreneurship education through five-step design thinking over the three years, Huq, Huq [9] apply spiral discussion with students and industry partners to jointly develop innovative education course curriculum and materials, which in turns to enhance student satisfaction and their learning outcomes. Using five-step design thinking framework, the study continues to develop the digital content of iCT² online training, and its assessment as one of the three-fold research purpose. The training content is applied to both onsite and online instruction, i.e., the blended training of online to onsite (O2O).

One of the three-fold research purpose, this research also aims to understand how individuals differ in their self-efficacious belief after being introduced the importance of critical thinking in the perspectives of HR recruitment. To achieve this goal, understanding one's belief of being capable of performing a task is of importance relatively. As elaborated, this empirical study is to understand the self-efficacious belief and motivation among the college students and working professionals.

Method

Based on the quasi-experimental pre-post research design with stratified proportionate sampling, the researcher has completed the empirical validation administered to the 739 research participants with valid return of 75%. The research participants are undergraduate and graduate students with three levels, i.e., full-time students, full-time students with part-time work experience, full-time students with full-time work experience. Of the 739 participants from 20 undergraduate semester courses, 64.0% (n=473) were females and 36.0% (n=266) were males. Regarding the working experiences, the 75.9% (n=561) of the participants do not have work experiences, 20.6% (n=152) of the participants have part-time work experiences, and the rest are full-time students with full-time work experience. The participants rated their perception level on an 8-point Likert scale, which ranged from strongly disagree (1) to strongly agree (8). The items exhibiting low loadings on the corresponding construct were eliminated to enhance the reliability of measures. The measurement scale was developed based on the extensive literature review, and were adapted to the operational definition accordingly to ensure the contextual consistency of the study.

Results

A. Measurement Model

Reliability is an alternative indicator of convergent validity that has been verified using consistency reliability (CR) and average variance extracted (AVE) [10]. Convergent validity refers to the extent to which multiple items or indicators share a proportion of variance. Ideally, acceptable values of CR exceed .70 [11]. This study reports that the CR falls between .927 and .956, and AVE values falls between .718 and .814, which both met the recommended thresholds as shown in Table 1. An AVE value of .50 or higher suggests

adequate convergence, whereas an AVE value of less than .50 implies a higher level of error variance than was explained by the variance remaining in the measurement model.

As part of construct validity, discriminant validity refers to whether a given construct is truly distinct from other constructs and includes two criteria: (1) the square root of the AVE for each construct should exceed the correlations between this construct and other constructs; (2) the factor loading should be larger than cross loadings [12, 13]. The factor loading of each construct (.702 –.920) exceeded .70 and the cross loadings. The above assessment demonstrated that the discriminant validity of the measures was adequate. In summary, the measurement model assessment substantiated that all of the construct measures were reliable and valid.

TABLE 1
MEASUREMENT MODEL ESTIMATION

Principal construct	M	SD	CR	CA	AVE
1. Verbal persuasion (VP)	6.28	1.23	.936	.914	.747
2. Vicarious modeling (VM)	6.00	1.24	.932	.909	.734
3. Sense of arousal (AR)	6.20	1.20	.956	.943	.814
4. Enactive mastery (EM)	6.20	1.19	.927	.899	.718

Note: SD: Standard Deviation, CR: Composite Reliability, and CA: Cronbach's Alpha.

B. Structural Model

To report the structural model, the path coefficients and the R² values are required. The path coefficients refer to the magnitude of the expected change in the observed variables, and the R² values are the amount of variance in dependent variables explained by their antecedents (Vinzi, 2010). On the other hand, the bootstrapping (BT) procedure deals with the overall explanatory power, the estimated path coefficients, and the associated t values of the paths. This Partial Least Square (PLS) analysis demonstrates that EM (R² = .743) was explained by VM (β = .843, p < .001) and AR (β = .06, p < .05), but not by VP (β = .002, p > .05). Sense of arousal (AR) (R² = .621) was explained by VP (β = .788, p < .001). Vicarious modeling (VM) (R² = .107) was explained by VP (β = .20, p < .001). That is, the research finding indicates that enactive master of the domain knowledge is directly influenced by vicarious modeling and sense of arousal, and indirectly by verbal persuasion.

C. Importance-Performance Matrix Analysis (IPMA)

Extending the results of PLS-SEM, the importance-performance matrix analysis (IPMA) takes the performance of each construct into account, and contrasts the structural model total effects (importance) and the average values of the latent variable scores (performance) to highlight critical determinants for the improvement of management practices [14]. The IPMA requires obtaining the total effects of the relationships of all the other constructs (i.e., AR, VM, and VP) on the target construct of EM to indicate their importance. The total effect of a relationship between two constructs is the sum of all the direct and indirect effects in the structural model; that is, the total effect equals to direct effect and indirect effect. The data used for the IMPA of enactive mastery (EM) as latent variable is presented in Table 2 for a graphical representation

of results. The three determinants tend to be equally performed, however, vicarious modeling (VM) is of high importance compared to verbal persuasion (VP) and sense of arousal (AR).

TABLE 2
THE IPMA PATH MODEL ON ENACTIVE MASTERY

	Importance (Total Effect)	Performance (Index Values)
Verbal persuasion (VP)	.31	75
Vicarious modeling (VM)	.85	70
Sense of arousal (AR)	.18	73

Conclusion

Based on the quasi-experimental pre-post research design with stratified proportionate sampling, the researcher has completed the empirical validation administered to the 739 research participants with valid return of 75%. The research participants are undergraduate and graduate students with three levels, i.e., full-time students, full-time students with part-time work experience, full-time students with full-time work experience. The finding contributes to the understanding of the key performance indicators among HR recruitment and in-service work performance after participating the iCT² training. The abovementioned tasks related to iCT² training practices and effectiveness assessment have been aligned to the issues of training transfer and talent development in bridging the potential candidates in academe to the professionals in industries. Still, there are certain tasks going on and being initiated the follow-up tasks for the future study.

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References

1. Haghparast, M., F.H. Nasaruddin, and N. Abdullah, *Cultivating Critical Thinking Through E-learning Environment and Tools: A Review*. Procedia-Social and Behavioral Sciences, 2014. **129**: p. 527-535.
2. Dwyer, C.P., M.J. Hogan, and I. Stewart, *An integrated critical thinking framework for the 21st century*. Thinking Skills and Creativity, 2014. **12**: p. 43-52.
3. Fell, E.V. and N.A. Lukianova, *British Universities: International Students' Alleged Lack of Critical Thinking*. Procedia-Social and Behavioral Sciences, 2015. **215**: p. 2-8.
4. Florea, N.M. and E. Hurjui, *Critical Thinking in Elementary School Children*. Procedia-Social and Behavioral Sciences, 2015. **180**: p. 565-572.
5. Rodzalan, S.A. and M.M. Saat, *The Perception of Critical Thinking and Problem Solving Skill among Malaysian Undergraduate Students*. Procedia-Social and Behavioral Sciences, 2015. **172**: p. 725-732.
6. Brown, T., *Change by design: How design thinking transforms organizations and inspires innovation*. 2009, New York: Harper-Collins.

7. Kokotovich, V., *Problem analysis and thinking tools: an empirical study of non-hierarchical mind mapping*. Design Studies, 2008. **29**(1): p. 49-69.
8. Rauth, I., et al. *Design thinking: an educational model towards creative confidence*. in *DS 66-2: Proceedings of the 1st International Conference on Design Creativity (ICDC 2010)*. 2010.
9. Huq, A., et al., *All the world's a stage: transforming entrepreneurship education through design thinking*. Education+ Training, 2017. **59**(2): p. 155-170.
10. Hair, J.F., et al., *An assessment of the use of partial least squares structural equation modeling in marketing research*. Journal of the Academy of Marketing Science, 2012. **40**(3): p. 414-433.
11. Hair, J.F., C.M. Ringle, and M. Sarstedt, *PLS-SEM: Indeed a Silver Bullet*. Journal of Marketing Theory & Practice, 2011. **19**(2): p. 139-152.
12. Hair, J.F., et al., *Multivariate Data Analysis: A Global Perspective*. 7 th ed. 2010, Upper Saddle River, New Jersey: Pearson Education. 800.
13. Bollen, K.A., *Structural Equations with Latent Variables*. 1989, New York: Wiley.
14. Hair, J.F., *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. 2013: SAGE Publications.

