

The Moderation Effect of Motivation on the Relationship between Internet Search and Critical Thinking

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Abstract: The advancement of Internet brought potential to engage learners in practicing using critical thinking skills by searching the information to solve any given academic problems. This study investigated a model incorporating the interaction between Internet search strategies and motivation, in influencing critical thinking skill. A web survey was conducted to gather data from 307 subjects from United States. The results supported the research hypothesis that motivation influences the strength of the predictive relationship between Internet Search and critical thinking. The post-hoc analysis suggested that the prediction of Internet search on critical thinking for the low motivation group was stronger than for the high and medium motivation groups. Implications for theories are recommended.

Keywords: Critical Thinking, Internet Search, Motivation

Introduction

Critical thinking skills was rated by experts from industry, economy, and education as the most important skill in successfully living in our information-rich and technology advanced society (Maricle, 2003). Web technology provides access to more types of information that can support learning than were available in the past. However, with this rich new source of information comes the challenge of more diverse and complex problems for learners to deal with after graduation.

Critical thinking is a complex reasoning process that improves with practice (Facione, & Facione, 1996; Paul & Elder, 2004; Van Gelder, Bissett & Cumming, 2004). The advancement of Internet technology enables learners to search the Internet for information that will help them solve given academic problems. Such an activity, which requires learners to interpret a learning problem based on multiple information sources, establish a plan to search for additionally required information, strategically conduct a search for the information, evaluate the results of the information found, and use the information to solve the given problem (Wallace, Shorten, Crookes, McGurk & Brewer, 1999), might engage learners in practice in using critical thinking skills. Learners may or may not have experience exploring the Internet; however various factors, such as their internet search strategies and motivation might influence a person's engagement in practicing critical thinking skills.

Motivated learners are guided by personally set goals and task-related strategies. They self-initiate their search process and are usually persistent in their search efforts. They are confident in their subject learning and search approach and utilize appropriate strategies

(Zimmerman, 2002, Zimmerman & Martine-Pons, 1988). These affect factors enhance their self-satisfaction and determine whether to continue improving their methods of searching. Not many empirical research studies could be found that investigate the inherent influence of motivation factors on engaging learners in the Internet search process to practice critical thinking skills. Therefore this study investigated a model incorporating the interaction between Internet search strategies and motivation in influencing critical thinking skills.

Literature Review

This study grounded intention Internet search (IIS) on the General Expectancy-value model and information seeking models, which view the motivational and behavioral components as interacting and reciprocally affecting each other. Learners' Internet search performance is directly influenced by the "skill" component (Pintrich & Schrauben, 1992), which includes: selecting Internet resources, adopting powerful search strategies for attaining the goals, planning the search process for attaining the goals, evaluating one's search strategies and the information being searched etc.

A "will" component is assumed to facilitate and influence the use of skill component. Motivation is generally regarded as the inclination to invest the necessary energy to successfully complete a task (Deci & Ryan, 1985). It consists of learners' beliefs about their ability to perform a task (*self-efficacy*), and their expectancy for success at the task (Pintrich, 1989). Learners' expectancy for success in an academic setting interacts with the value component, including their goal orientations regarding their reasons for undertaking academic tasks and their perceived task value (interest). This interaction between expectancy and value has been commonly used as an indicator of motivation. In addition to efficacy beliefs, learners' feelings about the value of learning tasks can not be ignored (Nicholls, 1990). Learners who adopt an intrinsic goal orientation to IIS tend to focus on understanding the problem they are investigating and the information they collect via the Internet. By contrast, learners with an extrinsic goal orientation to IIS tend to focus on grades, rewards, or approval from others. Thus, in addition to examining learner self-efficacy, it is important to understand how learners' goal orientations influence their IIS process use of search and metacognitive strategies.

The general expectancy-value theory (Pintrich, 1989; Pintrich & Garcia, 1991; Pintrich & Schrauben, 1992) provided an explanation of how each of these motivational components, task value, and goal orientation, affect students employment of cognitive strategies (i.e. Search strategies for IIS context). However, an individual's willingness to invest time and efforts in a task does not necessarily mean the individual has the skills to successfully achieve that task. Neither a highly motivated student without good search strategies, nor an unmotivated student with good search strategies, is likely to perform well in IIS learning activities.

Previous discussions indicated two factors that might be related to the success of Internet search and learners' level of engaging in practicing critical thinking during IIS process: (i) learners' knowledge of Internet searching, including selection of different internet resources, types of search strategies, and evaluation abilities, determines how effectively and precisely learners articulate their information needs, And (ii) learners' motivation, including goal orientation to their learning, value of the learning tasks, and self-efficacy of the subject and internet, is related to their persistence on the Internet search process. Thus, it is reasonable to assume the relationships exist among the three factors and learners' engagement in practicing critical thinking skills during an IIS process. Grounded on the assumption that critical thinking can be enhanced by deliberate practice, a reasonable

inference was proposed: Level of motivation influences the strength of the predictive relationship between Internet Search and critical thinking.

Method

1. Subject

307 participants, who were matriculated in graduate or undergraduate programs related to science or social science at spring 2007, participated in this study. Seventy percent (70 %) of the participants (N=307) were females and 69.4 % of the participants reported a GPA higher than 3.5. Further, the academic level of participants was reported as follows: 32.6 % (n=100) were post-master students, 37.1 % (n=114) were master students and 30.3 % (n=93) were undergraduate students. The numbers of each subset of academic levels were approximately equal. In regard to academic major, nearly 45.6 % (n=140) of the participants majored in education, 24.5 % (n=75) majored in information studies, 8.8 % (n=27) majored in engineering, 10.1 % (n=31) majored in science and 11.1 % (n=34) majored in other areas of social science. The number of the education subset is higher than other subsets. This high percentage of education majors might delimit the generalizability of the results to populations with non-education majors.

2. Variables and Measures

The dependent variable, critical thinking skills, is defined as one's analysis skills, evaluation skills, interpretation skills, and reference skills. This variable was measured by the Williams Critical Thinking Assessment (WCTA) (Williams, 2002), which was comprised of 41 multiple-choice short problem statements. The reliabilities reported by different studies ranged from .79-.83.

Two sets of independent variables served as indicators for two constructs: Internet search and motivation. Motivation was indicated by self-efficacy, goal orientation and task value (Pintrich, 2000), measured by the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & Garcia, 1995). Internet Search was indicated by three variables: selection of the Internet resources, search knowledge and evaluation of the Internet resources. This set of variables was measured by the Intentional Internet Search Behavior Scale (Wu, Koszalka, & Wu, 2007) and the reported reliabilities range from 0.89 to 0.51.

3. Data Collection and Data Analysis

A survey method was employed to gather data for the following variables via a Web-based questionnaire from March, 2007 to May, 2007. Two demographic variables were considered in the procedures of stratified sample recruitment: academic levels and academic majors. The researcher recruited participants from schools' listservs or department research boards, in-class promotion and the researcher's personal network.

A structural equation model (SEM) with latent variables, using the Amos 7.0, was used to test the hypothesized relationships among variables. Scale validation procedures using Confirmatory Factor Analysis were performed followed by hypothesis testing. The model testing was made on three levels: First, several global fit indices including the Chi-square, the ratio of the chi-square statistic to the model degrees of freedom, CFI, NFI, RMSEA etc. Second, a detailed assessment was made in which differences between the

observed and reproduced covariances were examined. Third, indices suggesting possible model revisions were provided by Amos.

Findings and Discussions

1. Examination of Research Hypotheses: Measurement model validation

The confirmatory factor analysis (CFA) was performed to test the measurement model of the hypothesized structural equation model. The results of three hypothesized measurement models, critical thinking, motivation, and Internet Search have indicated the fit of data to these modified proposed model were moderate (see Table 1). Overall the quality of the three measures (i.e. the critical thinking scale, motivation scale, and Internet search scale) all reached acceptable levels. Table 1 also presents the summary of the reliabilities (Cronbach's alphas) of each measure, which indicate excellent consistency across the items that form these scales.

Table 1. *Goodness fit and the Reliabilities of Proposed Measurement Models*

Construct	Indicators	Goodness-of-fit indexes	Cronbach's Alpha	Notes
Critical Thinking	Analysis, Evaluation, Inference, Interpretation	$\chi^2 = 1.68$; DF = 2; $P = 0.43$ CMIN/DF = 0.84 NFI = 0.99 CFI = 1 RMSEA < 0.001	0.52 ~0.83	Reasonable Supported
Motivation	Goal orientation, Task Value, Self-efficacy	$\chi^2 = 295.78$; DF = 131; $P < 0.001$ CMIN/DF = 2.26 NFI = 0.93 CFI = 0.96 RMSEA = 0.06	0.86 ~0.93	Reasonable fit Supported
Internet Search	Selecting Internet Resources, Search Strategies, Evaluation of Internet Sources, Self-efficacy of IIS	$\chi^2 = 234.42$; DF = 127; $P < 0.001$ CMIN/DF = 1.846 NFI = 0.88 CFI = 0.94 RMSEA = 0.05	0.59 ~0.87	Reasonable Supported

2. Examination of Research Hypotheses: Model Testing

Model Testing

The moderation effect of motivation was tested using the indicant product approach and the moderation effect was supported with reasonable model fit statistics (i.e. $\chi^2 = 84.93$, $df = 46$, $p < 0.0001$, the ratio of χ^2 and DF = 1.85, NFI=0.96, CFI=0.98, and RMSEA=0.05). No direct effects of motivation and Internet search on critical thinking were found. The path from the interaction latent variable to the critical thinking latent variable was 0.38, which was statistically significant ($Z = 5.180$, $P < 0.0001$). In sum, Internet search and motivation do not impact critical thinking directly. Rather, they only influence critical thinking through the interaction. The magnitude of the increase in critical thinking for each unit of increase in

Internet search was greater as motivation decreases. In summary, the proposed structural equation model was partially supported with slightly adjustment (see Figure 1).

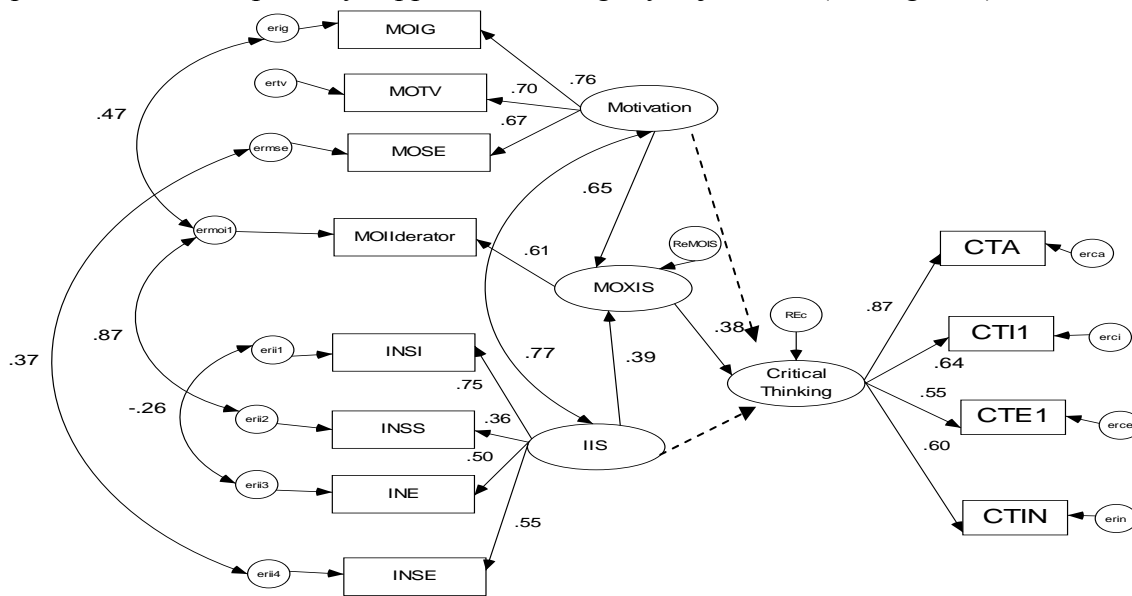


Figure 1 Standardized Output for the Structural Equation Model of Critical Thinking
 Note: MOXIS represents the latent interaction variable, MOIIderator represents the interaction, dot-line presents non-significant relationships

The Nature of Interaction Effect

To visualize the nature of the interaction effect, a plot was constructed on the basis of forming approximately equal-sized groups of high, medium and low motivation. Previous analyses have determined that motivation could be indicated by three factors: intrinsic goal orientation, task value, and self-efficacy. The test results of the motivation measurement model also produced unstandardized factor loadings for these three indicators. The research multiplied the unstandardized factor loading by the raw score of their corresponding indicator and summed to create a composite index of motivation (Wei, Mallinckrodt, Russell, & Abraham, 2004). The distribution of these scores was used to form three approximately equally sized groups: low motivation (n=102) v.s. medium motivation (n=103) v.s. high motivation (n=103).

Table 2. Moderation Effect of Motivation

Group	Mean	Std	Skew	Kurtosis
High	32.45	8.61	-0.54	-0.45
Med	31.71	8.50	-0.44	-0.76
Low	28.70	8.40	-0.09	-0.86

Internet Search	High Motivation	Medium Motivation	Low Motivation
L	~31	~31	~24
M	~32	~32	~31
H	~33	~33	~38

Note: L is -2 standard deviations from the mean of Internet Search, M is the mean of Internet Search; H is 2 standard deviations from the mean of Internet Search

Table 2 indicates that Internet search is significantly positively associated with critical thinking, which was evidenced in the low motivation group. However, the positive relationship between Internet search and critical thinking is not statistically significant for the high and medium motivation groups. Interestingly the magnitude of the increase in

critical thinking for each unit of increase in Internet search was greater as motivation decreased. The intercepts of the regression lines for the high and medium motivation groups is larger than that for the low motivation group. The mean scores of the high and medium motivation groups are higher and closer to the perfect score of 41. However, the slopes of regression line for the high and low motivation groups are smaller than that for the low motivation group. In other words, the prediction of Internet search on critical thinking for the low motivation group is stronger than for the high and medium motivation groups.

3. Discussion

The proposed model representing how Internet search interacts with motivation to predict critical thinking skills was partially supported with the study data. A final model was developed and modified according to the critical ratios of parameter estimates, modification indexes and several goodness-of-fit statistics. Overall the Cronbach's alphas of the three measures indicated acceptable to good internal consistency of the sets of items in measuring the latent variables. The significant findings of the final measurement models as well as the latent model were discussed.

3.1 Findings and Implications of the Structural Equation Model

Multiple goodness-of-fit statistics reported reasonable to good model fit of the final measurement model of critical thinking, Internet search and motivation. The significant factor loadings of items to the measured latent variables suggested the items contributed to explaining the variance of the latent variables. The factor loadings of four items related to extrinsic goal orientation were not statistically significant, thus were eliminated for the analysis thus the decision of eliminating items was made. The General Expectance-Value theory suggests the learner's goal orientation might be extrinsic or intrinsic. The relationships among intrinsic goal orientation, task value and self-efficacy were supported by substantive research. However, not many research studies explicitly support the relationships between extrinsic goal orientation and the other three indicators of motivation. The data structure of this study did not support this relationship, either.

The results supported the research hypothesis that motivation influences the strength of the predictive relationship between Internet Search and critical thinking. First, no direct effects of motivation and Internet search on critical thinking were found. The correlations among critical thinking, Internet search and motivation were statistically significant; however, no direct causal-effect relationships existed between any two of them. This confirms the findings of many previous studies. Second, Internet search or motivation only influences critical thinking through the interaction of motivation and Internet search. This finding explained why the direct relationships among motivation, Internet search and critical thinking were not significant and why motivation and Internet search did not add to the explanatory power of the model predicting critical thinking. More importantly, the finding evidenced the interaction of Internet search and motivation as one possible mechanism mediating the prediction of Internet search and critical thinking. Third, the moderation effect of motivation was supported. Internet search was significantly and positively associated with critical thinking, which was evidenced in high, medium and low motivation groups. This is consistent with previous studies. Internet search interacts with motivation to predict critical thinking. However, interestingly the magnitude of the increase in critical thinking for each unit of increase in Internet search was greater as motivation decreases (Table 2). The intercepts of the regression lines for the high and medium

motivation groups are larger than that for the low motivation group; however, the slopes of regression line for the high and low motivation groups are smaller than that for the low motivation group. In other words, the prediction of Internet search on critical thinking for the low motivation group is stronger than for the high and medium motivation groups. One possible explanation for this finding could be discussed from examining several descriptive statistics listed in Table 2. The mean scores of the high and medium motivation groups are higher and closer to the maximum score (41). Several outliers were identified in the left tail of the critical thinking score distributions of the high and medium groups. These outliers influenced the variances of these variables, which are higher in these two groups. The skewness coefficients indicate the negatively skewed distributions of these two groups' scores and the kurtosis coefficients indicate these distributions are less peaked with smaller deviations. Excluding these outliers, it could be reasonable to infer that less variations in the scores of high and medium groups, which might influence the prediction power of Internet search in these two groups.

Conclusion and Implications

Many academic areas are struggling with inventing diverse teaching techniques or methods to enhance critical thinking. The advancement of Internet technology brings much potential. As learners in college are spending as much time on the Internet as they are studying today (as cited from Buschman & Warner, 2005), understanding whether and how Internet search contributes to learners' critical thinking is beneficial to theories and practice of instruction design. This study contributes to the literature by empirically presenting: (1) a measurement model of the proposed three latent constructs taking into account measurement error; (2) a moderation effect of the motivation between Internet search and critical thinking and how such an effect occurs. The results suggested the Internet search or motivation only influenced critical thinking through the interaction of motivation and Internet.

Several limitations of the research were presented. First, the data were collected mostly from the college students and graduate students matriculated in the universities at east coast of USA by a snowball sampling technique, which might limit the generalizability of the findings to other particular populations. Second, a half portion of the dataset was collected from a single source using self-report (i.e. Measures of motivation, and Internet search). This key informant method was commonly used by researchers in social science but is increasingly criticized as having common method variance problem (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Common method variance can inflate or deflate observed relationship between constructs, leading to both Type I and Type II errors (Podsakoff et al., 2003). With the threat of Common method variance, the observed causal relations in this study risked the possibility of being spurious rather than true causal relationship. Third, all the data were collected concurrently, thus proving causality was not possible and the direction of causality may be opposite to what was proposed in this study. This problem can be solved by collecting longitudinal data.

The study results developed and validated a structural equation model representing the complex relationship among motivation, Internet search and critical thinking. Taking into account of measurement errors, this study adopted multiple indicators to single latent construct while constructing the measurement model of the proposed latent constructs. This study validated these proposed measurement models, which make them appropriate for use in further studies. This study also provides evidence of the moderation effect of motivation. This moderation effect explains why the measures of direct relationship among motivation, Internet search and critical thinking were not significantly added to the explanatory power of the model predicting critical thinking. More interestingly, this study found that the

magnitude of the increase in critical thinking for each unit of increase in Internet search was greater as motivation decreased. These findings raise the necessity to further explore and validate the structure model. To avoid the threat of common method variance, collecting data from different sources is recommended. To validate the direction of the causality, longitudinal study is also recommended. To expand the predictive dimension of Internet search on critical thinking, future studies could adopt *critical thinking disposition* as a predictor to validate whether the motivation moderate the predictive relationship between Internet search and critical thinking disposition.

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