Abstract

The present study attempts to examine the impact of metacognition on critical thinking. The study explored the role of metacognitive awareness for promoting critical thinking of higher secondary students. The sample of the study consists of 420 higher secondary students who were enrolled in CBSE affiliated schools at Allahabad city. The standardized tool ‘Metacognitive Awareness Inventory’ (MAI) developed by Schraw and Dennison and ‘Critical Thinking Test’ constructed by researcher has been used as a measure of metacognitive awareness and critical thinking of students. The relationship between metacognition and critical thinking was examined using correlation analysis and the hypothesis model was tested through Structural Equation Modeling. Results were discussed in the light of literature. The findings of the study reveal that metacognition has significant impact on critical thinking of higher secondary students. The model demonstrated fit ($\chi^2=1038.94$, $df=419$, $p=.00$, RMSEA=0.049, GFI=.99, AGFI=.99, CFI=.99, NFI=.99, IFI=.99, RFI=.99, SRMR=.009). Thus, the model depicted the positive relationship between metacognition and critical thinking.

I. INTRODUCTION

Metacognition is a psychological approach which emphasizes the development of thinking skills to enhance learning. It is a conscious mental process that enables all students to become more strategic, self reliant, flexible and productive in their learning endeavors. Recently metacognition become a more popular topic as it implies those modes of teaching which may lead to more effective learning. Metacognitive awareness
benefits students from instruction by influencing the use and maintenance of cognitive processes. Many researchers believe that metacognition helps students to identify appropriate learning strategies for better academic performance. Such strategies aim for successful learning with the development of reasoning and problem-solving abilities. John Flavell initially coined the term metacognition in the late 1970s to mean as a way of “thinking about thinking”. Metacognition was originally referred to as the knowledge about and regulation of one’s own cognitive activities in learning processes (Flavell, 1979; Brown, 1978). Metacognitive knowledge includes knowledge about oneself as a learner. It also refers to an individual’s awareness about his capabilities and learning habits as well as nature the factors that might impact performance. Metacognitive regulation is the monitoring of one’s cognition and learning experiences that help learner to monitor control and restructure their on-going learning process. Schraw and Dennison (1994) defined metacognitive regulation as comprising of the planning, information management strategies, comprehension, monitoring, debugging strategies and evaluation. Thus, metacognition is a multi-dimensional concept related to a series of higher-level cognitive skills (Braten, 1992). The use of metacognitive strategies become more powerful in learning as they help us to evaluate information gathered from various resources. When children begin to master these strategies they are able to learn more efficiently and intentionally (Brown, 1987). Therefore, metacognition is the foundation upon which students become independent learners for accomplishing the task to make progress towards the goals.

Critical thinking plays a central role in learning as it involves cognitive procedures such as reasoning, analyzing, and evaluating. Black (2005) stressed that critical thinking happens when individuals practice higher order thinking skills. Critical thinking is reflective thinking that helps to determine what to do or what to believe (Ennis, 1985). Developing critical thinking skills enhance the ability to draw conclusions and make informed decisions (Stewart, 2003). Moreover, the aim of critical thinking is to develop reasoning ability to make meaningful decisions from the collected information. Individual who apply critical thinking not only practice daily life ability of summarizing, retrieving, analyzing and synthesizing information but also properly decide relevance and reliability of information received from the developing world (Gomez & Gomez, 2007).

The association between metacognition and critical thinking was firstly introduced by Schoen (1983). He proposed a successful pedagogy that can serve as a basis for the enhancement of thinking will have to incorporate ideas about the way these representations change and resist change when new information is encountered. Thus, the enhancement of knowledge referred to metacognition and the process of organizing knowledge was a significant factor of critical thinking (Magno, 2010). Many studies proposed that metacognitive awareness enables students for developing their critical thinking skills. Therefore, the use of metacognitive strategies has been asserted as a significant factor during thinking process (Facione, 1990; Swartz 2003). In order to find the impact of metacognition on critical thinking, Structural Equation Modeling is one such
statistical technique that helps to analyze the structural relationships between measured and latent variables. It estimates the multiple and interrelated dependence among variables in a single analysis.

II. SIGNIFICANCE OF THE STUDY

We are living in the ‘Information Era’. Now, information is constantly changing and developing day by day. With the rapidly increasing changes, individuals have to be able to think critically about what happens around them. A great deal of data is regularly received from diverse sources of information. Among the bulk of data and information it is necessary to choose the correct one by thinking critically. Review of studies have indicated that metacognition and critical thinking are two of the most important internal motivational factors correlate to higher order thinking process (Arslan, 2015; Arslan & Akın, 2014; Arslan, Akın and Çitemel, 2013; Magno, 2010; Choy and Cheah, 2009; Coutinho et al., 2005; Schroyens, 2005; Kuhn and Dean, 2004). Many researchers believe that emphasizing metacognitive strategies within an environment intended to foster critical thinking. Halpern (1998, 2001) pointed out that when engaging in critical thinking, students need to monitor their thinking process, checking whether progress is being made toward an appropriate goal to ensure accuracy. It shows that there are various factors that affect the continuity of thinking process. Hence, present study was chosen by researcher specifically for higher secondary students to examine individual differences in the use of metacognition and critical thinking at different dimensions via Structural Equation Modeling.

III. RESEARCH METHODOLOGY IMPLEMENTED

1) **Method:** Descriptive survey method was used to study the Metacognition and Critical Thinking of higher secondary students. Correlation analysis was used to examine the relationship between metacognition and critical thinking. The hypothesis model was tested through structural equation modeling. No causation was hypothesized.

2) **Sample:** Simple random sampling was used in the selection of students. The tools were administered to the students in groups in the classrooms. Sample of the study consists of 420 students of class-XI (230 female and 190 male) enrolled in CBSE affiliated schools in Allahabad city.

3) **Tools selected for the study:** Meta-Cognitive Inventory (MCI) developed by Schraw and Dennison (1994) was used to collect the data. There are 52 items in inventory that represents two components of metacognition, knowledge of cognition and regulation of cognition. The inventory based on five point Likert scale ranging from “Always” to “Not at all”. The Internal consistency of inventory was ranging from 0.93 to 0.88. The value of reliability coefficient was found to be 0.82 for the inventory. Critical Thinking Test constructed by researcher has been used to measure critical thinking of higher secondary students.
4) **Statistical techniques used**: In this research, Pearson correlation coefficient and structural equation modeling was utilized to determine the impact of metacognition on critical thinking. The analysis of data was carried out by SPSS 20. LISREL 8.54 (Joreskog & Sorbom, 1996) was used for structural equation modeling.

**IV. RESULTS**

**Descriptive Data and Inter-correlations**

Table 1 shows the means, descriptive statistics, inter-correlations and internal consistency coefficients of the variables used.

<table>
<thead>
<tr>
<th>Variables Evaluation</th>
<th>Knowledge of cognition</th>
<th>Regulation of cognition</th>
<th>Inference</th>
<th>Assumption</th>
<th>Deduction</th>
<th>Interpretation</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of cognition</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation of cognition</td>
<td>.57**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inference</td>
<td>.62**</td>
<td>.53**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assumption</td>
<td>.59**</td>
<td>.61**</td>
<td>.56**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deduction</td>
<td>.54**</td>
<td>.58**</td>
<td>.49**</td>
<td>.52**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpretation</td>
<td>.60**</td>
<td>.52**</td>
<td>.58**</td>
<td>.63**</td>
<td>.60**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>.63**</td>
<td>.55**</td>
<td>.64**</td>
<td>.67**</td>
<td>.58**</td>
<td>.62**</td>
<td>1</td>
</tr>
<tr>
<td>Mean</td>
<td>26.3</td>
<td>16.9</td>
<td>22.5</td>
<td>28.2</td>
<td>26.7</td>
<td>29.4</td>
<td>32.9</td>
</tr>
<tr>
<td>Sd</td>
<td>5.0</td>
<td>3.7</td>
<td>4.1</td>
<td>4.3</td>
<td>4.0</td>
<td>3.8</td>
<td>3.6</td>
</tr>
</tbody>
</table>

**In the above table, the subscales of metacognition i.e. knowledge of cognition is positively correlated with Inference (r = .62), Assumption (r = .59), Deduction (r = .54), Interpretation (r = .60) and Evaluation (r = .63). Regulation of cognition is positively correlated with Inference (r = .53), Assumption (r = .61), Deduction (r = .58), Interpretation (r = .52) and Evaluation (r = .55). This indicates that there is significant correlation between the metacognition and critical thinking.**

Further, the assumptions of Structural Equation Modeling (SEM) i.e. Multivariate normality tests were investigated via LISREL. The results indicated that the data are multivariate normally distributed. Then, multivariate outliers were investigated using Mahalanobis distance. Influential outliers were concerned because they have potential to bias the model and to affect major assumptions. 10 cases for dimensions of burnout were a significant distance from the model (Arslan, 2015). Box’s M test for equality of variance-covariance matrices was used to test for homoscedasticity. This assumption of
SEM i.e. Homoscedasticity means that the variance around the regression line is the same for all values of predictor variable. Based on a statistically significant (p<.05) Box’s M test indicates a homoscedasticity assumption violation (Stevens, 2002). It reveals that the data meets criteria of homoscedasticity.

Chi-square=1038.94, df=419, P-value=0.00000, RMSEA=0.049

Figure 1:- Path Model to show the direction and magnitude of path coefficients
KC: Knowledge of cognition, RC: Recognition of cognition,
F1: Inference, F2: Assumption, F3: Deduction, F4: Interpretation,
F5: Evaluation
In the present study, Structural equation modeling (SEM) was used to test the hypothesis model to examine whether metacognition would be positively associated with critical thinking. Using SEM, all the parameters of model were tested simultaneously in one step. Such models represent the direct paths from metacognition to critical thinking. Figure 1 represents the results of path analysis to show direct or indirect effect of metacognition on critical thinking.

The above path diagram depicts the strong causal effects between the dimensions predictor variable (Metacognition) and criterion variable (Critical Thinking). Figure 1 showed that the model is saturated i.e. there are no unused degrees of freedom. Consequently, the fit of the model (Hu & Bentler, 1999) is necessarily perfect ($\chi^2$=1038.94, df=419, $p=.00$, RMSEA=0.049, GFI=.99, AGFI=.99, CFI=.99, NFI=.99, IFI=.99, RFI=.99, SRMR=.009). This means that knowledge of cognition and its regulation have significant effect on critical thinking.

V. DISCUSSION AND RECOMMENDATIONS

The present study examined the relationship between metacognition and critical thinking. The hypothesis was confirmed by Correlation analysis and SEM. The findings revealed that there is a positive relationship between factors of metacognition and critical thinking. Moreover, indexes the model was acceptable according to the goodness of fit and the model explained correlations among measures (Hu & Bentler, 1999). These results are in line with the findings of the previous models that indicated the association between metacognition and critical thinking (Arslan, 2014; Başbay, 2013; Black, 2005; Choy and Cheah, 2009 and Magno, 2010). The important relationship between metacognition and critical thinking has been investigated by Kuhn (1999) and Willingham (2008). Moreover, Lipman (1991) stated that one’s metacognition must be “self-correcting” in order to qualify it as critical thinking. It is necessary for each individual to analyse own thinking process. Thus, previous experiences and prior cognitive development are essential for successful critical thinking.

Many studies proposed the strategies for enhancing critical thinking. Critical thinking necessitates higher level of metacognition (Choy and Cheah, 2009). Whereas, Kogut (1996) claimed that specific strategies, promoting critical thinking are metacognitive in nature. To make students think critically, it is necessary to teach them how to be aware of the underlying ways of thinking (Magno, 2010). The study of Ku and Ho (2010) indicated that good critical thinkers engaged in more metacognitive activities, especially higher order planning and higher order evaluating strategies. The result of present study describes metacognitive knowledge and regulation is important supporting factor to explore critical thinking and reasoning skills.

Hence, metacognitive monitoring skills need to be made explicit so that students can evaluate information to take right decisions. In support of this, Swartz (2003) claimed that Metacognition i.e. thinking about their thinking has dramatic effects on students’ learning and is usually not a difficult or complicated task for even primary-level children.
Thus, metacognitive awareness plays an important role in the learning process of each student. Ku and Ho (2010) examined thinking process of two groups of participants that were matched in terms of their cognitive ability, thinking disposition and academic achievement. The results revealed the importance of metacognitive strategies in enhancing critical thinking. Furthermore, Chisholm (1999) stated that there was a significant relationship between metacognitive and critical thinking skills in terms of comparing students’ grades.

VI. CONCLUSION
In the light of review of literature, the present study emphasizes metacognition as an important factor affecting critical thinking. It is necessary to promote metacognitive awareness of students in order to achieve observable improvements in their decision-making ability. Thus, the findings of the present study could be considered as a yardstick to increase our understanding in terms of the relationship between metacognition and critical thinking.

VII. REFERENCES
Available online through- http://www.ijifr.com/searchjournal.aspx