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Ramification of Metacognition and Cognitive Styles on Thinking Styles with impeding effect of Cognitive Rigidity in Engineers

[1]Ms. Garima Saini, [2]Dr. Shabnam

ABSTRACT --*This paper establishes a connection between the concepts of thinking styles in conjunction with cognitive psychology. The eventual goal is development of a deeper understanding and a formal methodology by examining the repercussion of metacognition and cognitive styles on thinking styles. The mediating role of cognitive rigidity with cognitive styles, metacognition, and thinking styles are also assessed. A sample of 205 engineers from different public and private engineering firms were taken which are used for data analysis. SPSS 22.0 and Partial Least Square (PLS) analysis with Smart PLS 3.0 software is used. Structural analysis was applied and* ***suggested*** *that cognitive styles and metacognition influence the thinking styles and the way the task is performed. Moreover, cognitive rigidity; stress, depression, and anxiety mediate the relationship between cognitive styles, metacognition and thinking styles. The thinking style in context to cognitive styles, metacognition helps in understanding and improving the efficiency by planning, evaluation, monitoring, and implication of the task that they are performing. Stress, anxiety, and depression act as cognitive rigidities hamper and impede the metacognition and cognitive styles. Implications, suggestions, and limitations for future research are also provided.*

Keywords--*Thinking styles, Metacognition, Cognitive styles, Cognitive rigidity.*

I. INTRODUCTION

Thinking styles are the individual's way of how he uses his abilities to think. In the last decade, scholars in the field of thinking styles critically evaluate in the field of styles (Coffield, 2005). Adding in the field of thinking styles every individual deals with the situation in his respective way (Sternberg, 2006). Thinking styles cannot be called as ability but the collective use of abilities that an individual possesses (Zhang, 2007). People perform and complete a task according to their abilities, some like performing a task in a unique manner which reflects their creativity and noble chores of performing a task another may be fearful of going out of the classical ways and trying new things while completing a task. Some individuals complete a task in a systematic and orderly manner and some perform the task defying systematization. Thinking styles are divided into thirteen styles that are legislative, executive, judicial, monarchic, hierarchic, oligarchic, anarchic, global, local, internal, external, liberal and conservative thinking styles (Sternberg, 2005). As different careers are opted by different individuals and their way of performing and completing a task is different they succeed in it with their abilities and capacities (Holland, 2015). Different professionals work accordingly to the activities that are related to abilities and competencies. This study throws light on thinking styles of engineers showing the consanguinity of

[1] *Research Scholar, Department of Humanities National institute of Technology, Kurukshetra Haryana,India , Garimasaini3@gmail.com*
[2] *Assistant Professor, Department of HumanitiesNational institute of Technology, Kurukshetra Haryana,India*

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thinking styles, cognitive styles, and metacognition; they possess and how they cope up with stress, depression, and anxiety which work as cognitive rigidities. Cognitive styles are the stable, strategic and preferred manner in which an individual seeks and responds which helps him to bring out the solution to the problem. Cognitive styles are the dimension of personality that doesn't change with time (Zhang, 2001). J. Flavell in 1970 has worked on the cognitive development investigation by working on the concept of metacognition. He investigated that to assess the cognitive capabilities individual develops a skill which makes metacognition a significant predictor that measures the efficiency of cognitive system performance (Bensley & Spero, 2014). A past study of thinking styles on engineers have studied which states that a particular thinking styles choose realism and helps in development of particular thinking styles (Schmid, 2001).A comparative study of artists and engineers reveals that engineers preferred more external input in their work and are inclined towards prioritize/hierarchical thinking (Gridley, 2014). Every career is different from another and you have to think differently in each problem domain. Scientist seeks in understanding; Engineer seeks in solving a problem and an entrepreneur seeks in solving a problem with more organizational nature (Fieldman, 2009). A comparative difference can be seen in the thinking styles of engineers working in urban and non-urban areas (Asrami, 2016). Engineers, researchers, and practitioners show a capacity for system thinking which is necessary for a successful design and complex engineered system (Greene, 2016). Thinking styles in computer engineers show an evident preference for external, hierarchical, executive and legislative thinking styles (Huincahue et.al., 2019). Effect of design activities on the performance of engineering students of different cognitive styles is studied and found out that scientific creativity and research styles are found as a predictor of scientists' choice of career fields and correlated with engineers (Beasley, 1995). Cognitive styles of engineers are studied and preference towards convergent category was indicated the then divergent category (Ashford et.al. 2003). Judicial, legislative and hierarchical styles of thinking are related to the relativism scale (Zhang, 2002).The significant difference is seen between engineering students and management students in the preference of cognitive style and they differ in intellectual styles as engineering students possess Local and monarchic styles, management students have judicial, legislative and hierarchical styles (Gozef, 2015). Metacognitive skills in engineers are analyses that will be helpful to them in problem-solving, critical thinking and learning efficiently (Kesici et al., 2011). Metacognitive skills in future engineers help to perceive information which is easily understandable and stored in memory (Valeyeva et.al. 2017). Metacognitive learning when studied with proper implications regulated and increases the performance of IT engineers. Metacognitive abilities in the engineering team state that combining awareness of their teammates and identifying priorities increased success in team performance (Newell et al. 2004). Metacognition by experts and engineering designers plays a major role in solution space and tend to do more planning (Dixon, 2010). When engaged in the metacognition of engineering design projects, a significant change was seen in mechanical engineering students (Lawanto, 2010). When working in a group critical thinking helps in increasing knowledge as metacognitive awareness plays a stimulating role (Bersley; Spero, 2014). Thinking styles such as judicial and legislative contributes in metacognitive styles (Braojos, 2013). Two Scope (internal and external) level of mental self-government showed a positive relationship with the knowledge component of metacognition (Heidari&Bahrami, 2012). Legislative, liberal and hierarchical thinking styles predict that metacognition is beyond self-rated abilities (Zhang, 2010). Occupational stress has an impact on the performance and health of engineers (Rothmann, 2001). Stress levels are higher in senior engineers in comparison to junior engineer (Saleh, 1986). Demographic characteristics; academic education, organization type (state, private, etc.) and income may be variables of job stress among engineering professionals (Dikshit, 2014). The occupational stress is considered as one of the most important workplace hazards the construction sites, which may have a detrimental effect on job satisfaction (Rengamani, 2018).

II. RESEARCH METHODOLOGY

2.1 Hypothesis

H1- Metacognition has a positive impact on the thinking styles.

H2- Cognitive styles has a positive impact on the thinking styles.

H3-Cognitive rigidity playing a mediating role on metacognition, cognitive styles and thinking styles.

2.2 Research Instrument

Measurement for dimensions of metacognition, cognitive styles, and thinking styles were measured on standardized tools on a 5- point Likert-type scale.

Thinking Style Inventory (TSI) (Sternberg & Wagner& Zhang, 2007) is a self-report test including 65 items with 13 thinking styles; legislative, judicial, executive, hierarchic, monarchic oligarchic, global, anarchic, internal, local, external, and conservative and liberal thinking styles.

Metacognition skill scale (MSS) (Madhu Gupta and Suman, 2017) was used to assess the level of meta-cognitive skills comprised of 42 items under four dimensions i.e. planning skill, implementation skill, monitoring skill, and evaluation skill.

Cognitive style inventory (CSI) (Pradeep Jha, 2001) consists of 40 items that measure systematic cognitive style and intuitive cognitive style.

Depression, anxiety and stress scale (DASS) *(*Lovibond & Lovibond, 1995) comprised 21 items which measure Depression, Anxiety, and Stress dimensions

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2.3 Sample design and Data collection

The survey was conducted after face to face interaction with the engineers of the various public and private sector. A total of 205 questionnaires were distributed to those who are willing to participate in the survey. This sample size meets the minimum sample adequacy (Westland, 2010). The entire dataset contains no missing values.

2.4 Data Analysis

When both the dependent and independent variables are collected by self-reported questionnaires from the same person common method of variance must be used to analyze the data (Ali et al., 2016). This study has adopted different remedies to overcome this problem. Firstly, psychological separation among the respondents was maintained that assures the confidentiality and anonymity of responses. Then SPSS 22.0 was used and analyzed on principal component analysis using varimax rotation. It came out with 7 factors solution with 82.39% of the variance. Then to analyze the research model, Partial Least Square (PLS) analysis with Smart PLS 3.0 software is used. Two-stage analytical procedures that are reliability and validity and then the structural model are examined (Saestedt, 2013). The skewness statistics ranged from -1.96 to -.40 and kurtosis statistics from -0.052 to 2.045 which shows a value less than 2 for skewness and kurtosis value is less than 3.This means that the data is normally distributed (Kline's, 2011).

III. FINDINGS AND RESULT

3.1 Measurement model

The convergent validity of the measurement model is calculated. This was assessed through factor loadings, composite reliability and average variance extracted. In the next step discriminate validity which measures that the one variable is not the reflection of another variable which indicates low correlation value between variable and other constructs.

3.2 Structural Model

Structural model can be assessed by looking at its R^2 and beta (β) values (Hair et.al.2013). First we look at the relationship between the variables. Metacognition positively and significantly affect the thinking styles (β= 0.830, p<0.01). The beta value (β) which studies the impact of cognitive styles on thinking styles is 0.130 whereas cognitive styles significantly contributes to metacognition (β= 0.858, p<0.01) (Figure A).The R^2 value of thinking styles with metacognition and cognitive styles are higher than the 0.26 value which suggests would indicate a substantial model (Cohen 1988, Ali 2016). The model shows R^2 of 0.89 on thinking styles Table A shows the value of cronbach's alpha and composite reliability which having a value of 0.914, 0.924 and 0.904; .901, .922 and .893 respectively. The item loadings exceeding the value of 0.6 are justifiable (Chin & Brown, 2008). Composite reliability values indicate the recommended value of 0.7 (Hair et al. 2013). The F square value of thinking styles with cognitive styles and metacognition are 2.446 and 1.646 respectively. Average variance extracted (AVE) calculated for all the cognitive constructs are 0.221, 0.235 and 0.137 for cognitive styles, metacognition and

thinking styles respectively.

Variables	Cronbach's Alpha	Composite Reliability	Discriminant Validity	Average Variance Extracted (AVE)
COGNITIVE STYLE	0.914	.901	.485	0.221
METACOGNITION	0.924	.922	.470	0.235
THINKING STYLES	0.904	.893	.370	0.137

Table A - Reliability and validity of metacognition and cognitive styles.

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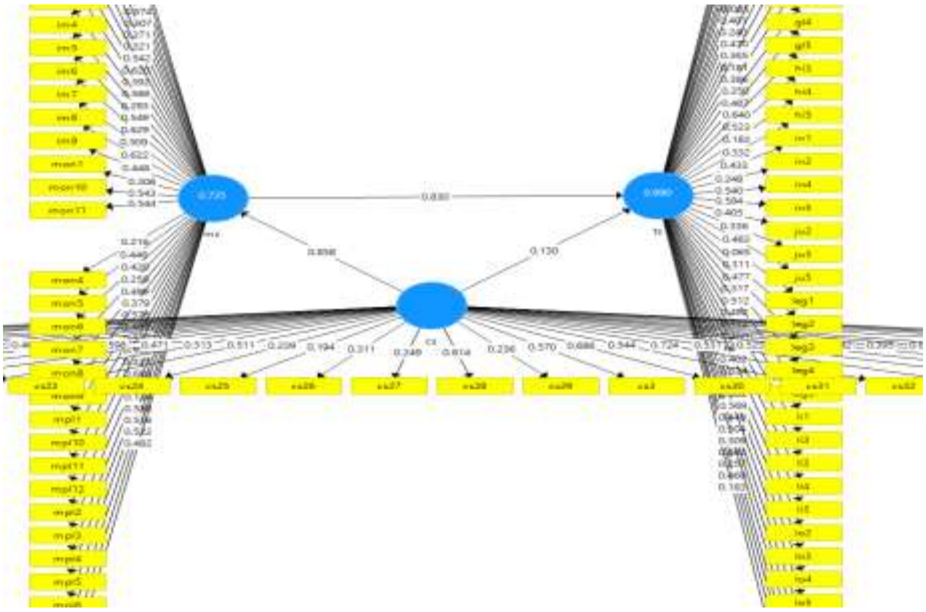

Figure A - Model showing a relationship between thinking styles and metacognition and cognitive styles. Indicators such as ex1,ex4,ex2,hi1,hi2,im4,ju1,ju4,mo1,mo3,mon2,,hi4,in2,lo1,ol5,cs14,cs4,cs5,an4,an3and co5are exempted.

3.3 Mediation effect of cognitive rigidity on metacognition and cognitive styles

3.3.1-Mediation effect of stress on thinking styles, metacognition and cognitive styles

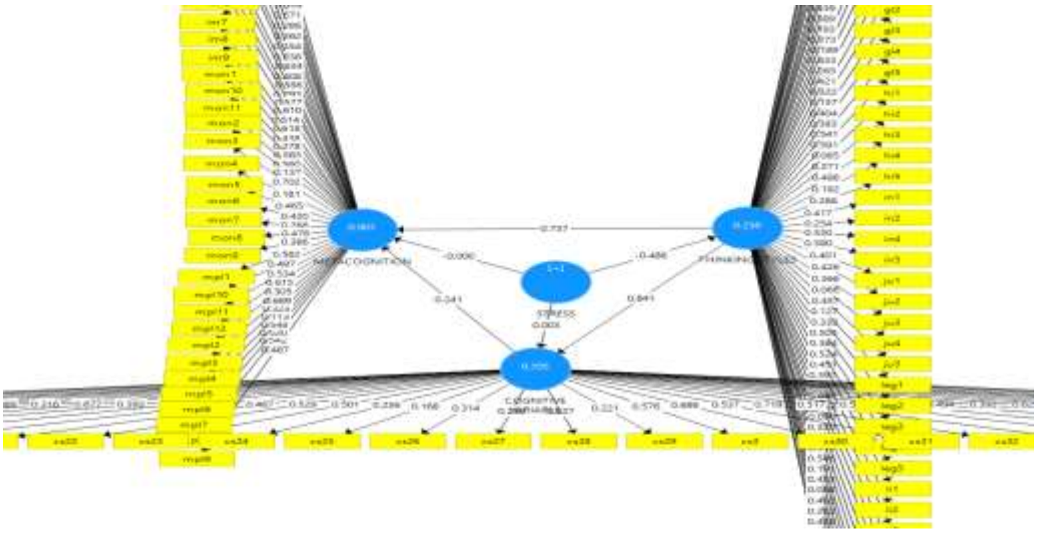

Figure B- Mediation effect of stress on metacognition and cognitive styles. Indicators such as ex1,ex4,ex2,hi1,hi2,im4,ju1,ju4,mo1,mo3,mon2,,hi4,in2,lo1,ol5,cs14,cs4,cs5,an4,an3and co5are exempted.

Stress showing a mediation effect on metacognition and cognitive styles has a negative impact on thinking styles showing a β of -0.486 and $R^2$of 0.236 (Figure B).The values of composite reliability and cronbach's alpha showing a justifiable value of 0.89, 0.92 and 0.85 for cognitive style, metacognition and thinking styles. Discriminate validity shows a low correlation between the construct having a value of 0.21 with thinking styles.

3.3.2-Mediation effect of depression on thinking styles, metacognition and cognitive styles

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Depression showing a mediation effect on metacognition and cognitive styles has a negative impact on thinking styles showing β of -0.302 and a negative β of -0.056 with metacognition (Figure C). The values of composite reliability and cronbach's alpha have a value above 0.85. Discriminate validity shows a low correlation between the construct having a value of 0.28 with thinking style.

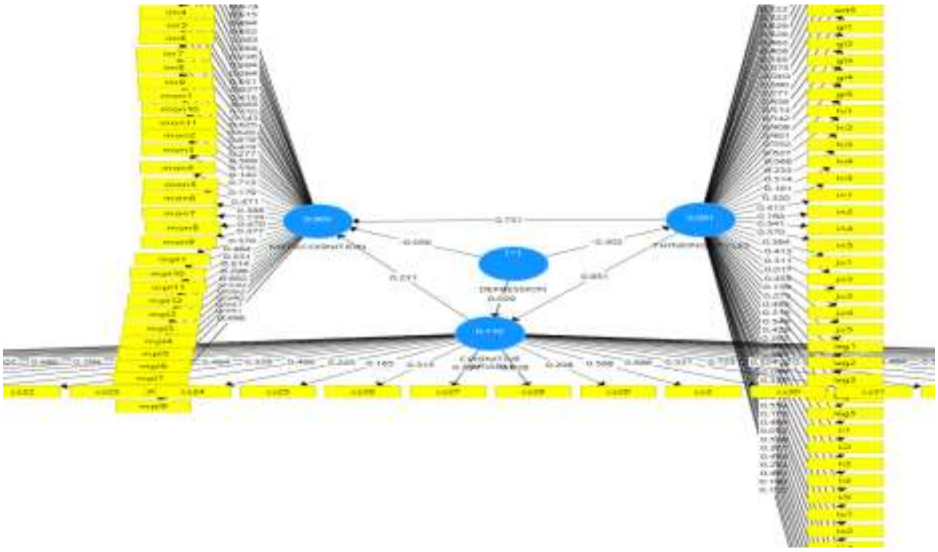

Figure C- Mediation effect of depression on metacognition and cognitive styles. Indicators such as ex1,ex4,ex2,hi1,hi2,im4,ju1,ju4,mo1,mo3,mon2,,hi4,in2,lo1,ol5,cs14,cs4,cs5,an4,an3and co5are exempted.

3.3.3-Mediation effect of anxiety on thinking styles, metacognition and cognitive styles

Anxiety showing a mediation effect on metacognition and cognitive styles has a negative impact showing a β of -0.455 with thinking styles and a negative β value of -0.049 with metacognition (Figure D). The values of composite reliability are above 0.85 for metacognition and cognitive styles but anxiety shows a value of 0.424 and cronbach's alpha shows a value above 0.85 for the variables .Discriminate validity shows a low correlation between the construct having a value of 0.32 with thinking styles.

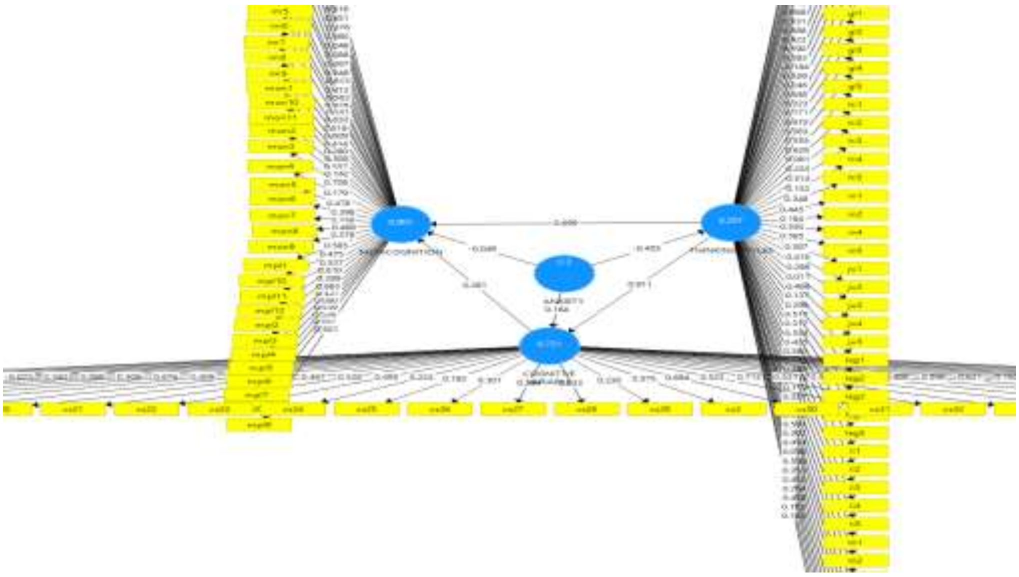

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Figure D- Mediation effect of anxiety on metacognition and cognitive styles. Indicators such as ex1,ex4,ex2,hi1,hi2,im4,ju1,ju4,mo1,mo3,mon2,,hi4,in2,lo1,ol5,cs14,cs4,cs5,an4,an3and co5are exempted.

IV. DISCUSSION AND THEORETICAL IMPLICATIONS

This study's findings contribute to the knowledge by its empirical support for the contribution of metacognition and cognitive styles on thinking styles. The contemporary researches in the field have highlighted the need to study the impact of metacognition, cognitive styles, and cognitive rigidity. The engineer's metacognition and cognitive styles have an impact on thinking styles. Metacognitive awareness in engineers found out that the engineer's efficacy and his effectiveness are highly correlated (Poh, 2016). These abilities comprised of knowledge, experience, and strategies possessed by engineers are aware which evaluates his thought process; correlating with their thinking styles involves self-regulation, self-reflection of the types of strategies they make reflecting their thinking styles. These have an impact on an engineer's motivation to perform a task. Cognitive rigidity; stress, depression, and anxiety negatively affect the thinking styles hampering their efficiency and performance. The impact of job stress on job satisfaction among engineers has a significant impact on the quality of life *(*Rasi, 2014). Considering the hypothesis of this study three hypothesis has been framed and tested. The results by structural equation modeling support all hypotheses, so it can be stated that metacognition and cognitive styles impact different thinking styles. Cognitive styles are the strategic variables that would help to use prior knowledge which would help him to plan a strategy to solve a problem and reflect, evaluate and modify the results which suit their styles of thinking. The variables of cognitive rigidity; stress, depression, and anxiety negatively affect the thinking styles which impedes their efficiency. High levels of perceived competition are associated with increased risks of depression and anxiety (Posselt et.al., 2016). Job strain was associated with an increased risk of depression and anxiety (Chen et al., 2014). Thinking styles vary from individual to individual. As our sample is concerned different engineers possess different thinking styles which affect the way they think and perform a task different to others (Feildman, 2018). Thinking styles of engineers have a significant impact on metacognition and cognitive styles; metacognition and cognitive styles which contribute that different thinking styles show with the planning, evaluation, monitoring, and implication in engineers. The consanguinity between the engineer's quality of life and occupational stress is negatively related (Teichmann, 2016). It has an effect on their performance and the way they complete their tasks. The entire dimensions of this study if worked systematically would be helpful in critical evaluation by planning, monitoring and evaluating the successful learning in engineers.

V. CONCLUSION

This study has an implication in the field of Career Choice Selection showing an area of interest and preference in the sphere of occupations. When the individual is doing a preferred task that compliments his thinking styles it contributes to his career development. As thinking style and metacognition and cognitive styles are showing consanguinity this would help in the preferred selection of jobs. Favorable thinking styles also help in task-oriented performance in the public and private sector as it can easily identify the methods and techniques that are most appropriate to the specificity of their work. This would have a significant impact on the employee's commitment towards its organization by boosting and escalating his satisfaction level, motivational level. If the task is suiting thinking styles and another cognitive construct which goes with the abilities of the employees, it helps in avoiding burnouts and exhaustion by reducing the stressors which he is facing in day to day chores. It can be concluded that skills, abilities, aptitudes, as well as levels of performance required in various occupational areas including engineering conjuncts with the cognitive construct that individual is possessing by escalating its planning, evaluation, monitoring and implication in a task.

VI. LIMITATIONS AND FUTURE RESEARCH SUGGESTIONS

As with any research, these studies to have the limitation that gives scope for further researches. Further researches may extend this study with a more holistic approach to thinking styles with more experimental work on the performance of engineers. The sample size and the sampling technique are the obvious limitations. In this study convince sampling is used and data is selected from a particular sector of engineers. Further research may consider engineers from various countries to study their impact cautiously generalized on the broad population to study the impact of cognitive variables on the thinking styles.

VII. CONFLICT OF RESEARCH

In this manuscript there is no conflict of interest.

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