METACOGNITIVE AWARENESS OF COLLEGE STUDENTS: PERSPECTIVES OF AGE AND GENDER

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Abstract

The study examined the perspectives of age and gender on the development of metacognitive awareness of college students. Four hundred students including equal number of boys and girls in five age groups of 14 to 24 years were administered the Metacognitive Awareness Inventoryto measure their metacognitive knowledge, regulation and executive control. Each of these constructs was measured through its relevant skills. With respect to the nature of development, the results showed low, slow but consistent development of the skills across the span of 10 years of college life. The developments were also observed to follow the predicted sequence, i.e., metacognitive knowledge, followed by metacognitive regulation, and then, metacognitive control and execution. Some directions in the issue of gender difference were also observed that overall, girls are significantly better than boys in metacognitive knowledge while boys in metacognitive regulation. However, they did not show any difference in metacognitive control and execution, the supposed higher order skill of metacognitive awareness.

Keywords: metacognitive knowledge, regulation, control and execution

Introduction

Most of the models of metacognition assume that students are active learner. They construct their own strategies and goals and actively regulate various elements of cognition, motivation and behavior towards their learning goals. This self-regulation is a metacognitive skill which mediates between the individual's performance, contextual factors, and personal characteristics (Moss, 2007). According to different models, three components underlie the metacognitive behavior of students (Brown, 1987; Desoete&Ozsoy, 2009; Flavell, 1979; Fleming & Dolan, 2012). Those are metacognitive knowledge and experience, metacognitive regulation, and metacognitive execution. Metacognitive knowledge consists of the knowledge and beliefs about task, strategies and goals of learning. Metacognitive regulation involves the voluntary use of strategies for controlling cognitive process (Desoete&Ozsoy, 2009). Subsequently, an additional ''monitoring'' component was proposed, corresponding to the use of metacognitive knowledge and experiences to guide behavior (Nelson &Narens, 1990). This monitoring process is linked to self-regulation, proactive control, and metacognitive

decision. This part of metacognition is important in decision-making through a meta-level modulation and coordination between memory retrieval and problem-solving processes by generation of strategies and the evaluation of options in particular situations where the solution is not obvious (e.g. Zysset, Huber, Ferstl, & von Cramon, 2002).

Gender difference in metacognition

Gender difference in metacognition has been a controversial issue. Prior research has shown inconsistent results regarding the differences in metacognitive skills of boys and girls. Some research suggests that there are differences regarding boys' and girls' metacognitive skills, while others suggest that these differences are not significant. Pajeres and Valiante (2002), in their study on academic achievement among adolescents found girls showed more confidence in ability to self-regulate their learning tasks which reflect on their higher metacognitive ability. Peklaj and Peejak (2002) found that girls were more aware about the role of thinking in self-regulation of learning. They used more metacognitive strategies and were motivated than boys to express feelings related to learning. Similarly, Zimmerman and Martinez (2010) interviewed the students of eleventh grades to study gender differences in use of self-regulated learning strategies. Girls displayed more goal setting, planning strategies and self-monitoring than boys and also surpassed them in their ability to structure their environment for optimal learning. Further, Pokay and Blumenfeld (2012) found that girls used more cognitive and metacognitive strategies and also displayed better strategy management. On the other hand, research indicate that the self-perception of academic ability, particularly in mathematics and science tend to be lower in the case of females, and this tendency appears to reach its highest point during adolescence (Virtanen &Nevgi, 2010). Nonetheless, Zimermann and Martinez-Pons (1990), and recently Zhu (2007) reported that there are no significant differences between boys and girls regarding mathematics self-efficacy. Niemivirta (1997) reported that compared to girls, boys are more natural in the use of their metacognitive skills, while girls are more effortful.

Age and metacognitive development

Piagetian researches have often concluded that young children are not capable of formal operations necessary for abstract thinking. Accordingly, several metacognitivestudies of young children showed that metacognition is a late developing skill (Flavell, 1979; Schraw&Moshman, 1995; Whitebread et al., 2009). Schraw and Moshman (1995) concluded that young children have difficulty in monitoring their thinking during task performance and

constructing metacognitive frameworks that integrate cognitive knowledge and cognitive regulation. Planning also appears to be a late-developing skillnot appearing until 14 years of age. Kuhn (2000) characterized development of metacognition as very slow and gradual to acquire better cognitive strategies. Several researchers have concluded that metacognitive abilities appear to improve with age (Cross & Paris, 1988; Hennessey, 1999; Kuhn & Dean, 2004; Schneider, 2008; Schneider &Lockl, 2002; Schraw&Moshman, 1995). Schraw and Moshman (1995) described that metacognitive development proceeds as follows: cognitive knowledge appears first, and consolidation of cognitive skills is typically evident by 8-10 years of age. Ability to regulate cognition appears next by 10-14 years of age in the form of planning. Monitoring and evaluation of cognition are slower to develop and may remain incomplete in many adults.

The above discussions pointed out that issue of gender difference in the abilities and use of metacognition is still unsettled. Prior researches have largely focused on the ability differences in the metacognition of boys and girls little emphasizing on the part of monitoring or execution of the metacognitive skills. As observed by Desoete&Ozsoy (2009) this monitoring process is linked to self-regulation and executive control skills which actually focuses the metacognitive awareness into action and decision processes. Observing this gap in the research, the present study examined the gender differences in all three levels of metacognitive functioning namely; knowledge and experience, regulation and executive control. Further, the period of student life in the college could be a significant source of development in metacognitive awareness. Hence, studying the effects of college experience on the development metacognitive experience is another objective of this study.

Objectives

1. To examine the nature of developments in each of the constructs of metacognitive awareness of college students during a long span of 10 years of college life.

2. To examine gender differences in the development of each of the constructs of metacognitive awareness across the span of college life.

3. To examine the areas of strength and weaknesses in development of metacognitive skills of the college students.

Method

Participants were 400 students from higher secondary to post graduate classes, including equal number of boys and girlsfrom each of the 14-15, 16-17, 18-19, 20-21 and 22-

23 years of age.Forty subjects were included in each of the ten groups. All the subjects completed the Metacognitive Awareness Inventory (MAI-Schraw& Dennison, 1994)and Metacognitive Executive Control Inventory (MECI). The MAI consisted of 52 items in statements to be responded by the subject on a five-point scale (0-4) ranging between completely false to completely true about him / her. It measures two constructs namely knowledge about cognition, and regulation of cognition. Knowledge about cognition includes declarative knowledge (8 items); procedural knowledge (4 items) and conditional knowledge (5 items). Regulation of knowledge includes planning (7 items), information management (10 items),comprehension monitoring (7 items), debugging strategies (5 items) and evaluation (6 items).Further 18 items were added to measure Executive control of cognition which includes self-regulation (6 items), proactive control (6 items), and metacognitive decision (6 items).It is a widely used measure of metacognitive skills with sound psychometric properties established by previous researchers (Harrison &Vallin, 2017).

Results

Metacognitive awareness of 400 college students in 10 groups of boys and girls were measured. Boys and girls included in the study were between 14 to 23 years of age and their skills were assessed for three measures of metacognitive knowledge, five measures of metacognitive regulation and three measures of metacognitive executive control. The means and standard deviations of each of the measures for boys are reported in Table 1 and for girls in Table 2. As the maximum scores for different measures in the scale were not same, comparability across the measures would be difficult. Therefore, the score of all the subjects in each of the measures was converted into a standard score as 'out of 40' because one of the measures (Information management strategies) has the highest maximum score as 40. Converting the score into percent as standard score was not used to avoid dealing with big numerals.

Descriptive analysis of data

As observed from means**,** developments of metacognitive knowledge among both boys and girls were found low. Among boys in the entirefivegroups, the mean scores are less than 50% of the maximum score for all measures except only for conditional knowledge of 22-23 years old boys. Similarly among the girls, only two groups (20-21 & 22-23 age groups) have means more than 50% of the maximum score (Table 1, Table 2, & Figure 1). Observation of mean for the measures of metacognitive regulation shows that the

development in planning, information management, and comprehension monitoring are better for boys during 18 to 23 years of age while for girls, such development is observed only in planning (Table 1, Table 2, & Figure 2 a). On the other hand, with respect to debugging and evaluation, the development is very slow for both boys and girls (Table 1, Table 2, & Figure 2b). Over all, the development of metacognitive regulation is also low for both boys and girls as only in few measures, they have means more than 50% of the maximum scores. Further, with regard to executive control of cognition, both boys and girls are found to be developing in self-regulation, girls being better than boys across all the age groups. On the other hand, in proactive control and metacognitive decision, the development of both boys and girls are found to be very low (Table 1, Table 2, & Figure 3).

Group comparisons

The above descriptive analysis of data is clearly suggestive for further statistical analyses to find out the exact nature of gender difference and age related developments with respect to all the constructs of metacognitive awareness. In order to examine this perspective at a broader level, two-way analysis of variance was computed on the total scores of each construct of metacognitive awareness. The results of ANOVA are reported in Table 3.

In metacognitive knowledge, the main effect of gender is found significant (F= 7.63, p<.01). The overall mean of boys' is 16.46 and of girls' is 17.10, implying that girls are significantly better than boys in metacognitive knowledge. It may be observed from the data that girls' better development in declarative and procedural knowledge hold them high in metacognitive knowledge than boys. The main effect of age is also found significant (F=17.86, p<.01) to suggest that although overall development in metacognitive knowledge is low and slow, both boys and girls consistently develop in metacognitive knowledge as they grow up in age. In this analysis, interaction effect between age and gender is also found significant (4.02, p<.05) to suggest that in some measures, girls are better only in later ages while in other boys are better in later ages.

The main effect of gender also came out significant for metacognitive regulation but in favor of boys (F=5.88, p<.05). The overall mean for boys is 13.83 while that of girls is 12.70. The distinct advantages of boys in information management and comprehension monitoring have possibly led to this gender difference. There is also significant main effect of age (F=21.76, p<.01) to assume that although the development of metacognitive regulation is low among the students, its development is consistent across their age. Interaction effect

between age and gender is also found significant (F=6.33, p<.05). It is suggesting that boys and girls differently respond to skills of metacognitive regulation at different ages. For example in our result, boys developed priorities to information management while girls' priority of later ages was planning of metacognitive behavior. Finally, with respect to executive control, the main effect of gender is not significant nor also the interaction effect. However, the main effect of age is significant. Executive control being a higher order skill of metacognitive awareness may not be possibly addressed by gender factor at this early period of development. However, significant main effect of age is appreciative of the fact that college students are developing with regard to their metacognitive awareness in all its facets.

Table 1 Means and Standard Deviations of metacognitive awareness measures in standard units for the five groups of boys.

Metacognitive Skills	Boys / Age in Years					
(i) Metacognitive Knowledge		14-15	16-17	18-19	20-21	22-23
Declarative	Mean	13.31	13.46	16.19	16.34	17.81
	SD	2.17	2.44	2.19	3.12	2.85
Procedural	Mean	16.23	16.84	18.37	18.95	18.91
	SD	3.07	2.62	3.11	3.46	3.67
Conditional	Mean	12.66	14.19	15.97	17.28	20.36
	SD	1.64	2.21	2.28	2.17	2.78
Total of Metacognitive Knowledge	**Mean**	**14.07**	**14.83**	**16.84**	**17.52**	**19.02**
	SD	**1.93**	**2.36**	**2.68**	**2.71**	**2.56**
(ii) Metacognitive Regulation						
Planning	Mean	10.26	11.25	14.77	20.21	24.26
	SD	2.07	2.34	3.29	2.76	3.44
Information Management	Mean	11.27	11.36	12.85	16.34	21.54
	SD	2.32	2.19	2.66	3.31	3.45
Comprehension Monitoring	Mean	10.96	12.67	14.21	18.45	21.26
	SD	2.77	2.53	2.81	3.69	4.08
Debugging Strategies	Mean	8.56	9.35	11.86	12.34	12.86
	SD	1.39	2.12	2.06	1.84	2.21
Evaluation	Mean	9.93	9.37	11.28	14.36	14.21
	SD	2.64	3.11	2.87	3.65	3.37
Total of Metacognitive Regulation	**Mean**	**10.20**	**10.8**	**12.99**	**16.34**	**18.83**
	SD	**2.09**	**2.16**	**2.47**	**2.93**	**2.25**
(iii) Executive Control of Cognition						
Self-regulation	Mean	12.14	13.36	13.88	16.12	17.15
	SD	2.86	2.61	2.54	3.22	3.18
Proactive Control	Mean	6.71	7.73	9.86	12.22	13.17
	SD	1.08	0.97	1.36	1.51	1.39
Metacognitive Decision	Mean	7.71	7.68	8.14	9.44	11.39
	SD	0.87	0.93	1.19	1.20	1.36
Total of Executive Control	**Mean**	**8.85**	**9.59**	**10.63**	**12.59**	**13.90**
	SD	**1.77**	**1.35**	**1.69**	**1.52**	**2.37**

Note: As the maximum scores for the measures are different, the scores of each subject for

each measure wasconverted to a standard score out of 40 to help comparability of different measures

Table 2 Means and Standard Deviations of metacognitive awareness measures in standard units for the five groups of girls.

Metacognitive Skills		Girls / Age in Years				
(i) Metacognitive Knowledge		14-15	16-17	18-19	20-21	22-23
Declarative	Mean	14.96	15.61	16.57	17.58	18.47
	SD	2.23	2.19	2.54	2.61	3.25
Procedural	Mean	18.03	18.36	19.78	20.35	20.61
	SD	2.67	2.83	2.54	2.96	2.22
Conditional	Mean	10.29	13.16	15.22	17.73	19.84
	SD	2.25	2.61	1.95	2.35	3.17
Total of Metacognitive Knowledge	**Mean**	**14.43**	**15.71**	**17.19**	**18.55**	**19.64**
	SD	**2.27**	**2.43**	**2.81**	**2.32**	**2.85**
(ii) Metacognitive Regulation						
Planning	Mean	11.19	11.74	14.47	19.71	22.38
	SD	2.28	2.76	2.83	2.45	2.69
Information Management	Mean	9.63	10.20	11.16	13.91	14.65
	SD	1.86	1.93	2.22	2.54	2.67
Comprehension Monitoring	Mean	8.65	10.21	11.36	14.44	18.29
	SD	2.23	2.76	2.41	2.95	2.86
Debugging Strategies	Mean	8.63	9.41	11.54	12.68	12.75
	SD	2.09	2.08	2.19	2.25	2.64
Evaluation	Mean	9.61	9.95	11.07	13.97	14.52
	SD	2.17	2.64	2.28	2.81	2.95
Total of Metacognitive Regulation	**Mean**	**9.54**	**10.30**	**11.92**	**14.94**	**16.82**
	SD	**2.42**	**2.31**	**2.29**	**2.66**	**2.58**
(iii) Executive Control of Cognition						
Self-regulation	Mean	14.63	14.91	15.35	18.29	18.96
	SD	3.19.	3.12	2.96	2.81	3.22
Proactive Control	Mean	6.23	7.75	9.54	11.85	13.08
	SD	1.19	1.24	1.57	1.93	1.82
Metacognitive Decision	Mean	6.20	7.38	7.98	9.36	10.44
	SD	1.37	1.05	1.17	1.33	1.38
Total of Executive Control	**Mean**	**9.02**	**10.01**	**10.96**	**13.17**	**14.16**
	SD	**1.21**	**1.67**	**1.54**	**1.61**	**1.95**

Note: As the maximum scores for the measures are different, the scores of each subject for each measure was converted to a standard score as out of 40 to help comparability of different measures

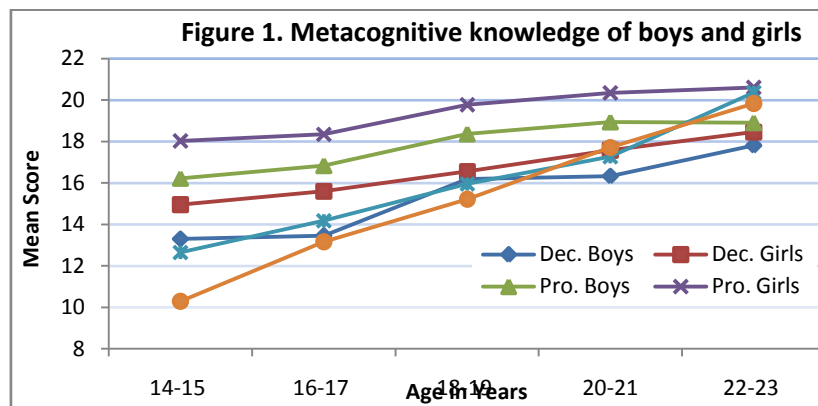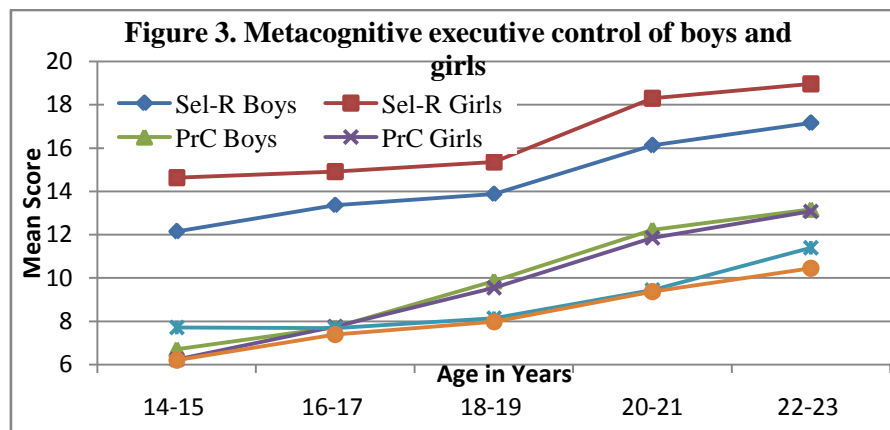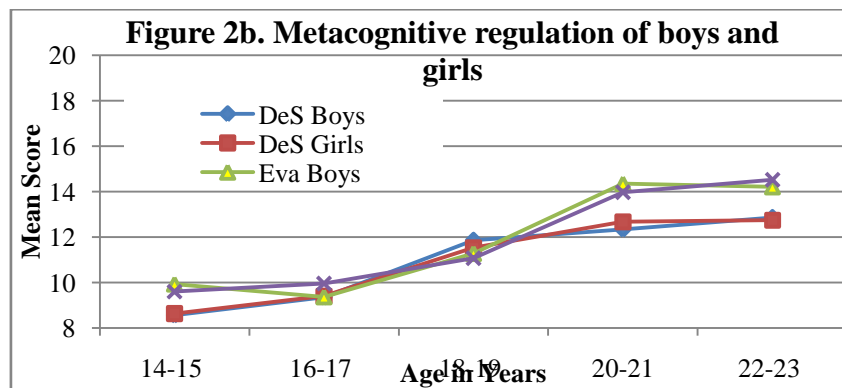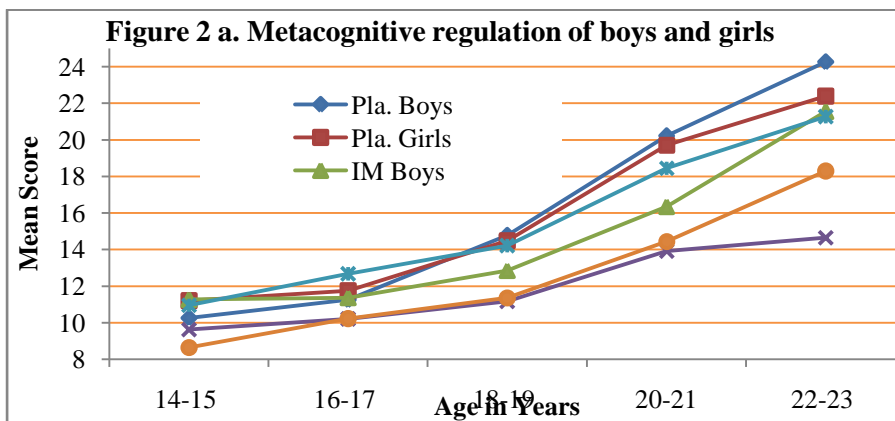Figure 1. Metacognitive knowledge of boys and girls

Table 3. Summary of Analysis of Variance showing the Gender and age related differences in Metacognitive awareness

Metacognitive Knowledge

Sources	SS	df	Ms	F
Gender (A)	48.37	1	48.37	7.63**
Age (B)	452.93	4	113.23	17.86**
A x B	101.95	4	25.49	4.02*
Within	2472.62	390	6.34	
Mean	**Boys-16.46**		**Girls-17.10**	

Metacognitive Regulation

Gender (A)	33.69	1	33.69	5.88*
Age (B)	498.74	4	124.68	21.76**
A x B	145.08	4	36.27	6.33*
Within	2234.76	390	5.73	
Mean	**Boys-13.83**		**Girls-12.70**	

Executive Control

Gender (A)	12.33	1	12.33	2.34
Age (B)	343.39	4	85.85	16.29**
A x B	31.83	4	7.96	1.51
Within	2055.32	390	5.27	
Mean	**Boys-11.11**		**Girls-11.46**	

Figure 2 a. Metacognitive regulation of boys and girls

Figure 2b. Metacognitive regulation of boys and girls

Figure 3. Metacognitive executive control of boys and girls

Discussion

The results of the study confirmed several findings relating to metacognitive development of adolescents as reported in prior researches. Kuhn (2000) observed that metacognitive development is very slow and gradual along the entire life span. It is found in the present study that each of the three constituents of metacognitive awareness has progresses very slowly among the college students during a long span of 10 years. On the average, the metacognitive knowledge improved by 12.5%, regulation by 20% and executive

control by 12.5% for boys in 10 years. Likewise, for girls the developments are 13%, 18% and 13% respectively. Hence, the rate of development of metacognitive awareness for both boys and girls are definitely very slow. Further, Schraw and Moshman (1995) observed that in the process of metacognitive development, metacognitive knowledge is earliest to develop followed by regulation and then control and execution. This sequence is also clearly apparent in the results of the present study. It is observed that in 14-15 years age group, the means of metacognitive knowledge, regulation, and execution are respectively 14.07, 10.20, and 8.85 for boys and respectively 14.43, 9.54, and 9.02 for girls. With regard to gender difference in the development of metacognitive awareness, the findings of prior researches are mostly inconsistent. But results of the present research showed some direction in the sense that girls are better in some aspects of metacognitive measures while boys are better in others. For example, girls are found significantly better in metacognitive knowledge while boys are significantly better in metacognitive regulation. However, gender difference was not observed about metacognitive control and execution. For each of the three measures, significant age-related developments were observed to suggest that period of college life is the foundation for metacognitive developments among students.

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