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METACOGNITIVE ABILITY AND ACADEMIC ACHIEVEMENT IN BIOLOGY

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Abstract

The present study examines the metacognitive abilities of secondary school students in relation to their achievement in biology. A total of 840 students were chosen as a sample for the study. An inventory of metacognition has been adapted for local use. Metacognitive Inventory and Achievement Test in Biology for Students (Self constructed) used for the collection of data. The impact of student metacognition and other factors such as gender, age, locality, social factors, and internet use, watching TV, library habits, parent education, tuition availability, and parent guidance were examined. Data analysis involved the use of mean, standard deviation, t-test, multiple analyses of variance, chi-square, Pearson product-moment and Kendall's Tau-b correlation coefficient. The results revealed that there was no significant difference between Metacognitive Ability Inventory (MAI) score of male and female students who studies biology. The scores in the MAI test of urban students are very much higher than the scores of rural students. Internet use has a significant impact on the MAI and test score of students.Those students who always consulted library books have higher mean score on MAI and achievement test.

Key Word: Metacognition, Metacognitive Ability, Metacognitive Ability Inventory (MAI), Secondary School Students,Achievement Test in Biology.

Justification of the Study and Reviews

The National Curriculum Framework (NCF) developed by the National Council of Educational Research and Training (NCERT) in 2005, recommends a paradigm shift from rote memory to learning by understanding. It suggests that schools should facilitate the process of knowledge construction and help them to become independent thinkers capable of solving their everyday problems. In the new curriculum, teachers are seen as the main agents of change. The existing teaching practice is of "information loaded" education, which puts a

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lot stress on students. In accordance with the postulates put forth by NCF 2005, school should avoid filling students' minds with mere facts; rather they should facilitate the process of knowledge of metacognition.

The review of related literature revealed that Metacognitive Skills can be developed in the classroom. A good number of reviews of studies such as Schofield, Linda (2012), Devaki, VandPushpam, M (2011), Santhi, S. et al. (2011), Efklides, A (2018), Iiskala, T. et al. (2016), Akyol, G. (2010), Papantoniou, G. et al. (2019), Wilson, N. S. and Bai, H. (2017), Joseph, N. (2019), Haider, A. (2018), Schraw, G. et al. (2006) revealed that Metacognitive ability is appropriate for the improvement in the academic achievement, especially achievement in science.

Research literature on metacognition indicated that much work has been done in abroad. However, research on students' and teachers' metacognition has been a neglected area in our country. Due to its importance this research study has been conducted to examine "Metacognitive Ability and Academic Achievement in Biology". Thus the present study attempted to fill this gap.

Objectives of the Study

1. To measure the metacognitive abilities of secondary school students who studies biology.
2. To explore the variance accounted for different social factors in metacognitive abilities of secondary school studentswho studies biology.
3. To determine the significance of difference in the metacognitive abilities of male and female secondary school students who studies biology.
4. To find out the significance of difference between metacognitive abilities of urban and rural secondary school students who studies biology.
5. To investigate the impact of metacognitive abilities on secondary school students achievement in biology.

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Hypotheses of the Study

1. There is no significant difference between metacognitive abilities of male and female studentswho studies biology.
2. There is no significant difference between metacognitive abilities of urban and rural students who studies biology.
3. There is no significant impact of metacognitive abilities on secondary school students' achievement in biology.

Population of the Study

Out of all the schools, only 30 secondary schools from urban and rural areas of Rangareddy District, Telangana (15 schools from urban and 15 from rural area) were selected through stratified random sampling method for the purpose of enlisting the population of secondary school students. Populations of the study are male and female students who studies biology.

Table-1: Population details

District Rangareddy	Male Urban	Male Rural	Female Urban	Female Rural	Total
Government Secondary Schools	41	102	28	25	197
Students Enrolled	2580	2365	2145	2055	9145

(*Source*: Educational Statistics: Commissioner and Director of School Education, Telangana)

Sample of the Study

For selection of sample a multistage sampling technique was used.Thus, a total of 840 students who studies biology were chosen as a sample for the study, this being highly representative of the population.The detail of the sampling frame is as follows:

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Table-2: Sample of biology students

Area	Male Biology Students	Female Biology Students
Urban	235	185
Rural	235	185
Total	570	370

Table-3: Sample of biology students by gender

Gender	Frequency	Percent
Male	487	58
Female	353	42
Total	840	100

Table 3 shows that students' sample comprised of greater number of male students as compared to female students.

Table-4: Sample of biology students by locality

Locality	Frequency	Percent
Urban	420	50
Rural	420	50
Total	840	100

Table 4 indicates that sample consisted of equal number of students who studies biologyfrom urban and rural area.

Tools Used

After an extensive literature review the researcher adapted Schraw and Dennison (1994) Metacognitive Inventory.Based on Schraw and Dennison inventory, the researcher constructed separate inventory for students.

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- Metacognitive Inventory for Studentswho studies biology and
- Achievement Test in Biology (Self constructed)

Data Collection Procedure

For collection of data, formal approval was obtained from the Commissioner and Director of School Education, State Project Director Rajiv Vidya Mission (SSA), Hyderabad and School Principals, explaining the purpose and requirements of the study through a letter. Then, in a meeting with school biology teachers, the objectives of the study and application procedure were discussed. The researcher personally administered the inventories in all schools. Before giving inventories, a brief introduction about the research was provided to the students. The students were mentioned and persuaded to give honest and frank responses and were ensured that the data will only be used for research purposes.

Analysis and Interpretation

The scores obtained from test were analyzed statistically.Mean and standard deviation was done for assessing the metacognitive abilities of students, t-test and multiple analyses of variance were used for testing the hypotheses of mean differences of male Vs female and urban Vs rural studentswho studies biology. Hypotheses were tested at 0.01 & 0.05 levels. SPSS was used for the analysis of data. Pearson product-moment coefficient of correlation was applied for the measurement of correlation between the variables. Chi-square was also used in the data analysis.

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Students' Metacognitive Ability

Table-5: Mean score of students by gender

MAI Sub Scales	Male students		Female students		Statistics	
N=840	**M**	**SD**	**M**	**SD**	**t-test**	**P**
Procedural knowledge	16.0	2.5	15.7	2.3	2.6	P < 0.01
Declarative knowledge	24.6	3.1	23.9	3.1	5.1	P < 0.001
Conditional knowledge	16.7	2.3	16.8	2.4	-0.6	n.s
Planning	21.1	2.8	20.6	3.1	3.3	P < 0.001
Management strategies	40.7	4.9	43.3	4.9	-10.08	P < 0.001
Evaluation	28.2	3.9	27.4	4.3	4.1	P < 0.001

Table-5 discloses a comparison of male and female students for different sub scales of the inventory. Table reveals that male students possessed high mean score on declarative knowledge, and evaluation while female students have high average score on management strategies. However, the differences, although highly significant, are very small.

Table-6: Students' mean score on different components of MAI

	Knowledge of Cognition				Regulation of Cognition			MAI Score		
	N	**M**	**SD**	**t-test**	**M**	**SD**	**t-test**	**M**	**SD**	**t-test**
Urban	420	58.4	5.8	T=11.2 P<0.01	91.6	8.7	T=4.9	150.0	12.4	T=8.4 P<0.001
Rural	420	55.3	6.0		89.5	9.8	P=0.001	144.8	13.9	

Table-6 presents a picture of MAI mean score of students of urban and rural localities. In every case, the urban students performed better.

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Table-7: Students mean scores on different components by gender

Knowledge of Cognition					Regulation of Cognition			MAI Score		
	N	M	SD	t-test	M	SD	t-test	M	SD	t-test
Male	487	57.3	6.2	T=3.4	90.0	8.8	T=-2.8	147.3	13.0	T=-0.4
Female	353	56.3	5.9	P<0.001	91.3	9.9	P<0.01	147.6	14.1	n.s

It is revealed from table-7 that male students have higher mean score than female on knowledge of cognition while the female students performed better on the regulation of cognition.

Table-8: Male and female students test achievement

Students					
Male Student Achievement Test		N	Female Student Achievement Test	N	t-test
M	64	487	60	353	t=7.2
SD	5.0		4.7		p<0.001

The table-8 indicated significant difference between test score of male and female students. Thus male students performed better than female students on the test.

Table-9: Urban and Rural Student's Achievement in biology test

Students					
Urban Student Achievement Test		N	Rural Student Achievement Test	N	t-test
M	70	420	63	420	t=5.3
SD	4.5		5.2		p<0.001

The table-9 indicated significant difference between test score of urban and rural students indicating that urban students performed better than rural students on the test.

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Table-10: Mother education Vs student MAI & achievement score in biology test

				Mean Score	
N = 840	**Option**	**Frequency**	**%**	**Student MAI Score**	**Student Achievement Test Score**
Mother's Education	Illiterate	546	65	147	67
	Primary	152	18	148	67
	Middle	8	1	151	67
	Matric	67	8	150	64
	Inter	17	2	150	64
	Bachelor	50	6	152	70

It is possible to correlate the mother's education level with the student MAI score ($r = 0.07$, $p < 0.01$) and test score ($r = -0.03$, n.s.) using Kendall's Tau-b (table-10). This means that students tend very, very slightly to be more self-aware in terms of metacognition if their mothers are better educated but they do not perform any better in the test.

Table-11: Parental guidance related to MAI & achievement score of students

				Mean Score	
Variable	**Option**	**Frequency**	**%**	**Student MAIScore**	**Student AchievementTest Score**
Parents' Guidance	Not at all	152	18	147	70
	Sometimes	235	28	146	67
	Always	453	54	149	67

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It is possible to correlate the student perceived level of parental guidance with the student MAI score ($r = 0.03$, n.s.) and test score ($r = -0.04$, $p < 0.05$.) using Kendall's Tau-b (table-11). This means that the student perceived level of parental guidance is not related to either metacognitive awareness or performance.

Table -12: Tuition availability, MAI and students achievement in biology test

				Mean Score	
Variable	**Option**	**Frequency**	**%**	**Student MAIScore**	**Student AchievementTest Score**
Tuition	Not at all	370	44	148	67
	Sometimes	260	31	145	67
	Always	210	25	149	70

It is possible to correlate tuition availability with the student MAI score ($r = 0.03$, n.s.) and test score ($r = 0.11$, $p < 0.01$) using Kendall's Tau-b (table-12). This means that tuition availability was related only to performance, as might be expected.

Table-13: Internet use, MAI and achievement score of students

				Mean Score	
Variable	**Option**	**Frequency**	**%**	**Student MAIScore**	**Student AchievementTest Score**
Internet use	Not at all	387	46	146	67
	Sometimes	218	26	148	67
	Always	235	28	149	67

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It is reported in table-13 that internet use can be correlated with MAI of students ($r = 0.06$, $p < 0.002$) and test score ($r = 0.26$, $p<0.01$) by using Kendall's Tau-b. It is highly likely that those with access to the internet and an interest in using it will be those who are more academically aware.

Table-14: TV watching, MAI and achievement scores

				Mean Score	
Variable	**Option**	**Frequency**	**%**	**Student MAIScore**	**Student AchievementTest Score**
TV Watching	Not at all	67	08	147	67
	Sometimes	370	44	147	67
	Always	403	48	148	67

It is reported in table-14 that TV watching can be correlated with MAI of students ($r = 0.05$, $p < 0.005$) and test score ($r = 0.26$, $p<0.01$) by using Kendall's Tau-b (table 4.2.10).

Table-15: Library use, MAI and achievement score of students

				Mean Score	
Variable	**Option**	**Frequency**	**%**	**Student MAIScore**	**Student AchievementTest Score**
Library Habits	Not at all	420	50	146	67
	Sometimes	294	35	148	67
	Always	126	15	150	70

It is reported in table-15 that library use can be correlated with MAI of students ($r = 0.07$, $p < 0.001$) and test score ($r = 0.26$, $p<0.01$) by using Kendall's Tau-b. Again, this is entirely unsurprising in that the library is a powerful tool in developing academic skills.

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Table-16: Student MAI and test scores

Group	N	Pearson Correlation (r*)
All Students	**840**	**0.53**
All Male Students	487	0.55
All Female Students	353	0.53
All Urban Students	**420**	**0.45**
Male urban students	235	0.58
Female urban students	185	0.33
All rural students	**420**	**0.57**
Male rural students	235	0.54
Female rural students	185	0.70

*p = 0.001

It is to be expected that students who perform better are more aware of the whole nature and purpose of learning as well as their role in it. It is possible to look at each of the six separate areas and relate these to test scores (as indicated in table-16).

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Table-17: Student achievement and different components of inventory

Sub Scale	Procedural knowledge	Declarative knowledge	Conditional knowledge	Planning	Management strategies	Evaluation
Procedural knowledge						
Declarative knowledge	0.38*					
Conditional knowledge	0.41*	0.41*				
Planning	0.29*	0.43*	0.44*			
Management strategies	0.21*	0.20*	0.26*	0.31*		
Evaluation	0.30*	0.35*	0.41*	0.57*	0.29*	
Achievement Test	0.35*	0.41*	0.35*	0.39*	0.26*	0.43*

* Correlation is significant at 0.01 levels.

Table-17 indicates the correlations among test score and different components of the metacognitive inventory. The data revealed a medium correlation among test score and procedural knowledge, declarative knowledge, conditional knowledge, planning and evaluation. However, the correlation was weakest in the case of management strategies.

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Table-18: Testing of research hypotheses

Hypotheses	Statistics	P	Results
Hypothesis-1: There is no significant difference between metacognitive abilities of male and female studentswho studies biology.	t = -0.40	n.s	Null hypothesis accepted, there was no significant difference between MAI score of male and female students
Hypothesis-2: There is no significant difference between metacognitive abilities of urban and rural students who studies biology.	t = 8.41	<0.001	The scores in the MAI test of urban students are very much higher than the scores of rural students.
Hypothesis-3: There is no significant impact of metacognitive abilities on secondary school students' achievement in biology.	F=12.33	<0.01	Performance of the students who possessing highmetacognitive abilities was better on the achievement test than the students who possessing low metacognitive abilities.

The urban students are clearly showing behaviour characteristics related to learning which is much more positive than those of the rural students. This probably reflects the different paces of educational development in urban and rural areas. There is also a strong tendency for those who perform better to be those who are more educationally aware.

Findings of the Study

1. There was a significant difference in the response pattern of male and female students in all areas of metacognitive inventory except conditional knowledge.
2. Male students performed better on the knowledge of cognition while female students achieved higher score on the regulation of cognition.
3. Similarly a significant difference was observed in the MAI score of urban and rural students.

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4. It was also found that male students performed better than female students in the achievement test. Similarly there was a significant difference in the test score of urban and rural students.

5. It is revealed that children of highly educated mothers performed better on the MAI. Similarly performance of the students who possessing high metacognitive abilities was better on the achievement test than the students who possessing low metacognitive abilities.

6. It was indicated that parent guidance was always available to the majority of students. The students who always enjoyed more parental guidance have higher MAI mean score.

7. It was also found that tuition availability related to better performance of students in the test.

8. It is reported that only 28% of students always used Internet and internet use has a significant impact on the MAI and test score of students.

9. It is reported in that students who always consulted library books have higher mean score on MAI and achievement test.

Conclusion

The study has revealed that with respect to class ninth students, achievement in biology showing correlation with metacognitive abilities. This result implies that teacher could make use of the metacognitive strategy of teaching biology to students of secondary school to promote achievement in biology. This finding also implies that the metacognitive strategy of teaching needs to become an integral part of the pedagogy of biological sciences or methodology of teaching biology at secondary level.Teachers should make earnest effort to enhance the metacognitive ability of the students by providing ample opportunities to them to think divergently and to explore their unique potentials. For this, teachers can arrange science fairs; conducting science projects etc. so that the students' achievement also increases.Teachers should encourage students to take up investigatory projects so that they can create their own knowledge which will lead them to metacognitively aware individuals.

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As per the suggestion by NCF (2005) Science teaching requires change throughout the entire system. By teaching with metacognitive strategies students will be greatly influenced by the methods of teaching. By these methods students understanding is actually constructed through individual and social processes.Mother education has a positive impact on metacognition of children. This highlights the importance of girls' education. What has happened is that the education of girls has been under-supported in the past in India. The results of this study suggested that the role of the mother is far more than simply bringing children into the world. There is a vast influence in very early childhood between the key caregiver and the child. Thus, educating girls is critical for this brings a powerful future influence to future children of these girls, a role which males have great difficulty in performing. Therefore, encourage the education of girls: it brings great benefit to future generations of young folk.Similarly parental guidance has a key role in the performance of students. The parents may give attention to this aspect for the betterment of their child.

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