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Metacognitive Abilities of Secondary School Biology Teachers

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Abstract

The present study examines the metacognitive abilities of secondary school biology teachers. A total of 120 biology teachers was chosen as a sample for the study. An inventory of metacognition has been adapted for local use. Metacognitive Inventory for Biology Teachers used for the collection of data. Teacher related factors such as academic and professional qualification, teaching experience and in-service training were also taken into account. Data analysis involved the use of mean, standard deviation, t-test, chi-square, Pearson product-moment coefficient of correlation. The results revealed that there was no significant difference between Metacognitive Ability Inventory (MAI) score of male and female, rural and urban biology teachers.

Key Word

Metacognition, Metacognitive Abilities, Metacognitive Ability Inventory (MAI), Secondary School, Biology Teachers.

Introduction

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 lot stress on students.

When we talk about qualitative education, we must think of competent teachers. It is now widely accepted notion that teaching is an art with a well-defined scientific process. By using various skills and activities a teacher can be made effective. There are some common skills which all efficient teachers need, but some specific skills and abilities are required by biology teachers for successful functioning. There is scope for research in teaching in order to discover the specific skills and abilities which the teacher should develop. Research studies have indicated that teachers who are aware of their own Metacognitive functioning tend to play a more significant role in helping learners develop skills in metacognition (Daley, 2002). Brown (1987) has

categorized metacognitive knowledge into declarative, procedural and conditional knowledge. Declarative knowledge refers to "knowing what", procedural knowledge refers to "knowing how" and conditional knowledge refers to "knowing why and when". Schraw & Moshman (1995) divided metacognition into metacognitive knowledge and metacognitive control processes (regulation of cognition). They argued that metacognitive knowledge is not necessarily stable, but children routinely use metacognitive knowledge without being able to express that knowledge. They also classified metacognitive regulation into three skills as planning, monitoring and evaluation.

(i) Planning involves the selection of strategies and the allocation of resources.

(ii) Monitoring refers to awareness of comprehension and task performance.

(iii) Evaluation refers to value judgment.

Certain reviews such as Kim, Hye and Pedersen, Susan (2010), Lee, H (2010), Magno, C (2010), O'Shea, M (2010), Wang, W (2010), Willingham, D (2008) revealed that those who are practicing Metacognitive abilities have possessed a greater thinking ability than others. Since metacognition is thinking about thinking, those who practicing Metacognitive strategies in the classroom can enhance the student thinking which will later contribute much in the creativity of then students?

Objectives of the Study

1. To measure the metacognitive abilities of secondary school biology teachers.
2. To find out impact of personal factors on metacognitive abilities of biology teachers.
3. To determine the significance of difference in the metacognitive abilities of male and female biology teachers.
4. To explore the significance of difference between the metacognitive abilities of urban and rural biology teachers.

Hypotheses of the Study

1. There would be no significant difference between Metacognitive abilities of male and female biology teachers.
2. There would be no significant difference between the metacognitive abilities of urban and rural biology teachers.

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 teachers. Populations of the study are male and female Biology Teachers.

Table-1: Population details

District Rangareddy	Male Urban	Male Rural	Female Urban	Female Rural	Total
Government Secondary Schools	41	102	28	25	197
Biology Teachers	41	72	53	43	209

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

Sample of the Study

A multistage sampling technique is used. For this study a sample of 60 urban science teachers (35 male and 25 female) and 60 rural science teachers (35 male and 25 female) are selected randomly from the population. The detail of the sampling frame is as follows:

Table-2: Sample of biology teachers

Area	Male Biological Science Teachers	Female Biological Science Teachers
Urban	35	25
Rural	35	25
Total	70	50

Table-3: Sample of biology teachers by gender

Gender	Frequency	Percent
Male	70	58
Female	50	42
Total	120	100

As there was less number of female biological science teachers in the district Rangareddy, therefore the sample contained 42% female and 58% male biology teachers.

Table-4: Sample of biology teachers by locality

Locality	Frequency	Percent
Urban	60	50
Rural	60	50
Total	120	100

It is revealed in table-4 that sample consisted of equal number of science teachers from both 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 biology teachers.

- Metacognitive Inventory for Biology Teachers

Procedure for Data Collection

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 teachers. The teachers 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 the test were analyzed statistically. Mean and standard deviation was done for assessing the metacognitive abilities of biology teachers, t-test and multiple analyses of variance were used for testing the hypotheses of mean differences of male Vs female and urban Vs rural biology teachers. 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.

Teachers Metacognitive Ability

It is possible to consider several variables and see whether they relate to the metacognitive ability of the biology teachers. The variables are: teacher's academic qualifications, professional

qualification, teaching experience, in-service training, computer training, use of Internet, and gender.

Table-5: Academic qualification of biology teachers

	Academic Qualification (%)		
Gender	**Bachelor**	**Master**	**M. Phil.**
Male	7	90	3
Female	16	84	0

Table-5 suggests a greater number of male science teachers possessing higher qualifications although this cannot be shown statistically.

Table-6: Professional qualification of biology teacher

	Professional Qualification (%)	
Gender	**B.Ed.**	**M.Ed.**
Male	26	74
Female	50	50

Table-6 shows that a greater number of male biology teachers possessed higher professional qualifications than female teachers ($\chi 2 = 7.5$ (df1), $p < 0.01$).

Table-7: Teaching experience of biology teachers

	Teaching Experience (%)			
Gender	**< 5 years**	**5-10 years**	**11-15 years**	**>15 years**
Male	19	14	30	37
Female	30	22	8	40

Table-7 reports that sample of teachers consisted of experienced teachers, with 38% of the sample having more than 15 years teaching experience. The data also indicated gender differences ($\chi 2 = 9.5$ (df3), $p < 0.05$).

Table-8: Report of in service training of biology teachers

	% In-Service Training	
Gender	**No**	**Yes**
Male	23	77
Female	34	66
Total	28	72

Table-8 shows the majority have received some in-service training, there being no statistical difference in males and females ($\chi 2$ = 1.8 (df1), Not Significant)

Table-9: Computer training of biology teachers

	% Computer Training	
Gender	**No**	**Yes**
Male	69	31
Female	64	36
Total	67	33

The majority of the biology teachers have not had any computer training. The table-9 did not indicate any significant gender differences ($\chi 2$ = 0.27 (df1), p < Not Significant).

Table-10: Internet use by biology teachers

	% Internet Use		
Gender	**Not at all**	**Sometimes**	**Always**
Male	23	60	17
Female	30	48	22
Total	26	55	19

Table-10 shows that there is a lack of Internet facilities in many secondary schools and the low proportion using the Internet on a regular basis reflects this ($\chi 2 = 1.7$ (df2), p < Not Significant).

Table-11: Correlation between teachers' experience and their MAI score

N = 120		
Teachers MAI Scores		
Teaching Experience	R = 0.22	P < 0.05

Table-11 suggests that, with experience, the teachers become more aware of what they are doing in terms of teaching and learning.

Table-12: Professional qualification and MAI

Professional Qualification		**Teachers' MAI Score**
B.Ed. (N=43)	M	151
	SD	13.2
M.Ed. (N=77)	M	153
	SD	13.3

Table-12 shows that the level of professional qualification seems to make little difference to the teacher MAI score. This raises the interesting issue about teacher qualifications.

Table-13: In-service training and MAI score

In-service Training		**Teacher MAI Score**
Option		
No (N=33)	M	150
	SD	11.5
Yes (N=87)	M	154
	SD	13.7
t-test		1.6
p		Not Significant

In-service training makes no difference to the MAI score for teachers.

Table-14: Mean score of teachers by gender

MAI Sub Scales	Male Teachers		Female Teachers		Statistics	
N=120	**M**	**SD**	**M**	**SD**	**t-test**	**P**
Procedural knowledge	17.3	1.78	17.1	1.62	0.56	Not Significant
Declarative knowledge	26	2.97	25.6	3.06	0.39	Not Significant
Conditional knowledge	17	1.99	16.6	2.05	1.5	Not Significant
Planning	21	2.38	21.5	2.84	-0.36	Not Significant
Management strategies	43	5.49	42	4.40	0.76	Not Significant
Evaluation	29	3.99	27.6	4.7	1.9	P<0.05

Table-14 reveals that male teachers possessed high mean score on management strategies and evaluation sub scales of the metacognitive inventory. However, the difference was significant only in the case of evaluation sub scale.

Table-15: Teachers 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	70	60.3	5.9	0.89	93.5	9.2	1.3	153.8	13.4	1.3
Female	50	59.3	5.8	n.s	91.4	8.8	n.s	150.7	12.9	n.s

It is revealed from table-15 that male teachers have higher mean score than female on knowledge of cognition and regulation of cognition.

Table-16: Male and female teacher's MAI score

Teachers

Male Teacher MAI Score		N	Female Teacher MAI Score	N	t-test
M	154	60	154	60	t=1.3 n.s
SD	13.4		13.4		

Table-16 showed no significant difference between MAI score of male and female teachers.

Table-17: Mean score of teachers by locality

MAI Sub Scales	Urban Teachers		Rural Teachers		Statistics	
N=120	**M**	**SD**	**M**	**SD**	**t-test**	**P**
Procedural knowledge	17.6	1.5	16.9	1.8	2.4	P<0.01
Declarative knowledge	26.3	2.7	25.2	3.2	2.1	P<0.04
Conditional knowledge	17.2	1.9	16.7	2.1	1.3	n.s
Planning	21.7	2.3	21.2	2.8	1.0	n.s
Management strategies	43.2	4.8	42.1	5.3	1.1	n.s
Evaluation	28	4.7	29.1	4	-1.3	n.s

Table-17 reveals that urban teachers possessed high mean score on all sub scales except evaluation sub scale of the inventory. However a significant difference was noticed in the procedural and declarative knowledge only.

Table-18: Teachers score on different components MAI

Knowledge of Cognition					Regulation of Cognition			MAI Score		
	N	**M**	**SD**	**t-test**	**M**	**SD**	**t-test**	**M**	**SD**	**t-test**
Urban	60	61.1	5.2	2.2 P<0.02	92.9	8.1	0.33	153.97	11.2	1.2 n.s
Rural	60	58.7	6.3		92.4	9.9	n.s	151.1	15	

Table-18 presents a picture of MAI mean score of teachers of urban and rural localities. In every case, the urban teachers performed better, however, the difference was not statistically significant.

Table-19: Urban and rural teacher's MAI score

Teachers	N	M	SD	t-test
Urban Teacher MAI Score	60	153.9	11.2	t = 1.2
Rural Teacher MAI Score	60	151.1	14.9	n.s

Table-19 showed no significant difference between MAI score of urban and rural teachers.

Metacognitive grouping of Teachers

Teachers were also grouped into three categories i.e.; high, average and low metacognitive ability group on the basis of their MAI score as indicated in table-20.

Table-20: MAI and test score of metacognitive groups

Biology Teachers Groups	Biology Teachers	%	Teacher MAI
High Metacognitive	21	18	172
Average Metacognitive	82	68	152
Low Metacognitive	17	14	132

It is revealed in table-20 that 18% teachers have high metacognitive ability, 68% teachers were average metacognitive ability and only 14% teachers possess low metacognitive ability.

Table-21: Testing of research hypotheses

Hypotheses	Statistics	P	Results
Hypothesis-1: There would be no significant difference between metacognitive abilities of male and female biology teachers.	t=1.27	Not Significant	Null hypothesis accepted, there was no significant difference between metacognitive abilities score of male and female biology teachers.
Hypothesis-2: There would be no significant difference between the metacognitive abilities of urban and rural biology teachers.	t = 1.20	Not Significant	Null hypothesis accepted, there was no significant difference between metacognitive abilities

			score of urban and rural biology teachers.

Findings of the Study

1. The majority of the biology teachers agreed with the statements in all six areas (procedural knowledge, declarative knowledge, conditional knowledge, planning, management strategies and evaluation) of metacognitive process with significant evidence of gender differences in case of evaluation subscale of the metacognitive inventory.

2. No significant difference was found between Metacognitive Ability Inventory (MAI) scores of male and female biology teachers.

3. No significant difference was found between Metacognitive Ability Inventory (MAI) scores of rural and urban biology teachers.

4. It was found that biology teachers with more than 15 years' experience possessed higher scores on the metacognitive inventory.

5. It was found that biology teachers with in-service training possessed higher mean score on the metacognitive inventory.

6. It was revealed that biology teachers who always consulted library and used internet achieved higher mean score on the metacognitive inventory.

7. The biology teachers having higher academic and professional qualification and computer training achieved higher score on the metacognitive inventory. However, the majority of teachers (67%) did not get any computer training.

Conclusion

It was found that male biology teachers achieved higher scores on knowledge of cognition and regulation of cognition; similarly, the overall score of male biology teachers on Metacognitive Abilities Inventory was also higher than female teachers. However, this difference was not significant. It was found that teachers with more than 15 years' experience possessed higher scores on the metacognitive inventory. Biology teachers with in-service training possessed higher mean score on the metacognitive inventory. Teachers with higher academic qualifications achieved higher score on the Metacognitive Abilities Inventory. Further, the teachers with higher professional qualification also achieved a higher score on the metacognitive inventory. It was also revealed that teachers who always consulted library achieved higher mean score on the metacognitive inventory. The findings of the study also supported the claim of previous research that teaching experience of teachers is positively correlated with metacognition.

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. The study revealed that there were some metacognitive areas in which the teachers need support and training. These areas may be focused in the training programs of teachers. These included: Self-motivation, Self-abilities about intellectual strengths and weaknesses, Abilities about learners' expectations, Analyzing usefulness of teaching strategies, Help in thinking strategies, Learning strategies, Computer training, Setting teaching and learning goals and summarizing lessons. The findings of the study also suggested that internet surfing, TV watching and reading library books have good impact on metacognitive abilities. Therefore the teachers may be encouraged to use these. For this purpose computer with internet connectivity may be provided to all schools. However, this involves huge financing which is quite difficult task for a country like India. At least it may implements in all teacher education institutions. Seminars and workshops should be organized for the teacher educators on different strategies in metacognition. Detailed theory on metacognition should be included in the D.El.Ed, B.Ed. and M.Ed. programme and metacognitive strategy of instruction should be incorporated in the pedagogic analysis of education. Refresher courses need to be organized by the government agencies to the in-service teachers on metacognitive strategy. Lack of retention is the basic problem in science classroom. By using metacognitive strategy in the instruction of biology, the teachers can improve the retention ability of the students.

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