



## ASSESSMENT OF METACOGNITION OF ELEMENTARY SCHOOL LEARNERS IN SCIENCE: INCLINATIONS AND CONCERNS

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### ABSTRACT

Metacognition, 'the cognition of cognition' in the layman language is basically the control and coordination of any individual on his/her own learning and knowing process. This piece of work is confined to four components of metacognition of children assessed in science in later elementary as well as early secondary age of schooling in Mayurbhanj district of Odisha, an eastern state of India. While children reading in classes VI, and VIII of Government schools of the state are the main targets of the study the study also appreciates the cognitive and metacognitive consequences of schooling. Development of these competencies as consequences of schooling in grade VI and VIII were assessed by using the Metacognitive Knowledge Assessment Test (MKAT), Metacognitive Skill Assessment Test (MSAT), Metacognitive Attribution Assessment Test (MAAT) and Metacognitive Awareness Assessment Scale (MAAS). In this study it was found that all the components of Metacognition increases with grade. Ethnicity is having significant impact on these competencies i.e. learners with different ethnic background were distinct with their performances in metacognitive components. The learners from different locality are almost equally competent in all the competencies of except metacognitive skills, where rural student perform significantly better than their counter parts of rural locality in all the grades as well as ethnicity.

**KEYWORDS :** Metacognition, Cultural schema, Metacognitive knowledge, Metacognitive skill, Metacognitive awareness.

### INTRODUCTION

The term Metacognition first emerged from the works of American developmental psychologist *J H Flavell*. According to *Flavell (1976,1979, 1987)*, "metacognition consists of both metacognitive knowledge and metacognitive experiences or regulation. Metacognitive knowledge refers to acquired knowledge about cognitive processes, knowledge that can be used to control cognitive processes." In order to understand and assess metacognition the four aspects of metacognition (knowledge, regulation, belief and awareness,) are further sub-categorized in to nine major metacognitive parameters such as Declarative knowledge, Procedural knowledge, Conditional/strategic knowledge, Prediction skill, Planning skill, Monitoring skill, Evaluation skill (*Nayak & Mohanty 2017*).

**Metacognitive Knowledge :**Metacognitive knowledge may be understood as the knowledge of any individual about his/her own cognition. Metacognitive can be divided in to three different types of constructs for its better understanding as well as assessment viz. declarative knowledge, conditional knowledge and procedural knowledge

**Metacognitive Skills:** Metacognitive skills are strategies applied consciously or automatically during learning, cognitive activity, and communication to manipulate cognitive processes before, during, or after a cognitive activity (*Flavell, 1976, 1979*).

**Metacognitive Attribution: Metacognitive attribution** based on the belief on one's own cognitive functioning. There have been controversies on inclusion of *meta-cognitive belief* as a dimension of Meta-cognition. However, it may be understood as the broader general ideas and theories people have about their own and other people's cognition.

**Metacognitive awareness:** Metacognitive awareness means being aware of how you think. Developing metacognitive awareness is an important part of helping learners become more effective and, importantly, more autonomous. If learners are conscious of how they learn then they can identify the most effective ways of doing so.

### BACKGROUND OF THE STUDY

The study appreciates the phenomenal change in the in the school curriculum, curricular expectations and text books in India in the last two decades with the development of National Curriculum Framework 2005 and implementation of other government initiatives like District Primary Education Programme (1997-2002) in primary schools of selected educationally backward districts and Sarva Shiksha Abhiyan (from 2001) in all elementary schools. In addition to this, the Right to Free and Compulsory Education (RCFCE) Act, 2009 is also vocal for making the learning experience more qualitative. Continuous and

comprehensive Evaluation (latter, Continuous and comprehensive assessment) has made significant changes in the classroom assessment system by making it comprehensive as well as an integral part of learning. Witnessing the inclination of curriculum and curricular process towards a constructivist epistemic stand, the study assumes that the learners studying science in elementary school may have a satisfactory basic cognitive and meta-cognitive consequences schooling. The study also appreciates the academic consequences of the existing difference in the cognitive as well as cultural schema of learners of different cultural and ethnic background. Against this background, it was planned to study whether the cultural experience of the learners is imparting any impact on the Meta-cognition abilities of the learners across the grades in science during their elementary schooling. In order to investigate the cultural influence on metacognitive indicators Metacognitive Knowledge (Declarative, Conditional and Procedural) Metacognitive Skills (Prediction, Planning, Monitoring, and Evaluation), Metacognitive Attribution along with Metacognitive Awareness Assessment have been the aspects of the study. Written, oral, and observational techniques have been employed for making extensive as well as intensive examination of the problem. Apart from this assessment of science achievement is also a significant component of the study to make the investigation more comprehensive.

### OBJECTIVE:

To examine the difference in the metacognitive indicators, i.e. Metacognitive Knowledge, Metacognitive Skills, Metacognitive Attribution and Metacognitive Awareness of elementary school learners in science of different grade, ethnicity and home environment (locality).

### Major Hypotheses

Basing on the objective of the study and on the major findings from the related literature, the tentative directions in the results have been proposed as the hypotheses for the study.

1. There would be significant and positive relationship between the existing indicators of learning achievement in science and those of metacognition
2. With the progression of grades, the learners in the elementary grades would demonstrate acquisition of more, higher level metacognitive.
3. There would be no significant difference among the learners of tribal and non tribal community reading in a particular grade in their metacognition.
4. There would be no significant impact in home environment (rural and urban) on metacognition in science.

### METHOD OF THE STUDY:

The survey method has been used for the study. Accordingly, appropriate procedures of sampling, data capturing instruments, data

collection, analysis and interpretation of data have been followed.

**Sample / Participants :** Samples for the study were selected through purposive sampling procedure in different stages. Mayurbhanj district was taken as the sample district due to its rich tribal culture. spite of considering educational institution as unit, the study considers village as the unit for selection of sample. The four urban area were selected on the basis availability of rural areas adjacent to them where people of various tribal communities are leaving. In this study the sample consists of 320 students as described in the following table.

**Table 1 : Description of sample of the study**

Class	Tribal Learners			Non-Tribal Learners			Total		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
VI	47	33	80	33	47	80	80	80	160
VIII	44	36	80	36	44	80	80	80	160
Total	91	69	160	69	91	160	160	160	320

**Tools / Data Capturing Instruments :** Four types of tools and techniques were used for collection of information and data for the study:

- a) Metacognitive Knowledge Assessment Test (MKAT) for grade VI and VIII to assess meta-cognitive knowledge of these learners in science
- b) Metacognitive Skill Assessment Test (MSAT) for grade VI and VIII to assess meta-cognitive skill of these learners in science.
- c) Metacognitive Attribution Assessment Test (MAAT) for grade VI and VIII to assess meta-cognitive attribution (Belief) of these learners in science.
- d) Metacognitive Awareness Assessment Scale (MAAS) for grade VI and VIII to assess meta-cognitive awareness of these learners in science

**Pilot Testing :** The draft tool was subjected to two pilot testing, one in urban setup of Bhubaneswar (D. M School of NCERT) with 110 students and another in a SSD department (tribal) school situated in Mayurbhanj district with 117 students. The analysis of the results of the result show that students were not able to answer some of the questions whereas in some questions every student answered correctly. These items were removed from the final tool and the item number in this tool was reduced to 10 for each of the grades.

**Reliability and Validity:** Internal consistency for reliability and content as well as construct validities of all tests used in this study were ensured through careful analysis of the content and responses obtained during tryout of the tests. Extreme care was taken to ascertain the quality of test items in all the tests used in the study. While the clarity in meaning and purpose of each item was ensured through content analysis based on the feedback received from the tryout of the tests, the construct validity of the tests was ensured through logical analysis of the content as well as the functionality of each item of the tests.

**Procedure of Data Collection**

After the finalization of all the tools, the researcher moved to different villages/localities and collected data from the subjects of the research study. The testes were administered by the researcher and one of his colleague working a science teacher in an elementary school of Mayurbhanj district functioning under govt. of Odisha. All possible efforts were made to ensure accurate recording and interpretation of observation. The researcher took utmost care to minimize the influences of the biases in the data collection.

The scores obtained from the tests were subjected to quantitative analyses comprising of both descriptive (means and standard deviations) and inferential statistical techniques (mostly 3 way-GradeCultureLocation ANOVA).

**RESULTS AND DISCUSSION**

In this study, effort has been made to assess the existing status of four dimensions of Metacognition i.e. metacognitive knowledge, metacognitive skills, metacognitive attribution and metacognitive awareness being inculcated through the pedagogical practices practiced in the science classroom of the state in general and of Mayurbhanj in particular

**Metacognitive Knowledge in Science:** The ten items meant for assessment of metacognitive knowledge were asked to each student individually. Each item had three components to assess metacognitive

knowledge i.e. declarative, procedural and conditional. The total mark on this sub-test is 60 marks with 10 marks for declarative metacognitive knowledge, 20 marks for conditional metacognitive knowledge and 30 marks for procedural metacognitive knowledge. To investigate the effect of schooling (Grade variation: classes V and VIII), location of school (rural and urban) and the cultural difference (in terms of ethnicity: tribal and non-tribal), a three-way ANOVA was conducted. The results of which are presented in Table 2. The table presents 2 (Grade) X 2 (Location) X 2 (Gender) ANOVA conducted on procedural meta-cognitive knowledge scores. The results showed that, the main effects of grade ( $F = 62.5, p 0.01$ ) and Ethnicity ( $F = 28.6, p 0.01$ ) are significant while none of the interaction effects is significant.

**Table 2 : Summary of ANOVA Showing Effects of Grade, Location and Ethnicity on Metacognitive Knowledge in Science**

Source	SS	df	MS	f value	Remarks
Grade (A)	2554.8	1	2554.8	62.5	Significant**
Ethnicity (B)	1169.6	1	1169.6	28.6	Significant**
Location (C)	108.5	1	108.5	2.7	Not Significant
AB	31.2	1	31.2	0.763	Not Significant
BC	19.6	1	19.6	0.480	Not Significant
AC	1.7	1	1.7	0.480	Not Significant
ABC	29.3	1	29.3	0.716	Not Significant
Error	12577.8	312	40.9		
Total	16768.3	319			

The significant main effects of grade indicate to the higher performance of tribal as well as non-tribal students reading in class VIII (in both the localities) over the performance of their counterparts in Class VI. Hence, the performance of students on the declarative metacognition knowledge increased significantly over the advancement in grades. Similarly, non-tribal students perform significantly better than the tribal learners on the declarative Metacognition knowledge irrespective of their grade and locality

**Metacognitive Skills in Science:** The six items meant for assessment of metacognitive skills were asked to each student individually. Each item had four components to assess metacognitive skill i.e. prediction, planning, monitoring and evaluation. The total mark on this sub-test is 90 marks with 24 marks each for prediction, monitoring and evaluation with 18 marks for planning skill.

The effect of schooling (Grade variation: classes V and VIII), location of home (rural and urban) and the cultural difference (in terms of ethnicity: tribal and non-tribal), was investigated by using a three-way ANOVA was conducted. The results of which are presented in Table 3. The table presents 2 (Grade) X 2 (Location) X 2 (Gender) ANOVA conducted on procedural meta-cognitive knowledge scores. The results showed that, the main effects of grade ( $F = 17.8, p 0.01$ ), Ethnicity ( $F = 14.06, p 0.01$ ) and Location ( $F = 6.14, p 0.05$ ) are significant. Except the interaction effect of Ethnicity and Locality ( $F = 10.596, p 0.01$ ) none of the interaction effects is significant.

**Table 3 : Summary of ANOVA Showing Effects of Grade, Location and Ethnicity on Metacognitive Skill in Science**

Source	SS	df	MS	f value	Remarks
Grade (A)	8853.780	1		39.06	Significant**
Ethnicity (B)	3186.427	1		14.06	Significant**
Location (C)	41696.249	1		183.980	Significant**
AB	41.629	1		.184	Not Significant
BC	2401.423	1		10.596	Significant**
AC	719.802	1		3.176	Not Significant
ABC	7.603	1		.034	Not Significant
Error	707110.136	312			
Total	125874.42	319			

\*\* $p < .01$

The significant main effects of grade indicate to the higher performance of students reading in class VIII (in both the localities) over the performance of their counterparts in Class VI. Hence, the performance of students on the metacognitive skills increased significantly over the advancement in grades. Similarly, non-tribal students perform significantly better than the tribal learners on the metacognitive skills and rural students are having better metacognitive skill than those of urban students.

**Metacognitive Attribution in Science:** The six items meant for assessment of metacognitive skills were asked to each student individually. Each item had four components to assess metacognitive skill i.e. prediction, planning, monitoring and evaluation. The total mark on this sub-test is 90 marks with 24 marks each for prediction, monitoring and evaluation with 18 marks for planning skill.. The following table presents 2 (Grade) X 2 (Location) X 2 (Gender) ANOVA conducted on procedural meta-cognitive knowledge scores. The results showed that, the main effects of grade ( $F = 15.044, p 0.01$ ) and Location ( $F = 10.87, p 0.01$ ) are significant while none of the interaction effects is significant.

**Table 4 : Summary of ANOVA Showing Effects of Grade, Location and Ethnicity on Metacognitive Attribution in Science**

Source	SS	df	MS	f value	Remarks
Grade (A)	313.8	1	313.8	15.044	Significant**
Ethnicity (B)	226.888	1	226.888	10.877	Significant**
Location (C)	1.933	1	1.933	.093	Not Significant
AB	11.575	1	11.575	.555	Not Significant
BC	3.183	1	3.183	.153	Not Significant
AC	12.07	1	12.07	.609	Not Significant
ABC	3.407	1	3.407	.163	Not Significant
Error	6507.932	312	20.859		
Total	7083.687	319			

\*\* $p < .01$

The significant main effects of grade indicate to the higher performance of tribal as well as non-tribal students reading in class VIII over the performance of their counterparts in Class VI. Hence, the metacognitive attribution of students on the increased significantly over the advancement in grades. Similarly, non-tribal students perform significantly better than the tribal learners on the metacognitive attribution irrespective of their grade and locality. The non-significant interaction effects indicates a counter balance by the variables in metacognitive awareness.

**Metacognitive Awareness in Science:** The twenty items meant for assessment of metacognitive skills were asked to each student individually. The test was of 70 marks distributed among the three categories of the test items as 30, 20 and 20. The following table presents 2 (Grade) X 2 (Location) X 2 (Gender) ANOVA conducted on metacognitive awareness scores. The results showed that, the main effects of grade ( $F = 23.879, p 0.01$ ) and interaction effect of Grade, Ethnicity and Location ( $F = 16.529, p 0.01$ ) are significant while none of the other main or interaction effects is significant.

**Table 5 : Summary of ANOVA Showing Effects of Grade, Location and Ethnicity on Metacognitive Awareness in Science**

Source	SS	df	MS	f value	Remarks
Grade (A)	2004.949	1	2004.949	23.879	Significant**
Ethnicity (B)	192.952	1	192.952	2.298	Not Significant
Location (C)	108.112	1	108.112	1.288	Not Significant
AB	235.77	1	235.77	2.808	Not Significant
BC	38.795	1	38.795	.462	Not Significant
AC	110.394	1	110.394	1.135	Not Significant
ABC	1387.882	1	1387.882	16.529	Significant**
Error	2619.6953	312	83.965		
Total	30770.672	319			

\*\* $p < .01$

The significant main effects of grade indicate to the higher performance of students reading in class VIII (in both the localities) over the performance of their counterparts in Class VI. Hence, the performance of students on the metacognitive awareness increased significantly over the advancement in grades. The non-significant main effects of Ethnicity and locality implies that neither the culture nor the location of home has any impact on learners' metacognitive awareness. The non-significant interaction effect of Grade-Ethnicity, Grade-Location and Ethnicity- Location indicates that combining no two variables are putting any impact on metacognitive awareness whereas all the three variables interact among themselves and influence metacognitive awareness. However non-tribal students perform significantly better than the tribal learners on the declarative Metacognition knowledge irrespective of their grade and locality.

## MAJOR FINDINGS

- The students demonstrated higher level of performance (around 70%) in declarative meta-cognitive knowledge and moderately medium level (around 40%) in conditional meta-cognitive knowledge. The poorest performance (near about 25%) was observed in the procedural meta-cognitive knowledge.
- The performance on the Metacognitive Knowledge Test increased with the progression of grades.
- The students in urban schools demonstrated higher performance than their counterparts in rural schools in the overall meta-cognitive skills.
- The students in rural schools have demonstrated similar performance as by the students in urban schools in overall meta-cognitive knowledge.
- Effects of grade was significantly visible in all the components of metacognitive skill.
- There is distinct trend in rural-urban difference in meta-cognitive skill, rural learners have better skills.
- The students of both the grades showed higher meta-cognitive attribution towards mathematics learning.

## CONCLUSIONS

It is clear from the findings of the study that, learners demonstrated higher level of performance in declarative knowledge in comparison to conditional and procedural knowledge. The finding of the study strengthens such types of assumptions which were reflected in NCF 2005. Another dimension with respect to the findings from meta-cognitive knowledge can be said as, due to less focus on experiential learning, which is the key to development of critical thinking and development of conditional knowledge. The reason for students of higher grades demonstrating better performance in meta-cognitive skills may be attributed to their own initiatives to develop critical appraisal of their own thinking process and own performance. This may also be effect of maturation which brings more control over one's working to solve any problem. The results on meta-cognitive attribution in Science are at a higher level in both the grades while its correlation with Science achievement and Meta-cognitive abilities are at a low level in both the grades especially those are not significant at grade VI stage. This somehow leads one to think that the beliefs about their performance in Science are not very mature and they tend to rate their performance at a higher level when in reality it is otherwise. With the progression of grades, such a rating is going to be more reality based.

## REFERENCES:

- An, Y. J. & Cao, L. (2014) Examining the Effects of Metacognitive Scaffolding on Learners' Design Problem Solving and Metacognitive Skills in an Online Environment. MERLOT Journal of Online Learning and Teaching, Vol. 10, No. 4.
- Evangeline, C. J. (2016) Examining the effect of metacognitive skills on performance of learners. Scholarly research journal for interdisciplinary studies. OCT-NOV, VOL. 3/18 retrieved from www.srjis.com Page 4054
- Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), The nature of intelligence (pp. 231-235). Hillsdale, NJ: Erlbaum
- Lederman, N.G., & O'Malley, M. (1990). Students' perceptions of tentativeness in science: Development, use, and sources of change. Science Education, 74, 225-239.
- Nayak, T.K., & Mohanty, M.M. (2016). Assessment of Meta-cognition in mathematics problem solving: Trends and issues. *Prangnya*, 6(1 & 2), 5-20.
- Nishida, H. (1999). Cultural Schema Theory: In W.B. Gudykunst (Ed.), *Theorizing About Intercultural Communication*, (pp. 401-418). Thousand Oaks, CA: Sage Publications, Inc
- NCERT (2005) National Curriculum Framework. National Council of Educational Research and Training (NCERT), New Delhi
- Schoenfeld, A.H. (1992). Learning to think arithmetically; problem solving, metacognitive, and sense making in arithmetic's. In D.A. Grouws (Ed.), Handbook of research on arithmetic teaching and learning: A project of the National council of Teachers in Arithmetic (pp. 334-370). New York; Simon & Schuster.