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Assessing Impact of Metacognitive Interventions on Academic Achievement of Higher Secondary School Students

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Abstract
The present study investigates the impact of metacognitive interventions on the academic achievement of higher secondary school students in education. The study used a quasi-experimental design where two different Govt. aided higher secondary schools were selected randomly from the Sambalpur locality. The treatment was assigned randomly, where the students of the experimental group were taught using metacognitive interventions i.e., thinking aloud, brainstorming, concept mapping, and self-assessment, and the students of the control group were taught by following the traditional approach. Achievement test in Education subjects was constructed and used. The total number of 79 samples were taken into account (experimental group = 41, control group = 38) for experimentation. The collected data was analyzed with the help of Analysis of Covariance. The results of the study revealed a significant positive impact of metacognitive interventions on the academic achievement of higher secondary school students in Education with reference to contributors of educators, learning and motivation, and current issues in education. There was no significant interaction effect among strategy of teaching, gender, and caste on academic achievement of students in Education. The present study has implications for policymakers, principals, teachers, parents, and students.

Keywords: Academic achievement; Education; Higher secondary school students; Metacognition; Metacognitive interventions;

1. INTRODUCTION

Metacognition is a buzz word in educational psychology, which refers to a higher order thinking involving strong control over cognitive activities of individuals. In the process of knowledge construction, emphasis is given on the students' independent learning, cognition, creative thinking, intelligence, attitude and capabilities where students generate new and innovative ideas and understanding in collaboration with their peers. On the other hand, active social classroom also helps students where they involve in peer-interaction and develop understanding about subject matter in a

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socially desirable way. In constructivist approach of learning the idea of self-regulated learning is deeply rooted in true sense; as in self-regulated learning the students plan, monitor and evaluate their understanding in cyclical process. In this cyclical process, first of all, the students analyse learning task, formulates objectives and plan innovative strategies. Secondly, the students implement the pre-determined plans and monitor their performance through self-observation and finally, the students assess their performance and reflect on their understanding (Zimmerman, 2002). The self-regulated students become able to plan and monitor their efforts in practical situation, to create suitable learning environment and also direct their mental process to fulfil their goals, this process is called as metacognition. Metacognition involves the awareness of individuals' knowledge of what they know and don't know. 'The knowledge about cognition and monitoring/regulation of cognition are the two elements of metacognition' (Flavell, 1979; Cross & Paris, 1988; Brown, 1987; Paris & Winograd, 1990; Schraw & Moshman, 1995; Schraw et al., 2006). The model of metacognition given by Brown was also widely cited and acceptable as the model of Flavell, but both these two models were different, although related. Brown (1987) proposed two major components of metacognition i.e., 'knowledge of cognition' and 'regulation of cognition'. Brown defined metacognition in two parts, firstly it is the knowledge of persons about their own knowledge, secondly, it is the regulation or control of person's own thinking process. The knowledge of cognition was defined by Brown as the sum of activities performed by individuals with conscious reflection on their own cognition (Brown, 1987). It includes the sum total of knowledge and information that the human beings have about their own cognitive process and activities. This component is characterised by Brown as stable, fallible and age developmental.

Metacognition in students' learning is a strong predictor of the learning outcomes among students (Kruger & Dunning, 1999; Dunning, et al., 2003; Young & Fry, 2008; Kallay, 2012; Sahin & Kendir, 2013; Oyuga et al., 2016; Dogan & Tuncer, 2017). In educational setting the academic achievement of students is commonly measured through examination or continuation and comprehensive evaluation. In measuring the academic achievement of students their procedural knowledge i.e., skills, and declarative knowledge i.e., understanding of facts are assessed generally (Ward, Stoker, & Ward, 1996). It is measured through standardized tests, performance assessment, and portfolio assessment (Santrock, 2006). Researchers have identified that so many factors affect the academic performance of the students (Aremu & Sokan, 2003, Vandamme, et al., 2005; Cheesman, et al., 2006; Hajazi & Naqvi, 2006). In school premises much emphasis is put on the promotion of academic achievement of students considering it as a major goal (Adeyemo, 2001), and this very thing becomes the expectation of parents (Osiki, 2001). Out of different factors, gender is considered as one of the most significant factors, as differences in motivational skills, functioning skills, cognitive processes, intellectual abilities, perceptions and interests among boys and girls are found (Lightbody, et al., 1996; Hanson, 2000). Along with this, the family incomes and socio-economic status of the students also affect their academic achievement (Simmons, et al., 2005). The psychological, cognitive and demographic factors concerned to students' learning also influence their performance in school (Mckenzi & Schweitzer, 2001). Inside the classroom situation also a number of factors influence the students' performance such as students' attendance in attending class, time devoted by students for study, educational status of parents and their annual income (Hajazi & Naqvi, 2006; Silvia, 2006). Apart from these, intelligence level of students, their home environment, grade retentions, functional literacy and interest also correlate with their academic achievement (Smith et al., 2002).

Metacognition of students includes two important aspects of their mental functioning, i.e., knowledge about their own cognition and regulating their cognition, and these two components help them to understand their subject matter properly, as a result of which they get academic success. Each and very students have their own achievement goals which are reflected towards their learning a new task, and these achievement goals of students are based on their mastery performance goals (Dweck & Leggett, 1988). The study of Elliot and Dweck (1988) stated that the students' mastery goals are primarily related to their self-efficacy beliefs and metacognition, so, people with mastery goals always prefer risky operations in complex situations. The research studies of achievement goals suggest that it helps students for adopting different goals together for getting mastery and perform better during the assessment (Nolen, 1988; Pintrich & Garcia, 1991; Meece & Holt, 1993). The use of metacognitive strategies in classroom context work as a predicator of the academic performance of students as it includes the students' knowledge about their own cognitive functioning and regulating the same, so the

students having better metacognitive skills get ample opportunity to get academic success (Kruger & Dunning, 1999; Dunning, et al., 2003). Metacognition among students enable them to gather new learning experience more and more along with their previous learning (Everson & Tobias, 1998). The research studies on metacognition and the students' learning objectives reveals that these two concepts are positively associated to each other (Dweck & Legett, 1988; Ames & Archer, 1988), while some other studies reveal weak positive association (Butler, 1993), while no relationship is also reflected in a study (Ford, et al., 1998). In a study negative relationship is also found between metacognition and performance goals (Wolters, 1998). The study of Coutinho (2007) reveals that metacognition of the students acts as a mediation between the students' academic achievement and performance and mastery goals.

The students' academic achievement is highly affected by their home environment as the home environment is endowed with the psychological, emotional, social and economic perspectives. As inside the home environment the parents' play vital role in students' learning in terms of socialization, so their academic performance is highly influenced (Ajila & Olutola, 2007). Along with the home environment, the parental involvement in students' learning also affects their academic performances (Taylor et al., 1995). The better study habits of the students also help them to enhance their academic performance, along with this the learning approaches and behaviour of the students (Soares et al., 2009). The students use different learning styles in educational setting, which also influences the academic achievement of students, but this area is less investigated (Martin et al., 2008). Among different learning skills, concept mapping also influences students' performance, where the students get idea about relating one main concept with other sub-concepts (Sleight & Mavis, 2006). The interaction of students with their teachers and their involvement in study greatly influences their academic performances, higher the involvement results in higher academic performances (Terenzini, et al., 1982; Pascarella, 1980, 1985; Astin, 1984). The research study of Dev (2016) revealed that girls are superior to boys in terms of academic achievement which is positively related to their general mental ability and home environment. The results of experimental studies reveal that the students taught with metacognitive strategies perform better than the students taught with traditional approaches, so it may be concluded that the use of metacognitive interventions in has effectiveness in terms of students' academic success (Magaji & Umar, 2016; Prabawanto, 2016; Dike et al. 2017; Lata & Bala, 2018; Miller & William, 2019). The related literatures also revealed that metacognitive interventions had a positive impact on the academic achievement of the learners (Landine & Stewart, 1998; Isaacson & Fujita, 2006; Ozosoy & Atman, 2009; Sahin & Kendir, 2013; Toit & Wilkinson, 2013; Maxwell & Grenier, 2014; Alshammri, 2015; Gonzalez, 2016; Laistner, 2016; Magaji & Umar, 2016). It was also found that the metacognitive scaffolding had no effect on group performance or the domain of knowledge (Molenaar et al., 2010). Based on the research gaps in terms of knowledge gap, inconsistence of findindings, sample gap, subject gap etc., in this present study, the effectiveness of metacognitive interventions in terms of students' academic achievement in education was following a quasi-experimental methodology. 'Education' is a school subject in Odisha state, India at higher secondary level. And so far as the available literature is concerned, a smaller number of studies were found in 'Education' subject at higher secondary school level. Along with these, different widely metacognitive interventions were found in different forms, but in the present study four important interventions were combined in the form of lesson plans and used i.e., thinking aloud, brainstorming, concept mapping and self-assessment. The effectiveness of these metacognitive interventions was examined through experimentation.

This study was conducted to test the hypothesis 1) there is significant positive impact of metacognitive interventions on academic achievement of higher secondary school students in education, and 2) there is significant interaction effect among strategy of teaching, gender and caste on academic achievement of higher secondary school students.

2. METHODS

In the present study, two separate groups were formed viz; experimental group and control group, where the students of the experimental group were taught by using metacognitive interventions and the students of the control group were taught through traditional approach, finally the cause-effect relationship

between the two groups was studied quantitatively on the basis of pre-test and post-test points. In the present study, quasi-experimental design was followed, as two existing groups were pretested, administered a treatment, and posttested. Out of different quasi-experimental design suggested by Campbell and Stanley (1963), non-equivalent control group design was used in the present study. In order to investigate the interaction effect in the present study 2*2*3 factorial design was also used to examine interaction effect among strategy of teaching, gender and caste on academic achievement of higher secondary school students. There were two levels of strategy of teaching i.e., metacognitive approach, and traditional approach, two levels of gender i.e., boys and girls, three levels of caste i.e., general, scheduled caste and scheduled tribe. The population of the study was all students studying Class-XII, Arts stream in Govt.-aided higher secondary schools or junior colleges of Sambalpur having Education as their one of the elective subjects affiliated to Council of Higher Secondary Education, Odisha of 2020-2021 academic year.

As the present study was quasi-experimental in nature, Sambalpur district was selected purposively based on the feasibility of experimentation. Two Government Aided higher secondary schools/junior colleges affiliated to Council of Higher Secondary Education (CHSE) and nearer to Sambalpur city were selected randomly for through lottery method. As a result, Hirakud Higher Secondary School and Burla N.A.C. Higher Secondary School of Sambalpur district, Odisha were taken for experimentation in the present study. All the students of the selected schools studying in standard-XII Arts and having 'Education' as one of their elective subjects were the sample for the present study. Out of these two, one school was randomly assigned as experimental group and other as control group by tossing a coin method. As a result, Hirakud Higher Secondary School was the experimental group (N=41), and Burla N.A.C. Higher Secondary School was the control group (N=38) in the present study. Both the groups were pre-tested and post-tested.

The following instruments were used in the present study to collect primary data.

a) 5E Lesson Plans with Metacognitive Interventions: Lesson plans by following 5E approach were developed for teaching the students of experimental group as the development of students' metacognitive perspective is an important element in constructivist approach of teaching in classroom (Paris & Winograd, 1990; Baird, Fensham, Gunstone & White, 1991; Gunstone, 1994). The researchers developed 40 5E lesson plans covering Unit-I (Contributors of Education), Unit-II (Learning and Motivation), Unit- III (Current Issues in Education) of Education subject as per the revised syllabus of CHSE for the higher secondary school students. Metacognitive interventions like thinking aloud, brainstorming, concept mapping, and self-assessment were used in the five major steps of 5E lesson plan as per suitability.

b) Lesson Plan in Herbartian Approach: For teaching the students of control group, lesson plans were developed following Herbartian approach. The researchers developed 40 Herbartian lesson plans covering Unit-I (Contributors of Education), Unit-II (Learning and Motivation), Unit- III (Current Issues in Education) of Education subject as per the revised syllabus of CHSE for the higher secondary school students.

c) Achievement Test in Education: Achievement test in Education for higher secondary school students was constructed and validated both in Odia and English. The researchers followed standard procedures to construct the achievement test i.e., planning, preparation, tryout and evaluation. The preliminary form of achievement test consisted of 75 MCQ items in total covering Unit-I (Contributors of Education), Unit-II (Learning and Motivation), Unit- III (Current Issues in Education) of Education subject as per the revised syllabus of CHSE for the higher secondary school students of Odisha. Item analysis was done after piloting, where 25 test items were rejected based on item difficulty and item discrimination index. The KR-20 reliability of the achievement test was found to be 0.914 and split-half reliability was found to be 0.965, which revealed high internal consistency. Face validity and content validity of the test was also determined through expert's suggestions.

d) Group Test of General Mental Ability: Intelligence was taken as a covariate in the present study. For this purpose, The Group Test of General Mental Ability developed and validated by Dr S. S. Jalota was used. It was implemented once during the experimentation (Sansanwal, 2020). The test consisted of 100 items in total. In the test, some sorts of problems were given for the students related to reasoning, synonyms, antonyms, and odd point out etc.

e) Stress Scale: Stress was also taken as a covariate in the present study. For this purpose, stress scale developed and validated by Dr Vijaya Lakshmi and Dr Shruti Narain was used (NPC, 2020). It was implemented once during the experimentation (Sansanwal, 2020). The stress scale consisted of 40 items having four important components i.e., pressure (14 items), physical stress (04 items), anxiety (13 items), and frustration (09 items).

3. RESULTS AND DISCUSSION

A. Analysis of Pre-Test Scores

The achievement test in education was constructed based on three units of Education syllabus i.e., contributions of educators (Unit-I), learning and motivation (Unit-II), and current issues in education (Unit-III). So, the achievement score of students of both experimental and control group along with these three units were compared with the help of t-test using SPSS-23, and the results are given below.

Table 1. Group wise N, Mean, SD, df, and t-value of pre-test scores of the students

Unit	Groups	N	Mean	SD	df	t-value	Sig.	Remark
Pre-Achievement in Education	Experimental	41	19.66	4.40	77	1.75	.085	ns
	Control	38	17.74	5.37				
Pre-Achievement in Unit-I	Experimental	41	8.05	2.30	77	1.31	.195	ns
	Control	38	7.34	2.51				
Pre-Achievement in Unit-II	Experimental	41	4.80	1.83	77	1.80	.075	ns
	Control	38	4.05	1.87				
Pre-Achievement in Unit-III	Experimental	41	6.80	2.37	77	0.89	.378	ns
	Control	38	6.32	2.54	77			
Stress	Experimental	41	18.71	5.10	77	1.45	.152	ns
	Control	38	17.24	3.78				
General mental ability	Experimental	41	58.22	7.54	77	5.52**	.000	P<0.01
	Control	38	49.21	6.93				

ns: not significant
**significant at 0.01 level

From the table, it is evident that the t-values of pre-academic achievement in education, pre-academic achievement scores in unit-I, Unit-II, and Unit-III were 1.75, 1.31, 1.80, and 0.89 respectively, which were not significant at 0.05 with df = 77. It shows that the mean scores of pre-academic achievements in education, pre-academic achievement in unit-I, Unit-II, and Unit-III of higher secondary school students of experimental and control group did not differ significantly. Although significant difference was not found in pre-test scores of academic achievements of students, still it was considered as a covariate during the analysis of posttest data as a measure of controlling extraneous variable. The table also revealed that the t-value of stress was 1.45, which was not significant at 0.05 with df = 77. It shows that the mean scores of stresses of higher secondary school students of experimental and control group did not differ significantly. Although significant difference was not found in stress of students, still it was considered as a covariate during the analysis of posttest data as a measure of controlling extraneous variable. It is also evident that the t-value of general mental ability was 5.52, which was significant at 0.01 with df = 77. Further, the mean score of general mental ability of students of experimental group was 58.22, which was significantly higher than the mean scores of students of control group whose means scores was 49.21. It may therefore, be said that the higher secondary school students of experimental group were having significantly higher general mental ability score than the students of control group. As significant difference was found in general mental ability scores of students, so, it was considered as a covariate during the analysis of posttest data.

B. Analysis of Post-Test Data

Impact of Metacognitive Interventions on Academic Achievement Scores of Students in Education

One of the objectives of the study was to compare the adjusted mean scores of academic achievements of experimental and control group students by considering their pre-academic achievement, stress, and general mental ability as covariates. The data were analysed with the help of One-Way ANCOVA using SPSS-23, and the outputs are given below.

Table 3. Test of Between-Subjects effects on post-academic achievements of students

Sources	Sum of Squares	Df	Mean square	F	Sig.
General mental ability	.040	1	.040	.001	.973
Stress	18.78	1	18.78	.522	.472
Pre-Academic achievement	101.56	1	101.56	2.83	.097
Strategy of teaching	712.43	1	712.43	19.82	.000
Error	2659.98	74	35.95		
Total	40184.00	79			
Corrected Total	4030.84	78			

From the table, it can be seen that the adjusted F-Value is 19.82, which is significant at 0.01 level with df = 1/74. It indicates that the adjusted mean scores of post-academic achievement of higher secondary school students of experimental and control group differ significantly, when their pre-academic achievement, general mental ability, and stress were taken as covariates. Thus, the research hypothesis that there is positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education is accepted.

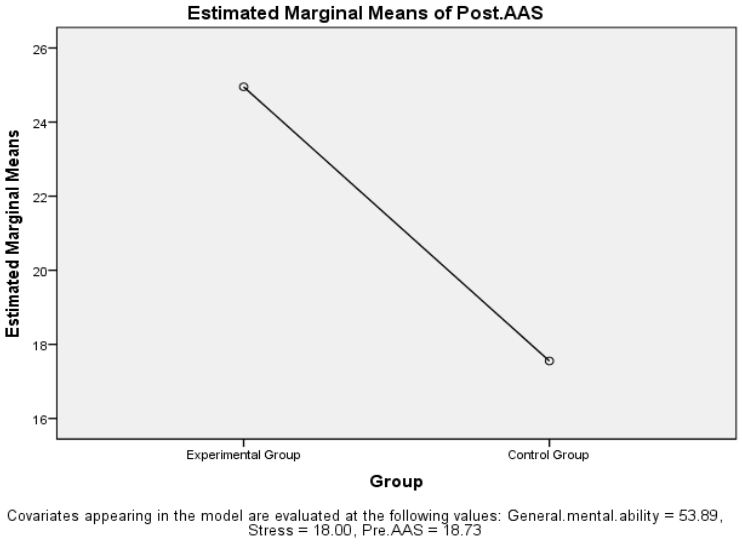

Figure 1. Estimated marginal means of post-academic achievement score of students

From the Figure 1, it is evident that the adjusted mean score of academic achievement of students of experimental group is 24.95, which is significantly higher than that of students of control group, whose adjusted mean score of academic achievement is 17.55. It may be said that metacognitive intervention in teaching was found to be significantly superior to traditional method of teaching in terms of academic achievement of students in Education when groups were matched in respected of pre-academic achievement, general mental ability and stress of higher secondary school students. Therefore, it was concluded that there was significant positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education.

Impact of Metacognitive Interventions on Academic Achievement of Students in Education with reference to Contribution of Educators (Unit-1)

The achievement test in education was constructed covering three units i.e., Contribution of educators (Unit-I), Learning and motivation (Unit-II), and Current issues in education (Unit-III). So, the impact of metacognitive interventions on these three units were examined separately.

Table 4. Test of Between-Subjects effects on post-academic achievements of students in Education with reference to contribution of educators

Sources	**Sum of Squares**	**df**	**Mean square**	**F**	**Sig.**
General mental ability	.004	1	.004	.001	.980
Stress	1.37	1	1.37	.209	.649
Pre-achievement in contribution of educators	54.69	1	54.69	8.36	.005
Strategy of teaching	190.18	1	190.18	29.08	.000
Error	484.01	74	6.54		
Total	6968.00	79			
Corrected Total	871.34	78			

From the above table, it can be seen that the adjusted F-Value is 29.08, which is significant at 0.01 level with df = 1/74. It indicates that the adjusted mean scores of post-academic achievement scores of students in Education with reference to contribution of educators (Unit-I) of higher secondary school students of experimental and control group differ significantly, when their pre-academic achievement scores of students in Education with reference to contribution of educators (Unit-I), general mental ability, and stress were taken as covariates. Thus, the research hypothesis that there is positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education with reference to Unit-I is accepted. Further, the adjusted mean score of academic achievement scores of students in Education with reference to contribution of educators (Unit-I) of students of experimental group is 10.61, which is significantly higher than that of students of control group, whose adjusted mean score is 6.82. It may, be said that metacognitive intervention in teaching was found to be significantly superior to traditional method of teaching in terms of academic achievement scores of students in Education with reference to contribution of educators (Unit-I) of students, when groups were matched in respected of pre-academic achievement in Unit-I, general mental ability and stress of higher secondary school students. Therefore, it was concluded that there was significant positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education with reference to Unit-I i.e., Contributors of educators.

Impact of Metacognitive Interventions on Academic Achievement of Students in Education with reference to Learning and Motivation (Unit-2)

The impact of metacognitive interventions on academic achievement of students in education with reference to learning and motivation was examined.

Table 5. Test of Between-Subjects effects on post-academic achievements of students in education with reference to learning and motivation

Sources	**Sum of Squares**	**df**	**Mean square**	**F**	**Sig.**
General mental ability	1.58	1	1.58	.477	.492
Stress	.109	1	.109	.033	.856
Pre-Achievement in learning and motivation	2.31	1	2.31	.699	.406
Strategy of teaching	21.06	1	21.06	6.38	.014
Error	244.19	74	3.30		
Total	2535.00	79			
Corrected Total	270.08	78			

From the table, it can be seen that the adjusted F-Value is 6.38, which is significant at 0.05 level with df = 1/74. It indicates that the adjusted mean scores of post-academic achievement scores of students in Education with reference to learning and motivation (Unit-II) of higher secondary school students of experimental and control group differ significantly, when their pre-academic achievement scores of students in Education with reference to learning and motivation (Unit-II), general mental ability, and stress were taken as covariates. Thus, the research hypothesis that there is positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education with reference to Unit-II is accepted. Further, the adjusted mean score of academic achievement scores of students in Education with reference to learning and motivation (Unit-II) of students of experimental group is 5.97, which is significantly higher than that of students of control group, whose adjusted mean score is 4.69. It may be said that metacognitive intervention in teaching was found to be significantly superior to traditional method of teaching in terms of academic achievement scores of students in Education with reference to learning and motivation (Unit-II) of students, when groups were matched in respected of pre-academic achievement in Unit-II, general mental ability and stress of higher secondary school students. Therefore, it was concluded that there was significant positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education with reference to Unit-II i.e., Learning and motivation.

Impact of Metacognitive Interventions on Academic Achievement of Students in Education with reference to Current Issues in Education (Unit-3)

The impact of metacognitive interventions on academic achievement of students with reference to current issues in education (Unit-III) was examined.

Table 6. Test of Between-Subjects effects on post-academic achievements of students with reference to current issues in education

Sources	**Sum of Squares**	**df**	**Mean square**	**F**	**Sig.**
General mental ability	1.91	1	1.91	.221	.639
Stress	8.29	1	8.29	.961	.330
Pre-achievement in current issues in education	15.21	1	15.21	1.76	.188
Strategy of teaching	86.61	1	86.61	10.04	.002
Error	638.16	74	8.62		
Total	5047.00	79			
Corrected Total	832.71	78			

From the above tables, it can be seen that the adjusted F-Value is 10.04, which is significant at 0.01 level with df = 1/74. It indicates that the adjusted mean scores of post-academic achievement scores of students in Education with reference to current issues in education (Unit-III) of higher secondary school students of experimental and control group differ significantly, when their pre-academic achievement scores of students in Education with reference to current issues in education (Unit-III), general mental ability, and stress were taken as covariates. Thus, the research hypothesis that there is positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education with reference to Unit-III is accepted. Further, the adjusted mean score of academic achievement scores of students in Education with reference to current issues in education (Unit-III) of students of experimental group is 8.54, which is significantly higher than that of students of control group, whose adjusted mean score is 5.98. It may be said that metacognitive intervention in teaching was found to be significantly superior to traditional method of teaching in terms of academic achievement scores of students in Education with reference to current issues in education (Unit-III) of students, when groups were matched in respected of pre-academic achievement in Unit-III, general mental ability and stress of higher secondary school students. Therefore, it was concluded that there was significant positive impact of metacognitive interventions on academic achievement of higher secondary school students in Education with reference to Unit-III i.e., Current issues in education.

Interaction Effect of Teaching Strategy, Gender, and Caste on Academic Achievement of Students in Education

One of the objectives of the present research was to study the interaction effect of teaching strategy, gender, and caste on academic achievement of students by considering their pre-academic achievement, general mental ability, and stress as covariates Thus, the data were analysed with the help of Three Way ANCOVA or 2*2*3 Factorial Design ANCOVA using SPSS-23. The outputs are given below.

Table 7. Summary of Three Way ANCOVA of post-academic achievement scores of students

Sources of variations	Sum of Squares	Df	Mean Square	F	Remark
Strategy of teaching * Gender (A*B)	41.75	1	41.75	1.29	ns
Strategy of teaching * Caste (A*C)	118.67	2	59.34	1.83	ns
Gender * Caste (B*C)	83.63	2	41.81	1.29	ns
Strategy of teaching * Gender * Caste (A*B*C)	137.34	2	68.67	2.12	ns
Error	2076.87	64	32.45		
Total	40184.00	79			

ns: not significant

The result of Three Way ANCOVA revealed that that the adjusted F-Value for interaction among Strategy of teaching * Gender , Strategy of teaching * Caste, Gender * Caste and Strategy of teaching * Gender * Caste were found to be 1.29, 1.83, 1.29 and 2.12 respectively which were not significant at 0.05 level with 1/64, 2/64, 2/64 and 2/64 df respectively. The results of the three-way ANCOVA made it clear that there is no significant interaction effect among strategy of teaching, gender and caste on academic achievement of higher secondary school students. So, the alternative hypothesis was rejected and null hypothesis was accepted in this situation.

4. DISCUSSION OF RESULTS

So far as the results of present study related to the impact of metacognitive interventions on academic achievement of students are concerned, the findings were matched with some of the studies, which reflected that the students taught with metacognitive interventions performed better than the students taught with traditional approach, which revealed that metacognitive interventions in teaching had a positive impact on the academic achievement of students (Burger et al., 2008; Vrugt & Oort, 2008; Ozsoy & Atman, 2009; Alci & Yuksel, 2012; Kallay, 2012; Eluemuno & Obieke, 2013; Sahin & Kendir, 2013; Toit & Wilkinson, 2013; Hadi & Forawi, 2014; Oz, 2014; Abdellah, 2015; Alshammari, 2015; Dogra, 2016; Laister, 2016; Magaji & Umer, 2016; Prabawanto, 2016; Dike et al., 2017; Dogan & Tuncer, 2017; Jain et al., 2017; Sonowal & Kalita, 2017b; Lata & Bala, 2018; Miller & William, 2019; Oqleh et al., 2019). All these studies revealed metacognitive interventions as promoter of student's metacognition. On the other hand, the findings of the present study were contrasted to the findings of some research studies, which revealed no significant difference between the academic achievement of students taught with metacognitive interventions and traditional approach, which ultimately revealed no impact of metacognitive interventions on academic achievement of students (Molenaar et al., 2010; Goli et al., 2016; Soicher & Gurung, 2016; Sonowal & Kalita, 2017a). There may be possibility of lack of controlling of extraneous variables in the above cited studies. However, in the present study academic achievement of students was measured in Education subject, which is offered at higher secondary level in Odisha, and in this regard less studies were found, so it may be further investigated.

5. CONCLUSION

The present study has implications for students, teachers, principals, curriculum developers and policy makers. Metacognitive way of learning should be encouraged among students, instead of memorization, much more emphasis should be given on their understanding for the construction of new knowledge

with the help of their metacognition, thinking aloud should be encouraged among them. Teachers should be encouraged to teach the students by using metacognitive interventions in classroom rather than traditional teaching. They should be encouraged to ask metacognitive and reflective questions to the students. They should use models of metacognition in classroom emphasizing higher order skills among students in terms of knowledge of cognition and regulation of cognition. Principals should create school environment by giving utmost importance to metacognition of students rather than marks. They should encourage teachers to teach some chapters of Education subject using metacognitive interventions. Parents of students should give much more importance to student's metacognition rather than memorization. They should encourage their children to use metacognitive way of learning than memorizing. Curriculum developers should include such activities in curriculum which could develop student's metacognitive knowledge. They should include content which is based on student's metacognition. The present study was delimited to the higher secondary school students (+2 2nd year Arts) of Govt.-Aided Hirakud Higher Secondary School and Burla N.A.C. Higher Secondary School affiliated to CHSE, Odisha of 2020-21 session. It was delimited to the use of four metacognitive interventions i.e., thinking-aloud, brainstorming, concept mapping and self-assessment in 5E lesson plans in only one subject area i.e., 'Education' in the selected higher secondary schools of Sambalpur. The present study was delimited to academic achievement of the higher secondary students of class-XII having "Education" subject belonging to Govt.-Aided Hirakud Higher Secondary School and Burla N.A.C. Higher Secondary School affiliated to CHSE, Odisha. It was also delimited to stress and general mental ability of higher secondary students of class-XII, which were used as covariates. From the present study it could be concluded that metacognitive interventions i.e., thinking aloud, brainstorming, concept mapping, and self-assessment have positive impact on student's academic achievement in Education, as the students taught with metacognitive interventions scored better the students taught with traditional approach in terms of academic achievement in Education. The study also proves that metacognitive interventions and constructivist approach of teaching are closely related to each other, as metacognitive interventions were used in the form of 5E model lesson plans.

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No conflict of interest has been reported in the study.

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