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EFFECTIVENESS OF PASS BASED REMEDIAL PROGRAMS FOR CHILDREN WITH READING, SPELLING AND MATHEMATICAL DEFICITS

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The current study examined the effectiveness of remedial programs based on PASS theory in reading, spelling and mathematical deficits and among PASS processes of children with reading and mathematical disabilities. Total 280 students with reading (N= 140) and mathematical disabilities (N= 140) aged 9-12 years were tested on Wide Range Achievement Test - 4 (WRAT 4) and Cognitive Assessment System (CAS) in pre and post test conditions. The students with reading and mathematical disabilities were diagnosed as scoring below sixteenth percentile on specific WRAT - 4 and CAS subtests. The experimental group got PREP remedial intervention for reading and planning facilitation for mathematical disability for four months and was retested on an equivalent form of WRAT 4 and CAS. Results suggested that control group did not differ in pre and post test situations in any deficit area and PASS processes. Conversely, the experimental group presented significant improvement in reading, spelling and simultaneous and successive synthesis ($p < .001$) in reading disability and on math computation and planning and simultaneous processes ($p < .001$) in mathematical disability group. The findings provide an evidence for the validity of PASS based remedial programs in improving upon these areas of deficits among reading and mathematical disabled children.

INTRODUCTION

The key feature of a learning disability is a person's low achievement in reading, spelling, and/or mathematics despite having average to above average intelligence, proper instruction, fair school attendance, and favorable environmental conditions. Sizeable number of researches has been undertaken over the past thirty years in an effort to understand the causes of learning disabilities.

The cognitive processing approach proposed by Das *et al.* (Das, Naglieri & Kirby, 1994) combines the elements from cognitive psychology to neuropsychological theory in order to understand and mediate learning disability. Basically, the model proposes four distinct, though related, processes involved in human intelligence - the Planning, Attention, Simultaneous, and Successive processing (PASS). On the basis of this model, Das and Naglieri (1997) developed the Cognitive Assessment System (CAS), and also the techniques of intervention for reading and mathematical disabilities. The present study aims to investigate the effectiveness of such intervention programs, based on PASS Model, on students with reading and mathematical disabilities.

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PASS model of cognitive processing was initially given by Das, Kirby and Jarman in 1975 and Das, Naglieri and Kirby (1994) and Das, Kar and Parrila (1996) expanded the model later on.

The PASS model opposes the 'g' theory of intelligence and suggests that years of neuropsychological and neuro-imagining studies favors the notion that brain is a system of separate, but interdependent cognitive processes. Supported by Luria's (1966) influential work on cognitive processes and decades of neurological research, the PASS theory of intelligence proposes that intelligence is a product of four interdependent and interrelated cognitive processes. PASS theory further recommends that after receiving information from external and internal sources, these cognitive processes get activated to analyze the information within the framework of an individual's knowledge base. The information is also processed multiple ways in the context of knowledge base including semantic and episodic memory and implicit or procedural memories (Das, 2002).

Das *et al.* (1994) suggested that the planning processing is responsible for solving problems, making decisions and performing tasks. Further, it involves describing goals, estimating consequences and applying feedback on them. Planning is basically related to the cerebrum part of the brain and also connects to other cognitive processing including attention, simultaneous and successive processing. Planning processing is very important for mathematical calculations. Attention-Arousal is responsible to attend specific stimuli, while ignoring others. The children with Attention Deficit and Hyperactivity Disorders (ADHD) show deficits in this processing. The arousal part is mainly associated to brain stem while higher attention processes are considered to be related to the frontal lobes of the brain. Attention processing is important in performing every cognitive task. Simultaneous processing is based on the Gestalt principle where things are perceived as a whole. It is the ability to assemble different stimuli, perceive and interpret them as a whole. Simultaneous processing plays a crucial role in language comprehension (Naglieri & Das, 1997). The ability to join stimuli in a sequence is related to successive processing. This processing is required to read and write words in a sequence. Successive processing is considered to be associated to the frontal-temporal lobe areas of the brain (Das, 2002).

A theoretical framework has been developed by Naglieri and Das (1997) in the form of Cognitive Assessment System (CAS) to measure the four PASS cognitive processes. The test comprehensively provides information about the intellectual functioning and further depicting cognitive weaknesses and strengths of an individual in the four PASS processes. CAS focuses more on tapping cognitive processes and avoids the term abilities. Apart from providing a full scale Intelligence Quotient score and four subscales scores, CAS is also very useful for diagnosing learning disabilities and Attention Deficit and Hyperactivity Disorder (ADHD). CAS can be used on children ranging 5 to 17 years of age.

The PASS model of cognitive processes has been proven very useful for assessment and intervention for learning disabilities. For example, on one side the model provides a robust assessment system in the form of CAS and other side it forms a theoretical base for two intervention programs as PASS Reading Enhancement Program (PREP) and Planning Facilitation Method for reading and mathematical disabilities, respectively. PREP is a remediation program that intends to improve the key cognitive processing underlying reading (Das, 1999). PREP is a product of long researches by Krywaniuk and Das, Kaufman and Kaufman, and Brailsford, Snart and Das in 1976, 1979 and 1984, respectively. These researchers confirmed that the simultaneous and successive processes can be applied by students in an efficient manner which further improves "their performance on that process and some transfer to specific reading tasks also occurred" (Ashman & Conway, 1997, page 169). The current PREP version is focused on improving simultaneous and successive processes and includes four tasks to improve simultaneous and four to improve successive processing. The tasks are non-academic in nature and do not ask a student real or spell, but still improves his reading and spelling. Das, Mishra and Pool (1995) and Carlson and Das (1997) performed studies of the usefulness of PREP for students with reading decoding deficits. Carlson and Das (1997) tested control and experimental group pre-post intervention using Word Attack and Word Identification and found undoubted efficacy of the program. Similarly, Das *et al.* (1995) observed that PREP groups outperformed the control group. Das, Mok, and Mishra (1993) and later Pagedar (2008) also concluded that phonological awareness trainings have useful effects on reading and spelling. Das, Parrila and Papadopoulos (2000) suggested that PREP has been found effective in supporting readers with both average and severe reading disabilities. Some recent studies by Mahapatra, Das *et al.* (2010) and Mohanty (2007) also suggest that PREP works equally efficiently in case of children who are the native speakers of English language and those who use English as their second language (ESL children). The current version of PREP includes total eight tasks; four tasks mend to improve successive processing while other four tasks are considered to improve underlying simultaneous processing.

The planning facilitation method described by Naglieri (1999) is an intervention that may be administered after a classroom activity, such as completion of an arithmetic worksheet. Once the students have worked on the problems, the teacher facilitates a discussion intended to encourage participants to take account of different ways to be more successful in completion of the worksheets. In the phase of intervention, the students are given a 10 minute time for completing a maths worksheet, following a 10 minute period is kept for facilitating planning and again a 10 minute time for maths. Studies show that Planning facilitation has significantly improved multiplication problems for those students who have low planning scores, but not for those having high scores in planning. In response to planning facilitation

method, students learn problem solving approaches, selecting strategies and ideas from the class discussion that are perceived to be useful. We can say that planning facilitation method is based on the assumption that planning processes are not directly taught but facilitated indirectly so that the students find out the value of plan and strategy without being specifically directed. Naglieri and Gottling (1995, 1997) and later Naglieri and Johnson (2000) conducted studies focusing on improving math calculation performance. There studies suggested that planning facilitation is highly useful for improving multiplication tasks for those having low scores on planning but not on high scorers on planning. These studies also confirm that students are benefitted differently, on the basis of their cognitive processes, from the same intervention program. Thus, it is vital to assess the cognitive strengths and weaknesses of a child before selecting an intervention program. Kroesbergen *et al.* (2003) investigated the relationships between PASS processes and mathematical learning difficulties (MLD). The results suggest that these students had a planning or successive processing weakness. More recently, Cai, *et al.* (2010) studied the basic working process of learning in maths from Grade 3 to 8 among Chinese students through PASS, and suggested the considerable role of simultaneous processing in anticipating MLD. Later, Iseman and Naglieri (2011) also suggested usefulness of planning in computing math worksheets.

A number of recent studies have shown significant effect of remedial programmes based on PASS model in the improvement of children with learning disabilities. Current researches with the PASS model suggests that poor individual word reading is most strongly related to successive processing, while mathematical problems are most often associated with planning processing among children with learning disabilities. While these conclusions have generally been supported by research the current operationalization of the PASS model, or the Cognitive Assessment System (CAS), has never been tested for various forms of validity on Indian population. To understand more about reading and mathematical disabilities among Indian children, what is needed is some way to conceptualize and assess their cognitive skills with little interference from the cultural biases inherent in many IQ tests. The CAS, which is based on the PASS model, appears to suit this purpose.

The primary relevance of this the research is that it has the opportunity to assist the participants in their cognitive functioning and their reading, spelling and mathematical skills. There has been a paucity of research utilizing the PREP and Planning Facilitation Method with this particular cultural population. The present study would add considerably to the research on the effectiveness of PREP and Planning Facilitation Method in a cross-cultural setting. This research is not only just describing and examining relationships between cognitive processes and reading and mathematical disabilities, but an opportunity to offer practical help to students who could really benefit from this sort of help.

METHOD

Sample

A total of 280 children with reading (N = 140) and mathematical (N = 140) disabilities in the age range of 9 to 12 years participated in the present study. The reading and mathematical disabilities group were further divided into two groups as experimental (N =70) and control (N =70) groups randomly. The participants were drawn from ten schools of Karnal and Kurukshetra District in Haryana, India. The diagnosis of reading and mathematical disabilities was based on multiple criteria described by Naglieri (1999) where he suggested that for the eligibility of learning disability a cognitive weakness should have accompanied by an achievement test weakness matched to the level of the cognitive weakness assessed by CAS. He further stated that the children having cognitive and an academic weakness can be confirmed qualifying the eligibility for special educational services if other related conditions are also met (particularly that the child's academic needs are not fulfilled by educational environment). Considering this, the children studying in various schools were tested on the standard achievement and PASS cognitive measures.

RESEARCH INSTRUMENTS

Cognitive Assessment System (CAS)

The cognitive processes of PASS were measured by Cognitive Assessment System (CAS), a robust tool to measure brain's cognitive functions. CAS was developed in 1997 by Naglieri and Das. Naglieri (1999) states that, "the single most important goal of the CAS is to encourage an evolutionary step from the traditional Intelligence Quotient (IQ), general ability approach to a theory-based, multidimensional view with constructs built on contemporary research in human cognition". CAS carries four subscales named Planning, Attention, Simultaneous and Successive subscales and further, the four subscales consists three subtests (in Standard Battery) and two subtests (in Basic Battery) for representing the total score of the cognitive functions. The Basic Battery of CAS has been used in the present research. The reliability coefficient for CAS for basic battery is .87 and for standard battery is .96 and. The mean reliability coefficients for the four subscales are for Planning, Attention, Simultaneous Processing, and Successive Processing are 0.88, 0.88, 0.93 and 0.93, respectively.

Wide Range Achievement Test 4 (WRAT 4)

The Wide Range Achievement Test – Fourth Edition (WRAT 4) is tailored to give "a quick, simple, psychometrically sound assessment of academic skills" (Wilkinson & Robertson 2006). The present research utilized the reading subtests of word reading, and spelling and math computation. This test also suits to measure the

weak English readers' reading ability level in Indian schools. Two parallel forms for interchangeable use are available in WRAT- 4. The two forms are also named the Blue Form and the Green Form. The current research uses, both the blue form and green form (Pre test – Green Form and Post Test – Blue Form) for comparable results. Wilkinson & Robertson (2006) had calculated the reliability for the WRAT-4 to make sure the internal consistency and the coefficients which in totality show high levels as ranging from .92 to .98. Further, the tool also shows reasonable levels of internal consistency with reliability coefficients covering a range from .87 to .93 within its subtests.

Procedure

First of all, the subjects were assessed on the four PASS cognitive processes by CAS and then reading and spelling and math computation subtests of WRAT 4. Cognitive processes of PASS processes are Planning, Attention, Simultaneous and Successive; reading and spelling processes are word reading and spelling or writing, whereas math computation includes mathematical processing. About 60 minutes are used to perform CAS while about 45 minutes time was given in administering WRAT-4. As the CAS is an individual test, the basic battery of CAS was performed individually to assess cognitive functions and scores were computed manually. For ensuring good rapport with each participant, the test was performed separately in classroom in the schools and complete efforts were made to control any external disturbance. Few instructions were also translated in Hindi language to make sure that participant completely understand the procedures and tasks to be performed. CAS mostly includes visual exposures, but few successive and simultaneous subtests also include verbal activities.

CAS and WRAT 4 scores were used to identify children with reading, spelling and mathematical deficits through determining cognitive strengths and weaknesses and achievement discrepancies. Then PASS Reading Enhancement Program (PREP) in reading disability and Planning Facilitation method (PFM) in mathematical disability were applied on the experimental group over a period of 4 months and no intervention was given to the control group. There were 16 PREP and 16 PFM sessions were organized for small groups of five children. CAS and WRAT 4 were given pre and post treatment to see the effect of PREP and PFM program. Parallel forms of WRAT 4 (Green and Blue) were used for pre and post treatment.

RESULTS AND DISCUSSION

The results of repeated measures t-test comparison (pre-post test) are presented in Tables 1.1 and 1.2 for reading and mathematical disability groups, respectively. Since degrees of freedom is same in the two analysis, the critical values of 't' required to be significant are also same. Here the (df = 69) 't' ratios of 2.01 and 2.68 are significant at .05 and .01 probability level, respectively.

Table 1.1 summarises the results of descriptive statistics and t-test for pre and post test comparison of control and experimental group for reading disability. In experimental studies a control group is also tested in pre and post-treatment conditions so as to rule out that results may not vary due to something other than the experimental treatment. Here it is clear from the results summarized that the values of t-ratios are smaller than the critical value (i.e., 2.01). The t-ratios for PASS processes and achievement scores range between .132 and 1.765. Therefore, all the t-ratios are non-significant. These results show that simple passage of time or anything else that could happen as a matter of chance has no effect on the scores on Planning, Attention, Simultaneous and Successive processes and reading and spelling tests. We can see that mean scores of these variables are quite similar. Further, during the span of study, regular instructions and teaching in school did not affect these scores.

A perusal of these results also indicates that four of the six t-ratios of difference between pre and post test scores in experimental group are significant. The t-ratios for the dependent variable simultaneous processing equals to 8.11, which is significant at .001 probability level, mean scores of pre and post-test conditions are 94.88 and 99.94, respectively. The post-test condition (M = 99.94) shows clearly higher mean score than pre-test (M = 94.88) indicating thereby facilitative role of PREP in simultaneous processing. Similarly the impact of PREP on successive processing is also significant ($t = 11.47$, $p < .001$). Mean scores show that post test condition had higher level of successive processing (M = 98.20) than that of pre-test (M = 90.91).

TABLE 1.1: MEANS, SDS AND T-RATIOS FOR PRE AND POST TREATMENT CONDITIONS.

Control Group (N = 70)	*Pre Test*		*Post Test*			
Variables	*Mean*	*SD*	*Mean*	*SD*	*t*	*p*
Planning	97.49	9.73	97.91	9.71	.837	.405
Simultaneous	94.97	12.91	94.72	12.57	-.468	.641
Attention	96.91	10.21	97.47	9.88	1.765	.082
Successive	92.12	13.29	92.18	12.86	0.132	.896
Reading	72.11	8.20	72.61	8.18	1.446	.153
Spelling	73.88	7.55	74.51	7.95	1.316	.193
Experimental Group (N = 70)	*Pre Test*		*Post Test*			
Variables	*Mean*	*SD*	*Mean*	*SD.*	*t*	*p*
Planning	96.31	9.85	96.58	9.36	0.859	.393
Simultaneous	94.88	12.03	99.94	9.28	8.111	.001***
Attention	97.57	11.19	97.30	10.33	-0.566	.573
Successive	90.91	11.11	98.20	8.09	11.466	.001***
Reading	73.18	7.26	77.78	7.86	10.036	.001***
Spelling	74.55	6.47	78.54	6.64	6.936	.001***

**Significant at 0.01 level, ***Significant at 0.001 level

Table 1.2 presents the results of pre and post-test comparison of control and experimental group on PASS processes and math achievement. Here it is apparent from the results given in Table 1.2 that the values of t-ratios are smaller than the critical value (i.e., 2.01). The t-ratios for PASS processes and math achievement range between -.368 and 1.361 in the control group. Thus, all the t-ratios are below the critical level of .05 possibility level and are non-significant. These results confirms that any chance effect or simple passage of time has no effect on the scores on Planning, Attention, Simultaneous and Successive processes and math computation scores.

An examination of the experimental group results in table 1.2 indicates that three of the five t-ratios of difference between pre and post test scores are significant. The t-ratios for the dependent variable planning processing equals to 10.23, which is significant at .001 probability level, mean scores of pre and post-test conditions are 91.48 and 97.57, respectively. The post-test condition (M = 97.57) shows evidently higher mean score than pre-test (M = 91.48) indicating thereby facilitative role of Planning Facilitation Method in planning processing. In the same way, the impact of Planning Facilitation Method is also significant on simultaneous processing ($t = 4.54$, $p < .001$). Mean scores show that post test condition had higher level of simultaneous processing (M = 96.34) than that of pre-test (M = 99.18).

TABLE 1.2: THE 'T' VALUES OF MEAN SCORES IN PRE TEST AND POST TEST CONDITIONS FOR PASS PROCESSES AND MATH COMPUTATION FOR CONTROL AND EXPERIMENTAL (PFM) GROUP

Control Group (N = 70)	*Pre Test*		*Post Test*			
Variables	*Mean*	*S.D.*	*Mean*	*S.D.*	*t' test*	*p value*
Planning	92.01	11.12	92.20	9.93	0.428	0.670
Simultaneous	94.98	11.19	94.75	11.23	-0.368	0.714
Attention	98.81	12.76	98.94	11.99	0.273	0.786
Successive	96.30	9.85	96.57	8.92	0.668	0.506
Math Computation	72.78	5.63	73.28	6.12	1.361	0.178
Experimental Group (N = 70)	*Pre Test*		*Post Test*			
Variables	*Mean*	*S.D.*	*Mean*	*S.D.*	*t' test*	*p value*
Planning	91.48	12.64	97.57	9.64	10.229	0.001***
Simultaneous	96.34	12.11	99.18	9.58	4.538	0.001***
Attention	97.32	11.57	97.38	11.32	0.159	0.875
Successive	96.50	10.28	96.55	9.45	0.204	0.839
Math Computation	73.00	6.02	77.11	7.12	8.594	0.001***

**Significant at 0.01 level, ***Significant at 0.001 level

Attention and successive processes have t-ratios as .16 and .20, respectively. Both these values are non-significant even 't' at .05 possibility. The mean comparison score for attention (Pre-test: M = 97.32, Post-test: 97.38) and successive

processes (Pre-test: 96.50, Post-test: 96.55) are almost similar indicating no improvement. This suggests that attention and successive processes are not affected by planning facilitation method among children with mathematical disabilities.

There is significant difference between pre and post-test conditions of math achievement in experimental group. The t-ratio for math achievement equals to 8.59 ($p < .001$). The mean scores for math achievement are 73.00 and 77.11, respectively. Similar to cognitive processing variables, on math achievement also post-test scores are substantially higher than pre-test scores, indicating enhancing effect of Planning Facilitation Method. Therefore, there exists strong support for the validity of Planning Facilitation Method toward remediation of mathematical disabilities.

The findings of the study, in general, provide empirical support to the validity of PREP and planning facilitation in mediating reading and mathematical difficulty, respectively. There were trends in the data which suggested that PREP have helped to improve skills in reading areas. More specifically, the scores on reading and spelling improved significantly after PREP intervention. These results support the findings of Carlson and Das (1992) that used PREP for four months with children with reading disabilities. These were then compared with children who had had similar reading profiles. Improvement was noted when comparing pre- and post-testing results. Our findings go along with the view that "the treated children who received remediation gained almost one year in word-decoding ability within sixteen weeks of training. This was significantly more than the control group of reading-disabled children who were receiving the regular remedial instruction from their teachers," (Das & Abbott, 1995, p. 178). Results show that this improvement is directly attributable to PREP intervention as there was no significant difference between pre and post-treatment conditions of control group. The improvement in reading was further evident in significant difference between control and experimental group in post-test condition.

The findings of the study are also directly comparable to the research by Das, Mishra and Pool (1995) which included the participation of 51 underachieving students in Grade 4, with children in the experimental group receiving PREP instructions twice weekly for fifteen sessions. The control group simply received regular classroom in-put. In this study also children in the PREP group made gains in word attack skills and in word identification that were significantly greater than those made by children in the control group. Not only this, results from certain follow-up studies (i.e., Das, Mishra and Pool, 1995) are also indicative of consistency between earlier data and present one. The study has also examined the effectiveness of PREP remediation in spelling achievement, the area which is least researched in this respect. Both the lines of mean differences, within groups pre and post-test and between groups post-test have clearly indicated that remediation through PREP had brought about significant change in the level of spelling

achievement. As claimed by Das, Mok, and Mishra (1993), the findings of the current study indicate that PREP has been equally successful in remediating performance in the area of spelling. Further, these findings are in agreement with those reported by Pagedar (2008) where they tend to conclude that phonological awareness significantly improves reading and spelling. Findings support the view that PREP is useful in supporting readers with both average and severe reading disabilities.

There were indications of successful implementation of PREP in improving both word reading and reading comprehension skills of children (Mohanty, 2007; Mahapatra, Das, Stack Cutler & Parrila, 2010). The findings of these studies suggest that PREP works equally efficiently in case of children who are the native speakers of English language and those who use English as their second language (ESL children) like the children of Odisha. The similar results were found in the present study as the PREP improved the reading and spelling skills of children in Haryana, who use English as their second language and are from different culture. Further research may be planned to investigate the effectiveness of PREP across various cultural groups in India so that the findings could be validated. In view of Das's cognitive processing theory the proficiency in reading and spelling increased in children with the use of PREP may be because its tasks improved the cognitive processes underlying reading. The results of the study also indicated that PREP program have improved simultaneous and successive processes, while planning and attention processes remained unaffected by the PREP intervention. These results meet the expectation because PREP includes total eight tasks; four tasks mend to improve successive processing while other four tasks are to improve underlying simultaneous processing. This way, PREP undoubtedly improves information processing strategies, particularly simultaneous and successive processing, which are considered to underlie some aspects of reading. Earlier researches are also supported (e.g., Churches, Skuy, & Das, 2002; Das, Georgiou, & Janzen, 2008; Naglieri & Rojahn, 2004) that have hinted the observation that the remediation program based on the PREP successfully enhance children's cognitive processing.

Results of the study also show that the planning facilitation method has significantly improved math computation skills of children with mathematical disabilities. These results support the intervention studies focused on planning by Naglieri and Gottling (1995, 1997) and Naglieri and Johnson (2000) which show the basis for their work that focused on improving math calculation performance. These studies confirmed that planning facilitation improves score on mathematics worksheets for those students who are weak in planning but not for those with high planning scores. The similar results are found in the present study. Further, our finding are consistent to Iseman and Naglieri (2011) also found that planning strategy instruction seems to help students in developing useful strategies which further help in improving their math scores. In results, we found that Planning

Facilitation has improved scores on math computation among children with mathematical disabilities. The same method has also increased the scores of particular PASS processes which include planning and simultaneous processes. So the results suggest that there is a link between planning and simultaneous processes with math in children with mathematical disabilities. This finding strengthen the notion that planning and simultaneous coding strongly predict mathematics achievement (e.g., Kroesbergen, Van Luit, et. al., 2003).

CONCLUSION

The study tested empirically the effectiveness of remedial program based on PASS Model of cognitive processes toward improvement in achievement scores among children with reading and mathematical disabilities. Two programs, PASS Reading Enhancement Program (PREP) and Planning Facilitation Method (PFM) were used in the study with comparable control groups. The comparisons, i.e., within group's pre and post-test provided ample support to the effectiveness of the PREP and Planning Facilitation Method. The study confirms the efficacy of PREP and PFM as an effective remediation programs for reading and spelling, and mathematical deficits, respectively.

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