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COGNITIVE APPRENTICESHIP MODEL: EFFECT ON METACOGNITIVE SKILLS

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ABSTRACT

Classrooms comprise of students with individual differences even in metacognitive abilities. The term metacognition refers to 'the individual's own awareness and consideration of his or her cognitive processes and strategies' (Flavell, 1979). It is also defined as 'thinking about thinking'. The teachers have to develop a keen sense of observation and make note of the metacognitive ability of the children in classrooms. The specially selected methods and models of instruction allow the teacher to focus on the most important behavioural characteristics and needs of the individual students. Promoting students' metacognitive ability is critical to improve their academic performance and success in life. The Cognitive Apprenticeship Model (Collins, Brown, & Newman, 1989) is a model of instruction that works to make thinking visible through the six phases of teaching: Modelling, Coaching, Scaffolding, Articulation, Reflection, and Exploration. In this study, the researchers adopted experimental method with pretest-posttest non-equivalent groups design. The sample comprised of 76 students of standard eight. The experimental group (N=38) was taught through the Cognitive Apprenticeship Model and the control group (N=38) through the existing activity oriented method practiced in the schools which follows the curriculum designed by the Board of Secondary Education in Kerala State. The scale of metacognitive skills was administered before and after the experiment in order to measure metacognitive skills in mathematical problem solving of the students in the experimental and control groups. The findings of the study showed that Cognitive Apprenticeship Model is more effective than the existing activity oriented method in developing metacognitive skills of secondary school students. The school curriculum is suggested to be modified to suit the Cognitive Apprenticeship Model and thus provide opportunities to the students to articulate reflect and explore themselves so that the students develop metacognitive skills.

KEYWORDS: Students with Individual Differences Even in Metacognitive Abilities

INTRODUCTION

The traditional method of teaching, practised in our schools was grounded on Behaviourist philosophy based on objectivist view of knowledge. In objectivist paradigm, the teacher transmits knowledge to the learners who are considered as passive receivers. It is believed that the teacher has all the knowledge and the teacher is the source of 'right' knowledge and 'correct' answers. In contrast, the constructivist paradigm is based on the assumption that knowledge is subjective and learners construct knowledge in the social and cultural environment in which they are embedded. The Constructivist paradigm calls for a change in the classroom culture, attitudes, beliefs and practices. Role of the teacher in this paradigm shifts from 'transmitter' of knowledge to 'researchers' and 'explorer' of knowledge. Role of student changes from 'knowledge acquisition' to 'knowledge construction'. In the constructivist classroom, the student designs experiments, tests hypothesis, draws conclusions, compares his findings and results with those of others. In the constructivist classroom, teacher is the manager and organiser of the classroom rather than the controller of the class. The constructivist paradigm is thus a new culture, a new environment in the class. The tenets of constructivism as theory of learning, presently, are finding more and more place in the educational programmes across the globe.

The National Curriculum Framework (NCF, 2005) influenced by the constructivist philosophy, brought about a paradigm shift in the basic process of education at school level–'from teaching to learn' to 'helping to know'. It recommends that the school curriculum should help learners to become constructors of knowledge and emphasizes the active role of teachers in relation to the process of knowledge construction. Learners construct knowledge while engaged in the process of learning and the teacher's role is to engage them in the process of learning through well-chosen tasks and questions.

Constructivism as a general philosophy has a long history (Hawkins, 1994). The theorists such as John Dewey, Maria Montessori, Jean Piaget and Lev Vygotsky are constructivists at root. Piaget, Vygotsky and Novak have suggested different theories of constructivism. Constructivist approaches to human learning have lead to the development of "Cognitive Apprenticeship Model". The concept of cognitive apprenticeship originates from social constructivist theory based on the work of Vygotsky. Cognitive apprenticeship model is mostly related to the situated cognition theory. Situated cognition is a theory of instruction that suggests learning is naturally tied to authentic activity, context and culture (Brown, Collins, & Duguid, 1989). It is more difficult to learn from unnatural activities. Cognitive apprenticeship is an example of situated learning in which learners participate in a community of practice that is developed through activity and social interaction in ways similar to that in craft apprenticeships (Mc Lellan, 1994).

Cognitive apprenticeship uses many of the instructional strategies of traditional apprenticeship but emphasizes metacognitive and problem solving skills rather than cognitive and physical skills. Allan Collins (1991) and his colleagues describe 6 core teaching strategies in cognitive apprenticeship – modelling, coaching, scaffolding, articulation, reflection and exploration – designed to support students' emerging skills.

Modeling

The teacher models how someone proficient in the field would perform the task at hand by making thinking visible as s/he works through it. It includes two kinds of modeling: modeling of processes observed in the world and modeling of expert performance, including covert cognitive processes.

Coaching

The teacher coaches the students through observation while they practice a task and provides hints and helps when needed.

Scaffolding

The teacher provides direct support at the right level of current skill while a student is carrying out a task, and then gradually fades out the assistance.

Articulation

It leads students to think about their actions and give reasons for their decisions and strategies in such a way making their tacit knowledge more explicit.

Reflection

Students reflect on their practice, usually compare with the model provided by the teacher and analyze their own performance.

Exploration

Students use the skills they have learned to solve problem on their own. The teachers encourage students to try out different strategies and hypotheses and observe their effects. The support from the teacher fades out and students apply their knowledge and skill to complete the task.

A cognitive apprenticeship environment allows both teachers and students to demonstrate and share their expertise. In this setting, the teacher's goal is to help students gradually take on more complex forms of reasoning and performance through observation and guided practices. The theory underlying the cognitive apprenticeship (Collins, Brown & Newman, 1989) is that learning is a constructive process when students can meaningfully incorporate new knowledge into the existing knowledge structure. Cognitive apprenticeship model is aimed at teaching the externalization of processes that are usually carried out internally. Students do not usually have access to the teacher's relevant cognitive processes. Moreover, the teacher usually is not able to discover students' cognitive processes, because most subjects at school are taught and learned without revealing inner thinking processes.

Mandl and Prenzel (1992) suggest that the concept of the cognitive apprenticeship identifies two types of knowledge: explicit and implicit. Explicit knowledge consists of the general conceptual, factual and procedural knowledge. Implicit strategic knowledge consists knowledge of how concepts, facts and procedures are applied in solving problems and coping with tasks. The cognitive apprenticeship model enables students to explore the relationship between explicit and implicit strategic knowledge and how they are generated. The model offers various types of conceptual and procedural knowledge that need to be made explicit in analyzing teachers' expertise. In this model the emphasis is there on how students learn to articulate and reflect on what they do during their learning process and thus pupils are encouraged to engage in self monitoring.

SIGNIFICANCE OF THE STUDY

Classrooms comprise of students with individual differences even in metacognitive abilities. The term metacognition refers to 'the individual's own awareness and consideration of his or her cognitive processes and strategies' (Flavell, 1979). It is also defined as 'thinking about thinking'. The teachers should observe the students and make note of their metacognitive abilities. The specially selected methods and models of instruction allow the teacher to focus on the most important behavioral characteristics and needs of the individual student. Promoting students' metacognitive ability is critical to improve their academic performance and success in life.

For developing metacognitive skills, students must be able to monitor and regulate their own cognitive processes. Researchers (Kumar, 2010; Ozsoy & Ataman, 2009) suggest that teachers should directly teach metacognitive strategies to students. One way of teaching metacognition is to explicitly infuse the language of thinking and learning into the framework of teaching and classroom discussion. Teachers should explicitly bring out the knowledge and cognitive strategies involved in a problem situation, while attempting its solution through several means: telling the student what needs to be done, stepping the student through the problem, modeling appropriate strategies and explaining while modeling. Modeling of thinking processes involved in expert problem solving is especially important for enhancing metacognition. The expert helps the student by reducing his/her cognitive workload. Teachers provide a scaffold that enables a student to solve a problem that is beyond his or her unassisted efforts. The teacher does those parts of the task that the student cannot, while allowing the student to participate as fully as possible. Thus a true dialogue between the teacher and the student will develop. Also teachers take less of the workload as students demonstrate increasing competence. This ceding of control encourages the student to complete more of the task on his or her own. On the basis of the literature reviewed, it is found that the cognitive apprenticeship model (Collins, Brown, & Newman, 1989) is a model of instruction that works to make thinking visible through the six phases of teaching: Modeling, Coaching, Scaffolding, Articulation, Reflection, and Exploration. The researchers think that during the processes of making thinking visible the students get opportunity to develop metacognitive skills. So the researchers were interested to find out the effectiveness of cognitive apprenticeship model in developing metacognitive skills. This has led the researchers to select the present problem for the research.

OBJECTIVES OF THE STUDY

- To study the effect of cognitive apprenticeship model on metacognitive skills when compared with the existing activity oriented method among secondary school students.
- To study the effect of cognitive apprenticeship model on metacognitive skills in terms of its components when compared with the existing activity oriented method among secondary school students.

HYPOTHESES OF THE STUDY

- There is significant effect of cognitive apprenticeship model when compared with the existing activity oriented method on metacognitive skills among secondary school students.
- There is significant effect of Cognitive Apprenticeship Model when compared with the existing activity oriented method on metacognitive skills in terms of its components among secondary school students.

METHODOLOGY

Design of the Study

The researchers adopted an experimental method to find out the effectiveness of cognitive apprenticeship model. The design selected for the present study was pretest- posttest non equivalent-groups design.

Sample of the Study

The sample comprised of 76 students of standard eight of secondary school of Kerala State, India. The experimental group (N=38) was taught through the Cognitive Apprenticeship Model and the control group (N=38) through the existing activity oriented method practiced in the schools which follow the curriculum designed by the Board of Secondary Education in Kerala State, India.

Tools Used

The scale of metacognitive skills was administered before and after the experiment in order to measure metacognitive skills in mathematical problem solving of the students in the experimental and control groups. In order to statistically equate the experimental and control groups, the researchers administered the Raven's Progressive Matrices

Test as pre test to measure Intelligence.

Statistical Techniques

The researchers used analysis of co-variance (ANCOVA) and Multivariate Analysis of Co-variance (MANCOVA) for the analysis of the data pertaining to the study.

RESULTS

Effectiveness of Cognitive Apprenticeship Model over the Existing Method on Metacognitive Skills

For the purpose of finding out the effectiveness of cognitive apprenticeship model on metacognitive skills, post test scores of the experimental and control groups were compared using the ANCOVA by taking pre test scores on metacognitive skills and intelligence as covariate. The results are presented in Table 1.

Table 1: Sum of Squares, Mean Square Variance, Degrees of Freedom, F Ratio and P-Value of the Scores on Metacognitive Skills

Source	Sum of Squares	df	Mean Square	F ratio	P- Value
Covariate – pre test score on Metcognitive Skills	3278.536	1	3278.536	46.979	.000
Covariate – IQ	406.563	1	406.563	5.826	.018
Between group	3683.049	1	3683.049	52.775*	.000
Within group	5024.731	72	69.788		
Corrected Total	13609.632	75			

Note:* Significant at .05 levels

The obtained F values ($F_{(1,\ 72)} = 57.775$; $p < 0.05$) is significant at 0.05 level. This indicates that cognitive apprenticeship model has significant effect on the metacognitive skills when the researchers considered the pre test scores of metcognitive skills and intelligence as covariates.

In order to know whether the observed effect is positive or negative or whether the effect is to improve the metacognitive skills, the investigator compared the estimated marginal means of scores on metacognitive skills of experimental and control groups. Table 2 provides the comparison of estimated marginal means.

Table 2: Details of the Pair Wise Comparison of Estimated Marginal Means of Post test Scores on Metacognitive Skills of Experimental and Control Groups

Groups	Estimated Marginal Mean	Mean Difference (I-J)	Std. Error	p-Value	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Experimental	99.396	14.214*	1.957	.000	10.313	18.114
Control	85.183					

Note:* Significant at .05 levels

From Table 2 the researchers observe that the estimated marginal means (means of scores adjusted for the covariates) of the post test scores on metacognitive skills of experimental and control groups are different and the mean difference (14.214) is significant at .05 level. The means of post test scores on metacognitive skills of experimental group is 99.396 and that for the control group is 85.183. Therefore it is evident that the means of post test scores on metacognitive skills of experimental group is higher than the control group. Therefore it is clear that the experimental group improved much than the control group with respect to the scores on metacognitive skills as a result of the instruction using Cognitive Apprenticeship model compared with existing method by taking pre test scores on metacognitive skills and intelligence as covariate.

Effectiveness of Cognitive Apprenticeship Model over the Existing Method on the Components of Metacognitive Skills

Declarative Knowledge, Procedural Knowledge, Conditional Knowledge, Prediction, Planning, Monitoring and Evaluation are the components of metacognitive skills included in the study. For the purpose of finding out the effectiveness of the cognitive apprenticeship model over the existing method on the components of metacognitive skills, the researchers used the statistical technique MANCOVA by treating Intelligence and pretest scores on metacognitive skills as covariates. The SPSS output of MANCOVA gives the effect of the cognitive apprenticeship model over the existing method on the components of metacognitive skills. The data and results are presented in Table 3.

Table 3: Summary Table of MANCOVA on the Components of Metacognitive Skills

Source of Variation	F Value	Hypothesis df	Error df	P-Value
Intelligence	1.63	7	66	.143
Metacognitive skills	7.80	7	66	.000
Experimental and Control Groups	8.75*	7	66	.000

Note. Intelligence and pretest scores on Metacognitive skills are treated as covariates.

* Significant at .05 level

Table 3 depicts that the F-value for the experimental and control groups ($F_{(7, 66)} = 8.75$, $p < .05$) is significant at .05 level. Therefore it is concluded that there is significant effect of the cognitive apprenticeship model over the existing method on the components of metacognitive skills when the effects of Intelligence and pretest on metacognitive skills were controlled statistically by treating these variables as covariates.

Since the MANCOVA output shows a significant effect on the components of metacognitive skills, the researchers analyzed the effectiveness of the cognitive apprenticeship model on each of the components separately by using the ANCOVA results given, in the SPSS output of MANCOVA. Table 4 represents the results of ANCOVA for the components of metacognitive skills.

Table 4: Sum of Squares, Degrees of Freedom, Mean Square and F Value for the Components of Metacognitive Skills

Source of Variation	Dependent Variables	Sum of Squares	df	Mean Square	F value	P-Value
Intelligence	Declarative Knowledge	20.73	1	20.73	5.82	.018
	Procedural Knowledge	15.08	1	15.08	3.31	.073
	Conditional Knowledge	1.80	1	1.80	.273	.603
	Prediction	10.72	1	10.72	1.69	.197
	Planning	25.17	1	25.17	4.56	.036
	Monitoring	0.11	1	0.11	0.02	.883
	Evaluation	2.45	1	2.45	0.56	.458
Pretest on metacognitiv	Declarative Knowledge	40.41	1	40.41	11.36	.001
	Procedural Knowledge	55.43	1	55.43	12.17	.001

e skills	Conditional Knowledge	85.48	1	85.48	12.94	.001
	Prediction	50.63	1	50.63	8.00	.006
	Planning	75.93	1	75.93	13.75	.000
	Monitoring	94.59	1	94.59	17.92	.000
	Evaluation	108.85	1	108.85	24.76	.000
Between Group	Declarative Knowledge	88.95	1	88.95	24.99*	.000
	Procedural Knowledge	51.74	1	51.74	11.36*	.001
	Conditional Knowledge	70.40	1	70.40	10.65*	.002
	Prediction	66.90	1	66.90	10.57*	.002
	Planning	46.89	1	46.89	8.49*	.005
	Monitoring	51.47	1	51.47	9.75*	.003
	Evaluation	155.22	1	155.22	35.31*	.000
Within Group	Declarative Knowledge	256.26	72	3.56		
	Procedural Knowledge	328.04	72	4.56		
	Conditional Knowledge	475.81	72	6.61		
	Prediction	455.56	72	6.33		
	Planning	397.49	72	5.52		
	Monitoring	379.99	72	5.28		
	Evaluation	316.52	72	4.40		
Total	Declarative Knowledge	441.63	75			
	Procedural Knowledge	478.95	75			
	Conditional Knowledge	644.04	75			
	Prediction	607.95	75			
	Planning	586.95	75			
	Monitoring	528.74	75			
	Evaluation	597.41	75			

Note. Intelligence and pretest scores on metacognitive skills are treated as covariates.

* Significant at .05 level

Table 4 shows that F-values for the components of metacognitive skills, namely, Declarative Knowledge ($F_{(1,72)}$ = 24.99, p < .05), Procedural Knowledge ($F_{(1,72)}$ = 11.36, p < .05), Conditional Knowledge ($F_{(1,72)}$ = 10.65, p < .05), Prediction ($F_{(1,72)}$ = 10.57, p < .05), Planning ($F_{(1,72)}$ = 8.49, p < .05), Monitoring ($F_{(1,72)}$ = 9.75, p < .05) and Evaluation ($F_{(1,72)}$ = 35.31, p < .05) are significant at .05 level.

In order to know whether the cognitive apprenticeship model or the existing method is superior to improve the metacognitive skills, the researchers compared the adjusted means (marginal means) of the post test scores on the components of metacognitive skills. Table 5 details the comparison of the marginal means of the post test scores on the components of metacognitive skills of the students in the experimental and control groups.

Table 5: Comparison of the Marginal Means of the Post Test Scores on the Components of Metacognitive Skills

Dependent Variable	Groups	Mean	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Declarative Knowledge	Experimental	14.846	2.271*	.444	.000	1.386	3.156
	Control	12.575					
Procedural Knowledge	Experimental	14.341	1.735*	.501	.001	.736	2.734
	Control	12.606					

Conditional knowledge	Experimental Control	15.198 13.197	2.001*	.603	.001	.800	3.202
Prediction	Experimental	13.197	1.977*	.591	.001	.799	3.156
	Control	9.985					
Planning	Experimental	14.342	1.631*	.547	.004	.542	2.721
	Control	12.711					
Monitoring	Experimental	14.091	1.655*	.537	.003	.585	2.726
	Control	12.436					
Evaluation	Experimental	14.616	2.943*	.491	.000	1.965	3.921
	Control	11.673					

Note:* Significant at .05 levels

Table 5 shows that the difference between the adjusted means (adjusted to the covariates) of the marginal means of the post test scores on the components of metacognitive skills are significant at .05 level for all the components of metacognition; Declarative knowledge (Mean difference=2.271, p <.05), Procedural Knowledge (Mean difference=1.735, p <.05), Conditional knowledge (Mean difference=2.001, p <.05),Prediction (Mean difference=1.977, p <.05), Planning (Mean difference=1.631, p <.05), Monitoring (Mean difference=1.655, p <.05) and Evaluation (Mean difference=2.943, p <.05). Therefore, the researchers found that the cognitive apprenticeship model is more effective over the existing method on the components of metacognitive skills when the effects of Intelligence and pre test on metacognitive skills were controlled statistically by treating these variables as covariates.

FINDINGS OF THE STUDY

- There is significant effect of cognitive apprenticeship model over the existing activity oriented method on metacognitive skills among secondary school students.
- There is significant effect of cognitive apprenticeship model over the existing activity oriented method on the components of metacognitive skills among secondary school students.

CONCLUSIONS

The findings of the study showed that cognitive apprenticeship model is more effective than the existing activity oriented method in developing metacognitive skills of secondary school students. The results of the present study agrees with the results of Ramganesh and Amutha (2010) and Kashihara et al. (2008) whose studies revealed that the cognitive apprenticeship model is effective on enhancing teachers' metacognitive and comprehension skills and developing metacognitive skills and metacognitive knowledge (De Jager et al., 2005). The last three steps in the cognitive apprenticeship model emphasises on the development of metacognitive skills. Activities that encourage a reflective and strategic stance toward learning should be embedded in the regular activities of a classroom. The school curriculum must be modified to suit the cognitive apprenticeship Model. Curriculum should provide opportunities to the students to articulate reflect and explore themselves so that the students develop metacognitive skills.

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