Effectiveness of Cognitive Apprenticeship Model on Problem Solving Skills in Mathematics through Multimedia Instructional Approach

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Abstract

The objective of this study is to reveal the effectiveness of Cognitive Apprenticeship Model of learning taught through Multimedia Instructional Approach on Problem Solving Skills at grade Nine of the secondary education. The study used the Experimental method with pre-test post-test equivalent two group design. The study group of the research consists of 32 (64) students in experimental and control group each selected from random sampling. The content instructed to the experimental group was prepared using methods and techniques based on Cognitive Apprenticeship model and taught using Multimedia Approach while the control group was instructed through conventional method specified in the curriculum. At the end of the experimental period the data was tested at .05 level of significance using 't' test as the statistical tool. The findings revealed the significant effect of Cognitive Apprenticeship Model of Learning on Problem Solving Skills in Mathematics taught through Multimedia Instructional Approach at Secondary school across ability levels. This study explores the elements of Cognitive Apprenticeship Model through Multimedia Instructional Approach and concludes with a call for more systematic and integrated programme of studies working towards the development of guiding principles to support curriculum, instructional design, teaching, and learning based on the Cognitive Apprenticeship Model.

Key words: Cognitive Apprenticeship Model, Multimedia Instructional Approach, Problem Solving Skills, Mathematics.
Introduction

Mathematics is described as the fundamental science. Mathematics is an indispensable subject of study. It plays an important role in forming the basis of all other sciences which deal with the material substance of space and time. It is that branch of science that uses numbers and symbols.

Mathematics may be broadly described as the science of space, time, measurement, quantities, shapes and numbers and their relationships with each other.

National Curriculum Framework (2005) of India has rightly identified 'a sense of fear and failure regarding Mathematics among majority of children as a major problem in teaching and learning of Mathematics. A major reason for children doing less well in school mathematics seems to be the way the subject is taught in schools in India. Though it is a major problem only a few have made an attempt to find out the cause and implement the ways for improving the standard of Mathematics teaching.

The term Multimedia Approach to teaching - learning may be referred to the use of appropriate and carefully selected verities of learning experiences which, when presented to the learner through selected teaching strategies, will reinforce and strengthen one another in such a way that the learner will achieve predetermined objectives in an effective way (Pakiam, 1986). It is one of the important innovations in the field of education technology to improve the process and product of education or teaching. Multimedia approach is an approach of teaching in which different mediums are incorporated to make the teaching- leaning more effective, enthusiastic, inspirational, meaningful and interesting.

Emerging technologies are leading to the development of many new opportunities to guide and enhance learning that were unimagined even a few years ago. Computer-based technologies hold great promise both for increasing access to knowledge and as a means of promoting learning. Around 1987, Collins, Brown, and Newman developed six teaching methods — modeling, coaching, scaffolding, articulation, reflection and exploration. Collins, Brown, and
Newman's teaching methods rooted in Cognitive Apprenticeship theory and claim these methods help students attain cognitive and metacognitive strategies for "using, managing, and discovering knowledge". Within the framework of Cognitive Apprenticeship, computer-based technologies can be powerful pedagogical tools that enhance and expand the power and flexibility of the resources that can be deployed to support the various component of Cognitive Apprenticeship. In turn, Cognitive Apprenticeship approach can serve as solid foundation for the instructional design of computer-based environments whether it is a multimedia, hypermedia, web-based, or any means of technological delivery systems (Casey, 1996).

Furthermore the studies conducted by a few researchers strengthen the use of Cognitive Apprenticeship Model through Multimedia Instructional Approach in classroom instructions. According to Neo and Neo (2009) multimedia provides a technology based constructivist learning environment where students are able to solve a problem by means of self explorations, collaboration and active participation. Fenrich, 1997 opined that “Multimedia is the exciting combination of computer hardware and software that allows one to integrate video, animation, audio, graphics, and test resources to develop effective presentations on an affordable desktop computer”. Johnson and Fischbach (1992) experimented on “Teaching problem solving and technical mathematics through cognitive apprenticeship at the community college level”. It was found that quantitative data from students in the cognitive apprenticeship group scored slightly better than the control group on a problem solving exam and the final exam.

**Purpose**

Mathematics is essential to all learning and it is the base for all sciences and arts. Hence it forms an unavoidable part of the secondary school curriculum.

Mathematics is considered to be a difficult subject by most of the pupils mainly due to its abstract nature. Intense dissatisfaction with the traditional system of instruction made it necessary to recognize
the instructional system in the mathematics classroom. The explanation for low achievement in mathematics by students could be that (a) they are not taught the appropriate strategies (b) cannot regulate the study strategies and (c) do not understand how to apply them. Instructional planning plays a pivotal role in connecting curriculum to instruction, developing effective learning environments and effecting what occurs in the classroom context. Even experienced teachers rely on it to ensure the direction of their teaching and boost their confidence (McCutcheon, 1980). The ability to plan instruction effectively can affect not only a teacher's success but also the results of education reform.

The major purpose of this study is to reveal the effectiveness of Cognitive Apprenticeship Model of learning taught through Multimedia Instructional Approach on Problem Solving Skills in Mathematics when compared with existing method among secondary school pupils in Dakshina Kannada District.

**Researchable Questions**

The following research questions were drawn for the study by the investigator:

- Does the Cognitive Apprenticeship Model taught through Multimedia Instructional Approach improve the Problem Solving Skills?
- How does the Cognitive Apprenticeship Model taught through Multimedia Instructional Approach affect Problem Solving Skills in Mathematics among the Above Average Achievers and Below Average Achievers?

**Objectives**

- To study the effectiveness of Cognitive Apprenticeship Model taught through Multimedia Instructional Approach on Problem Solving Skills when compared with conventional method among Standard Nine Pupils of Dakshina Kannada District.
- To study the effectiveness of Cognitive Apprenticeship Model taught through Multimedia Instructional Approach on Problem Solving Skill in Mathematics among the pupils above the average
in Standard Nine.

• To study the effectiveness of Cognitive Apprenticeship Model taught through Multimedia Instructional Approach on Problem Solving Skill in Mathematics among the pupils below the average in Standard Nine.

Hypothesis

• There is a significant difference on Problem Solving Skills in Mathematics among Pupils of Standard Nine taught using Cognitive Apprenticeship Model through Multimedia Instructional Approach and conventional method.

• There is a significant difference on Problem Solving Skills in Mathematics among the Pupils above the average in Standard Nine taught using Cognitive Apprenticeship Model through multimedia instructional approach.

• There is a significant difference on Problem Solving Skills in Mathematics among the Pupils below the average in Standard Nine taught using Cognitive Apprenticeship Model through multimedia instructional approach.

Research Methodology

The Experimental method used in this study was pre-test post-test equivalent two group design. Two groups of students of class IX were selected for the study, and one group was selected randomly as experimental and other as control group on the basis of the achievement test grades scored by the students in the previous grade. Experimental group was exposed to Cognitive Apprenticeship Model of Learning and control group was taught by conventional method. The duration of the experiment was two weeks with twelve lessons of 40 minutes duration. In the present study, Pupils who have scored above the mean score in Pre Achievement test conducted by the school before treatment are the Above Average Achievers and the one who scored below the mean score in Pre Achievement test conducted by the school are the Below Average Achievers.

Sample of the Experimental Study

The sample consisted of 64 students studying in standard Nine with
their age ranging from 13 to 15 years with different socio economic status, religion and geographical area. Investigator randomly selected (close matching) two groups as Experimental and Control group with 32 cases in each group.

**Tools used in the Study**

In order to fulfil the objectives of the study the following tools were used in the study.

- Instructional material using Cognitive Apprenticeship Model.

The investigator used the six steps involved in Cognitive Apprenticeship Model as described by Allan Collins (1989) and his colleagues.

The instructional materials were prepared by the Investigator to teach the different concepts of Mathematics with the help of the activities based on the following steps:

| Sl. No | Steps                    | Activity                                                                 |
|--------|--------------------------|--------------------------------------------------------------------------|
| 1.     | Modeling                 | • Show students how to do task.                                          |
|        |                          | • Build a conceptual model of the process                                |
|        |                          | • Explains reasons and provide rationale                                 |
|        |                          | • Expert shows how things work and how things are done using animations  |
|        |                          | • Online problem solving samples                                         |
| 2.     | Coaching                 | • Observe students attempt a task                                        |
|        |                          | • Provide assistance as needed                                           |
|        |                          | • Offer hints, feedback and guidance                                     |
|        |                          | • Students work on programming/ multimedia/ hypermedia/ online tasks of  |
|        |                          |   increasing difficulty                                                  |
|        |                          | • Online problem solving strategies                                      |
| 3.     | Scaffolding/fading       | • Offer little support, guidance and reminders                           |
|        |                          | • Assists students to manage complex task performance                    |
| Step | Process |
|------|---------|
| 4    | Articulation |
|      | • Gradual removal of support (fading) |
|      | • Online diagnosis |
|      | • Online instructions |
|      | • Require their students to explain what they are doing. |
|      | • Encourage students to explicate their knowledge, reasoning, problem solving strategies. |
|      | • Hypermedia representations of problem solving solutions |
|      | • Multimedia tools |
|      | • Online questioning and answering |
| 5.   | Reflection |
|      | • Encourage students to reflect on their tasks. |
|      | • Provide students to compare their work with masters, other students and with an internal cognitive model of the relevant expertise. |
|      | • Play Movie button plays a digitized movie of an expert expressing his view on the reflection question posed. |
|      | • Online discussion via e-mail, listservs, chat rooms, and forums. |
| 6.   | Exploration |
|      | • Encourage students to solve new, but similar tasks. |
|      | • Push students to be independent learners. |
|      | • Force to engage in exploration. |
|      | • Online exploration strategies. |
|      | • Multiple representations of problem/Hypermedia representations. |

**Problem Solving Skill Test**

The Problem Solving Skill test in Mathematics was constructed by the investigator based on the objectives 'Application',...
'Analytical Reasoning', Logical Deduction and Inference. It consisted of 25 test items and was validated by the experts.

Statistical Techniques

The following statistical techniques were by the investigator used to analyze and interpret the data pertaining to the study

a) Arithmetic Mean.
b) t-test

Analysis of Results

Objective One: To study the effectiveness of Cognitive Apprenticeship Model taught through Multimedia Instructional Approach on Problem Solving Skills when compared with conventional method among Standard Nine Pupils of Dakshina Kannada District.

The analysis of the above objective is done and hypothesis has been tested using 't' test shows the following result.

Table No. 1: Number (N), Mean (M), Standard Deviation (SD), 't' Test Details on the Pre-test Post-test Gain Mean Scores on Problem Solving Skills in Mathematics of Control Group and Experimental Group.

Source: Primary data

The interpretation of the table indicates that, the obtained 't' value (2.205.=t) exceeds the 't' theoretical value ( 205.=t) at 62 degrees of freedom. This rejects the null hypotheses and confirms the acceptance of the research hypothesis which concludes that Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is significantly effective than conventional method of teaching in enhancing the Problem Solving Skills in Mathematics among Pupils of Standard Nine. Further the mean score of Experimental Group is significantly higher than that of the Control Group. So Experimental Group has performed better than Control
group on Problem Solving Skills in Mathematics.

**Objective Two:** To study the effectiveness of Cognitive Apprenticeship Model taught through Multimedia Instructional Approach on Problem Solving Skills in Mathematics among the Pupils above the average in Standard Nine. The analysis of the above objective is done and hypothesis has been tested using 't' test shows the following result.

**Table No. 2 : Number (N), Mean (M), Standard Deviation (SD), 't' Test Details on the Pre-test Post-test Gain Mean Scores on Problem Solving Skills in Mathematics of Above Average Achievers of Control Group and Experimental Group.**

| Source : Primary data |
|-----------------------|

The interpretation of the Table brings out the fact that the obtained 't' value (2.05) exceeds the 't' theoretical value (2.04) at the .05 level at 30 degrees of freedom. This rejects the null hypothesis and confirms the acceptance of the research hypotheses which concludes that Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is effective than conventional method of teaching in enhancing the Problem Solving Skills in Mathematics among Pupils above the average in Standard Nine.

**Objective Three:** To study the effectiveness of Cognitive Apprenticeship Model taught through Multimedia Instructional Approach on Problem Solving Skill in Mathematics among the pupils below the average in Standard Nine.

The analysis of the above objective is done and hypothesis has been tested using 't' test shows the following result.
Table No. 3: Number (N), Mean (M), Standard Deviation (SD), 't' Test Details on the Pre-test Post-test Gain Mean Scores on Problem Solving Skills in Mathematics of Below Average Achievers of Control Group and Experimental Group

|                  | Control Group | Experimental Group |
|------------------|---------------|--------------------|
| N                | 30            | 30                 |
| M                | 28.5          | 30.5               |
| SD               | 3.4           | 2.8                |
| 't' Value        | 2.08          | 2.04               |

The data presented in the Table depicts that the obtained 't' value (2.08) exceeds the 't' theoretical value (2.04) at the .05 level at 30 degrees of freedom. This rejects the null hypothesis and confirms the acceptance of the research hypotheses which concludes that Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is effective than conventional method of teaching in enhancing the Problem Solving Skills in Mathematics among Pupils below the average in Standard Nine.

Major Findings of the Study

Findings of the study reveal that Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is significantly effective in enhancing the Achievement and Problem Solving Skills in Mathematics among the Pupils of Standard Nine. Based on the study undertaken by the investigator the major findings of this study are as follows:

- Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is more effective than conventional method of teaching in enhancing the Problem Solving Skills in Mathematics among Pupils of Standard Nine.
- Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is more effective than the conventional method of teaching in enhancing the Problem Solving Skills in Mathematics among the Pupils above the average in Standard Nine.
Cognitive Apprenticeship Model taught through Multimedia Instructional Approach is more effective than the conventional method of teaching in enhancing the Problem Solving Skills in Mathematics among the Pupils below the average in Standard Nine.

Educational Implications

Dr. Kalam was a practical educational thinker and visionary who stood for integrating ancient and modern educational ideals for the development of a balanced Indian society. According to Dr. A.P.J Abdul Kalam (2006), the education system has a tremendous responsibility to transform a child is to a leader- the transformation from 'what can you do for me' to 'what can I do for you?' The most important part of education is inculcating in the Pupils the spirit of 'we can do it'. Education is an endless journey- through knowledge and enlightenment. Education is drawing out and developing creativity inherent in Pupils. Real education enhances to correlate education with the problems of life.

Suggestions

- Based on the major findings we can say that, the Cognitive Apprenticeship Model, in its entire dimension, can be applied to teaching the school curriculum related to mathematics. This model also helps to redesign the schooling so as to help Pupils acquire true expertise and robust Problem-Solving Skills, as well as an improved ability to learn throughout life.
- Training in Cognitive Apprenticeship Model to be incorporated in teacher training process. And it should form an essential part of the ongoing training and formation of the in-service and pre-service teachers under context of aim methodology of teaching Mathematics.
- Seminars and workshops should be organized for teachers on Cognitive Apprenticeship Model as well as on Multimedia Instructional Approach and the workshop should provide training for the teachers in preparation of lessons based on Cognitive Apprenticeship Model using Multimedia Instructional Approach in different subjects and practice the same in their own subject in real classroom setting.
Conclusion
The study investigated the effect of Cognitive Apprenticeship Model through multimedia instructional approach on secondary school students' Problem Solving Skills in mathematics. The results of the study showed that the content taught using Cognitive Apprenticeship Model through multimedia instructional approach enhanced secondary school students' Problem Solving Skills in mathematics across the learning abilities.

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