

Teaching Science Through Information Processing Model: A Review

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Abstract

Models of teaching, like plans, patterns, or blueprints present the steps necessary to bring about a desired outcome. Models create the necessary environment, which facilitates the teaching learning process. There are many powerful models of teaching designed to bring about particular kinds of learning and to help students to learn more effectively. Information processing models share an orientation towards the information processing capability of students and the ways in which they can improve their ability to master information. This review discussed the information processing models used by different researchers to study their effectiveness in the teaching different science subjects with an aim to help the future researchers possessing the interest in using information processing models.

Keywords: Information processing model, chemistry, biology, physics, mathematics, teaching

1. Introduction

Models of teaching is a recent, advanced and fast growing area of educational research. Almost all the studies on models of teaching have used experimental design. It is observed that major work in the field of models of teaching has been done since 1980. Most of these studies have been short term studies with a limited treatment. Some studies have not even specified duration of the treatment, number of exposure, number of demonstrations, practice, feedback session etc. Many studies have conducted to compare the efficacy of various models of teaching . In most of the comparative studies, the effectiveness of information processing models among themselves and against that of traditional methods of teaching in relation to many criterion variables

2. Sources

Following sources have been scanned to write this review

1. Education Resources Information Center (**ERIC**)
2. PsycINFO
3. Readers' Guide Abstracts
4. Social Sci Search
5. Wilson Social Sciences Abstracts
6. Directory of Open Access Journals (**DOAJ**)
7. Fourth survey of Education, India
8. Fifth Survey of Education, India
9. Sixth Survey of Education, India
10. Dissertation abstract International
11. British Education Index
12. Dissertation Abstracts Online

3. Classification

This reviews has been classified on the basis of teaching science subjects through information processing model as under:

- i. *Teaching Chemistry through IPM*
 - ii. *Teaching Physics through IPM*
 - iii. *Teaching Mathematics through IPM*
 - iv. *Teaching Biology through IPM*
 - v. *Review not cover under the above head*
- i. *Teaching Chemistry through IPM*

Aziz (1990) compared the relative effectiveness of inductive thinking model, concept attainment model and traditional models of teaching in developing concepts in chemistry at secondary stage. The result of the analysis

showed that the performance of the students taught through different models was superior than the performance of the students taught through traditional approach.

Jamini (1991) Investigated the relative effectiveness of AOM and CAM on conceptual learning efficiency and retention of chemistry concepts in relation to divergent thinking which indicated that although both AOM and CAM were effective in fostering concept learning, AOM was comparatively more beneficial in concept learning to pupil with high divergent thinking while CAM was more beneficial to pupils with low divergent thinking.

Remadevi (1998) has applied information processing models in teaching chemistry at the secondary and higher secondary levels with respect to (a) Knowledge level of cognitive achievement; (b) Comprehension level of cognitive achievement; (c) High Intelligence categories; (d) Low Intelligence Categories; (e) Categories of high achievers on scientific attitude scale; and (f) Categories of low achievers secondary and higher secondary on scientific attitude scale. The major findings of the study were: (1) The pupils taught through IPM were found to have significantly higher achievement than those taught through CM with respect to knowledge level of cognitive achievement, comprehension level of cognitive achievement and application level of cognitive achievement at .01 level. (2) The pupils belong to high intelligence categories taught through IPM were found to have significantly higher achievement than those taught through CM. (3) The pupils belong to low intelligence categories taught through IPM were found to have significantly higher achievement than those taught through CM. (4) The pupils belonging to the categories of high achievers on scientific attitude scale taught through IPM were found to have significantly higher achievement than those taught through CM. (5) The pupils belonging to the categories of low achievers on scientific attitude scale taught through IPM were found to have significantly higher achievement than those taught through CM.

Sreelekha and Nayar (2004) conducted a study to compare the achievement level between traditional method and concept attainment model with respect to knowledge objectives, understanding objectives and application objectives. The major finding was CAM was effective in improving the overall level of achievement in chemistry.

Daniel (2008) conducted a study to address the effectiveness of using an advance organizer as the sensitization technique within an undergraduate content-based first-year chemistry laboratory activity in order to improve students' conceptualizations of the role creativity plays in the scientific process. The major finding of this study is that using an advance organizer pertaining to creativity, when implemented as an introduction to a problem-based laboratory activity, can lead to a statistically significant greater percentage of students constructing more informed views.

Domin (2008) used an advance organizer pertaining to the nature of science (NOS) aspect of the role creativity plays in science, incorporated into a problem-based laboratory activity of an undergraduate first-year chemistry curriculum. The advance organizer was presented in one of three versions to different sections of students: (1) definite explication of the NOS learning outcome, (2) indefinite explication, and (3) no explication. An NOS survey was administered to 235 students prior to implementation of the advance organizer and to 136 students after completion of the instructional activity involving the advance organizer. The results of this study indicate that the different versions of the advance organizer differ with respect to altering students' conceptualization of creativity: specifically, only the indefinite explication of the intended learning outcome led to a significant change in the percentage of students holding more informed views. This finding suggests that a relatively small change in instructional design can advance improvement in achieving NOS learning outcomes within a large-scale content-based science course Bernard and Rachel (2008) was engaged to develop and use advance organisers to augment the teaching of commercial arithmetic and then investigate its effects on student achievement in the topic. The results indicated that students taught using advance organizers had significantly higher scores in mathematic achievement test (MAT) than those taught in the conventional way. Gender did not affect achievement.

Khan and Saeed (2010) conducted a study to investigate the effectiveness of concept formation teaching model over traditional method on class IX students' achievement in chemistry. The results of the study indicated that concept formation teaching model was more effective as compared to traditional method. Furthermore, concept formation teaching model appeared to be favorable for both boys and girls for the understanding of chemistry concepts.

Khan et al (2011) conducted a study to see the effect of inquiry-based instruction as a supplementing strategy on the academic achievement of secondary school students in the subject of chemistry. The major objectives of the study were to find out the relative effects of inquiry based instruction as supplementing strategy on the academic achievement in chemistry and to explore the difference between treatment effects on the students of high and low intelligence. The performance of high achievers of experimental group on post-test was significantly better than that of control group. In case of low achievers, the difference between the means on post-test was not significant.

Hence, it can be concluded that the performance of the high achievers on the post-test was significantly better than that of low achievers. Since there was no significant difference between the mean scores of low achievers of experimental and control groups, it effected the significant of treatment. The overall results of the study indicate that inquiry based instruction, as a back up strategy to support traditional teaching methods. Improved students' achievement in the subject of chemistry at secondary level with higher achievement gains for the groups of high achievers. The results of the study were mostly in line with those of previous researches carried out in other cultures. However, individual variations were found regarding the impact of inquiry.

ii. Teaching Physics through IPM

Singh (1990) compared the effectiveness of inquiry training model and concept attainment model over traditional model for the teaching of physical science. The finding revealed that inquiry training model and concept attainment model are equally effective and both the model established their superiority over traditional models of teaching.

Sidhu and Singh, (2005) compared the effect of concept attainment model, advance organiser model and conventional method in teaching of physics in relation to intelligence and achievement motivation of class IX students. They found that there was no significant effect between various teaching techniques, intelligence and achievement motivation on scholastic achievement of students for learning of concepts in physics.

Vandana and Jadhav (2011) conducted an experiment to examine the effectiveness of AOM over traditional model in the teaching of Physics of 9th grade students. They found that AOM strategy is more effective than conventional Strategy.

iii. Teaching Mathematics through IPM

Chitrive (1983) compared the concept attainment model to advance organizer model and traditional model in terms of performance in concept knowledge. The major findings were (i) both Ausubel and Bruner's strategies were superior to traditional strategies for teaching mathematical concepts to XI grade students, so far as knowledge transfer and heuristic transfer of the concepts were concerned, (ii) Both the strategies are equally effective so far as students ability to acquire to knowledge of the concept were concerned, (iii) Conceptual style preferences of students seemed to have different effect their acquisition of mathematical concepts when taught by Ausubel strategy.

Viney (1992) tried to compare the effectiveness of the concept attainment model and computer model in terms of mathematical concepts in relation to intelligence and cognitive style. The computer model of teaching was found to superior to the concept attainment model for the teaching of mathematics. Cognitive style and intelligence were found to be interacting.

Naik (1996) conducted a study to develop and try out Inductive Thinking Model of teaching mathematics to develop student's reasoning ability. The researcher also intended to compare the use of inductive thinking model over the traditional method in developing inductive thinking and to try out the efficiency of this model in terms of achievement of pupil. The finding of the study reveals that inductive thinking model was effective in increasing reasoning ability that the conventional method and this model was found to be interesting for the students to earn through it.

Bharambe (1997) conducted a study to compare the effectiveness of the three different procedures, namely, advance organizer model, analytic-synthetic method and traditional method of teaching in the teaching of logical geometry to the students of secondary schools from the points of view of school differences, area differences, sex differences and potentiality difference pertaining to the conceptual-dissemination- process-discrimination and analytic-synthetic skills. He found that AOM was more effective than ASM of teaching in every case of comparison and ASM was found more effective that traditional method. From the point of view of the development of the three mental processes, it was found that, for the development of conceptual-discrimination, AOM is more effective than ASM; for the same process, the comparison between ASM and TM, ASM is more effective than TM.

Shah (2002) compared the effectiveness of concept attainment model and self learning material with traditional methods for the of mathematical concepts. The educational achievement of pupils studying through CAM and self learning was found to be higher in achievement than traditional methods.

Githua and Nyabwa (2008) examined how the use of advance organisers during instruction affect students achievement in commercial arithmetic. A simple random sample of four provincial mixed-sex secondary schools in Nakuru district was obtained. The study was carried out in a mathematics classroom setting. Solomon four-group design was employed. The experimental groups received the advance organisers as treatment and two control groups were taught in the conventional way. The sample size was 142 students. A mathematics achievement test (MAT) was used. The MAT was administered to two groups before the teaching of the topic and then to all four groups after learning the topic of commercial arithmetic. Descriptive statistics (mean,

standard deviation, percentages) and Inferential statistics (ANOVA, ANCOVA and t-test) were used for data analysis. The level of significance for acceptance or rejection of hypothesis was set at 0.05 α -level. The results indicated that students taught using advance organisers had significantly higher scores in MAT than those taught in the conventional way. Gender did not affect achievement.

Pachpande (2012) conducted a study to check the effect of advanced organizer model on achievement of students in mathematics teaching at school level. For this study 74 students of VIIIth std Marathi medium from A.T. Zambre high school Jalgaon were selected by random method. For this purpose intelligence test of Dr. Prayag Mehta and achievement test in mathematics subject was given to collect data. From this study it was found that advanced organizer model is more effective than traditional method on achievement of students in mathematics teaching.

iv. Teaching Biology through IPM

Dennis (1984) investigated the effect of advance organizer and repetition on achievements in a high school biology class. The sample consisted of four groups of 10th grade students. California achievement test, a Lindquist type I research design and a multivariate analysis of variance were utilized. The findings showed that there was no significant interaction between treatments on the two dependent variables. However, there was a significant gain in achievement by students in all groups from pre-test to post-test.

Lewis (1986) compared the effectiveness of Ausubelian advance organizer and simplified readability of science content when used together or separately in the biology laboratory. The findings showed that either the advance organizer or simplified reading material was significantly better than no treatment but the two together were significantly better than either alone.

Sushma (1987) compared the effectiveness of concept attainment model and biological science inquiry model for teaching biological science to class VIII students. The results showed that both the models i.e. concept attainment model and biological science inquiry model were found to be effective at 0.01 level but CAM was found to be more effective than biological science inquiry model.

Kaushik (1988) conducted a study whose objectives were i) To investigate the long-term effect of written advance organizers upon the achievement of biology of ninth grade students, (ii) to study the effect of advance organizer on students of different reading abilities, intelligence and scientific attitude, (iii) to study the interaction of the study conditions, (iv) to study the relative effectiveness of study conditions on immediate ability, intelligence and scientific attitude as covariates, and (v) to study the relationship of reading ability, intelligence and scientific attitude with mean achievement scores on immediate and delayed test, respectively of other groups viz. advance organizer model, general introduction and traditional methods. The major findings were : (i) Advance organizers' facilitated immediate and delayed learning in biology, (ii) A general introduction or an overview, generally preceding the learning material in the lectures, lessons are text books, was of little value as compared to the advance organizer, (iii) pupils with high intelligence, reading comprehension and scientific attitude derived the greatest advantage from the presentation of an advance organizer, (iv) general students were also benefitted by advance organizer and (v) the achievement of the learners in biology was found to be highly positively correlated with their intelligence, reading comprehension and scientific attitude.

Bhaveja (1989) conducted an experiment to study the efficacy of CAM and Inductive thinking model with regard to the degree of conceptualization in Biology. The result shows that the students who underwent lessons through the models get better conceptualization.

Ghosh (1989) conducted a study with following objectives: (i) to develop instructional materials on the unit 'photosynthesis' on the basis of Ausubelian principles, (ii) to develop series of subsumption test to assess the consolidation of learnt subject matter, (iii) to develop CRT for measuring immediate learning and retention of learnt subject, (iv) to perform the experiment and compare the effectiveness of two types of advance organizer on the criteria of immediate learning and retention, (v) to study the effects of interaction between instructional strategies and readiness for learning and (vi) to study the effects of interaction between readiness for learning and cognitive style. The major findings were : (i) both types of advance organizers facilitates the retention of subject matter even after an interval of four weeks, (ii) Instructional strategy having pictorial type of advance organizer was found better than the instructional strategy having prose-passage type of advance organizer on the cognitive subsumption, (iii) retention of learnt material as measured CRT is found higher for the pictorial type advance organizer, (iv) cognitive subsumption of complex subject matter is dependent on the factor of readiness for learning, (v) individual having higher readiness are likely to acquire and retain concepts adequately more than those having low readiness for learning, (vi) the field dependent subjects whose ability to deal with formal structures is limited could not achieve better than field-independent on the criteria of immediate learning and retention.

Manocha (1991) conducted a study to determine the comparative effectiveness of the developed textual materials of biology for class IX in terms of reception vs traditional and reception vs selection strategies of concept attainment model. The reception strategy of CAM was significantly superior to the conventional strategy. There is no significant difference between selection and reception strategies of CAM.

Bagget (1993) compared the relative effectiveness of using different concept map presentations as advance organizer in teaching photosynthesis to community college science students. The subjects in the study were grade III students from six intact Biology classes in a Southern Mississippi Community College. A no concept map control group and two concept maps experimental groups were utilized. The experimental design was pre-test – post test multiple linear regression analysis was employed to test the hypotheses. Teaching through concept map as advance organizer was found to be superior than that of control group.

Raina (1994) compared advance organizer model and biological science inquiry model in teaching of biology. The major findings were (i) advance organizer model is significantly effective in teaching of biology in terms of pupil's achievement, (ii) biological science inquiry model is significantly effective in teaching of biology in terms of pupil's achievement, (iii) advance organizer model is significantly more effective as compared to biological science inquiry model in terms of pupil's scholastic achievement, (iv) biological science inquiry model is significantly more effective as compared to advance organizer model in terms of pupil's interest in inquiry activities, (v) Biological science inquiry model is significantly more effective than advance organizer model in terms of pupil's reaction towards models of teaching.

Patnaik (1994) conducted study to know the effect of teaching through Inquiry Training on achievement in Biology with respect to sex difference and different intellectual levels. In this investigation, the pre-test and post test equivalent group design was used. The experimental group was exposed to Inquiry Training strategy and the control group was taught as usual conventional methods. It was observed that there was a significant difference in all the objectives and total scores of achievement in biology among control and experimental groups. This showed that the Inquiry Training was highly effective in achieving all the objectives of achievement in biology.

Alam (1996) conducted a study to comprise the relative effectiveness of inductive thinking model and inquiry training model for teaching biology to the students of secondary schools. The major findings were (i) for concept learning and retention in biology, inductive thinking and inquiry model are more effective than the conventional teaching methods, (ii) inductive thinking model is more effective as compared to inquiry training model in terms of students' concept attainment in biology, (iii) mental ability, socioeconomic status and previous scholastic achievement in biology have no bars on the concept attainment in biology.

Sivakumar and Prema (1996) find out the relative effectiveness of ITM in learning Biology at secondary level. The study also intended to develop package based on ITM for the topics genetics, ecology and evolution and apply these packages at the IX standard level to find out their effectiveness in comparison to conventional approach. The study reveals that Suchman's ITM was more effective than teaching with conventional approach. This also reveals that the ideas or concepts should not be developed through a natural way of scientific inquiry.

Sahoo (2001) conducted an experiment to compare the relative effectiveness of computer assisted instruction and instruction with advance organizers in the teaching of life science in relation to cognitive style of learners. The major findings of the study was that there is a real difference between two treatments.

v. *Review not cover under the above head*

Tamthai (1982) conducted a study to determine the facilitating effects of a pictorial diagrammatic advance organizer on science learning achievement. The findings were (i) advance organizer model had no facilitating effect on male students who were field independent. (ii) There exist a relationship between dependent-independent cognitive style and science learning achievement.

Rajoria (1987) studied the effectiveness of Advanced Organizer Model and the traditional method for teaching science at VIII grade students. The sample consisted of 114 students of class VIII in Govt. middle school no 24, Indore. She found that the AOM was significantly superior to traditional methods in terms of achievement in science of class VIII students when the groups were matched separately in respect of intelligence and previous year achievement in science.

Grewal and Kaur (1987) conducted a study to compare the outcome of three approaches to teaching namely, the Bruner's model, the Ausubel's model and the traditional model, quantified on the basis of achievement scores. The finding reveals that there was a difference in the efficacy of CAM, AOM and traditional method for learning of concepts of science. It also reveals that CAM was more effective than AOM and there is no difference in the efficacy of AOM and traditional method.

Chaudhury (1988) studied the effectiveness of CAM for acquiring new concepts in science. The finding shows that CAM was found to be effective in teaching concepts of science.

Gupta (1993) assessed differential effectiveness of concept attainment model, inductive thinking model and inquiry training model of teaching on mental process and attitude towards science through science teaching at class IX stage. The objectives of the study were (i) To study the effectiveness of teaching through concept attainment model on (a) development of pupil's mental process and (b) development of favorable attitudes of the students' towards science, (ii) To study individual effectiveness of teaching through inductive thinking model on (a) development of pupil's mental process and (b) development of favorable attitudes of the students' towards science, (iii) To study individual effectiveness of teaching through inquiry training model on (a) development of pupil's mental process and (b) development of favorable attitudes of the students' towards science, (iv) to find out relative effectiveness of teaching through concept attainment model, inductive thinking model and inquiry training model in developing mental processes of the students, (v) to find out relative effectiveness of teaching through concept attainment model, inductive thinking model and inquiry training model on development of favorable attitude of the students towards science. The major findings were (i) concept attainment model and inductive thinking model has been found to be effective in developing reasoning and scientific creativity as well as favorable attitude towards science among the students, (ii) Inquiry training model has been found to be effective in developing reasoning and scientific creativity as well as favorable attitude towards science among the students, (iii) Inductive thinking model and inquiry training model were found to be equally effective in developing problem awareness ability among the students.

Likia (1996) compared the effectiveness of teaching Science through Inquiry Training Model (ITM) and traditional method on the achievement in Science in relation to intelligence. The study reveals that ITM was more effective than traditional approach in teaching science. The reasons for this were found to be a very active participation by students while learning they tried to understand the problem, formulate hypotheses by asking questions. They are conscious of their inquiry process and cooperative efforts among the students enriched their thinking process.

Verma, (2001) attempt to compare the effectiveness of mastery learning model and inductive thinking model on pupils' achievement in science and their creative thinking abilities. The findings of the study were: (1) The group of students taught science through mastery learning model and inductive thinking model have scored significantly higher on the criterion achievement test than the group of students taught science through conventional method and the group of students taught science through inductive thinking model have scored significantly higher on the criterion achievement test than the group of students taught science through mastery learning model. (2) The group of students taught Science through inductive thinking model have scored significantly higher gain on the test of verbal creativity than the group of students taught science through conventional method. (3) The group of students taught science through inductive thinking model have scored significantly higher gain on the test of verbal creativity than the group of students taught science through mastery learning model.

Wanjari, (2005) compared concept attainment model with inductive thinking model of teaching on students' achievement in science, scientific creativity and attitude towards science. The findings were: (1) Both concept attainment model and inductive thinking model of teaching was found to be effective in developing reasoning ability, scientific creativity and favourable attitude towards science among the students of IX standard. (2) concept attainment model and inductive thinking model of teaching are equally effective in terms of achievement in science of IX class students, reasoning ability, scientific creativity and attitude towards science.

Jadhav (2008) studied the effect of advance organizer model on student –teachers' teaching and its influence on the school pupil's performance in science .The objectives were (i) To develop self- instructional material on theory, planning and evaluation of AOM suitable for Indian conditions. (ii) To analyze the Science Syllabus of Std. IX to identify the units which can be taught using AOM. (iii) To determine the Student Teachers' teaching performance using AOM. (iv) To determine the student teachers' performance in terms of achievement of pupils in paper-pencil tests based on different sub units in Science. The major findings were (i) The final draft of the self-instructional material was found comprehensive, self explanatory and instructive for planning and practice teaching. (ii) Out of the syllabus prescribed for std. IX, 75 sub-units were found suitable to the Advance Organizer Model (AOM). (iii) In the first two lessons the teaching performance of the conventional group was found comparatively effective in simulated situation, whereas, in the last three lessons the teaching performance of AOM and conventional groups was found equally effective in simulated conditions. (iv) The AOM group of student teachers was found more effective than conventional method group in real classroom situations. (v) The performance of AOM group of student teachers was found superior in terms of pupils' achievement than that of the conventional group.

4. Summary of findings

Many studies have conducted to compare the efficacy of various models of teaching . In most of the comparative studies, the effectiveness of information processing models among themselves and against that of traditional methods of teaching in relation to many criterion variables such as Intelligence(Rajoria 1987; Koushik 1988; Viney 1992; Patnaik 1994; Likia 1996; Ramadevi 1998; Sadhu and Singh 2000), Scientific attitude (Koushik 1988; Gupta 1993; Wanjari 2005), creativity (Verma 2001; Updhyay 2001; Daniel 2008; Domin 2008) and reasoning ability (Naik 1996 ; Leuva 2002). In many experimental studies the effectiveness of two information processing models were compared and the design comprised of two experimental groups only.

One thing evident from all these researches is that approach of models of teaching has been found to be superior to the traditional methods, whatever the model be. It is difficult to determine which model is appropriate for teaching different subjects at various levels because no two studies are alike in all respects as sample, design, objectives, tools, treatment, dependent variables, independent variables etc. Generally the scholars have tried to restrict themselves to the framework of a single model and one or two dependent variables. A few have tried to move to two models and comparing their effects with that of traditional methods⁴⁵. However, most of the researches have accepted that models of teaching could prove to have a promising effect on the academic achievement of the students taught through them.

Instruction in science can be varied using methods of group work, projects, supervised study and research, demonstrations, case studies, field trips etc. Some topics or problems may be taught more economically through the use of one method than the other. Each science teacher should explore the use of the best suitable method for different topics in different classes. Through teaching experience the science teacher will learn which methods are most productive in promoting the learning of science in various classes.

5. Conclusion

On the basis of the above literature it may be said that the conventional method of teaching different subjects at various levels was found to be less effective than various innovative teaching patterns like programmed instruction, instructional strategies and models of teaching in terms of achievements of students. The thorough review of the reported studies of related literature showed that though very serious work has been done in instructional theory, leading to models of teaching, empirical studies with special reference to specific subjects as well as areas are not very many. This review of related studies throw light on the nature on work done in this area and help the investigators in designing their study, in formulating the objectives, selecting methods, tools and techniques.

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