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PROBLEM SOLVING MODEL STRATEGIES FOR ENHANCING INTEGRATED PROCESS SKILLS AMONG SECONDARY LEVEL

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Abstract

Problem-solving model is a systematic approach that reviews student strengths and weaknesses, identifies evidence-based instructional interventions, frequently collects data to monitor student progress, and evaluates the effectiveness of interventions implemented with the student. Problem solving is a model that first solves student difficulties within general education classrooms. Teaching models provide learning experiences by creating appropriate environment conducive to real behavioral outcomes. The different types of teaching objectives are achieved by organizing teaching elements in different ways. The main postulate 'Teaching Model' is that the learning outcome can be classified into distinctive categories and each objective can be achieved by generating specific situations. Problem solving depends on a person's previous experience and requires the capacity to reason, calculate, recognize patterns and handle logical thinking. The present study attempts to develop a Problem-Solving Model of teaching for nurturing Integrated Process Skills among students at secondary school level.

Keywords: Integrated Process Skills; Problem Solving Model

Introduction

Good thinkers can become good learners and good learners can become good problem-solvers. If our thinking process is in accordance with the scientific method of problem solving, will be able to find out ways to answer our questions about the world. This involves a number of independent variables influencing student learning. Problem-solving is one of the major learning skills students are expected to possess. Problem solving is a process of raising a problem in the minds of the students in such a way as to stimulate purposeful reflective thinking for arriving at a rational solution Risk (1965).Problem-solving occurs in novel or difficult situations in which a solution is not obtainable by habitual methods of applying concepts and principles derived from past experience in very similar situations. It is a process of overcoming difficulties that interfere with the attainment of a goal. It involves reflective thinking and making adjustments in spite of interferences for the purpose of arriving at rational conclusions relevant to the problem.

Problem solving involves the capacity to reason, calculate, recognize patterns and handle logical thinking. The scientists attack and solve their problems in various ways. But there are certain common elements or phases of procedure in all the scientific investigations. Scientific method refers to those common phases of procedure. Dewey's (1960) classification of the steps involved in problem solving, positively led to a highlighting of the immense potential of the process approach in science teaching. The five steps in problem solving includes occurrence of a felt difficulty, definition of the difficulty in terms of problem statement, occurrence of a suggested explanation or a problem solution to a given hypothesis, inference or theory, the rational development of an idea through the development of its implications by means of collecting data, and correlation of ideas and formulation of concluding belief (Dewey, 1960).

Problem-solving involves knowing what to do in the situation of not knowing what to do. Problem-solving is not only finding the correct answer, but also is an action which covers a wide range of mental abilities. Problem solving is a process which begins with the initial contact with the problem and ends when the answer is received in the light of the given information. Mayer (1983) defined problem solving as a multiple step process where the problem solver must find the relationship between past experience and the problem at hand and then act upon a solution. Galadima (2002) and Suleiman (2010) stated that problem solving is a complex process to learn; it consists of a series of tasks and processes that are closely linked together to form a set of heuristic pattern - a set of suggestions and questions that a person follow and ask himself in order to resolve a dilemma. The defining of the problem depends on individual's experience, therefore strategies and problem-solving approach is different for problem solvers.

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Science content is as important as integrated process skills. A students understanding of content information affect the assessment of integrated process skills (Harlen, 1999). Ormrod (2004) found that problem-solving ability depends on a person's previous experience and some skills can be learned well automatically and requires minimal effort. Problem solving relies heavily on the effective use of the integrated process skills for completing a scientific investigation. Integrating basic science process skills together with science teaching and gradually developing abilities to design fair tests is increasingly emphasized in successive grade levels. Hence if science is taught through problem solving, pupils will eventually develop the integrated process skills which in turn will lead to effective problem solving and achievement in life.

Significance of the study

Teaching is a means for generating an environment of learning. The major aim of teaching must be to create effective independent life-long learners. The content of study and skills of teaching functions as instructional inputs through which the student and teacher interact with each other. This interaction provides an opportunity to develop physical and social efficiency. Educational institutions have the moral responsibility of preparing students for the future by enabling them to develop the integrated process skills for accomplishing problem-solving in real life situations. This requires an inquiry approach and problem-solving model of teaching. Teaching for problem solving in a context- free situation has proved to be futile. It is preferable to use these stages in problem solving for developing the problem solving cycle. For facilitating effective problem solving among students, teachers should know the strengths and weaknesses of various problem solving strategies, realize what, why and how they are solving a problem, in order to understand the strategies completely and select the most appropriate ones.

Purpose of the study

For facilitating effective problem solving among students, teachers should know the strengths and weaknesses of various problem solving strategies, realize what, why and how they are solving a problem, in order to understand the strategies completely and select the most appropriate ones. Educators must adopt appropriate problem solving methods and offer opportunities for students to explore and prepare learning activities by encouraging them to think critically and creatively (Snyder, 1998). The major objective of the present study is to develop a Problem solving model of teaching for nurturing the integrated process skills viz., identifying variables, defining operationally, formulating hypotheses, experimenting and interpreting data among students at secondary school level.

Nature of Problem Solving

Padilla, Dillashaw and Okey(2006) expressed that although the philosophical importance of integrated process skills is unchallenged, there is a lack of research on when and how these skills may be best taught to students in the middle and secondary schools. Ayodele (2002) remarked that successful science teaching requires that the student make sense out of what they are taught. The traditional method of teaching means that the teacher stands in front of the silent group, while the students listen quietly during teaching. It is important for teachers to learn how to use a teaching method that encourages scientific processes and other desirable scientific attitudes. One of the ways by which this could be done is adopting a teaching method which encourages problem solving strategies. Erol (2006) observed that the implementation of the No Child Left Behind Act(NCLB) has prompted renewed efforts to hold schools and students accountable for meeting high academic standards, and as a result more specific approach to addressing academic difficulties, Response To Intervention(RTI) has been proposed as a component of problem solving. The results provides strong evidence that RTI can systematically improve the effectiveness of instruction for struggling students and provide school teams with evidence-based procedures that measures a student's progress and his or her need for special services. Several studies which highlight the nature of problem solving were reviewed. Phang (2010) observed that the patterns of problem solving and that of meta cognition is indistinguishable among children. Schmidt and Ford (2003) reported that student attitudes, behaviors, problem solving knowledge and skills become developed while solving a problem. Ayodhya (2007) found that Polya's heuristic approach is effective in developing problem solving skills. Downs and Downs (2004) proposed a teaching approach aimed to help students become aware of targeted strategy of significance in problem solving.

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Popular models of Problem Solving

For facilitating effective problem solving among students, teachers should know the strengths and weaknesses of various problem solving strategies, realize what, why and how they are solving a problem, in order to understand the strategies completely and select the most appropriate ones. Normah and Salleh (2006) observed that students who can successfully solve problems possess good reading skills, have the ability to compare and contrast various cases, can identify important aspects of a problem, can estimate and create analogies and attempt trying various strategies. Therefore, educators must adopt appropriate problem solving methods and offer opportunities for students to explore and prepare learning activities by encouraging them to think critically and creatively (Snyder, 1998).

Woodset.al (1975) proposed a problem-solving model which includes five steps viz., define the problem, think about it, plan a solution, carry out the plan and look back. 'Defining the problem' helps in identifying the system under study by interpreting the information provided in the problem statement as well as identifying the unknown and select criteria for success. 'Thinking about it' includes letting it simmer, identifying specific pieces of knowledge and collecting information. 'Planning a solution' enables the problem solver to consider all possible strategies and choose the best strategy. 'Carrying out the plan' involves executing the solution. 'Looking back' encourage the problem solver to reflect.

Mayer's (1992) model for problem solving consists of four phases viz., problem translation, problem integration, solution planning and monitoring as well as solution execution. During the first phase of problem translation, the problem-solver transforms the statements of the problem into a mental model that represents the problem-solver's interpretation of the problem. In the second phase, problem integration, the different pieces of this interpretation are combined into a coherent structure that will support a problem-solving plan. In the third phase, solution planning and monitoring, the problem-solver formulates a plan in the form of a sequence of steps for solving the problem. Finally, during the solution execution phase, the problem-solver carries out this plan, and solves the problem.

Heller and Heller (1995) proposed the 'Logical Problem-Solving Model' which involves five steps to solve problems in Physics: 'Focus the problem' develops a qualitative description of the problem. 'Describe the Physics' helps to prepare a quantitative solution using ones qualitative understanding of the problem. 'Plan the solution' helps to translate the description of physics into a set of equations. 'Execute the plan' helps the student to execute the planned solution and finally in 'Evaluate the answer' the work is checked to see that it is properly stated, reasonable, and has answered the question asked.

Gresham (2002) proposed a problem solving model which includes evaluating a student's response-to-intervention (RTI) as an alternative to the IQ-achievement discrepancy approach to identifying learning disabilities. RTI includes problem solving procedures viz., implementing evidence-based interventions, frequently measuring a student's progress to determine whether the intervention is effective, evaluating the quality of the instructional strategy and evaluating the fidelity of its implementation.

A three-tiered model for effective problem solving was implemented by the Office of Special Education Programs (2002). In this model, tier one incorporate problem-solving strategies directed by the teacher within the general education classrooms. Tier two consist of problem-solving efforts at a team level in which grade-level staff members or a team of different school employees team up to develop an intervention plan that is still within the general education curriculum and tier three involves referral to a special education team for additional problem solving and, potentially a special education assessment.

Nurturing Integrated Process Skills through Problem Solving Model of Teaching

Teaching is a means for generating an environment of learning. This involves a number of independent variables influencing student learning. The content of study and skills of teaching functions as instructional inputs through which the student and teacher interact with each other. This interaction provides an opportunity to develop physical and social efficiency.

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Model of teaching is a tentative theory or plan designed with a view to shape a curriculum or course, select appropriate instructional material and to guide the teacher's course of action. The main postulate of the concept of 'Teaching Model' is that the learning outcome can be classified into distinctive categories and each objective can be achieved by generating specific situations (Joyce and Weil, 1992). Teaching models provide learning experiences by creating appropriate environment conducive to real behavioral outcomes. The different types of teaching objectives are achieved by organizing teaching elements in different ways.

Teaching models are just instructional designs. Joyce and Weil (2003) defined teaching models as "a pattern or plan that we can use to design face to face teaching in classrooms or tutorial settings and shape instructional materials". A single model of teaching normally includes a number of teaching strategies based up on different theoretical aspects of the psychology of learning. The fundamental teaching strategies which form the layout of the problem solving model of teaching for nurturing integrated process skills are focus, syntax, principles of reaction, support system, social system, instructional effects and nurturant effects.

Focus: Focus is the goal or objectives of teaching. The focus of the Problem Solving Model for enhancing Integrated Process Skills in Physics at Secondary Level, is to nurture the integrated process skills viz., identifying and controlling variables, formulating hypotheses, defining operationally, experimenting and interpreting data, in Physics at secondary level by promoting the development of scientific attitude and various strategies of inquiring that are essential to an investigating mind. The Problem Solving Model was developed in the present study in accordance with the five phases of Wood's Problem-Solving Model (1975) viz., define the problem, think about it, plan a solution, carry out the plan, and look back.

Syntax: Syntax is the different stages of teaching. They are the phases of the model or the sequences of activities. It includes the sequences of steps involved in the organization of the complete program of teaching. In the present study, the syntax of the Problem Solving Model for enhancing Integrated Process Skills in Physics at Secondary Level, involves four stages viz., **Exposure**(defining the problem and thinking about it); **Exploration** (planning a solution), **Execution** (carrying out the plan) and **Evaluation** (looking back).

Stage 1: Exposure: involves two stages viz., 'defining the problem' and 'thinking about it' for creating an awareness of the problem. Defining the problem involves making observations consistent with the problem for identifying the different variables involved in the problem and interpreting the information provided in the problem statement as well as identifying the unknown elements for solving the problem. Thinking about the problem involves allowing the problem to simmer, identifying specific pieces of knowledge and collecting information for defining the variables operationally.

Stage 2: Exploration: focus on creating an environment for planning a solution enables the problem solver to consider all possible strategies and choose the best strategy.

Stage 3: Execution: This phase involves carrying out the plan and applying the solution for solving the problem which leads to formulating the hypotheses and experimenting.

Stage 4: Evaluation: involves the process of looking back which encourage the problem solver to reflect and facilitates interpreting the data for verifying the solutions evolved through its application in practical life situations.

Principles of Reaction: The principles of reaction tell the teacher how to regard the learner and how to respond to what the learner does. Teacher provide tasks to students level of cognitive activity, determines students readiness. Teachers can shape behaviour of the students by rewarding desirable behaviour and maintaining a neutral stands towards the real class room situation. The teacher's task is to facilitate discovery to nurture the process of inquiry and induce the students to reflect on it. The teacher needs to be careful that the identification of facts does not become the central issue and should encourage a good level of rigor in the investigation. He or she should aim to turn the students towards the generation of hypotheses, the interpretation of data and the development of constructs, which are seen as emergent ways of interpreting reality.

Support System: Support system includes all the additional requirements for teaching or any support for teaching that may beyond usual human skills, capacities and technical facilities. The aspect of a model is the support system, which means to provide facilities to teacher and the students to successfully implement the strategy of teaching. For example, number of audio visual aids, programmed text, laboratory work, quizzes and so on to cater to the needs of individual learner.

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A flexible instructor skilled in the process of inquiry, a plentiful supply of "real" areas of investigations and their ensuing problems and the required data sources from which to conduct inquiry into these are as provide the necessary support system for this model. The model requires flexible instructor skilled in the process of inquiry and supply of problem are of investigation.

Social System: Social system consists of the nature of the environment of the classroom. It describes the students and teachers role and relationships, and kinds of norms that are emerged. It refers to two elements: students and teachers roles. Specific learning's are very much controlled by kinds of relationships that are structured during the process of teaching. In the problem solving model the teacher acts as the scaffold or the facilitator. The teacher is the taskmaster for providing the problematic situation. Students are the active participants in this model. In a problem solving model a co-operative, rigorous climate is desired. During problem solving, the students need to hypothesize rigorously, challenge evidences and criticize research designs. The problem solving model maintains a moderate structure and a co-operative, rigorously intellectual climate in the laboratory and classrooms within its school system.

Instructional Effects and Nurturant Effects: Instructional effects are those directly achieved by leading the learner in certain direction (explicit effects) - cognitive effects. Nurturant effects means indirect effects of the model or hidden effects (implicit effects) in the learning environment which are effective changes in the learner. The Problem Solving Model for enhancing Integrated Process Skills in Physics at the Secondary Level promotes various strategies of problem solving abilities that are essential to an inquiring mind, including integrated process skills such as identifying and controlling variables, formulating hypotheses, defining operationally, interpreting data and experimenting. The model integrates several process skills into a single, meaning full unit of problem solving experience. Although its emphasis is on the underlying process of problem solving, it results in the learning of content in any curriculum area from which problems are selected. The specific objective of the Problem Solving Model for enhancing Integrated Process Skills in Physics at the Secondary Level is to realize seven instructional effects viz., observing, inferring, predicting,classifying, measuring, experimenting and communicating, which are the basic science process skills. The goal of Problem Solving Model for enhancing Integrated Process Skills in Physics at the Secondary Level is to enhance five nurturant effects viz., identifying and controlling variables, formulating hypotheses, defining operationally, interpreting data and experimenting, which are the five integrated process skills.

The Problem Solving Model for enhancing Integrated Process Skills in Physics at the Secondary level was developed in strict accordance with all the conventional procedures of developing and standardizing a model for teaching. The content validity of the Problem Solving Model for enhancing Integrated Process Skills in Physics at the Secondary level was assured by examining the different phases which form the layout of the problem solving model of teaching viz., focus, syntax, principles of reaction, support system, social system, instructional effects and nurturant effects in consultation with experts in the field of Educational Research.

Instructional Effects and Nurturant Effects: The problem solving model promotes various strategies of problem solving abilities that are essential to an inquiring mind, including integrated process skills such as identifying and controlling variables, formulating hypotheses, defining operationally, interpreting data and experimenting. The model integrates several process skills into a single, meaning full unit of experiences. Although its emphasis is on process, problem solving results too, in the learning of content in any curriculum area from which problems are selected. Each of these five instructional effects shall be facilitated through the basic process skills viz., observing, measuring, inferring, classifying, predicting and communicating. The nurturant effects of the problem solving model are the integrated process skills viz., identifying and controlling variables, defining operationally, formulating hypotheses, experimenting and interpreting data.

Conclusion

The integrated process skills directly or indirectly influence the day to day life of our children. There are several factors that hinder the performance of learners in science. Infrastructural limitations, large class size, heterogeneous grouping of students belonging to different motivational levels as well as diverse career interests of students are some of the challenges facing the science teachers at secondary level. Therefore it is essential to adopt certain strategies which facilitate the development of logical thinking and scientific inquiry for nurturing the development of Integrated Process Skills among students at secondary school level. Integrated Process skills tend to last longer than learned content. Therefore content-free

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laboratory games, where the focus is on the process of problem solving rather than on the specific scientific product maybe adopted as an effective strategy for developing Integrated Process Skills. Since logical thinking patterns developed through the problem solving approach can be readily transferred to new life or learning situations, Problem Solving Model of teaching may facilitate the development of integrated process skills.

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