CHAPTER – II
DEVELOPMENT OF IPAD ASSISTED INSTRUCTION AS COGNITIVE TOOL

2.1 Introduction to iPad assisted Instruction

This chapter provides a broad overview of the many strands that, together, contribute to the development of problem solving behavior. Many of the skills necessitated for learning according to the prescribed syllabus of secondary schools have direct or indirect relations with the learning and instructional theories propounded by Robert Gagne, Bruner, Piaget, Ausubel and others. Promotion of Problem Solving Behavior is more effective and meaningful at the secondary level because problem solving is higher order learning and the ability is related to formal operational stage.

The study of psychological theories would help in the identification of the components and the process of the development of the components of the Problem Solving Behavior. It has been presented briefly, in this chapter, some of the important learning and instructional theories, which help in transforming problems solving theories into meaningful practice. Based on the study of the psychological and instructional theories, the investigator has identified different components of problem solving behavior. The study of instructional theories based on Dick & Carey, ADDIE, KELLER’S ARC, ROSS & KEMP, ROBERT GAGNE’, ASSURE, and Merrill David’s First principles of instruction, has adopted several learning theories, which have helped in the development of an instructional model for the problem behavior. The methods adopted in schools for teaching mathematics, at present, concentrate only on mere understanding of the subject knowledge, but adopting instructional strategies based on modern instructional theories could develop different components of problem solving behavior.
Throughout the review, the researcher attempted to acknowledge gaps within the literature, as well as common themes that emerged. Additionally, differing perspectives on implementation of technology in teaching Mathematics are presented. The introduction provides a historical look at technology integration in schools and an overview of the iPad’s short history and introduction in education. The main areas of research are presented in separate sections and concluded with brief summaries and implications.

Use of technology help students to visualize, simulate, solve real world problems, collaborate, research, and design whenever possible. (Jong. H. Chung, 2007). Also, it supports the interdisciplinary collaboration to develop and implement innovative technological approaches (National Research Council, 2002). In addition, the technology expands what students can learn by providing them with access to an ever-expanding store of information. Yet the researchers (Roschelle, Penuel, 2004) emphasized that merely making computers available does not automatically lead to e-learning gains. They described technology integration as only one element in “what must be a coordinated approach to improving curriculum, pedagogy, assessment, teacher development, and other aspects of school structure”. Becoming literate in the 21st century puts new demands on learners to be able to use technology to access, analyze, and organize information.

The International Society for Technology in Education (ISTE) updated its National Educational Technology Standards for Students (NETS) in 2007 to better describe skills needed to learn and live in an increasingly digital world. “The ISTE Standards for Students” now includes creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem solving, decision-making, and digital citizenship along with technology operations and concepts. Research reports continue to reveal that instructional technology is not reaching its potential in classrooms. Teachers are reluctant to use technology for a variety of reasons. Some do not believe it is useful for teaching and learning mathematics (Hazzan, 2000), some lack
familiarity with the technological tools (Manoucheri, 1997), some lack knowledge related to the use of technology as part of classroom instruction (National Center for Education Statistics, 2000), and others may not be aware of the vast amount of resources available to assist them in this effort.

As technology becomes intertwined in our lives and with the birth of digital natives, schools are attempting to utilize technology to help provide the best learning experience for children. Traditionally, the use of Information and Communications Technology (ICT) in education has been segregated from the normal teaching classroom: personal computers were relegated to a separate computer lab where students would go to study computer-related topics. With the release of the Apple iPad, new and innovative ways of accessing and relating to information have emerged for both business and personal use. The iPad can be considered a pioneer, the first of its kind. It is neither a smartphone, a notebook nor a tablet PC, but includes some elements of all of them. The features which make the iPad stand out amongst other mobile devices include the streamlined design, the lack of peripheral attachment, the connectivity the large multi-touch screen and the variety of different applications available to the consumer. Although competing models of handheld and tablet devices are available, the Apple iPad is the most popular device currently on the market due to its unique design, accessibility features, and the abundance of available apps that, if implemented properly, could potentially impact educational practices. Apple’s iPhone and iPod Touch were already received, integrated, and accepted into the educational sphere before the release of the iPad in the spring of 2010.

Allowing students to use technological tools, such as the electronic tablet, for mathematical problem solving might represent a challenge for the teacher. Currently, technology is changing constantly and at high rate. As “most young people in many societies around the world carry mobile devices – cell phones, Sidekicks, iPhones – at all times”, it becomes increasingly possible
that many students have more experience with the new technologies than their teachers, particularly at high school level.

One of the newest approaches to using technology in the classroom is called the 1-to-1 initiatives. Many countries across the world have begun to equip their students and faculty with iPads: One iPad for every person. However, simply providing everyone with an iPad and saying, “Learn!” will not automatically make the world a better place. It is imperative that the iPad apps must be integrated with a suitable instructional design especially for teaching Mathematics through iPad apps. It is in this context iPad Assisted Instruction is operated as an individualized instructional strategy in which the instructional design is integrated with the use of iPad applications for learning Mathematics with Problem Solving ability. The purpose of this study was to examine the implementation of the iPad as an instructional tool through the experiences of classroom teachers.

2.2 Rationale for developing iPad Assisted Instruction as cognitive tool

To carry out this study, it was necessary to complete a critical review of the current literature. The literature review explores the experiences being provided to students across the nation who have been or who are currently engaged in iPad implementation initiatives in their classroom. Additionally, a review of literature related to the history of technology integration in schools and teacher preparation to support technology integration are also included. A review of the curricular or discipline-specific connections are being made to provide an understanding of how teachers are using the devices to forward academic or core curricula.

Despite the emphasis given to mathematical problem solving, however, research (Garofalo & Lester, 1985; Schoenfeld, 1985; 1987; Silver, 1985) shows that students’ low problem-solving performance is not due to the inadequacy of mathematical content knowledge and facts, but rather is associated with students’ inability to analyze the problem, to fully understand
it, to evaluate the adequacy of given information, to organize knowledge and facts they possess with the goal of devising a plan, to evaluate the feasibility of the devised plan before its implementation, and to evaluate the reasonableness of the results. Hence, individual’s awareness, consideration, and control of his or her own cognitive processes – metacognitive behaviors – are held to be essential in mathematics problem solving (Flavell, 1976).

Schoenfeld (1985) identified that together with heuristics, metacognitive control, and belief systems, resources (factual and procedural knowledge) a problem solver possess are fundamental for successful mathematics problem solving. However, further research (Carlson & Bloom, 2005; Lawson & Chinnappan, 2000; Schoenfeld, 1992) demonstrated that success in problem solving performance depends greatly on problem solver’s ability to retrieve more knowledge, activate links among knowledge schemas and related information, and to coordinate them at the same time. Carlson and Bloom (2005) pointed out in the direction of the importance of management of different mathematical resources.

A good learning theory not only describes but also prescribes what a teacher should do to facilitate learning of their students. Also learning theories were not comprehensive enough for structuring of practical educational situation. In brief, the contention is that psychology has focused on underlying principle of behavior that educators’ need scientifically tested general prescription for educational practice (Snelbecker, 1974).

One of the advocates of the theory of instruction Jerome Bruner (1966), advocates that theory of instruction can be a Guide to pedagogy. (Bruner, 1966). According to Glaser (1966) and Ausubel (1968) learning theories and instructional theories are independent and both are needed for a complete science of pedagogy. (Snelbecker, 1974). Glaser (1966), (Bruner, 1966), Siegel (1977), Ausubel (1976), and Snelbecker (1974) have been critical on using any one learning theory. According to them instructional theories can best be
formulated if theorist is free to draw from any and all learning researches, which can solve learning problems.

An overall goal is that implementation of the iPad and some of the many available academic apps geared toward math and literacy might somehow lead to improved student engagement to learn and increased performance on standardized tests (Kelleher, 2011; Marcoux, 2011). Critics, though, contend that technology usage in schools does not always meet the expectations of educators and other proponents of its integration (Murray & Olcese, 2011). The extent of implementation across grades and disciplines also varies, due in part to differences in technology and infrastructure budgets. As a result, the experiences being provided to students involved in these initiatives also vary across classrooms.

In discussing the evolving relationships between mathematics and technology, the role of student’s expectations around technology should also not be discounted. The great growth in popularity of children’s ‘educational’ notebooks, tablets, e-Readers and laptop equivalents is notable. Furthermore, it is remarkable to observe the increasing number of parents in cities around the world handing smart phones and iPads to babies in strollers and prams on public transport, in cafes and parks as a way to keep the children engaged and quiet. It is reasonable to think that these children are already being conditioned in ever-increasing numbers to expect to have learning delivered electronically! By the time this new cohort arrives at senior educational institutes, the question for them will be, “Why DON’T you use iPads to teach us? ”. Hence, iPad Assisted Instruction as an individualized instructional strategy is essential to help students enhance their learning skills.

2.3 Need for iPad Assisted Instruction in Math Teaching

Modern theoretical conceptions view learning as a set of processes having the function of information processing. According to the information processing theory, the processes that are presumed to account for learning
make certain kinds of transformation of inputs to outputs in a fashion somewhat analogous to the working of a computer. During a learning situation, physical stimulation of sensory organs is transformed into neural messages. These messages undergo other transformations in the nervous system so that can be stored and later recalled. The recalled information is again transformed into still other kinds of message that control the action of the muscles. This results in speech or other kinds of movements indicating the learning of some performance. These various types of transformations are called ‘Learning Process’. They are what go on “inside the learners head”.

Technology was not an academic silver bullet (Means, 2010) or babysitter (Fruend, 2011), or “a substitute for knowing numbers and operations or building fundamental concepts” (Kennedy & Tipps, 2000). Simply because technology was present in mathematics lessons did not guarantee that students would learn the mathematics content (Silk, Higashi, Shoop, & Schunn, 2009). Since Mathematics involves cognitive process, as Math learning requires Problem Solving Behavior the investigator as a teacher of Mathematics for the past 22 years has experimented that quite a few students are not able to rise up to the expectations in terms of their Problem Solving Behavior. Hence to suit their needs a blend of technology and pedagogy integration is essential which provides multisensory experiences to the Math students and helps them visualize the contents in Mathematics. Thus iPad Assisted Instruction as a blend of technology and pedagogy is the need of the hour in the present scenario to help students develop Problem Solving Behavior in Mathematics.

2.4 Developing a Model on Problem Solving Behavior in Mathematics

At the beginning of the 21st century “the rapid mathematization of work in almost all areas of business, personal decision making, and the social and life sciences dictates that most students learn more and different mathematics than school mathematics programs provide” (Fey, Hollenback, & Wray, 2010) creating unprecedented challenges in school practices. On the other hand, since the 1980s mathematics educators have agreed upon the idea of developing
problem solving ability and problem solving has become a focus of mathematics education as a means of teaching curricular material and seeking the goals of education (Stanic & Kilpatrick, 1989).

Problem solving plays an important role in present secondary level curriculum because (1) to build a new mathematical knowledge, (2) to solve problems that arise in mathematics and in other contexts, (3) to apply and adapt a variety of problem-solving strategies, and (4) to monitor and reflect on the mathematical problem-solving processes (NCTM, 2000).

Schoenfeld (1987) pointed out that the knowledge of meta-cognitive and cognitive skills will help students build a thinking plan which involves strategy, skills and procedures to solve the given problems. This new thinking plan is connected to the students’ understanding of the relevant mathematical concepts that will be used. While solving the problems, students will go through two phases such as interpretation of the mathematical language and the calculation process (A. Duru, 2011; Jonassen, 2003; Schoenfeld, 1987). Newman (1996) also postulated that both language and mathematical acumen are necessary for the successful solution of mathematical exercises. As Gagne (1987) suggested, in the process of mathematical word problem solving, student should be able to translate the concrete to the abstract and the abstract to the concrete. Therefore, the mathematical word problem is more unique and challenging task than the ordinary mathematics task. Mathematical problem solving is a “cognitive activity” involving processes and strategies.

Montague (2006) defined mathematical word problem solving as a process involving two stages: “problem representation” and “problem execution”. Both of them are necessary for solving problems successfully. Mathematical problem solving also requires “self-regulation” strategies. Mayer (2003) divided mathematical word problem solving into four “cognitive phases”: translating, integrating, planning and execution. Thus, students normally find difficulty in solving word problems firstly from translating the
word representations into mathematical representation. Hegarty and Kozhevnikov (1999) has approved that the use of visual representations was associated with success in mathematical problem solving.

The uses of visual representations in mathematical word problem are very useful. In elementary mathematical teaching and curriculum design, a representation that plays an important role in the teaching of basic whole number operations and generally in arithmetic, is the number line (D. Lucangeli, P. E. Tressoldi, M. Cendron, 1998). Thousands of applications have been developed that allow for word processing, database and presentation development, as well as spreadsheet entry. Designed to be durable enough for the roughest of users, even children, the iPad is constructed of the same glass and metal used in airplanes. In addition, operating system (iOS) and application software have yet to be penetrable by viruses or worms. Because of these design features and others, the iPad is currently the preferred choice for non-technical and young users. The case of use, coupled with the affordable cost, has encouraged educators to purchase the devices in bulk for implementation in their classrooms across the nation.

The principles set forth in educational psychology will contribute to improve educational practice only when schools operate in such a way that those principles are applied in their curriculum. Human abilities that may be improved through education are identified. ‘Problem Solving’ is one such ability, which needs the attention of the educators. Problem solving is a process and hence cannot happen at a point of time. It is related to other types of higher cognitive abilities. Problem solving has high positive correlation with problem judgment, reading and ideational thinking. Problem solving is the unique and invaluable aspect of human capability. Education can no longer restrict to only rote learning. The disciplines of education and psychology have produced a wealth of material on the problem solving behavior of humans and animals. Problem solving enables mankind both to adapt to the physical environment and to change parts of it. Everyone can think and solve problems,
but it is obvious that there are wide differences in this ability among individual at all age levels.

The main concern should be what can be done to have clarity in thinking among children, which solves problems more efficiently. It is an age of information technology wherein knowledge is expanding exponentially. It is difficult to keep up with this phenomenon. Information is not being used properly for solving the problem. It has been attributed to lack of ability to use the correct and appropriate information for solving problems. On the other hand researchers have been making efforts to develop instructional strategies to take care of inadequacies. An instructional model should have a strategy component as a module. However some important efforts have been made to include optimal combination of strategy components, which are far more useful than the piecemeal prescriptions. Gagne (1968) was a pioneer in attempting to integrate the piecemeal knowledge about the instructional strategies at the micro level. He identified nine events of instruction. One important area, which needs a detailed examination, is this idea of including the strategy component, suggested by Robert Gagne, in the instructional model. According to him the success of problem solving depends on the access to a larger body of well-structured domain of knowledge. Hence an eclectic model generation catering to the needs of the differentiated learners for enhancing their Problem Solving Behavior in Mathematics is the need of the hour.

Development of Problem Solving Behavior through iPad Assisted Instruction– A Model Generation.

According to J.P. Kieves the essential characteristics of a model is the proposed structure of the model, which is used to investigate the interrelationship between the variables. Research in education is concerned with the action of many factors, simultaneously or in a casual sequence in a problematic situation. Thus it is essential that research in the field of education should increasingly make use of models in the course of its inquiries. A useful model should fulfill the following requirements;
a) A model should contain structural relationship rather than associative relationship.
b) A model should lead to the prediction of consequences that can be verified by observation.
c) The structure of the model will desirably recall something of the casual mechanism, which is involved in the subject matter being investigated. Thus the model may contribute not only to prediction but also to explanation.
d) It should become an aid to the imagination in the formulation of new concepts and the new relationship and thus be the extension of inquiry.

Conceptual models provide a typical strategy to help students learn a concept task, or process which is frequently used in mathematics and science (Hodgson 1995; Mayer, 2003) respectively. Model-based learning makes three contributions to science education (Gilbert, 2000). First the formation and evaluation of mental models is central to developing an understanding of a scientific discipline. Second, the development and experimental testing of models supports authentic science inquiry-based learning. Finally, scientific models are major outcomes and products of scientific inquiry, and understanding the nature of science requires an understanding of these models within a philosophical, scientific and historical context.

A learner’s mental model is highly individualized and constantly changing as more input and learning take place. Lambert and Walker (1995) stated that a mental model is, “an individual’s existing understanding and interpretation of a given concept, which is formed and reformed on the basis of experiences, beliefs, values, socio-cultural histories, and prior perceptions. A mental model affects how one interprets new concepts and events.” Nersessian (2007) proposed that mental models are “organized units of mental representation of knowledge employed in various cognitive tasks including reasoning, problem solving, and discourse comprehension.” Donald Norman (1988) gave a current definition of mental models: “…….the models people
have of themselves, others, the environment, or things with which they interact. People form mental models through experience, training and instruction.” Norman also noted, “To gain control over a technical system humans try to build internal mental models of things with which they are interacting. These models provide predictive and explanatory power for understanding.”

Cognitive science researchers and scientists propose that the mind constructs mental models as a result of perception, imagination and knowledge, and the understanding of discourse. Mental models have become known as a summation of all of a person’s thoughts and understanding on a subject. More than just isolated bits of information, a mental model can become a system with which exploratory inputs can be fed and observed for its resultant behavior (Carroll & Olson, 1988). Mental models are incomplete, unstable, easily confused, and based on superstition instead of scientific fact. Despite these limitations, mental models play a very important role in understanding human cognitive change. Learners construct new knowledge and modify existing knowledge as they experience situations, problems, circumstances, and other events in learning settings (Tzenz & Schwen, 2003). One way to measure this learning is to examine the mental models of learners since they can reflect the type and level of construction that has occurred. Although mental models are different for novices and experts, the models of both continue to change as more knowledge is gained. Authentic project-based learning environments have the potential to provide an environment that allows students experience learning in situated contexts, and these experiences enrich and change their mental models. Model evolution is a teacher-student interaction process through which students restructure their initial ideas to produce successive intermediate models, until, hopefully, reaching the target model for the lesson.

The teacher, making a request for an explanation of a target phenomenon, often triggers a model. Assuming students have not already been given an explanation, they must invent an explanatory model that explains why the phenomenon occurred. Sometimes a student will volunteer an explanation
before the teacher requests it. The teacher and the students provide evidence to support an initial hypothesis.

The value of models and modeling to traditional scientific research is well documented (Black 1962). Models are important in scientific research both in formulating hypotheses to be tested and in describing scientific phenomena (Gilbert, J. 1995). In the past decade the value of models and modeling science education has been increasingly recognized among the science education reform movements (National Science Board Commission on Precollege Education in Mathematics 1983, Giere 1991, NRC 1996, AAAS 1993). With the directions of the reviews an initiative of exploration has been attempted by the present study to develop and generate a model on Problem Solving Behavior in Mathematics using iPad Assisted Instruction strategies.

The purpose of building a model, like that of advancing hypothesis, is that the model should be submitted to the test. The strength of certain types of models, for example models expressed in scientific form, is that they lend themselves more to data collection and testing.

To identify the Problem Solving Strategies to be integrated with the iPad Assisted Instruction the investigator has attempted to conceptualize various theories and concepts on Problem Solving theorized and studied by various researchers. These theories and concepts are tabulated from which the investigator has identified the Problem Solving Strategies.
<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Author/Model Name</th>
<th>Problem Solving Strategies / Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Polya (1945)</td>
<td>Understanding the Problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Devising a Plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carrying out a Plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Looking back</td>
</tr>
<tr>
<td>2</td>
<td>Humphrey (1948)</td>
<td>A problem situation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivating factors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trial and Error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some application in action</td>
</tr>
<tr>
<td>3</td>
<td>Bloom (1950)</td>
<td>Knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Understanding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Application</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Synthesis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluation</td>
</tr>
<tr>
<td>4</td>
<td>Mills and Dean (1960)</td>
<td>Recognizing the difficulty of the problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Classifying and defining the problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A search for a clue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluating and trying out the various suggestions</td>
</tr>
<tr>
<td>5</td>
<td>Robert Gagne (1965)</td>
<td>Gaining Attention</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Informing the learner of the objectives</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stimulating recall of prior knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presenting information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Providing Guidance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eliciting performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Providing feedback</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessing performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhancing retention &amp; transfer</td>
</tr>
<tr>
<td>6</td>
<td>ADDIE (1970)</td>
<td>Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implementation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluation</td>
</tr>
<tr>
<td>7</td>
<td>Anderson (1980)</td>
<td>Goal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cognitive Operation</td>
</tr>
<tr>
<td>8</td>
<td>Carpenter and Moser (1983)</td>
<td>External mental model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal mental model</td>
</tr>
<tr>
<td>9</td>
<td>Keller’s ARCS (1983)</td>
<td>Attention</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Confidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Satisfaction</td>
</tr>
<tr>
<td></td>
<td>Author(s)</td>
<td>Steps/Strategies</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>10</td>
<td>Bransford and Stein (1984)</td>
<td>Identify, Define, Explore, Act, Look back</td>
</tr>
<tr>
<td>11</td>
<td>Egon Koster (2003)</td>
<td>What is to be obtained? What is already known? What is the difference between the facts, which are given, and those, which are being looked for? What must be done to solve the problem? What helps searching?</td>
</tr>
<tr>
<td>13</td>
<td>Garofalo and Lester (1985)</td>
<td>Problem solving includes high-level cognitive skills that require regulation and coordination, such as “comprehension, visualization, abstraction, questioning, analysis, synthesis and generalization”</td>
</tr>
<tr>
<td>14</td>
<td>Gick (1986)</td>
<td>Construct, Search, Implement, Monitor</td>
</tr>
<tr>
<td>15</td>
<td>Wright and Williams (1986)</td>
<td>What’s happening, Isolate the unknown, Substitute, Evaluate</td>
</tr>
<tr>
<td>16</td>
<td>Heller, Keith and Anderson (1992)</td>
<td>Visualize the Problem, Plan a solution, Execute the Plan, Check and Evaluate</td>
</tr>
<tr>
<td>17</td>
<td>Montague (1992)</td>
<td>Problem Solving, Strategies include both cognitive and metacognitive strategies</td>
</tr>
<tr>
<td>19</td>
<td>Mayer and Sims (1994)</td>
<td>Spatial Ability</td>
</tr>
</tbody>
</table>
| 20 | Ross and Kemp Model (1994) | Identify Instructional Problems, and specify goals for designing an instructional program  
Examine Learner characteristics that should receive attention during planning  
Identify subject content, and analyze task components related to stated goals and purposes  
State instructional objectives for the learner  
Sequence content within each instructional unit for logical learning  
Design instructional strategies so that each learner can master the objectives  
Plan the instructional message and delivery  
Develop evaluation instruments to assess objectives  
Select resources to support instruction and learning activities |
|---|---|---|
Recency effect |
| 22 | Mark Hollabaugh (1995) | Focus the problem  
Describe the physics  
Plan the solution  
Execute the plan  
Evaluate the solution |
| 23 | Dick & Carey (1996) | Identify Instructional goals  
Conduct Instructional Analysis  
Identify Entry behaviors  
Write Performance objectives  
Develop criterion-referenced tests  
Develop Instructional strategy  
Develop and select Instructional Materials  
Develop and conduct Formative Evaluation  
Develop and conduct Summative Evaluation |
Cognitive processing  
Goal |
| 25 | ASSURE Model (1999) | Analyze Learners  
State Objectives  
Select Methods, Media and Materials  
Utilize Media and Materials  
Require learner Participation  
Evaluate and Revise |
| 26 | O’ Neil (1999) | Content Understanding  
Problem Solving Strategies  
Self-regulation |
Combining Problem elements  
Analogy  
Visualization  
Step-by-step analysis |
| 28 | Ganesan (2000) | Understanding the problem  
Organizing  
Exploring  
Analyzing  
Generating  
Integrating  
Evaluating |
| 29 | Maccini and Hughes (2000); Maccini and Ruhl (2000) | Search the word problem  
Translate the problem  
Answer the problem  
Review the solution |
Self – directed |
| 31 | Duch, Groh and Allen (2001) | Critical Thinking  
Analyze  
Find  
Evaluate  
Use resources  
Work Collaboratively  
Communication |
| 32 | Merrill’s First Principles of Instruction (2002) | Activation  
Demonstration  
Application  
Integration |
| 33 | Sutherland (2002) | Read  
Underline the Key terms  
Recognize information  
Recall relevant facts  
Relate facts to problem |
| 34 | Jean E.Pretz et.al (2003) | Recognize or Identify the problem  
Define and represent the problem mentally  
Develop a solution strategy  
Organize his or her knowledge about the problem  
Allocate mental and physical resources for solving the problem  
Monitor his or her progress toward the goal  
Evaluate the solution for accuracy. |
| 35 | Montague, M (2006) | Read  
Paraphrase  
Visualize  
Hypothesize  
Estimate  
Compute  
Check |
Presenting the analogy or aids  
Identification of problem situation  
Diagrammatic scheme of a problem  
Background knowledge of the problem  
Probing response  
Assessing entry behavior  
Verbal direction to thinking  
Analyzing  
Organizing  
Exploring relationship among variables  
Formulating Hypotheses  
Generating Solutions  
Verification  
Generalization |
Construct  
Organize  
Allocate  
Monitor  
Evaluate |
| 38 | Lambros (2004) | Problem based learning  
Active  
Investigative questions  
Explore  
Research relevant information  
Suggest solutions |
| 39 | Chung and Tam (2005) | Read  
Select  
Draw  
Write  
Check |
| 40 | Serap Caliskan et al., (2011) | Understanding the Problem  
Qualitative analyzing the Problem  
Solution plan for the Problem  
Applying the solution plan  
Checking  
Self-evaluation |

After conceptualizing the various Problem Solving Strategies mentioned above the investigator identified the following Problem Solving Strategies that can be suitable for teaching Mathematics at grade 10 level multicultural students of Fujairah, UAE.
The investigator carefully identified the following Problem Solving Strategies.

1. Advance Organizer
2. Gaining Attention
3. Analysis
4. Design
5. Development of Instructional Material
6. Implementation
7. Evaluation
8. Retention
9. Transform

To identify Problem Solving Behavior to be developed in Math Students the investigator has attempted to conceptualize various theories, concepts and studies on Problem Solving Behavior.

**Table 2.T.2. Theories and Concepts on Problem Solving Behavior**

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>Author</th>
<th>Components</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Weinstein and Meyer (1991)</td>
<td>Goal</td>
<td>For a learner to achieve specific learning goals and the degree to which the learner organizes, monitors, and modifies those</td>
</tr>
<tr>
<td>2</td>
<td>Schunk, 2001</td>
<td>Planning, Goal setting</td>
<td>Motivational and Behavioral processes including planning, Goal setting, and self-monitoring</td>
</tr>
<tr>
<td>3</td>
<td>Demetriou and Panaoura (2006)</td>
<td>Goal Setting, Planning, monitoring</td>
<td>Self-representation is an integral part of directive-executive function of the human mind. That is, the very process of setting goals, planning, monitoring action goals and the plans, and regulating real or mental action requires a system that can remember and review and therefore know itself.</td>
</tr>
<tr>
<td>4</td>
<td>Schank et al., (1999)</td>
<td><strong>Goal Setting</strong></td>
<td>Learning goals are the skills sets or knowledge that the learner needs to develop in order to be able to perform role or task.</td>
</tr>
<tr>
<td>5</td>
<td>Schraw (2006)</td>
<td>Setting <strong>goals, Planning</strong> and monitoring</td>
<td>Self-representation is an integral part of directive-executive function of the human mind. That is, the very process of setting goals, planning, monitoring action goals and the plans, and regulating real or mental action requires a system that can remember and review and therefore know itself.</td>
</tr>
<tr>
<td>6</td>
<td>Donovan, Bransford, (2005)</td>
<td>Goal setting and monitoring</td>
<td>Instructions should help students to learn to take a control of their own learning by defining learning goals and monitoring their progress in achieving them.</td>
</tr>
<tr>
<td>8</td>
<td>Coburn (2000)</td>
<td><strong>Advance Organizer</strong> (New knowledge based on prior Understanding)</td>
<td>Constructivism, which maintains that new knowledge, is built upon a learner’s prior understanding, including beliefs and knowledge</td>
</tr>
<tr>
<td></td>
<td>Author(s)</td>
<td>Concept/Method</td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>Sternberg (1986)</td>
<td>Advance Organizer</td>
<td>Presents the concept of an executive function that allows individual to access knowledge structures in a variety of ways. These strategies for accessing existing information and seeking new knowledge allow for a more effective use of stored knowledge structures.</td>
</tr>
<tr>
<td>11</td>
<td>Bruner (1996)</td>
<td>Advance Organizer</td>
<td>Learning is an active process in which, students construct new ideas or concepts based on their current or past knowledge.</td>
</tr>
<tr>
<td>12</td>
<td>Gagne (1965, 1977)</td>
<td>Information Processing Advance</td>
<td>Information –Processing model of learning could be combined with behaviorist concepts to provide a more complete view of learning tasks.</td>
</tr>
<tr>
<td>13</td>
<td>Gagne (1962)</td>
<td>Objectives</td>
<td>Need analysis helps to identify the objectives of instruction which will help the learners to achieve the purpose</td>
</tr>
<tr>
<td>14</td>
<td>Yager (1993)</td>
<td>Instructional Skills</td>
<td>Education programs should be based on objectives, generally expressed in performance terms that delineate a variety of instructional skills.</td>
</tr>
<tr>
<td>15</td>
<td>Thomas and McRobbie (2001)</td>
<td>Knowledge and awareness</td>
<td>In science education literature, metacognition is a knowledge, control and awareness of learning processes.</td>
</tr>
<tr>
<td></td>
<td>Author (Year)</td>
<td>Category</td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>17</td>
<td>Winograd (1990)</td>
<td>Regulating one’s knowledge, Process, cognitive and affective states</td>
<td>Peoples abilities and their affective states Concerning their knowledge, Self-management mental process that help learner of problem solving,</td>
</tr>
<tr>
<td>18</td>
<td>McRobbie (2001)</td>
<td>Knowledge, control and awareness of learning processes</td>
<td>In science education literature, metacognition has been defined as Knowledge, control and awareness of learning processes.</td>
</tr>
<tr>
<td>19</td>
<td>Anderson &amp; Schunn (2000)</td>
<td>Procedural skills</td>
<td>The use of examples to recollect the pre-requisite knowledge is a primary mechanism for learners to acquire procedural skill.</td>
</tr>
<tr>
<td>20</td>
<td>Merrill (1991)</td>
<td><strong>Time Management</strong> Identification of task complexity, Adjusting the Pace, Balancing intervening variable</td>
<td>Learning should be situated in realistic settings; testing should be integrated with the task and not a separate activity.</td>
</tr>
<tr>
<td></td>
<td>Author(s)</td>
<td>Process/Method</td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------</td>
<td>---------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sustain learning</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Donovan, Bransford, Pellegrino,</td>
<td>Organizing instruction</td>
<td>Teachers need to be able to make sense of experiences in the classroom and to organize their instructional actions within a coherent framework of teaching and learning.</td>
</tr>
<tr>
<td></td>
<td>(1999)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Corno (1994)</td>
<td>Plan, Organize, Self-instruct,</td>
<td>Self-regulated learners are people who can plan, organize, self-instruct, self-monitor, and self-evaluate at various stages of the learning process.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>self-monitor, self-evaluate</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Carr et al., (1998)</td>
<td>Thinking about thinking</td>
<td>Focus on what the child is thinking. Focus on how the child is thinking. Focus on child’s thinking about own thinking.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>regulation</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Kulik, (2002)</td>
<td><strong>Visualization</strong></td>
<td>Simulations that allow students to visualize complex phenomena and / or provide opportunities for practice and experimentation have proven very effective in particular contexts.</td>
</tr>
<tr>
<td>27</td>
<td>Selva Ranee Subramaniam (2009)</td>
<td>Higher-order thinking skills</td>
<td>Use of computer-assisted instruction is another intervention to be looked at in facilitating the teaching of thinking skills. One could expect teachers to face difficulties in employing specific techniques in the classroom to promote higher-order thinking skills among students.</td>
</tr>
<tr>
<td>28</td>
<td>Umadevi (2008)</td>
<td>Inquiry used to process information</td>
<td>Inquiry model useful in teaching students the skill of inquiry in order to process information.</td>
</tr>
<tr>
<td>29</td>
<td>Kozma, Chin, Russel &amp; Marx (2000)</td>
<td>Instructional technique - Simulations</td>
<td>In teaching simulation and experimentation allow students to explore concepts in new ways, enabling students to become self-directed learners.</td>
</tr>
<tr>
<td>30</td>
<td>Catherine McLoughlin Rowan Hollingworth (2001)</td>
<td>Simulations</td>
<td>In teaching simulation and experimentation allow students to explore concepts in new ways, enabling students to become self-directed learners.</td>
</tr>
<tr>
<td>31</td>
<td>Hartman (2001)</td>
<td>Graphic Organizer</td>
<td>Graphic Organizer techniques can help students analyze text and see how it is structured. Graphic Organizer help to understand concept map.</td>
</tr>
<tr>
<td>33</td>
<td>Bruce Weil (1978)</td>
<td>Information Processing Organizing data generate concepts</td>
<td>Information processing is the way people handle stimuli from environment, organize data, sense problem, generate concepts and solutions to the problems and employ verbal and non-verbal symbols.</td>
</tr>
<tr>
<td>34</td>
<td>King and Rosenshine (1993)</td>
<td>Connecting concepts</td>
<td>When students are trained they could make connections between concepts in different areas.</td>
</tr>
<tr>
<td></td>
<td>Author(s)</td>
<td>Reference</td>
<td>Method/Technique</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>35</td>
<td>Harpaz, Ausubel</td>
<td>(2003, 1968)</td>
<td>Connecting concepts / representations, connecting new information to former knowledge</td>
</tr>
<tr>
<td>36</td>
<td>Gagne</td>
<td>(1962)</td>
<td>Reinforcement, Strengthening with additional material</td>
</tr>
<tr>
<td>37</td>
<td>Bruner</td>
<td>(1973)</td>
<td>Revision Gap analysis / Performance gap</td>
</tr>
<tr>
<td>38</td>
<td>Trainin and Swanson</td>
<td>(2005)</td>
<td>Self-evaluation</td>
</tr>
<tr>
<td>40</td>
<td>Dirkes</td>
<td>(1985)</td>
<td><strong>Advance Organizer</strong>&lt;br&gt;Connecting new information to former knowledge</td>
</tr>
<tr>
<td>41</td>
<td>Garcia and Pintrich</td>
<td>(1994)</td>
<td>Implementing, monitoring, controlling, regulating, motivation and behaviors</td>
</tr>
<tr>
<td>42</td>
<td>Zimmerman</td>
<td>(1989, 2000)</td>
<td>Thoughts, feelings, and behaviors</td>
</tr>
</tbody>
</table>
After conceptualizing the various theories and concepts of Problem Solving Behavior mentioned above, the investigator identified the following Problem Solving Behavior to be developed in Grade – 10 level multicultural students of Fujairah, UAE with which they can enhance their Math learning.

The learning outcome which depict the strategy components are:

1. Reading ability
2. Selecting Key words
3. Understanding the given condition
4. Recognizing the goal
5. Student thought process
6. Logical Mathematical ability
7. Spatial ability
8. Choosing the correct Formula
9. Substituting values correctly
10. Following step by step process
11. Processing speed
12. Handling basic operations correctly
13. Simplifying expressions correctly
14. Achieving goal
15. Checking the answer (Reasonableness)

Based on their study of group problem solving, Artz and Armour-Thomas (1992) further expanded Garofalo and Lester’s framework and proposed a new approach to analyze cognitive-metacognitive behaviors of individual students solving mathematical problems in a group setting. In particular, Artz and Armour-Thomas approach to interpreting metacognitive behaviors of problem solvers included identification of behaviors serving dual purposes. Working with 27 seventh-grade students divided into six heterogeneous problem-solving groups, the authors identified eight categories of observed problem solving behaviors and classified them as cognitive or metacognitive.
A study was done by Mugundan & Ramganesh., (2015) on an innovative model developed to integrate the components of Problem Solving Behavior to make the students attitudinal and productive in Mathematics learning. The data were collected and analyzed qualitatively. A coding sheet was used. The data was collected then and there based on students’ response when they were asked to solve problems on the board, from the students’ work during the class, and on homework and quizzes. Given the frequent accumulation of different components of Problem Solving Behavior, students could begin to grow their sense of Problem Solving Behavior in Mathematics.

Artz and Armour-Thomas, differentiated between cognitive and metacognitive behaviors in a way consistent with Flavell (1979), Garofalo and Lester (1985), and Schoenfeld (1987), who identified that cognitive behaviors are focused on doing (e.g., reading, drawing, and calculating) and metacognitive behaviors as focused on what to do, selecting what has to be done, in what order, predicting outcomes, and monitoring performance. Using the purpose of a specific behavior as a guide, Artz and Armour-Thomas listed the identified classes of behaviors, and identified their types as (1) reading – cognitive, (2) understanding – metacognitive, (3) analyzing – metacognitive (4) exploring – cognitive or metacognitive (5) planning - metacognitive (6) implementing – cognitive (7) verifying – cognitive or metacognitive, and (8) watching and listening – Undetermined cognitive or metacognitive level.

The existing frameworks for analyzing cognitive and metacognitive behaviors within a problem-solving episode help to understand what solvers do as they engage in problem-solving activities; nevertheless, these frameworks suffer from a number of limitations. Researchers have been able to identify cognitive and metacognitive behaviors displayed by solvers as they engage in problem solving. Some, (e.g., Goos et al., 2002) additionally identified whether metacognitive behaviors observed in small-group interactions are focused on monitoring and evaluating one’s self-thinking or thinking of others.
After identifying the problem solving strategies and different components of Problem Solving Behavior a model for developing Problem Solving Behavior in Mathematics was generated. A simple design of instruction consisting of input, process and output was adopted. The identified Problem Solving Strategies were organized based on the requirements of Problem solving situation in Mathematics and the same were treated as input. Also all the Problem Solving Strategies given in the output are supplemented with suitable iPad apps. The following model explains the detailed function of problem solving strategies through iPad Assisted Instruction in which a set of Behavior could be developed in students on enhancing their problem solving behaviors in mathematics.

In that way, the process component of the model is set to regulate the directives of the Problem Solving Behavior. These directives along with the treatment as input are believed to develop different Problem Solving Behavior in Mathematics. It was further understood that the systematic interaction of different components of Problem Solving Behavior while solving different problems in Mathematics would enhance the Problem Solving Behavior in Mathematics among Grade – 10 students. The Model generation was perfected with the opinions and expertise of the experts in Mathematics Education and Educational Technology. The Model is given below:
2.5. Pentagon Representation of iPad Assisted Instruction

Incorporating technology effectively involves (a) engaging students in active learning (b) relying less on whole-group instruction, and (c) encouraging more independent and self-motivational learning (Hadley & Sheingold, 1993). Williams and Williams (1997) note that effective technology use should incorporate a variety of applications that focus on problem solving and help development of creativity, adaptability and collaborative problem-solving skills.

Technology exists in classrooms not just for the sake of its presence, but also to enhance the learning process. Scheffler and Logan (1999) emphasize that integrating technology not only involves the attainment of computer skills but also consists of process in which learners try, fail, access, evaluate, analyze and apply meaningful tasks including but not limited to researching, analyzing data, applying and representing knowledge, communication and collaborating. Thus integration of technology into education means using it as a tool to teach subject matter, and to promote problem-solving and higher-order thinking skills.

Becker (1994) notes that a social network of computer-using teachers and organizational support from the school are important factors that contribute to the successful technology integration. Hadley and Sheingold (1993) suggest
that technology is most valuable to teaching and learning once teachers integrate it as a tool into everyday classroom practice and into subject-matter curricula. It is only through integrated practices that they can realize the hopeful and idealistic claims for technology (Collins, 1991). This requires readily and flexibly incorporating technologies into their everyday life in relation to the subject they teach.

Technology can be used not only as an information management tool, but also as a means of reaching students of diverse backgrounds (Sianjina, 2000). Use of technology can help teachers relate to today’s students who are very media aware, prompt new approaches to curriculum, encourage developments in teaching skills (Schwarz, 2000).

2.6. **Implementing iPad Assisted Instruction in Mathematics classroom**

Script writing is the initial step for the development of efficient instruction. Script should be written in keeping all types of learners in mind. Relevant information pertaining to the topic should be added. Long sentences should be made into small chunks. In the present study the scripts of iPad Assisted Instruction were prepared on the basis of the “MUGUNDAN’S MODEL ON PROBLEM SOLVING BEHAVIOR IN MATHEMATICS”. Twenty such scripts were prepared and validated with the experts in the field of Mathematics Education and Educational Technology. One of the scripts is presented below:
### SLOPE AND RATE OF CHANGE

<table>
<thead>
<tr>
<th>Text</th>
<th>Instruction</th>
<th>Effect</th>
</tr>
</thead>
</table>
| Dear Students now you are going to Learn about the following: Teacher Writes the Objective of the Lesson on the Board:  
  - To find the slope of the given line  
  - To find the slope of a line joining two points.  
To create interest in students knowledge in Slope, the teacher pose the following questions: | | Learning Outcome: |
Recall Memories and Experience with steep hills, as they relate to roads, ski slopes, bike rides, etc., (Gaining Attention) – (Problem Solving Strategy). At this time, the teacher shows some pictures of ramps in the hospitals, which was used to move patients from one place to another in a wheel chair etc., (Advance Organizer) (PSS) – (Conceptual bridge from old information to new knowledge) – Process.
To bring about the readiness of the Students teacher pose the following questions to elicit their response:

Look at the following Graph:

Recollect
- X – axis
- Y – axis, and
- The Origin.
- Any point in the graph is denoted by \((x, y)\), where \(x\) is the distance measured along the x – axis from the origin and \(y\) is the distance measured along the y – axis.

This stimulates to receive instructions. (Process).

Teacher uses iPad app GEOMETRY PAD to explain the following:
During this process, the teacher explains how to name the coordinates in the XY-plane. Always the first coordinate represents the x-value (which was measured from the origin) along the X-axis and the second coordinate represents the y-value (which was measured from the origin) through y-axis.

Now the teacher defines the Concept of Slope as you go through now.

- The slope is defined to be the ratio between rise and run. OR
- The ratio between the difference in y-axis and the difference in x-axis values.

To explain this, the teacher uses the iPad app called GEOMETRY PAD & AIR SKETCH (Development of Instructional Material) – Design – PSS – (Development of a Plan) – Process. Teacher uses the AIR SKETCH iPad app and explains about the ratio with simple example like ‘a/b’- (‘a’ over ‘b’).

Teacher gives an example, where the UAE students’ are very familiar with: BMI (Body Mass Index) which is the ratio of a person’s weight and square of the person’s height in meters. (Advance Organizer) (PSS) – (Conceptual bridge from old information to new knowledge) – Process.

Teacher shows some short movies of Obese students picture and how their BMI was calculated.
- Teacher draws some line in the **AIRSKETCH app** as well, so that all students can easily follow the steps.
- **(Development of Instructional Material) - Design - PSS - (Development of a Plan) - Process.**

Teacher uses iPad app **GEOMETRY PAD & AIRSKETCH app** to explain the following:

<table>
<thead>
<tr>
<th>GEOMETRYPAD &amp; AIRSKETCHApp</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPad Math app ability,</td>
</tr>
<tr>
<td>Spatial ability - (PSB)</td>
</tr>
</tbody>
</table>
Slope and the Four-Step Process:

(Analysis) - PSS - (Pre-requisite Knowledge of Problems) – Process

**Step 1:** Place your pencil at the origin of the graphing grid and draw a point at the origin.

**Step 2:** Move the point of your pencil One unit to the right of the origin. This one unit is called as “RUN”

**Step 3:** Move the point of your pencil ‘North’ $k = 4$ units. (This Four Units is called as the “RISE”) which is equal to the slope. Draw a second point at this location.

**Step 4:** Draw a line that connects these two points. This line has slope $k = 4$.

Teacher uses iPad app GEOMETRY PAD to explain the following:

GEOMETRY PAD
&
AIRSKETCHapp.
iPad Math app ability,

Spatial ability - (PSB)
Teacher Explains the meaning of the **Slope – Intercept form of a linear equation**.

**Slope – Intercept form of a linear equation.**

\[ y = mx + b, \]

where \( m \) represents the slope of the graph of the equation and ‘b’ represents the \( y \) – intercept.

For an example, if you are given with a pair of points, or a graph, first, find the slope of the given line by choosing any two points on the line. Secondly, Use the slope any one of the given point in the formula \( y - y_1 = m(x - x_1) \) to get the equation of the line in slope-intercept form \( y = mx + b \). Teacher explains finding the slope of a line by using the formula, by choosing any two points on the line.

**Example: 1**

From the following example, students learn the steps involved in finding the slope of the line from the given graph.

Find the slope of the line from the graph.

**Reasoning:**
- Reading ability, Selecting Key words, Logical and Mathematical ability, Choosing the correct formula, Achieving the goal, Checking the answer (reasonableness), Processing Speed – PSB

**Tools Used:**
- GEOMETRYPAD
- AIRSKETCH App
- iPad Math app ability,

**Spatial ability - (PSB)**
SOLUTION:
Identify any two points on the given line, and mark them as $A(x_1, y_1)$ and $B(x_2, y_2)$. 
GEOMETRY PAD
&
AIRSKETCH App.
iPad Math app
ability,

Spatial ability—
(PSB)
Choose any two points as the graph, and substitute in the slope formula as follows.

(Implementation) – PSS – (Applying correct formula or rule for achieving the goal) – Process.

\[ m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{9 - (-3)}{3 - (-6)} \]

\[ m = \frac{12}{9} = \frac{4}{3} \]

(Choosing the correct formula, Following step by step process, Simplifying expression, & Achieving the goal) - PSB
Example: 2

- Write an equation for the line that passes through \((-2, 7)\) and \((3, -3)\).

(Evaluation, Retention, and Transform) – PSS – 
(Substituting the values & Handling the Basic operations correctly, Checking the answer (reasonableness) – PSB.

SOLUTION:

Read the problem carefully. (Reading ability) - PSB
Here you are given with pair of points.

First find the slope of the line passing through the given points. (Thought Process) – PSB.

Then use the value of the slope along with any one of the given point as \((x, y)\) in the Slope-intercept form \(y = mx + b\), to find the value of ‘b’. Then substitute the value of ‘m’ and ‘b’ to get the equation of the line in slope-intercept form as \(y = mx + b\).

STEP: 1 Find the slope.

Substitute \((-2, 7)\) and \((3, -3)\) as \((x_1, y_1)\) and \((x_2, y_2)\) in the slope formula as follows.

(Evaluation, Retention, and Transform) – PSS – 
Choosing the correct formula, Simplifying expression - PSB

Choosing the correct formula,

\[
\text{Slope } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-3 - (7)}{3 - (-2)} = \frac{-10}{5} = -2
\]

Simplifying expression - PSB

AIRSKETCH, & 
ALGEBRATOUCH app

iPad Math app ability, 
Spatial ability - (PSB)

Choosing the correct formula, Simplifying expression - PSB

AIRSKETCH App 
& 
ALGEBRATOUCH app
**STEP: 2**

To find the value of ‘b’ – the y-intercept.

Substitute any one of the given point, for an example \((-2, 7)\) as \((x, y)\) and the value of slope ‘m’ in the slope-intercept form

\[ y = mx + b \]

we get,

\[ 7 = -2(-2) + b \rightarrow 7 = 4 + b \rightarrow b = 3 \]

Simplifying expression, Substituting the values & Handling the Basic operations correctly - PSB

Now, substitute the value of the slope ‘m’ and the value of the y-intercept ‘b’ in the slope-intercept form \(y = mx + b\),

we get \(y = -2x + 3\), which is the required equation of the line. Checking the answer (reasonableness) – PSB. Processing Speed-PSB

---

**Teacher gives a Problem similar to the one solved in the class, to check the students’ understanding.**

**TRY YOURSELF**

1. Write an equation of the line passing through the following pair of points.
   - (a) Passes through \((-2, -6)\) and \((4, 6)\)
   - (b) Passes through \((-25, -10)\) and \((-28, 12)\)

(Choosing the correct formula, Simplifying expression - PSB

AIRSKETCH App &

ALGEBRATOUCUt app

(Evaluation, Retention, and Transform) – PSS

- Reading ability, Selecting Key words, Logical
| and Mathematical ability, Recognizing the goal, Choosing the correct formula, Achieving the goal, Simplifying the expression, Checking the answer (reasonableness), Processing Speed – PSB |
2.7. Conclusion

The development of the model was the result of the joint effort between the teacher and the students. It was not the product of an insight but a slower step-by-step, model evolution process. Even though the teacher’s goals were primarily content-driven in this case, these lessons also speak to many progress goals.