CHAPTER II

THEORETICAL CONSTRUCTS ON ENVIRONMENTAL EDUCATION AND PLAN OF ACTION – AN OVERVIEW

This chapter deals with the theoretical constructs on Environmental Education and Plan of Action meant for learning of Geography.

2.1 Theoretical Constructs on Environmental Education

2.1.1 Environmental Education

Environmental education creates opportunities where students can have a direct experience with what is, for many of them, a separate reality. It is implied that through the process of environmental education, students will develop knowledge about and concern for the natural world. The task of the instructor is to craft appropriate experiences in reflection of both "place" and "learner."

Environmental education has developed along a bifurcated path. On the one hand, we think of environmental education as 'strategies emphasizing the development of scientific knowledge and technical or managerial solutions to environmental problems'. On the other hand, there is also the dimension of environmental studies that seeks to instil a sense of caring and responsibility for the earth (1998). The synergism of these goals fuels both the enthusiasm for and the confusion about defining environmental education.

This outlines the historic roots, present practices and potential trajectories of environmental education. The opportunities have never been greater, nor the need more urgent, for an environmental education programme.

2.1.2 Environmental Education – the Genesis

Environmental education did not spring forth fully from any one discipline, but rather as a product of a co-evolutionary process within science, public awareness of environmental issues, and educational ideas.

Environmental thought in western countries has its roots in the Romantic-Nature Movement of the late 19th and early 20th centuries. Then, the difficult lessons of the dust bowl era in the 1930's and the extinction of previously abundant species such as the passenger pigeon sobered Americans into the development of the Conservation Movement - an approach to science that merged environmental thinking, science and life practice. Aldo Leopold, a college professor from Wisconsin, became the primary spokesman for the conservation movement. Rachel Carson's (1960) *Silent Spring* led to the first Earth Day celebration in 1970. In that same year, President Nixon signed into law Title Three, which provided funding for and mandated that every state develop and incorporate environmental education strategies and curriculum into their schools.

The educational roots of environmental education began in the early part of this century when a group of teachers and educational

leaders, led in part by educational philosopher John Dewey, began to work on new models for American education and learning. In 1919, they identified six basic principles for their Progressive Education Movement:

1. Children should have the freedom to develop naturally. The child's interests should be the basic motive for all his or her work
2. The teacher should function as a guide, not a taskmaster. Schools should pay equal attention to all facets of children's development, including the physical.
3. Record keeping should serve the goal and methods of the scientific study of children's development.
4. The school and the home must be active partners in meeting the needs of children.

One of Dewey's graduate students, L. B. Sharp, pragmatically started his child-centered, inquiry-based school camping approach in 1930, with his oft quoted phrase, "That which can best be learned in the out-of-doors, through direct experience, dealing with native materials and real life situations, should be learned there." Many schools in the early 1970's returned to Sharp's school camping model in order to fulfill their federal environmental education mandate. Federal financial support then sparked an explosion of summer camps adapting their facilities to serve school groups throughout the year. Despite the

disintegration of dollars in the late 1970's, residential environmental education continued to be one of the most popular expressions of experiential and environmental education available to school districts. Today these programmes are largely funded by the school districts themselves or by parents.

The events surrounding the twentieth anniversary of the first Earth Day coupled with the 1992 United Nations Earth Summit renewed Americans' interest in the environment and its potential role in education. However, as environmental education became an increasingly mainstream educational practice, it has become the subject of heightened analysis and tension.

There are basically two areas of contention. One relates to the ongoing debate of accuracy and fairness in environmental education materials and methods that have been historically fueled by industry. The second relates to environmental education's potential role in the educational reform movement.

During the last decade in particular, there has been considerable debate regarding the political motivations of environmental curricula. These arguments seem to coincide with the movement towards conservatism in western countries. In response to these concerns, in 1997, the Independent Commission on Environmental Education reviewed nearly 80 national and regional environmental education curricula for their accuracy in presenting environmental science and problems. Their

work revealed that most materials presented environmental science accurately reflecting current and evolving thought. However, some materials contained either consistent factual inaccuracies or falsely stated theories of science.

Environmental education also has contributed to the ongoing national debate on educational reform. The State Education and Environment Round Table has advanced project-based interdisciplinary studies as a way of breaking down the traditional compartmentalized approach to education. This has identified the environment as an integrating context for learning, their guidelines incorporate the following goals:

1. Break down the traditional boundaries between disciplines.
2. Provide hands-on learning experiences through problem-solving and project-based activities.
3. Create collaborative relationships between teachers.
4. Adapt to individual students and their unique skills and abilities.
5. Develop knowledge, understanding and appreciation for the environment, community and natural surroundings.

The work of the environmental agencies are focused on defining a new or clearer path for environmental education. There is also an emerging field of environmental education research that is attempting to identify the significant life experiences of pro-environmental adults and

how those events have shaped their life choices. The possible theoretical implication of this research is the substantiation of the concept that environmental education has the potential to serve a key role in educational reform.

2.1.3 Environmental movement

2.1.3.1 Western Try Out

In Europe, it was the Industrial Revolution that gave rise to modern environmental pollution as it is generally understood today. The emergence of great factories and consumption of immense quantities of coal and other fossil fuels gave rise to unprecedented air pollution and the large volume of industrial chemical discharges added to the growing load of untreated human waste. The first large-scale, modern environmental laws came in the form of the British Alkali Acts, passed in 1863, to regulate the deleterious air pollution given off by the Leblanc process, used to produce soda ash. Environmentalism grew out of the amenity movement, which was a reaction to industrialization, the growth of cities, and worsening air and water pollution.

In the United States, the beginnings of an environmental movement can be traced as far back as 1739, when Benjamin Franklin and other Philadelphia residents, citing "public rights," petitioned the Pennsylvania Assembly to stop waste dumping and remove tanneries from Philadelphia's commercial district. The US movement expanded in

the 1800s, out of concerns for protecting the natural resources of the West, with individuals such as John Muir and Henry David Thoreau making key philosophical contributions. Thoreau was interested in peoples' relationship with nature and studied this by living close to nature in a simple life. He published his experiences in the book 'Walden', which argues that people should become intimately close with nature. Muir came to believe in nature's inherent right, especially after spending time hiking in Yosemite Valley and studying both the ecology and geology. He successfully lobbied congress to form the Yosemite National Park and went on to set up the Sierra Club. The conservationist principles as well as the belief in an inherent right of nature were to become the bedrock of modern environmentalism.

In the 20th century environmental ideas continued to grow in popularity and recognition. Efforts were starting to be made to save some wildlife, particularly the American Bison. The death of the last Passenger Pigeon as well as the endangerment of the American Bison helped to focus the minds of conservationists and popularize their concerns. Notably in 1916 the National Park Service was founded by President Woodrow Wilson.

In 1949 'A Sand County Almanac' by Aldo Leopold was published. It explained Leopold's belief that humankind should have moral respect for the environment and that it is unethical to harm it. The book is

sometimes called the most influential book on conservation. In 1962, Houghton Mifflin published ‘Silent Spring’ by American biologist Rachel Carson. The book catalogued the environmental impacts of the indiscriminate spraying of DDT in the US and questioned the logic of releasing large amounts of chemicals into the environment without fully understanding their effects on ecology or human health. The book suggested that DDT and other pesticides may cause cancer and that their agricultural use was a threat to wildlife, particularly birds. The resulting public concern led to the creation of the United States Environmental Protection Agency in 1970, which subsequently banned the agricultural use of DDT in the US in 1972. The limited use of DDT in disease vector control continues to this day in certain parts of the world and remains controversial. The book's legacy was to produce a far greater awareness of environmental issues and interest into how people affect the environment. With this new interest in environment came an interest in problems such as air pollution and oil spills, and environmental interest grew. New pressure groups formed, notably Greenpeace and Friends of the Earth.

By the mid 1970s many felt that people were on the edge of environmental catastrophe. The ‘Back-to-the-land’ movement started to form and ideas of environmental ethics joined with anti-Vietnam War sentiments and other political issues. These individuals lived outside normal society and started to take on some of the more radical

environmental theories such as ‘deep ecology’. Around this time more mainstream environmentalism was starting to show force with the signing of the Endangered Species Act in 1973 and the formation of CITES in 1975.

In 1979, former NASA scientist James Lovelock published ‘Gaia: A new look at life on Earth’, which put forth the Gaia Hypothesis, that life on Earth can be understood as a single organism. This became an important part of the Deep Green ideology. Throughout the rest of the history of environmentalism there has been debate and argument between more radical followers of this Deep Green ideology and more mainstream environmentalists. Environmentalism has also changed to deal with new issues such as global warming and genetic engineering.

2.1.3.2 The Indian Try-out

The concern for nature and natural resources is not at all a new concept for Indians. Admiration of nature and the urge to concern and protect it has been part of our civilization. India’s wealth of literature, scriptures and folklore are rich with example, which shows that our ancestors were environmentally conscious and advocated concept of sustained usage of resources through many social customs, myth, taboos, tradition and religion. The rock edicts of Emperor Asoka (273-232 BC) are probably the first ever governmental directive towards environmental protection in recorded history. But, in spite of such an impressive

beginning, the conservation movement in India is less than two decades old. In India too, the era of environmental awareness began only in the 70's.

In the 1970s the Chipko movement was formed in India; influenced by Mahatma Gandhi, they set up peaceful resistance to deforestation by literally hugging trees (leading to the term "tree huggers"). Their peaceful methods of protest and slogan "ecology is permanent economy" were very influential.

2.1.4 Modern Approaches in Environmental Education

2.1.4.1 Evaluation approach

Due to the explosion in the students population, the written examination came into existence in 1702 through the sincere efforts of Cambridge University, England. But there was a problem to assess the students personality, traits, interests, attitudes, emotions, of the pupils. Before the existence of the term 'evaluation' the term 'test' was used to assess the acquired knowledge of the pupils. The term evaluation was developed in America and through the sincere efforts of Dr. B. S. Bloom in 1958. And this approach has also been adopted in Indian classrooms. Evaluation is always done in accordance with the various predetermined objectives. If any change in objectives is done, we should have to change the technique. In fact, examination is only part of evaluation. Various tests and techniques are used to judge about quantitative and qualitative changes in the students.

2.1.5 Teaching Strategies in environmental Education

Teaching strategy is a generalized plan for a lesson which includes structure, desired learner behaviour in terms of goals of instruction and an outline of planned tactics necessary to implement the strategy. The lesson strategy is part of a larger development scheme of the curriculum. There can be different types of teaching strategies.

A. Permissive Styles

Permissive styles of teaching strategy are based on modern theory of 'Organization of task and relationship centre'. This style seems less conventional. It is mainly child centered, the pupils largely determine the content. The affective objectives are primarily achieved by permissive style strategies. These strategies create situations for students and teachers interaction and both remains active in teaching. Teaching is organized with the consideration of student's interest, abilities and values. These strategies encourage the creativity of the pupils. The following are the strategies used in permissive styles. They are: Question-answer, Project strategy, Review, Group discussion, Role Playing, Discovery, Leaderless group and Brainstorming.

B. Autocratic Styles

Autocratic styles of teaching strategies are conventional. These strategies achieve different objectives more than permissive styles of teaching strategies. The autocratic style strategies are content centred,

teacher remains more active and students are passive listeners. The autocratic teaching strategies realize the cognitive and affective domains. The main emphasis is on presentation. These strategies do not consider the students abilities, interest and personality of the learner. There is no freedom for the learner in the teaching process. These are highly subjective and is a conventional style of teaching process. This style includes lecture, lesson demonstration, tutorials and programmed instruction.

2.1.6 Environmental Education-Background and Styles

Environmental education centers must challenge themselves to adopt institutional practices that model the same sorts of ideals they present in their educational programmes – to do less is to suggest hypocrisy. This involves committing to sustainability in design and practice, thus embodying what Oberlin College Professor David Orr has referred to as a "crystallized pedagogy," or to put it more simply, to practice what you preach. It also involves research: educational research for the growth of the environmental education profession and scientific research for the furtherance of knowledge and for the children's exposure to genuine science.

Effective environmental education brings about an increased awareness and appreciation of nature. It also reveals, in context, the wounds or separations that exist between the human and nonhuman worlds. Therefore, the problem every environmental educator must

address is how to motivate students into action without terrifying them into inaction. Environmental educators that fail to address the potential fear-producing effect of their lessons risk creating in their students a calloused or even fearful attitude toward nature, what educator David Sobel has referred to as "Ecophobia."

Australian educator Noel Gough has commented that environmental educators need to provide students with more complex and complicated discourse. I predict that this advanced discourse will involve creating landscapes of possible life-action in students and instilling an awareness of their responsibilities.

The inevitability of earth transformation does not preclude us from mindful decisions regarding the appropriateness of our actions. To be aware of the world around us is not enough, nor is it enough to be knowledgeable of ecology and earth systems. The critically important relationships we have with the natural world, including clean air, potable water and fertile soil, require the thoughtful application of personal and social practice. Creatively exercised, environmental education provides the context of concern necessary to develop this thoughtful application.

As environmental educators, we are teaching in the present, but preparing students for the future. We must strive to create educational experiences that challenge our students' perspectives both locally and globally. Whether we use a field guide or a database, the strength of our curricular tools is measured through the life actions of our students.

The impact of our methodology will be determined by the next generation.

2.1.7 Environmental Education –Operational Bases

Educating others in environmental principles and theories is a rewarding activity, and one that some individuals pursue as a full-time profession. Environmental education has evolved over the last century from a' once small field' of environmental interpretation to a growing discipline with new opportunities steadily arising.

Moreover, environmental issues have become increasingly important worldwide, and crucial decisions must be made with respect to balancing the use of resources, the needs of other organisms, and the economy. Environmental educators can provide an appreciation for the scientific method and the data behind these complex issues, leading to a better-informed populace. Teaching students and the public how data are collected and interpreted will give them a realistic view of information that influences the decision-making process. An informed public is likely to ask "Where and how were the data collected?" and "What are the assumptions and the alternative hypotheses?"

2.1.8 From Interpretation to Education

Environmental interpretation was a forerunner of environmental education, and was first undertaken on a broad scale by the National Park Service during the mid-twentieth century. Interpretation is defined

as an educational activity that aims to reveal meanings and relationships through the use of natural objects, by first-hand experience, and by illustrative media, rather than simply relating scientific principles in a formal classroom setting.

The uniformed park ranger presenting an evening campfire programmes or an interpretative nature walk was an early form of environmental educator. These types of programs were designed for a short-term, passive, noncaptive audience. Most visitors to natural areas simply desired to learn a little about the natural world while in an outdoor or on-site setting.

By the 1970s, traditional educators began to see a need to bring these educational activities into the classroom. The public's knowledge of the natural world was increasing, as well as awareness of the need for environmental protection and stewardship. Most states began to require an environmental education component in their established educational goals and benchmarks for higher secondary students. Hence, environmental education came into existence.

2.1.9 Types of Work

Most science teachers consider themselves multidisciplinary instructors, rather than environmental educators. A need therefore exists for curricula to fulfill the state’s requirements, and workshops that enhance teacher training in environmental sciences as well as in presentation methods.

Environmental education today combines both the principles of interpretation and formal science education. The overall goal is to teach environmental science in ways that are enlightening and enjoyable. This usually requires a combination of classroom work supplemented with outdoor field studies. The integration of traditional science with interpretive techniques is the greatest challenge the environmental educators encounter. Many educators supplement their instruction by bringing in guest speakers who are professionals in environmental disciplines.

Most quality environmental education programmes use an inquiry approach to learning. Students learn the basic principles and theories of environmental science and then apply them to the real world through the completion of research projects, field investigations, and hands-on activities. Work is performed outdoors, as well as in the classroom and at visitor centres. Some agencies and private companies have developed programmes that offer unique opportunities, including floating classrooms on a research vessel where students can study oceanography, marine biology, and water science. Internships at local, state, and federal agencies may provide additional opportunities.

2.1.10 Academic Preparation- Environmental Education

Environmental education is one of only a few professions that consider the Earth as an entire system, and not just the sum of its parts. To prepare for a career in environmental education, students must

become well versed in many different disciplines rather than specializing in just one field. Ecology, chemistry, geology, marine biology, aquatic science, and oceanography are all important if students wish to work in water science education careers. Mathematics is high on the list, as most studies relating to water science involve the use of mathematical formulae and statistics. Computer science and graphic design skills are prerequisites for those wishing to develop environmental education curricula that will satisfy audiences who increasingly prefer visual information.

2.1.11 Environmental Education in Class rooms

2.1.11.1 Sequencing of Instruction

One of the most important issues in the application of learning theory is sequencing of instruction. The order and organization of learning activities affects the way information is processed and retained (Glynn & DiVesta, 1977; Lorch & Lorch, 1985; Van Patten, Chao, & Reigeluth, 1986)

A number of theories (e.g., Bruner, Reigeluth, Scandura) suggest a simple-to-complex sequence. The algo-heuristic theory of Landa prescribes a cumulative strategy. According to Gagne's Conditions of Learning theory, sequence is dictated by pre-requisite skills and the level of cognitive processing involved. Criterion Referenced Instruction (Mager) allows the learner the freedom to choose their own learning sequence based upon mastery of pre-requisite lessons. Component

Display Theory (Merrill) also proposes that the learner select their own learning sequence based upon the instructional components available.

Theories that emphasize the goal-directed nature of behavior such as Tolman or Newell & Simon would specify that the sequence of instruction be based upon the goals/subgoals to be achieved. Gestalt theories, which emphasize understanding the structure of a subject domain, would prescribe learning activities that result in a broad rather than detailed knowledge for a particular domain.

On the other hand, behavioral (S-R) theories of learning such as Thorndike, Hull or Skinner, would tend to support a linear sequence of instruction. From the behavioral perspective, learning amounts to S-R pairings and mastery of a complex subject matter or task. It involves the development of a chain or repetoire of such connections. Indeed, a fundamental principle of Skinner's programmed learning was the "shaping" of such S-R chains.

Theories of adult learning such as andragogy (Knowles) or minimalism (Carroll) emphasize the importance of adapting instruction to the experience or interests of learners. According to these theories, there is no optimal sequence of instruction apart from the learner. A similar position based upon abilities would be espoused by theories of individual differences (e.g., Guilford, Cronbach & Snow, Sternberg) and supported by research on cognitive styles.

2.1.12 Cognitive Styles

Cognitive styles refer to the preferred way an individual processes information. Unlike individual differences in abilities (e.g., Gardner, Guilford, Sternberg) which describe peak performance, styles describe a person's typical mode of thinking, remembering or problem solving. Furthermore, styles are usually considered to be bipolar dimensions whereas abilities are unipolar (ranging from zero to a maximum value). Having more of an ability is usually considered beneficial while having a particular cognitive style simply denotes a tendency to behave in a certain manner. Cognitive style is usually described as a personality dimension which influences attitudes, values, and social interaction.

A number of cognitive styles have been identified and studied over the years. Field independence versus field dependence is probably the most well known style. It refers to a tendency to approach the environment in an analytical, as opposed to global, fashion. At a perceptual level, field independent personalities are able to distinguish figures as discrete from their backgrounds compared to field dependent individuals who experience events in an undifferentiated way. In addition, field dependent individuals have a greater social orientation relative to field independent personalities. Studies have identified a number of connections between this cognitive style and learning (see Messick, 1978). For example, field independent individuals are likely to

learn more effectively under conditions of intrinsic motivation (e.g., self-study) and are influenced less by social reinforcement.

2.1.13 Other Cognitive Styles

Scanning - differences in the extent and intensity of attention resulting in variations in the vividness of experience and the span of awareness

Leveling versus sharpening - individual variations in remembering that pertain to the distinctiveness of memories and the tendency to merge similar events

Reflection versus impulsivity - individual consistencies in the speed and adequacy with which alternative hypotheses are formed and responses made

Conceptual differentiation - differences in the tendency to categorize perceived similarities among stimuli in terms of separate concepts or dimensions

Learning styles specifically deal with characteristic styles of learning. Kolb (1984) proposes a theory of experiential learning that involves four principal stages: concrete experiences (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). The CE/AC and AE/RO dimensions are polar opposites as far as learning styles are concerned and Kolb postulates four types of learners (divergers, assimilators, convergers, and accommodators) depending upon their position on these two

dimensions. For example, an accommodater prefers concrete experiences and active experimentation (AE, CE). Pask has described a learning style called serialist versus holist. Serialists prefer to learn in a sequential fashion, whereas holists prefer to learn in a hierarchical manner (i.e., top-down).

Theoretically, cognitive and learning styles could be used to predict what kind of instructional strategies or methods would be most effective for a given individual and learning task. Research to date on this problem has not identified many robust relationships. However, the 4MAT framework based on the work of Bernice McCarthy which suggests 4 learning modes (Analytic, Imaginative, Common Sense, and Dynamic) has been widely applied in education.

2.2 Theoretical constructs on Plan of Action

2.2.1 Action Theory

Action Theory is concerned with the behaviour of an individual agent as a result of the individuals interaction with a situation. It is particularly interested in the nature of action: the distinction "between the things that merely happen to people -- the events they undergo -- and the various things they genuinely do" (Action, 2002). Action Theory is of interest to a wide and increasing number of fields, such as artificial intelligence, linguistics and human-machine interfaces. The role of Action Theory to solve a seemingly intractable problem in robotics illustrates its extensive applications (Agre, 1997). In the 1970s, robot

programmers found that despite their best efforts, no controlling software was complete enough to include a proper reaction to all situations encountered by a robot moving in a room with normal obstacles and imperfections. The two approaches initially considered to solve the problem were to increase the number of scenarios modelled at the expense of increasing complexity and increasing reaction time, or reducing the reaction time at the expense of not considering all scenarios. Action Theory, and more specifically the Situated Action model discussed later here, provided the rationale for what is now the standard solution to this problem: make the sensing and acting as local as possible, concentrating on immediate data. A relatively small central program detects the overall shape and solution of a problem ("turn right to avoid the table ahead"), but it does not describe the details of how to turn right to the wheeling actuators. Many construction practitioners will recognize similarities between this case and the challenges typically encountered in managing a project: no matter how detailed a project plan is, there will be unaccounted situations requiring a quick response. Action Theory models address this dilemma of thoroughness and central control versus versatility and fast turnaround.

2.2.2 The Deliberative Action Model

The Deliberative Action model asserts that project execution should be dictated by a comprehensive plan resulting from a deliberate intellectual effort to develop and use a symbolic model of the project

(Johnston, 2000). The main goal of the actors implementing this plan is to avoid divergences from the prescribed course of action, and to feed information to the symbolic model so that it can forecast deviations or change the original project plan.

In the Deliberative Action model, a central agent collects all possible information about the project and constructs a symbolic model of the world in which the project will be performed. Then, the model simulates an acceptable sequence of actions to achieve the desired goal, and the optimum output on the model is translated into 'actionable implications of Action Theories in instructions'. The output from this virtual model is The Plan, which serves as the command mechanism for the execution of all actions (Johnston and Brennan, 1996). Actors implementing The Plan have a subordinate role, if any, in deciding the steps to reach the desired goal. Successfully executing an action is synonymous with successfully following its Plan. Control consists primarily of measuring regularly project performance using measures that can identify variances from The Plan. This information is passed to the central agent, who translates it into input suitable to the symbolic action model.

The model simulates future state of the world, and the agent may decide – normally as a last resort – to change The Plan if the divergence between the world and The Plan is too large to get back to the originally intended track. It is common to find formal plans "decorating the project

management office walls on site" (Docherty, 1972). In most construction projects, particularly, "execution proper is governed by informal short-term planning performed by site/work field personnel, at times totally disavowing the formal plans" (Docherty, 1972). This dichotomy between the intended, centralized execution envisioned by The Plan and its seemingly inexplicable rejection by the actors in charge of its execution has mystified proponents of the Deliberative Action model: Regardless of any attention to detail, the updating of plans developed around this model cannot keep up with the execution pace of most projects.

2.2.3 The Situated Action Model

The Situated Action model has come to the fore of Action Theory in the last decades, challenging many of the premises of the Deliberative Action model. The fundamental insight of the Situated Action model is that everyone is immersed in an environment. This fact limits an agent's ability to perceive reality and to plan any action.

In contrast, the deliberative action model implicitly assumes that an agent can see the world from a detached position, "some 'aerial' viewpoint away from the action" (Agre, 1995). In other words, the deliberative model assumes that the agent sees all the pieces of the action. This is never the case. An agent is always situated in the world, hence the name of the Situated Action model. Situatedness has been frequently explained using game-playing metaphors (e.g., Chapman,

1991). The classic video arcade game of Pac-Man offers a good metaphor to explain this concept. The objective of the game is to circulate its hero – Pac-Man – through all the branches of a maze laid out in the screen so that it eats all the "pac-dots" spread on the branches, and the challenge is avoiding the moving evil ghosts trying to catch Pac-Man. It would be extraordinarily difficult to win at the game if it were played from Pac-Man's perspective, that is, if the player were able to see only the walls of the maze. The game is easier because the player can see the Pac-Man, the maze and the evil ghosts from above.

Similarly, planning and executing an action would be much easier if all eventualities could be observed from a vantage point. However, a planner can see only a small portion of the world, because she is immersed, or situated, in it. Another fundamental insight offered by the Situated Action model is that any action performed by an agent affects her environment, and any change in the environment affects the actions taken by the agent. This reciprocity has been described as "a dance between ourselves as relatively autonomous agents and an environment of rich structure" (Johnston, 2000). As Agree (1997) rightly points out, "action is not realized fantasy but engagement with reality. A situated action principle with great practical implications is that the vast majority of actions taken by an agent follow a stable routine; no one could function if each step in everyday life would need to be planned and

evaluated. It follows that the more routinised an environment can be, the more time actors can devote to the performance of actions meaningful to the pursuit of their goal (Johnston et al., 2005, using U.K. grammar routinised).

A structured environment relieves much of the cognitive burden that would be required to navigate an unstructured environment. As a corollary of the previous principle, planning an action should be an exceptional event, only becoming necessary when there is a break down of an agent's routine. The term breakdown is taken in the very general sense discussed by Heidegger (Heidegger, 1962) when he points out that routine artefacts, cultural or physical, are "invisible" to their user until a disturbance makes them "visible." Lastly, the Situated Action model posits that actions should be informed, but not dictated, by the project plan. Agre and Chapman (1990) call this distinction "plans-as-programmes" in the Deliberative Action model, and "plans as-communications" in the Situated Action model. The Situated Action model has been called a "congeries of theoretical views" by unforgiving authors (Vera and Simon, 1993).

The Situated Action model has evolved over time, and it has no canon defining what is or is not situated. Consequently, there is no "perfectly situated" project management system, although there have been attempts to formalize one (e.g., Johnson et al., 2005).

2.2.4 Instructions based on Action Theories

Instructions are the interface between the agent's intentions set forth in a plan and the actors in charge of executing the plan. Instructions, therefore, play an essential role in the execution of any plan, and are central to Action Theory. Suchman (1987), among others, makes the point that instructions, as any other cultural artefact, disappear from the forefront of attention when they are routinised. The need to follow instructions, amid the myriad of routine activities in a normal environment, is exceptional. As a corollary, instructions, similar to plans in general, must be envisioned as resources to manage action, and not as control mechanisms. All instructions are subjective and incomplete. As Suchman (1987) points out, "successful instruction-following is a matter of constructing a particular course of action.

Recognizing the indexicality of instructions is an essential component of the situated action model. The Deliberative Action model is especially weak in this area. Chapman (1991) considers instructions as an "intractable problem" of this model, since there is a fundamental contradiction in its plan-then-act requirement. This sequence requires perfectly clear instructions and assumes that plans can be implemented top-down, with actors being essentially replaceable executing machines. This assumption removes the possibility of subjective interpretation, and therefore the independence and initiative paradoxically essential to follow any set of instructions. The central role of the Plan in the

Deliberative Action model also brings a contradictory, absurd problem: it relies on the premise that instructions will be followed, and also that instructions will not be followed. Knowing when instructions should not be obeyed is the hallmark of any good manager. While it is true that good managers realize the absurdity of blindly following a set of instructions, it is also true that they will be held liable for breaking the plan if the project is unsuccessful.

Johnston and Brennan (Johnston and Brennan, 1996) discuss the case of a school improvement plan which relied on a centrally developed plan, with very detailed specifications. The plan quickly proved to be inappropriate for some schools. The school administrators tweaked the specifications, but the plan did not result in the intended improvements anyway. These school administrators were considered "recalcitrant" for not following the instructions provided, and "more training" was suggested to change the outcome.

2.2.5 Model-Centered Instruction and Design

Model-Centered Instruction is a set of principles to guide instructional designers in selecting and arranging design constructs, so it is appropriately called a design theory. It favors designs that originate with and maintain the priority of models as the central design structure.

A Layered View of Design— Model-Centered Instruction is closely tied to a layered view of designs. This view assumes that a designer

organizes constructs within several somewhat independent layers characteristic of instructional designs: the model/content layer, the strategy layer, the control layer, the message layer, the representation layer, the media-logic layer, and the management layer. The designer selects and organizes structures within each layer in the process of forming a design. The designer also aligns the structures within layers with those of other layers to create a vertical modularity in the design that improves its manufacturability, maintainability, and the reusability of designed elements. A design layer is typified by: characteristic design goals, building-block constructs, design processes, design expression and construction tools, and principles to guide the arrangement of structures. Over time, a layer becomes associated with specialized skill sets, publications, and a design culture.

Instructional theories provide principles to guide design within one or more of these layers, but no theory provides guidelines for all of them, suggesting to designers the wisdom of subscribing to multiple local theories of design rather than a single monolithic theory.

2.2.6 Model-Centered Instruction Theory

Model-Centered Instruction, as any design theory, can be described in terms of the prescriptive principles it expresses for each of these layers.

Content

The content of instruction should be perceived in terms of models of three types: (1) models of environments, (2) models of cause-effect systems (natural or manufactured), and (3) models of human performance. Together these constitute the elements necessary for performance and therefore for learning. Content should be expressed relative to the full model structure rather than simply as facts, topics, or lists of tasks.

Strategy

The strategy of instruction should be perceived in terms of problems. A problem is defined as any self-posed or designer-posed task or set of tasks formed into structures called "work models" (Gibbons, et al., 1995). These are essentially scoped performances within the environment, acting on systems, exhibiting expert performance. Problems may be presented as worked examples or as examples to be worked by the learner. During problem solution instructional augmentations of several kinds may be offered or requested. Dynamic adjustment of work model scope is an important strategic variable.

Control

Control (initiative) assignment should represent a balance between learner and instructor/designer initiatives calculated to maximize learner momentum, engagement, efficient guidance, and learner self-direction and self-evaluation. Instructional controls (manipulative) should allow

the learner's maximum ability to interact with the model and the instructional strategy's management.

Message

Contributions to the message arise from multiple sources which may be architecturally modularized: (1) from the workings of the model, (2) from the instructional strategy, (3) from the controls management, (4) from external informational resources, and (5) from tools supplied to support problem solving. The merging of these into a coherent, organized, and synchronized message requires some kind of message or display management function.

Representation

Model-Centered Instruction makes no limiting assumptions about the representation of the message. Especially with respect to model representation, it anticipates a broad spectrum of possibilities—from externalized simulation models to verbal "snapshots" and other symbolisms that call upon and make use of models learners already possess in memory.

Media-Logic

Model-Centered Instruction makes no assumptions regarding the use of media. Its goal is to achieve expressions that are transportable across media. The selection of the model and the problem as central design constructs assist in this goal.

Management

Model-Centered Instruction makes no assumption about the data recorded and used to drive instructional strategy except to the extent that it must parallel the model's expression of the content and align also with the chosen units of instructional strategy.

2.2.6.1 Scope of Model-Centered Instruction

When the designer enters design from the model/content layer, the priority of concerns follows this order:

What is the appropriate cause-effect model (or system) the learner should interact with?

What is the appropriate level of denaturing (reduction in fidelity and granularity) of models for a given learner?

What sequence or set of problems should the learner solve as a lens into or a mask on this model?

What resources and tools should be available as solving takes place?

What additional instructional augmentations should be supplied to support the solving of the problem?

Designers can enter design at any layer, placing highest priority on one of them. Design decisions made within the priority layer, however, then constrain decisions within the remaining layers and often either

create or destroy other layers and sub-layers of the design. This principle leads to important insights into the order of instructional design activities and thus layers provide a basis for generating and ordering design processes dynamically.

An analysis approach called the Model-Centered Analysis Process identifies the elements of all three model types and relates them directly to problems. This automatically unites the specification of the learning environments, instructional functionalities, surface dramatics, and logical thinking.

A model-centered design is centered around the model(s) selected by the designer. This is often a difficult and subtle choice. It is easy, for example, for a designer to mistakenly provide an interactive panel simulation for chemical analysis equipment, when what is needed is observation and interaction with an expert to interpret the outcome of chemical tests. The panel model can become the centre of the designer's attention because it is concrete and programmable, shifting attention away from the more important performance model from which the learner would benefit.

2.2.6.2 Principles of model-centered instruction

Experience

Learners should be given maximum opportunity to interact for learning purposes with one or more systems or models of systems. The models may be of three types: environment, system, and/or expert

performance. The terms model and simulation are not synonymous; models can be expressed in a variety of computer-based and non-computer-based forms.

Problem solving

Interaction with systems or models should be focused by the solution of one or more carefully selected problems, expressed in terms of the model, with solutions being performed by the learner, by a peer, or by an expert.

Denaturing

Models are necessarily denatured from the real by the medium in which they are expressed. Designers must select a level of denaturing matching the target learner's existing knowledge and goals.

Sequence

Problems should be arranged in a carefully constructed sequence for modeled solution or for active learner solution.

Goal orientation

Problems selected should be appropriate for the attainment of specific instructional goals.

Resourcing

The learner should be given problem solving information resources, materials, and tools within a solution environment (which

may exist only in the learner's mind) commensurate with instructional goals and existing levels of knowledge.

Instructional augmentation

The learner should be given support during solving in the form of dynamic, specialized, designed instructional augmentations.

2.2.7 Situated Learning

Lave argues that learning as it normally occurs is a function of the activity, context and culture in which it occurs (i.e., it is situated). This contrasts with most classroom learning activities which involve knowledge which is abstract and out of context. Social interaction is a critical component of situated learning -- learners become involved in a "community of practice" which embodies certain beliefs and behaviors to be acquired. As the beginner or newcomer moves from the periphery of this community to its centre, they become more active and engaged within the culture and hence assume the role of expert or old-timer. Furthermore, situated learning is usually unintentional rather than deliberate. These ideas are what Lave & Wenger (1991) call the process of "legitimate peripheral participation."

Other researchers have further developed the theory of situated learning. Brown, Collins & Duguid (1989) emphasize the idea of cognitive apprenticeship: "Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop and use cognitive

tools in authentic domain activity. Learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge." Brown et al. also emphasize the need for a new epistemology for learning -- one that emphasizes active perception over concepts and representations. Suchman (1988) explores the situated learning framework in the context of artificial intelligence.

Situated learning has antecedents in the work of Gibson (theory of affordances) and Vygotsky (social learning). In addition, the theory of Schoenfeld on mathematical problem solving embodies some of the critical elements of situated learning framework.

2.2.7.1 Scope of situated learning

Situated learning is a general theory of knowledge acquisition . It has been applied in the context of technology-based learning activities for schools that focus on problem-solving skills (Cognition & Technology Group at Vanderbilt, 1993). McLellan (1995) provides a collection of articles that describe various perspectives on the theory.

Lave & Wenger (1991) provide an analysis of situated learning in five different settings: Yucatec midwives, native tailors, navy quartermasters, meat cutters and alcoholics. In all cases, there was a gradual acquisition of knowledge and skills as novices learned from experts in the context of everyday activities.

2.2.7.2 Principles of situated learning

1. Knowledge needs to be presented in an authentic context, i.e., settings and applications that would normally involve that knowledge.

2. Learning requires social interaction and collaboration.

2.2.8 Elaboration Theory

According to elaboration theory, instruction should be organized in the increasing order of complexity for optimal learning. For example, when teaching a procedural task, the simplest version of the task is presented first; subsequent lessons present additional versions until the full range of tasks are taught. In each lesson, the learner should be reminded of all versions taught so far (summary/synthesis). A key idea of elaboration theory is that the learner needs to develop a meaningful context into which subsequent ideas and skills can be assimilated.

Elaboration theory proposes seven major strategy components: (1) an elaborative sequence, (2) learning prerequisite sequences, (3) summary, (4) synthesis, (5) analogies, (6) cognitive strategies, and (7) learner control. The first component is the most critical as far as elaboration theory is concerned. The elaborative sequence is defined as a simple to complex sequence in which the first lesson epitomizes (rather than summarizes or abstracts) the ideas and skills that follow. Epitomizing should be done on the basis of a single type of content

(concepts, procedures, principles), although two or more types may be elaborated simultaneously, and should involve the learning of just a few fundamental or representative ideas or skills at the application level.

It is claimed that the elaboration approach results in the formation of more stable cognitive structures and therefore better retention and transfer, increased learner motivation through the creation of meaningful learning contexts, and the provision of information about the content that allows informed learner control. Elaboration theory is an extension of the work of Ausubel (advance organizers) and Bruner (spiral curriculum).

2.2.8.1 Scope of Elaboration theory

Elaboration theory applies to the design of instruction for the cognitive domain. The theoretical framework has been applied to a number of settings in higher education and training (English & Reigeluth, 1996; Reigeluth, 1992). Hoffman (1997) considers the relationship between elaboration theory and hypermedia.

2.2.8.2 Principles Elaboration theory

1. Instruction will be more effective if it follows an elaboration strategy, i.e., the use of epitomes containing motivators, analogies, summaries, and syntheses.

2. 2. There are four types of relationships important in the design of instruction: conceptual, procedural, theoretical and learning pre-requisites.

2.2.9 Information Pickup Theory

The theory of information pickup suggests that perception depends entirely upon information in the "stimulus array" rather than sensations that are influenced by cognition. Gibson proposes that the environment consists of affordances (such terrain, water, vegetation, etc.) which provide the clues necessary for perception. Furthermore, the ambient array includes invariants such as shadows, texture, colour, convergence, symmetry and layout that determine what is perceived. According to Gibson, perception is a direct consequence of the properties of the environment and does not involve any form of sensory processing.

Information pickup theory stresses that perception requires an active organism. The act of perception depends upon an interaction between the organism and the environment. All perceptions are made in reference to body position and functions (proprioception). Awareness of the environment derives from how it reacts to our movements.

Information pickup theory opposes most traditional theories of cognition that assume that past experience plays a dominant role in perceiving. It is based upon Gestalt theories that emphasize the significance of stimulus organization and relationships.

2.2.9.1 Scope of Information pickup theory

Information pickup theory is intended as a general theory of perception, although it has been developed most completely for the visual system. Gibson (1979) discusses the implications of the theory for

still and motion picture research. Neisser (1976) presents a theory of cognition that is strongly influenced by Gibson.

Much of Gibson's ideas about perception were developed and applied in the context of aviation training during World War-II. The critical concept is that pilots orient themselves according to characteristics of the ground surface rather than through vestibular/kinesthetic senses. In other words, it is the invariants of terrain and sky that determine perception while flying, not sensory processing per se. Therefore, training sequences and materials for pilots should always include this kind of information.

2.2.9.2 Principles Information pickup theory

1. To facilitate perception, realistic environmental settings should be used in instructional materials.
2. Since perception is an active process, the individual should have an unconstrained learning environment.
3. Instruction should emphasize the stimulus characteristics that provide perceptual cues.

Conclusion

The overview of the theoretical constructs on Environmental Education and Plan of Action clearly indicates the theory support on the problem at hand which enabled the investigator to pursue the problem with vigour and vitality.