Effective teaching and effective student learning have always been a central focus of current educational reform movements. The overall effect of education is determined not only by its content, but also by the way in which it is delivered.

The formal education system fulfils the needs of a centralized society, but it is far less useful from the perspective of the locality in which people live. Now the nature of education itself is changing, as the prioritization of informal learning experiences, besides formal education, is expanding the range of learning options.

“In order to enhance rational thinking, knowledge and self sufficiency both the means as well as the requirements of the educational process have tremendously changed during the last few decades as there is a shift from the teacher-controlled approach towards a learner-directed approach in planning learning goals, learning environments composition, and learning resources” (Attwell, 2007; Brown & Adler, 2008; Anderson, 2009). Achieving well-defined standards of learning by children in schools is a powerful success indicator of the system that works. At the primary stage there is the need for comparability of formal and informal learning. Moreover, Indian parental expectations are so high that every parent wants that their child comes home disciplined (military style) and achieve success in examinations conducted by the schools. Thus, schools and parents help students to think, analyze, develop a variety of skills and excel in their chosen areas ultimately resulting in a more creative and a curious child.

The world of education goes through the process of change with the changing needs of the society. The methods of learning and teaching get altered according to the need of the learners at that particular time. Also, most of the educational researches now focus on the ways of teaching that can enhance academic achievement of the students using the best available resources. Researches have been conducted to test the effectiveness of new teaching learning approaches in order to improve the performance of the learners. Learning is a psychological phenomenon; no two
learners in a class are alike. In order to cater to the needs of the diverse learners and improve their academic achievement, research today has shifted its focus from autocratic and teacher oriented classrooms to instructional strategies wherein pupils are given due importance in putting their views in front of the teacher. Apart from physical participation of students in the class, it is important to involve their thoughts, ideas and surroundings into teaching. So, teachers need to adopt integrated and holistic education approaches today that can ensure a healthy future for students.

Teaching approaches thus must cater to the developmental needs of the students. In today’s world ecological approach is an emerging trend. Ecological approach is focused on a teaching learning process based on utilizing and integrating natural surroundings and environment of the learners. Ecological approach is pioneer in implementing such teaching strategies in classroom that utilizes the developmental principles of human development.

5.1 ECOLOGICAL APPROACH AND MATHEMATICS TEACHING

Universally mathematics is taught as one of the subjects in schools, colleges and universities. Mathematics is considered as “The Queen of all Sciences”. However, it is unfortunate to note that mathematics in general, is disliked by students and is not taught effectively by all teachers of mathematics in a classroom. Majority of the pupils feel that mathematics is a difficult subject and it can be understood and followed only by exceptionally intelligent students. Those who fail in the subject develop hatred towards it.

At present, how can pupil achievement in mathematics be optimized and yet be enjoyable at the same time, is a question which needs careful consideration. Much thought, research and in-depth searching for solutions to the problem are the needs of the day. What is required is learner-centered approach to enable them to work their own with little support from the teachers. When teachers carry out instructional process in the classroom, learners tend to be more passive listeners. No lesson can be effective unless there is effective pupil participation in it. In order to enable the learners to participate in the instructional process, there is an imperative need to adopt some kind of learner-centered new approaches in the classroom. Even the National Curriculum Framework 2005 lays a strong emphasis on the need to recognize the child as a natural learner, and knowledge as the outcome of the child’s own activity. It has stated
“In their everyday lives outside the school we witness the children enjoying the curiosity, inventiveness and constant querying. They actively engage with the world around them, exploring, responding, inventing and working things out, and making meaning.” (National Curriculum Framework 2005)

The teaching has to be integrated with environment based on real life situations using local experiences expertise and resources; the classroom territory has to be expanded over the whole environment so that the activities become supplementary to classroom teaching. If such an approach is systematically implemented with mobilization of required resources, it is very much likely that there may be an improvement in our mathematics education at school stage. One of the most innovative experiences in mathematics education at school level is ecological approach. In this approach, the learning is fitted to the abilities and interests of learners as there exists an opportunity for individual’s initiative, independent of collective study and creativity.

Thus, ecological approach enables all the students to create their own knowledge by interacting with the environment. In other words, there is a meaning that learner attaches to newly acquired knowledge in association with the experiences of the environment to which the learner is a part.

The main purpose of ecological approach is to actively involve students in the learning process; a level of student empowerment which is not possible in a lecture format. It is a process which requires knowledge to be discovered by students and transformed into concepts to which the students can relate. The knowledge is then reconstructed and expanded through new learning experiences.

Ecological approach is a methodology that employs a variety of learning activities to improve students’ understanding of a subject by using a structured approach which involves a series of steps, requiring students to create, analyze and apply concepts (Kagan, 1990). It utilizes ideas of Vygotsky, John Dewey and Bronfenbrenner’s in that both the individual and the social setting are active dynamics in the learning process as students attempt to imitate real life learning.

By combining teamwork and individual accountability, students work toward acquiring both knowledge and social skills. It is a teaching strategy which allows
students to work together in groups with individuals of various talents, abilities and backgrounds to accomplish a common goal.

In teaching of mathematics, an ecological approach focuses on looking at persons, families, cultures, communities, and policies in order to identify and intervene upon strengths and weaknesses in the transactional processes between these systems. The recent emphasis on individual-based models, which embrace methodological individualism, should be viewed as a return of reductionism in ecology. Johnston and Carter (2003) in their article titled integration as a sustainability teaching tool referred that “the reductionism inherent in our education systems must be countered with teaching strategies that imitate life. A main lesson of ecology is that everything is interconnected. But the longer students stay in the confines of the school, the more they are "subjected" to disconnection as they are taught through subject specialization and reductionism; a worldview in which everything is disconnected. They can’t see the real world "forest" that is life for all the homework and marks given out as "trees." Simply teaching the phrase "everything is interconnected" doesn't work if our students don't see and experience everything that is interconnected. This is because our education processes have been fragmenting life for students by compartmentalizing subjects. Hence there is an urgent need to introduce integrated approach in all subjects and especially mathematics, the most feared subject”.

Scientific literacy requires skill in maths, as does learning about ecology and environmental systems. There is plenty of mathematics to be discovered in the natural world, from patterns in nature to nature's engineering, and a symbiosis exists between basic scientific principles and their mathematical expressions in nature (Adam, 2003).

The principle of ecology makes tangible connections between mathematics and students' personal experiences, in other subject matters, their school lives, or their home life. For example, when working to understand percentage problems in an eighth grade classroom, students could relate their work to the division and distribution of understandable objects and materials such as money, pizza slices, or playing time on a video game system.

Excluding nature from the math classroom is unnatural and including nature would enliven the subject. Young students can be taught sustainability using simple
math, such as sharing. Basic mathematics-percents, ratios, graphs and charts, sequences, sampling, averages, calculus, variability and probability-all relate to current, critical issues such as pollution and the sustainable availability of resources. Understanding the math of exponential growth and limits to growth is essential for environmental literacy. Mathematical modeling is essential in assessing global environmental change.

“Science, mathematics and technology are defined as much by what they do and how they do it as they are by the results they achieve. To understand them as ways of thinking and doing, as well as bodies of knowledge, requires that students have some experience with the kinds of thought and action that are typical of those fields” (Rutherford & Ahlgren, 1990). Also, they have mentioned the various strategies used by the teachers in ecological approach such as:

- Starting with questions about nature
- Engaging students actively
- Concentrating on the collection and use of evidence
- Providing historical perspectives
- Insisting on clear expression

Thus, teaching mathematics ‘ecologically’ means teaching it with attention to the multiplicity of environments, systems, and potential in which and from which students learn. By teaching methods of conscious adaptation, mathematics teachers can offer students constructive strategies for recognizing, utilizing, and solving different problems within multiple environments.

Also, teaching through ecological approach provides opportunities to the students to apply mathematical concepts and reasoning to real life problems. It also helps in developing knowledge through the use of real world. It meets the learning needs of individual students and group of learners and meets their varying needs. It also helps students to develop social skills by creating content for interactions. In addition to improve academic performance and to cultivate more positive social behaviors, ecological approach has been found to lead to greater motivation towards learning and to improve self-esteem.

Thus ecological approach is learning from surroundings and through doing. It is the process through which individuals construct knowledge and acquire skills from
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direct contact with immediate environment. It occurs when individual engages in some activity reflects upon the activities, critically drive some useful insight from analysis and incorporates the result through a change in understanding and the behavior. This type of approach helps students to apply their knowledge in real life situations and help them to come with viable answers.

5.2 SIGNIFICANCE OF THE STUDY

The existing system of education is largely confined to knowledge transmission, while the need of the day is for students to learn and acquire wisdom to use knowledge for their own growth, character building and contributing to society. This view has been supported by the Delor’s Report (1972) which emphasizes that education must contribute to social and economic development ‘as also to bring out the treasure within the human beings’ and it can also be seen as a system for gainful employment resulting in sideling the development of a holistic personality. Education therefore, holds faster, deeper and more harmonious form of human development which could help in inculcating a respect for tradition, loyalty, culture and ideals of service to humanity. As formal education is one of many ways that children learn and develop. Learning begins well before children enter school, and once children are attending school they continue to learn both inside and outside the classroom. Parents play a critical role in providing learning opportunities at home and in linking what children learn at school with what happens elsewhere. By participating in learning interactions and activities outside the school, parents become important actors in a child’s learning.

As learning is subject to many influences, the most commonly accepted contemporary framework for viewing parental involvement was inspired by the ecological model of Bronfenbrenner (1979, 1986) and designed from a social and organizational perspective (Epstein, 1987, 1992, 2001). Also, some researchers make reference to an ecological theory of child development which emphasizes multiple interacting systems of influence and dynamic interactions between the child, the education system and wider social contexts over time (Bronfenbrenner 1979; AIHW 2012).
So, there is an urgency to reorient our existing teaching methods from ‘chalk and talk’ and lecture methods to problem-solving methods, from activity and issue-based approach to field work and case studies, from didactic to advise-based approach, and from rote learning to attitudes and skills development and learning through participation and educational training in order to deepen the experience and involvement with the natural surroundings. Our students learn what they live. If they spend all their school days in sterile classrooms, prison-like buildings and lifeless playgrounds, they will not become creative and critical thinkers, and they will not learn that human beings are a part of the beautiful web of life. Why should schools, by their very design, be allowed to kill the wonderful spirit of our youngest citizens?

Our students must learn some good things about the environment in school. Thus, educating for sustainability offers innumerable opportunities for integrating ecological literacy and an environmental ethic into the curriculum. This integration shows students, in a holistic way, that we value the earth and their future.

Mathematics is one important area of education for the child’s development. It is a subject quite like the Alladin’s Magic Lamp. The subject that can take scores of individual to heights or depths - be it in SSC, ICSE, CBSE, or competitive exams. Further, in today’s increasingly technological (and technologically dependent) society, more and more jobs are related to mathematics and science. It is also true that in each and every sphere of our daily life, mathematics provides us its help and patronage without which we cannot do anything. The knowledge of mathematics is very versatile and required in all the day to day life activities beginning from awakening to sleep in night. Thus we can say that in our daily life mathematics is as essential as the oxygen in the air. Each dealing of our life begins and ends with mathematical thinking and reasoning. For example, daily house hold problems, food, clothing, idea of quantity and quality, daily account of income and expenditure etc. Such type of day to day problems cannot be solved without the knowledge of mathematics.

Hence without the proper knowledge of mathematics literate as well as illiterate people cannot solve their daily life problems. Thus, knowledge of mathematics is closely related with our day to day life activities. Each and every individual needs the knowledge of mathematics at every moment. Also, all
mathematical concepts are present in nature, although they are not directly perceivable, but, they can be experienced. It is thus important to make child feel the presence of mathematics around him. So, we need to integrate theoretical aspects with practical implications of using mathematics in real life situations and natural world. But as Hart (1997) and Moore (2004) discussed that the culture of childhood that played outside is gone and children’s everyday life has shifted to the indoors. As a result, children’s opportunity for direct and spontaneous contact with nature is disappearing. Also, according to Kellert (2002), society today has become so estranged from its natural origins, it has failed to recognize our species’ basic dependence on nature as a condition of growth and development.

In these days as children’s lives disconnected from the natural world, their experiences are predominately mediated in media, written language and visual images (Chawla 1994). Pyle (2002) supported this view by stating that the virtual is replacing the real. Also Chipeniuk (1995) supplemented it by specifying that TV, nature documentaries, National Geographic and other nature TV channels and environmental fundraising appeals are conditioning children to think that nature is exotic, awe-inspiring and in far, far away, places they will never experience. Children are losing the understanding that nature exists in their own backyards and neighborhoods, which further disconnects them from knowledge and appreciation of the natural world.

Lack of outdoor activities not only hampers the growth and development of the child but also affect the natural environment. Research is clearly substantiating that an affinity to and love of nature, along with a positive environmental ethic, grow out of children’s regular contact with and play in the natural world (Bunting & Cousins 1985; Chawla 1988; Wilson 1993; Pyle 1993; Chipeniuk 1994; Sobel 1996; Hart 1997; Moore & Wong 1997; Kals et al. 1999; Moore & Cosco 2000; Kellert 2002; Bixler et al. 2002; Schultz et al. 2004).

But we need to incorporate conceptual knowledge of mathematics with its procedural knowledge, school mathematics with real world mathematics and with the changing needs of society. With this students will learn to look at mathematics as a whole, rather than piecemeal. Also, they will come to know that how the different mathematical concepts are connected to each other and to the real world. In mathematics, teaching with ecological approach means helping students staying
connected with the rest of nature. It includes a rich variety of interactive practices where by participants have opportunities to learn from their own and others experiences. The individual is actively and personally engaged in the processes like role playing and storytelling.

So much energy, time and money are spent in overcoming the phobia of mathematics which apparently appears as a jungle of abstract concepts. The mathematics subject, if taught in an organized way in classroom works wonders for students in the understanding the concept from childhood itself. In today’s world of education, where we are focusing on all-round development of child, ecological approach has been designed to make mathematics related to life and understanding of mathematical principles easier by integrating them with life practices. Once the fear is overcome the achievement scores are bound to rise. An integrated approach works only when content is well planned, assignments are ready and varied, and teachers are enthusiastic and willing to make mathematics livelier, more practical and more useful. We need to balance our approach to create a rich and novel learning experience for pupils. We can’t consider it to be an independent entity to be acquired or transmitted. Use of ecological approach in the present study aims at unlocking human potential within the classroom settings. Through this teachers will improve their practice, students will gain from an important paradigm shift in education, and ultimately society will be the greatest beneficiary. As suggested by one of the thought leaders of the emerging field “no one will consider educators as true professionals until they act like professionals in applying and analyzing the research (Wolfe, 2001). The present study is designed to research and collate empirical evidence of effectiveness of this new approach in Indian context.

5.3 STATEMENT OF THE PROBLEM

EFFECT OF ECOLOGICAL APPROACH TO MATHEMATICS ON ENVIRONMENTAL ETHICS AND ACHIEVEMENT IN MATHEMATICS IN RELATION TO PARENTAL INVOLVEMENT.

5.4 OBJECTIVES

The objectives of the present study can be stated as follows:

1. To develop and validate instructional material for implementing ecological approach for Class VI students in Mathematics.
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2. To study the effect of ecological approach and conventional approach on achievement in mathematics of Class VI students.

3. To study the effect of ecological approach on achievement in mathematics of Class VI students with high and low parental involvement.

4. To study the interaction between instructional approaches and parental involvement of mathematics students with regard to achievement in mathematics of Class VI students.

5. To study the effect of ecological approach and conventional approach on environmental ethics of Class VI students.

6. To study the effect of ecological approach on environmental ethics of Class VI students with high and low parental involvement.

7. To study the interaction between instructional approaches and parental involvement of mathematics students with regard to environmental ethics of Class VI students.

5.5 HYPOTHESES

In the light of above formulated objectives, following hypothesis were formulated in the present study:

**Hypotheses for Achievement in Mathematics of Class VI students:**

\( H_1 \) The two instructional approaches will yield equal mean gain scores on achievement in mathematics of class VI students.

\( H_2 \) The students with low and high parental involvement will yield equal mean gain scores on achievement in mathematics.

\( H_3 \) There will be no significant interaction between instructional approaches and parental involvement of mathematics students with regard to achievement in mathematics.

**Hypotheses for Environmental Ethics of Class VI students:**

\( H_4 \): The two instructional approaches will yield equal mean gain scores on environmental ethics of class VI students.

\( H_5 \): The students with low and high parental involvement will yield equal mean gain scores on environmental ethics.
H₆: There will be no significant interaction between instructional approaches and Parental involvement of mathematics students with regard to environmental ethics.

5.6 DELIMITATIONS OF THE STUDY

The present study was delimited to following areas:

1. The study was conducted on Class VI students only.
2. The lesson plans for Ecological Approach to mathematics were developed for fractions, decimals, lines & angles, perimeter & area, symmetry and data handling from prescribed syllabus of Class VI of CBSE/NCERT
3. The experiment was limited to forty seven days of the academic session.
4. The study was delimited to a Shivalik Public School, Phase-6, Mohali

5.7 METHODOLOGY OF THE STUDY

Tools Used

The following self-prepared tools were used to collect the data.

- Instructional material prepared on the basis of Ecological Approach.
- Mathematics Achievement Test.
- Environmental Ethics Scale.
- Parental Involvement Scale.

Sample

The study was conducted on 82 students of class VI of Shivalik Public School, Mohali, 42 for control group and 40 for experimental group. For selection, four groups were given Parental Involvement Scale. The scores of the groups were matched. It was found that all the four groups had no significant difference on their mean scores. So randomly two groups were selected for the experimental and control group.

Design of the study

Experimental method of research was followed. Two groups pre-test and post test design was used. The design of analysis was 2X2 factorial design for both
achievement and environmental ethics. The independent variable was the method of instruction i.e. ecological approach. Parental involvement was the classifying variable in the present investigation whereas achievement in mathematics and environmental ethics were the dependent variables.

### 5.8 STATISTICAL TECHNIQUES

Following statistical techniques were employed for analysis of data:

- Descriptive statistics such as mean and standard deviation was worked out to study the general nature of the sample.
- t-test was employed to find the matched groups.
- Analysis of variance was employed to analyze the data for significant F-ratios and to see the interaction effect of two variables on the third.

### 5.9 MAJOR FINDINGS

1. The students of experimental group taught by ecological approach scored more on achievement in mathematics as compared to control group taught by traditional method.
2. There was significant difference in mean gain scores of achievement in mathematics of students with low and high parental involvement.
3. There was no significant interaction between the instructional approaches and parental involvement on achievement in mathematics. The two variables may be treated as independent of each other.
4. The students taught mathematics by ecological approach exhibit similar environmental ethics as those taught by conventional approach.
5. There was no significant difference in mean gain scores on environmental ethics of students with low and high parental involvement.
6. There was no significant interaction between instructional approaches and parental involvement on environmental ethics.
7. The ecological approach enhances the achievement in mathematics as reflected from the feedback taken from the students.
5.10 CONCLUSIONS

1. The two instructional approaches did not yield comparable mean gain score on achievement in mathematics. The students of experimental group taught by ecological approach exhibited better achievement as compared to the students taught by traditional approach. Thus, the hypothesis $H_1$ stating “The two instructional approaches will yield equal mean gain scores on achievement in mathematics of class VI students” has not been accepted.

2. High and low parental involvement yielded different scores of students in mathematics. It implies higher the parental involvement higher shall be achievement in mathematics. Thus, the hypothesis $H_2$ stating “The students with low and high parental involvement will yield equal mean gain scores on achievement in mathematics” has not been accepted.

3. The two variables instructional approaches and parental involvement did not interact to yield differences with regard to achievement in mathematics of experimental and control groups. Thus, the hypothesis $H_3$ stating “There will be no significant interaction between instructional approaches and parental involvement of mathematics students with regard to achievement in mathematics” has been accepted.

4. Ecological approach reflected similar environmental ethics for both the experimental and control groups. Thus, the hypothesis $H_4$ stating “The two instructional approaches will yield equal mean gain scores on environmental ethics of class VI students” has been accepted.

5. The students with high and low parental involvement yielded nearly similar scores on environmental ethics. Thus, the hypothesis $H_5$ stating “The students with low and high parental involvement will yield equal mean gain scores on environmental ethics” has been accepted.

6. The two variables instructional approaches and parental involvement did not interact to yield differences with regard to environmental ethics of experimental and control groups. Thus, the hypothesis $H_6$ stating “There will be no significant interaction between instructional approaches and Parental involvement of mathematics students with regard to environmental ethics” has been accepted.
5.11 EDUCATIONAL IMPLICATIONS OF THE PRESENT STUDY

The ecological approach used in this study can be traced back to the work of Bronfenbrenner, Vygotsky and Dewey. Based on the ecological model of Bronfenbrenner (1979), the child is centrally positioned within a series of interconnecting environmental systems. The findings of the study revealed that ecological approach has positive effect on the achievement in mathematics of class VI students.

Ecological approach has been found to be a useful tool for enhancing the performance of the students in mathematics. Students taught mathematics by ecological approach scored better than the students taught by traditional method. Also it is found that students got motivated and became persistent in their learning process.

This approach is helpful in motivating students for bringing new ideas of learning in threat free environment. It is also helpful in enhancing their interest in learning by active participation in learning process. Students themselves start taking initiatives when they are given freedom by altering classroom environment and building rapport. They actively participate in the classroom in different activities.

Teachers should use ecological approach to the maximum to teach mathematics in lower classes in order to create interest and remove fear of mathematics, as it is crucial age when they develop habits, values and attitudes. It should be used for other subjects too.

Teachers should also make parents aware about this approach through parents teacher meetings and seminars to gain their support while implementing strategies under ecological approach.

So, ecological approach should be used maximally in our teaching-learning process. As nature itself is considered to be the children’s best teacher. So, there is a need to allow children’s exposure to the nature. The more personal students’ experience with nature, the more environmentally concerned and active children are likely to become.

Young children tend to develop emotional attachment to what is familiar and comfortable for them. So, they need to be taught by inducing familiarity viz, exposing in experience itself. It is the basic nature of the young children to be active, not immobile and bound in confines of the classroom. Movement is their natural action. They should, therefore be taught according to their nature i.e. by play way, by fun
activities, by various other outdoor activities and therefore ecological approach should be adopted in the schools. This will lead to preparation of self-motivated citizens for sustainable development.

It is well said that experience is the child of thought and thought is the child of action. So, in order to result in desirable behavior of the children, ecological approach must be adopted.

Thus, the ecological perspective is based on the understanding that the student and the learning environment mutually interact, learning is interactive and happens in relevant contexts only. But presently there is disconnect between the classroom learning and the real life due to over emphasis on achievement that takes away the joy of learning and its application in real situation. Educationists have been suggesting integration of classroom learning with real life. With rising concerns about environmental issues, the contemporary focus is on linking learning interaction to environment through green curriculum. So, there is a dire need of changing the process of teaching in order to improve the learning process. Teachers need to combine the surroundings, real life examples and understand the concept of ecological approach to strengthen their teaching. This approach needs to be applied in teaching and learning mathematics from the basic level so that the kids become well versed with basic concepts.

5.11 SUGGESTIONS FOR FURTHER RESEARCH

- The present study was confined to teaching mathematics. Similar research can be conducted to determine the effectiveness of ecological research for teaching science and social studies too.
- A similar investigation may be conducted on different levels viz., primary, secondary level in different subjects.
- Research may be conducted involving other important variables such as creativity, motivation, self concept, cognitive styles, environmental sensitivity and study habits too.
- Curriculum should be modified to suit the ecological approach.
- Effectiveness of ecological approach may be researched at larger scale for learners of different age groups, subject area etc.
Summary and Conclusions

- Student’s interest to study by experiences may further be probed and their effect on motivation may also be studied.
- More comprehensive researches with longer periods should be undertaken to determine the effect of ecological approach in enhancing environmental ethics.
- Role of parents and teachers in inculcating disposition to learn from environment needs to be studied.
- Use of ecological approach in rural areas is required as very few studies are done in these areas.

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