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Enhancing Science Process Skills and Scientific Attitude and Analysing their Interactions. :- An Intervention through Inquiry Learning Approach

* Sreetanuka Nath ** Dr. Sybil Thomas

Abstract

National Curriculum Framework (NCF) opens with a quotation from Rabindranath Tagore's essay, Civilization and Progress, in which the poet reminds us that "a 'creative spirit' and 'generous joy' are key in childhood, both of which can be distorted by an unthinking adult world". Learning in children takes place through interactions with the environment, nature, things and people. The physical activity of moving, exploring, doing things on one's own, with one's peers or company of adults gives rise to inquiry based questions are the key processes through which learning occurs. Most of the teaching is done in a traditional monologue session, where the teacher does the talking and the students are passive audience. Little is known to the teacher on the amount of knowledge consumed by the students. Unless the student seriously focuses on the key points delivered during the teaching, there is a definite reason for the knowledge to escape into thin air. This paper aims towards enhancing the science Process skills and scientific attitude of the students through inquiry learning approach of teaching science on Secondary school level. It also attempted to find out the interaction between science process skills and scientific attitude through inquiry learning approach.The results indicated an elevation science process skills and scientific attitude along with significant interaction between the variables under study.

Keywords : Scientific attitude, Science process skills, inquiry learning approach

Introduction:

Childhood is a period of growth and change, involving developing one's physical and mental capacities to the fullest. There is a constant need to recognize the child as a natural learner, and knowledge as the outcome of the child's own activity. In everyday lives, one can enjoy the curiosity, inventiveness and constant querying of children. They actively engage with the world around them, exploring, responding, inventing and working things out, and making meanings.

National Curriculum Framework (2005) lays emphasis on 'child centered' approach giving primacy to children's experiences, their voices, and their active participation. The key points are as under: -

- Learners actively construct their own knowledge by connecting new ideas to existing ideas on the basis of materials/ activities presented to them (experience).
- The structuring and restructuring of ideas are essential features as the learners' progress in learning.
- The engagement of learners, through relevant activities, can further facilitate in the construction of mental images of the relationships (cause-effect).

Gagne (1963) views science process skills as the foundation for scientific inquiry, and knowledge is developed inductively from sensory experience. These skills consist of basic and integrated science process skills. Learning integrated science process skills requires students to be at the formal operation stage according to Piaget's stages of cognitive development (Inhelder & Piaget, 1958; Brotherton & Preece, 1995). However, majority of the school students are operating at the concrete operational stage (Shayer, Kuchermann, & Wylam, 1976; Palanisamy, 1986). Many research studies (e.g., Allen, 1973; Klahr, Chen, & Toth, 1999) have shown that teaching school students on integrated science process skills require some form of specific training.

Some short-term studies have shown that students who use an inquiry approach have improved attitudes towards science For example, Selim and Shrigley (1983) compared two instructional modes, discovery and expository, for teaching science knowledge to fifth grade students. The treatment period was 21 days. After the treatment period, they found that students taught by teachers using the discovery approach (an inquiry approach) had a more positive science attitude than the control group who were taught by teachers using the traditional lecture approach.

The American Association for the Advancement of Science (AAAS) (1993) and the National Research Council (NRC) (1996) endorse science curricula that actively engage students in science using an inquiry-based approach. This approach has shifted the focus of science education from the traditional memorization of facts and concepts in separate specific disciplines to inquiry-based learning in which students seek answers to their own questions. The pedagogy advocated for is an inquiry approach, in which students are actively engaged using both science processes and critical thinking skills as they search for answers. Many studies conducted with middle and high school students found that inquiry-based science activities had positive effects on students' science achievement, cognitive development, laboratory skills, science process skills, and understanding of science knowledge as a whole when compared to students taught using a traditional approach (Chang & Mao, 1998; Ertepinar & Geban, 1996; Geban, Askar, & Ozkan, 1992; Mattheis & Nakayama, 1988; Padilla, Okey, & Garrand, 1984; Purser & Renner, 1983; Saunders & Shepardson, 1987; Schneider & Renner, 1980; Wollman & Lawson, 1978)20. Perhaps, as Hodson21 (1990) suggested, inquiry-based learning is a more effective way for students to learn science.

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Chang and Mao (1998) compared the impact of 2 weeks of traditional lecture-type instruction to 2 weeks of inquiry-based instruction on secondary students' achievement in earth science. They found that students who were taught using the inquiry-based instructional method scored significantly higher on an achievement test than those who were taught using the traditional lecturing approach. Similarly, Padilla, Okey, and Garrand22 (1984) studied the impact of a 14-week unit on integrated process skills (controlling variables, interpreting data, formulating hypothesis, defining operationally, and experimenting) on middle school students. In contrast, the control group received no direct instruction on integrated process skills. After 14 weeks they found that middle school students in the treatment group had significantly higher scores in process skills than the control group. Both studies demonstrated positive impact immediately following the treatment program, however, the impact on students' attitudes towards science has not been explored.

The researchers developed several inquiry learning activities in Science covering various topics of CBSE syllabus. Performing these activities facilitated Inquiry learning by giving rise to a lot of inquiry based questions which required to be catered by the facilitator. This research find out the effectiveness of these activities towards enhancing the science Process skills and scientific attitude of the students through inquiry learning approach of teaching science on Secondary school level. It also attempted to find out the interaction between science process skills and scientific attitude through inquiry learning approach.

Objectives Of The Study:-

- To develop inquiry based activities for teaching some concepts in science of standard IXth Science.
- To find out the usefulness of this inquiry based activities towards development of science process skills whilst comparing it with traditional face to face learning.
- To value the effectiveness of this inquiry based activities towards inculcation of scientific attitude vis-a-vis traditional face to face learning.
- To study the interaction between science process skills and scientific attitude through inquiry learning approach.

Operational definitions of the key terms

Inquiry Learning Approach:

Scientific inquiry is more complex than popular conceptions would have it. It is, for instance, a more subtle and demanding process than the naive idea of "making a great many careful observations and then organizing them." It is far more flexible than the rigid sequence of steps commonly depicted in textbooks as "the scientific method." It is much more than just "doing experiments," and it is not confined to laboratories. More imagination and inventiveness are involved in scientific inquiry than many people realize, yet sooner or later strict logic and empirical evidence must have their day (chapter1, benchmark, project 2061, AAAS) .

Inquiry learning approach is not about memorizing facts - it is about formulation questions and finding appropriate resolutions to questions and issues. Inquiry can be a complex undertaking and it therefore requires dedicated instructional design and support to facilitate that students experience the excitement of solving a task or problem on their own. Carefully designed inquiry learning environments can assist students in the process of transforming information and data into useful knowledge. Inquiry-based learning is often described as a cycle or a spiral, which implies formulation of a question, investigation, creation of a solution or an appropriate response, discussion and reflection in connection with results (Bishop et al., 2004).

Inquiry Learning Approach is a student-centered and student-lead process. The purpose is to engage the student in active learning, ideally based on their own questions. Learning activities are organized in a cyclic way, independently of the subject. Each question leads to the creation of new ideas and other questions. This learning process by exploration of the natural or the constructed/social world leads the learner to questions and discoveries in the seeking of new understandings. With this pedagogic strategy, children learn science by doing it (Aubé & David,2003). The main goal is conceptual change.

In the present study Inquiry learning Approach means some activities in Science specially developed by the researcher which constitute a student-centered and student lead process to engage the students in active learning based on their own questions and requires a complex undertaking and dedicated instructional design and support to facilitate that students experience the excitement of solving a task or a problem on their own and assist students in the process of transforming information and data into useful knowledge. Inquiry learning approach can be described as a cycle or a spiral, which implies formulation of a question, investigation, creation of a solution or an appropriate response, discussion and reflection in connection with results.

Scientific Attitude:

According to Ebel (1938) the accepted elements of scientific attitude were classified in terms of their common characteristics and arranged in accordance with the relations existing between them. In stating each element an effort was made to use clear, concise terminology. Because of the fact that there were no separate names available for each of the elements of the scientific attitude, it was necessary to refer to them in terms of their influence on behaviour. Hence, the word "readiness" was used to indicate a mental set which inclines the individual to certain types of behaviour. Thus, the statement, "Readiness to be open-minded" might be translated as, "A mental set, which inclines the individuals to be open-minded". "Open-mindedness" describes the behaviour; "Readiness to be open-minded" describes the attitude.

Noll (1935) opined that the scientific attitude includes the following habits of thinking:

i. Habit of accuracy in all operations including accuracy in calculation and report;
ii. Habit of intellectual honesty;
iii. Habit of open-mindedness;
iv. Habit of open suspended Judgement;
v. Habit of looking for true cause and effect relationship;
vi. Habit of criticalness, including that of self-criticism.

Davis (1935) tried to bring about brief and accurate list of elements of scientific attitude. He prepared a questionnaire with a list of characteristics. He sent them to 250 well-trained experienced teachers. He ranked the characteristics as selected by these experienced teachers, and finally accepted those which were chosen by atleast eighty percent of them. The following are the characteristics who are finally selected:

i. Willingness to change opinion on the basis of evidence (92%);

ii. Search for the whole truth regardless of personnel, religious or social prejudice (89%);

iii. Concept of cause and effect relationship 86%);

iv. Habit of basing Judgement on fact (85%);

v. Power of ability to distinguish between fact and theory (82%);

vi. Freedom from superstitious belief 82%).

Hiss, Obourn and Hoffman stated the following qualities of a person with scientific attitude:

1. Looks for the natural causes for things that happen-

i. Does not believe in superstitions, such as charms of good or bad luck;

ii. Believes that there is no connection necessarily between two event just because they happen at the same time or one after the other attitude.

Is open-minded towards works and opinions of others and information related to his problem -

i. Believes that truth never changes, but his ideas of what is true may change as he gains better understanding of that truth;

ii. Revises his opinions and conclusions in the light of additional reliable evidence;

iii. Listens to, observers, or reads evidence supporting ideas contrary to his personal opinions;

iv. Accepts no conclusion as final or ultimate.

3. Bases opinions and conclusions on adequate evidence -

i. Is slow to accept as fact anything not supported by convincing proof;

ii. Bases his conclusions upon evidence obtained from a variety of dependable sources;

iii. Searches for the most satisfactory explanation of observed phenomenon that the evidence permits;

iv. Sticks to the facts and avoids exaggeration;

v. Does not allow his personal pride, bias, prejudice or ambition to prevent the truth;

vi. Does not jump to conclusion.

4. Evaluates technique and procedure used and information obtained

i. Uses a planned procedure in solving his problems;

ii. Seeks to use the various techniques and procedures which have proved valuable in obtaining evidence;

iii. Seeks to adopt the various techniques and procedures to the problem at hand;

iv. Personally considers the evidence and besides whether it relates to the problem;

v. Judges whether the evidence is sound, sensible and complete enough to allow a conclusion to be drawn;

vi. Select the most recent, authoritative and accurate evidence related to the problem.

5. Is curious concerning the things he observers -

i. Wants to know the 'why', 'what' 'how' of observed phenomenon;

ii. Is not satisfied with vague explanations of these questions.

After going through all these definitions the investigators conceptualized the scientific attitude as, the mental attitude characterized by commitment of the value of rationality, to seek cause and effect relationship, acceptance of criticalness, desire for understanding new situations that are not explained by the existing body of knowledge and completions of knowledge, seeking to find out 'how' and 'why' of observed phenomena, willingness to search for truth, aversion to superstition, objectivity of intellectual beliefs, and to discriminate between fact and theory. Therefore, the following six dimensions were considered for the construction of scientific attitude scale for the present study:

i Rationality;

ii. Curiosity;

iii. Open-mindedness;

iv. Aversion to Superstitions;

v. Objectivity of Intellectual Belief;

vi. Suspended Judgement.

Hypothesis

- There is no significant difference between the pre-test scores of science process skills for experimental group and control group (Ho1).
- There is no significant difference between the post-test scores of science process skills for experimental group and control group (Ho2).
- There is no significant difference between the pre-test scores of scientific attitude for experimental group and control group (Ho3).
- There is no significant difference between the post-test scores of scientific attitude for experimental group and control group (Ho4).
- There is no significant interaction between science process skill and scientific attitude whilst learning through inquiry learning approach (Ho5).

Methodology And Design Of The Study:-

For the present study the researcher has selected the Experimental Method by keeping in mind the objectives of the study and the problem. The researcher has used Quasi experimental research design involving Pretest-Posttest Equivalent Groups Design.

O1 X O2 where, X gain = O2 - O1 O1 O3 = Pretests

O3 C O4 C gain = O4 - O3 O2 O4 = Posttests

The pre-tests was administered before the application of the experimental and control treatments and post-tests at the end of the treatment period. Gain scores were compared and subjected to test of significance of the difference between means. Pre-test scores were used in analysis of covariance to statistically control for any differences between the groups at the beginning of the study.

Moreover, in order to determine if the treatment interacts significantly with the variables, researcher has used Two-Way Factorial ANOVA for the independent variables science process skills and scientific attitude. Following is the factorial design used in the present study:

	Science Process skill	Scientific attitude Scale
Experimental group	O[illegible] O[illegible]	O[illegible] O[illegible]
Control group	O[illegible] - O[illegible]	O[illegible] - O[illegible]

Sample Of The Study

Sample for the present study includes 80 students of secondary school (CBSE Board) from class IX. 40 students of secondary school (CBSE Board) from class IX from AECS- 1, Anushaktinagar, Mumbai, were taken as experimental group and 40 students of secondary school (CBSE Board) from class IX from AECS- 4, Anushaktinagar, Mumbai, were taken as control group.

Tools Of The Study

The researcher developed activities based on inquiry learning approach for teaching and learning science to secondary school students. The activities were duly content validated by experts.

The researcher prepared test for science process skills (SPS). The overall test reliability (Cronbach's alpha reliability coefficient) was 0.89 whereas with rational equivalence the value was 0.89. The overall discrimination index was 0.7, and difficulty index was 0.50.

The researcher then prepared scientific attitude scale (SAS). The overall test reliability (Cronbach's alpha reliability coefficient) was 0.89. (Table - Annexure)

The blue print of Scientific Attitude Scale is as -

Testing Of Hypothesis

Ho1 and Ho2

Incidental sampling technique was used to select the samples for both experimental and control group. Science Process skill test was implemented for pre and post testing the students of both the experimental and control group. Thus the technique used to test the above mentioned hypothesis is ANCOVA. Means of Pre-test and Post-test scores of Experimental group are 15.375 and 32.55 respectively and for control group are 15.325 and 22.075 respectively.

Table 1 :- Summary of ANCOVA of pre-test and post-test scores are-

Source Of Variance	df	SS_X	SS_Y	$MS_X(V_X)$	$MS_Y(V_Y)$
Among Means	1	0.05	2194.513	0.05	2194.513
Within Groups	78	1222.15	1128.675	15.66859	14.47019
TOTAL	79	1222.2	3323.188		

The results of ANCOVA of Pre-test and Post-test Scores indicates FX = 0.003191and FY =151.6575 . From table F df 1/78, F at 0.05 level =4.00, F at 0.01 level= 7.08. Neither F is significant which shows that the experimenter was quite successful in getting equivalent groups. Thus, Ho1 is accepted. In the next step adjusted SS of Y was calculated

Table 2 Calculation of adjusted SS of Y-

SOURCE OF VARIATION	df	SS_X	SS_Y	S_{xy}	$SS_{Y.X}$	$MS_{Y.X}(V_{Y.X})$	$SD_{Y.X}$
AMONG MEANS	1	0.05	2194.513	10.475	2190.366	2190.366	
WITHIN GROUPS	77	1222.15	1128.675	236.775	1082.803	14.06238	5.565878
Total	78	1222.2	3323.188	247.25	3273.169		

Computation of adjusted SS for Y shows Fy.x = 155.7607. From table F df 1/77 F at 0.05 level =3.97 F at 0.01 level= 6.95 which is highly significant far beyond the 0.01 level. This FY.X should now be compared with Fy of 151.6575 obtained before correcting for variability in the initial pre-test scores.

Table 3: Calculation of adjusted Y means-

GROUPS	N	M_X	M_Y	$M_{Y.X}$ (adjusted)
EXPT	40	15.375	32.55	32.54516
CONTROL	40	15.325	22.075	22.07984
GENERAL MEANS		15.35	27.3125	27.3125

Now, testing the difference for df = 77, t0.05=1.99; t0.01= 2.64 significant difference at 0.05 level is 1.668658 and significant difference at 0.01 level is 2.213. Myx (difference) = 5.565 is much greater than 2.213 at 0.01 level, hence experimental group differs significantly from control group at .01 level. Hence null hypothesis(Ho2) is rejected. Thus it shows elevation in the performance w.r.t science process skills for experimental group students.

Ho3 and Ho4

Incidental sampling technique was used to select the samples for both experimental and control group. Scientific attitude Scale test was implemented for pre and post testing the students of both the experimental and control group. Thus the technique used to test the above mentioned hypothesis is ANCOVA. Means of Pre-test and Post-test scores of Experimental group are 134.6 and 173.37 respectively and for control group are 133.525 and 146.72 respectively.

Table 4:Summary of ANCOVA of pre-test and post-test scores are-

Source Of Variance	Df	Ss_x	Ss_y	$Ms_x(V_x)$	$Ms_y(V_y)$
Among Means	1	23.1125	14204.45	23.1125	14204.45
Within Groups	78	15783.57	6489.35	202.3535	83.19679
Total	79	15806.69	20693.8		

The results of ANCOVA of Pre-test and Post-test Scores indicates FX = 0.11421 and FY = 170.7331397. From table F df 1/90 F AT 0.05 level =3.95 F at 0.01 level= 6.92.Neither F is significant which shows that the experimenter was quite successful in getting equivalent groups. Thus, Ho3 is accepted. In the next step adjusted SS of Y was calculated

Table 5 :- Calculation of adjusted SS of Y-

Source Of Variation	Df	Ss_x	Ss_y	S_{xy}	$Ss_{y.X}$	$Ms_{y.X}(V_{y.X})$	$Sd_{y.X}$
Among Means	1	23.1125	14204.4	572.975	14052.3	14052.35	
Within Groups	77	15783.57	6489.35	1815.77	6280.46	81.56441	5.5658
Total	78	15806.69	20693.8	2388.75	20332.8		

Computation of adjusted SS for Y shows Fy.x =172.285 from table F df 1/89 F at 0.05 level =3.95 F at 0.01 level= 6.92 which is highly significant far beyond the 0.01 level. This FY.X should now be compared with Fy of 170.733 obtained before correcting for variability in the initial pre-test scores.

Table 6 :- Calculation of adjusted Y means-

Groups	N	M_x	M_y	$M_{Y.X}$ (Adjusted)
Expt	40	134.6	173.375	173.3132
Control	40	133.525	146.725	146.7868
General Means		134.0625	160.05	160.05

Now, testing the difference for df = 89, t0.05=1.99; t0.01= 2.63 significant difference at 0.05 level is 4.0187 and significant difference at 0.01 level is 5.311. Myx (difference) = 26.526 is much greater than 5.311 at 0.01 level, hence experimental group differs significantly from control group at .01 level. Hence null hypothesis (Ho4) is rejected.

Thus it shows elevation in the acquisition of scientific attitude for experimental group students by use of inquiry learning approach.

Ho5 :- There is no significant interaction between science process skill and scientific attitude whilst learning through inquiry learning approach of teaching. The technique used to test this hypothesis is the two-way classification of analysis of variance (ANOVA).

The variance estimates were obtained by dividing the sums of squares by their respective degrees of freedom. F-ratio for interaction effect was obtained by computing the ratio of 'interaction variance' and within sets variance since it is the best estimate of residual variance after the systematic influence of inquiry learning approach. The following table shows the mean differences in the approaches-

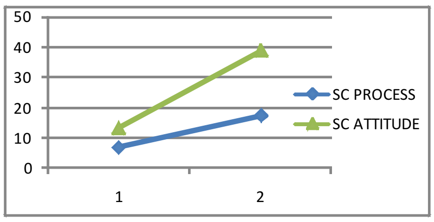
Table 7 : Mean differences in the approaches-

Approach	**Science Process Skills**	**Scientific attitude scale**	**Total**
Experimental group	Mean=17.175 Variance=28.455 N=40	Mean=38.775 Variance=226.99 N=40	Mean=27.975 N=80
Control group	Mean=6.75 Variance=19.679 N=40	Mean=13.2 Variance=250.98 N=40	Mean=9.975 N=80
Total	Mean=11.962 N=80	Mean=25.987 N=80	Mean=18.975

Table 8:-ANOVA for gain science process skills and scientific attitude scale by experimental and control group-

Source	**SS**	**df**	**MS**	**F**
Rows	12960	1	12960	98.53
Columns	7868.03	1	7868.03	59.82
r x c	2295.22	1	2295.22	17.45
Error	20518.65	156	131.53	
Total	43641.9	159		

Graph 1:- Graphical representation of mean gain values of control and experimental groups for science process skills and scientific attitude scale.



1- Control group
2- Experimental group

Table 9:-Results of computation of combination of cells for all possible differences between means-

No.	Combinations	M1	M2	M1-M2
1	Expt. science process skill and SAS	17.175	38.775	-21.6
2	Control. science process skill and SAS	6.75	13.2	-6.45
3	Expt. Science process skills and Control. Science Process skills	17.175	6.75	10.425
4	Expt. SAS – Control. SAS	38.775	13.2	25.575
5	Expt. Sc. Process skills- Control SAS	17.175	13.2	3.975

Table 10 :- Critical Values for the Tukey HSD Test:-

	HSD[.05]	HSD[.01]
Rows [2]	3.58	4.73
Columns [2]	3.58	4.73
Cells [4]	6.68	8.12

It is found that F for interaction of 17.45 exceeds significantly than required F of 3.9 at 0.05 and 6.81 at 0.01 levels of significance. Next, comparing the difference of means for the various combinations computed with the Tukey HSD value, it is found that the difference in points 3,4 are larger than the HSD, hence the difference are significant,Ho5 is rejected.

DISCUSSION

Learning integrated science process skills at the primary level requires students to be at the formal operation stage according to Piaget's stages of cognitive development (Inhelder & Piaget, 1958; Brotherton & Preece, 1995). However, majority of the primary school students are operating at the concrete operational stage (Shayer, Kuchermann, & Wylam, 1976; Palanisamy, 1986). Many research studies (e.g., Allen, 1973; Klahr, Chen, & Toth, 1999) have shown that teaching primary school students on integrated science process skills require some form of specific training. Klahr (1998) used direct instruction in teaching Grade Five students to control variables while Quinn and George (1975) used film loops in teaching Grade Six students to formulate hypotheses.

In the present study there is elevation in science process skills {Myx (difference) = 5.565 is greater than 2.213 at 0.01 level}as well as scientific attitude {Myx (difference) = 26.526 is much greater than 5.311 at 0.01 level}by inquiry learning approach of teaching when compared with teaching through conventional method. Also, in table 8, through ANOVA, F interaction (r x c) of 17.45 shows a significant interaction between science process skill and scientific attitude whilst learning through inquiry learning approach of teaching which is alternatively represented graphically in Graph 1 above. From the graph it is evident that the slope of the line showing gain in development of scientific attitude is more than that of science process skills. In an interest to figure out which of the means is different Tukey's HSD (honestly significant difference) test was employed. From table 9 can be seen that after trying out the various combinations of cells, point no 3 i.e. the difference between the means of experimental and control groups for science process skills and point no 4 i.e. the difference between the means of experimental and control groups for scientific attitude scale, are more than the HSD values among cells of 6.68 at 0.05 level of significance and 8.12 at 0.01 level of significance.

The reasons for the elevation in the performance of experimental group students by using Inquiry Learning Approach can be sketched as: The Inquiry Learning Approach to teaching provides the much-needed interactivity. Also, being interactive it allows collaborative learning opportunities to the learners, who can interact with their teachers as well as with peer groups or co-learners.

Collaborative learning with through Inquiry Learning Approach to teaching enhances team performance as well as development of science process skills through tools for communicating each person's ideas, structuring group dialogue and decision making, recording the rationale behind choices, and facilitating collective activities. All this add up to their intrinsic attraction towards science and in turn enhances their attitude towards science. The National Science Education Standards'Teaching Standard B (NRC, 1996, p. 32)prompts teachers to guide and facilitate learning by

- focusing and supporting inquiries while interacting with students;
- orchestrating discourse among students about scientific ideas;
- challenging students to accept and share responsibility for their own learning;
- recognizing and responding to student diversity and encouraging all students to participate fully in science learning;
- encouraging and modeling skills of scientific inquiry, as well as the curiousness, openness to new ideas and data, and skepticism that characterize science.

Adding up Inquiry learning approach not only develops children's learning but it also develops the teacher's competence in teaching. Because, when the teachers are engaged in preparation and use of different activity materials, they get experiences and perspectives in teaching through different ways. The present system of learning always wants that our learning environment must be democratic, congenial, satisfying and cooperative. All these elements are facilitated in inquiry based approach towards teaching-learning. The approach is psychological because it gives respect to the needs, interests and abilities of the children.

This approach is life centered in the sense that the inquiry based activities selected for the teaching learning are based upon the daily life situations. Since the students are engaged in divergent activities like games, puzzles, competitions, etc. their manifold creative and cognitive abilities develop simultaneously. The inquiry learning approach aims at developing scholastic and co-scholastic aspects of activity based joyful learning simultaneously, because the activities engaged in this approach of teaching include all the domains of behavior, i.e. head-related activities, hand- related activities and heart related activities.

Inquiry based learning acts as a suitable approach for imparting unified knowledge to the children, because it helps to achieve interdisciplinary competencies through teaching of one discipline. Since inquiry learning approach facilitates the achievement of interdisciplinary competencies through teaching of one discipline, this approach is suitable for single teacher/meagerly staffed schools.

Conclusion:

It is a known fact that, infants use inquiry to build their sense of the world. The babies turn towards voices, put things in their mouths, grasp things, and observe faces that come near. This inquiry process is mainly the gathering of information and applying them to senses like smelling, tasting, touching, hearing and seeing in science, the students' questions play an important role in the nature of their inquiry and in their learning; they need to be encouraged.

Students gain from inquiry-based learning-

- Work together as part of a problem-solving team and come to an understanding that shared efforts and abilities produce the best team result.
- Increase self-esteem from the fact that, their own individual effort contributes positively to the team solution of the problem.
- Develop problem-solving skills that can be applied to other areas in their lives and to other academic disciplines.
- Learn how to design an experiment and carry out scientific research including observations and data handling.

- Develop critical-thinking skills.
- Become actively involved in the learning process.
- Experience excitement about studying science because rigorous problem-solving can be enjoyable!
- Learn how to organize and interpret scientific information.
- Make written and oral presentations of the results of their research.
- Increase understanding of basic scientific knowledge through deductive reasoning rather than passive learning techniques.

Clearly, the more active students are in their science education, the more scientifically literate each student will become. Having students probe for answers to scientific questions will lead to a deeper understanding of scientific concepts than if the teacher simply provides students with the scientific facts alone. Introducing inquiry-based strategies not only into the classroom but also into the laboratory sections of science courses will help students enhance and develop their critical-thinking and communication skills.

Annexure 1

Dimensions	Components	Positive polarity	Negative polarity	Total
Rationality	Commitment to the value of rationality	1	-	1
	Tendency to test traditional belief	-	2	2
	Seeking for natural causes of events	2	-	2
	Acceptance of criticalness	1	1	2
	Challenges of Authority	-	1	1
Curiosity	Desire for understanding new situations that are explained by the existing body of the knowledge	2	-	2
	Seeking to find out the why and how of observed phenomena	-	2	2
	Giving emphasis on the questions in approach for novel situations	1	1	2
	Desire for completeness of knowledge	1	1	2
Open- mindedness	Willingness to revise opinions and conclusions	-	2	2
	Desire of new things and ideas	4	-	4
	Rejection of singular and rigid approach to people things and ideas	-	2	2
Aversion to superstitions	Rejection of superstitions and false belief	1	4	5
	Acceptance of Scientific facts	3	-	3
Objectivity of Intellectual belief	Demonstration of the greatest possible concern for observing and recording facts without any influence of personal pride bias or ambitions	3	2	5
	Not allowing any change in interpreting results on the basis of present social economic or political influence	1	2	3
Suspended Judgement	Unwillingness to draw inference before evidence is collected	1	1	2
	Unwillingness to accept facts that are not supported by convincing proof	2	2	4
	Avoidance of quick judgement	1	1	2
		24	24	48

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