

Development of Problem Solving Skill of Adolescents through Teaching of Science for Sustainable Development

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Abstract: *Adolescence is the span of years of life between childhood and adulthood. The adolescents of this age enjoy challenging physical and mental activities that prefer group activities than individual activities. The subject science has dual nature. It is a body of knowledge as well as it is seen as a process of thinking. The authors of present paper have conducted a study for adolescents of class IX of grant-in-aid, English Medium secondary school in Vadodara, Gujarat selected purposively, with the objective to study the effectiveness of Activity Based Program on the problem solving skill. The Program is related to the concepts that make students think about sustainable development from their science textbook. The tool to study the existing status of problem solving skill in the sample was designed on the basis of the indicators of problem solving skill. The activity based program was designed by selecting the topics that had scope to develop problem solving skill and that had concepts related to sustainable development that was conducted for the academic year 2011-2012. The study with pre test-treatment-post test single group design used Mean, Standard deviation and Correlated t-test to test the null hypothesis stated as 'there will be no significant difference between pre test and post test scores of problem solving skill of the sample'. The data analysis shows significant increase in the use of indicators of problem solving skill after the treatment. The change in behaviour of the sample showed its awareness for sustainable development. The findings implied that, using well designed activity based program to develop problem solving skill in adolescents while teaching science generates awareness about the problems faced by all due to ignorance towards sustainable development.*

KeyWords: *Adolescents of Secondary School, Teaching of Science, Problem Solving Skill, Sustainable Development, Activity Based Program.*

I. Introduction

Swami Vivekananda believed that "Education is the manifestation of perfection present already in man". It begins at home and continues in school. School education is an introduction of the world around us and science education at secondary level is a gateway to the world of work that can bring economic independence to the adolescent entering adulthood. Adolescence is very crucial stage in the development of human beings. Secondary school adolescents can be guided through the curriculum of different subjects. In the secondary school much importance is given to the subject science, which has dual nature. It is a body of knowledge as well as it is seen as a process of thinking. The teaching of the subject science should be developing thinking skills while trying to develop process skills in the students. Through science education which is activity based it is possible to develop core life skills like thinking skills and direct them towards better life. Position paper on 'Teaching of science' by NCERT (2006) at various stages states the purpose of teaching science at secondary stage categorically. The syllabi of 'Science and technology' and 'Mathematics' are such that makes the teachers and the students to use problem solving method. The activities that are to be assigned or to be conducted with students for formative assessment by the science teachers can be designed in such a way that gives scope to develop thinking skills. Rather well designed Problem Solving Skill Education Programme based on the concepts like Our Natural Resources, Our Environment, Food Resources, Energy can help the science teachers to evaluate the students for formative assessment and make them aware of Sustainable Development. Prior to actual study the researcher had queries like what is adolescence? What are their characteristics? What is the nature of subject science? Does it give scope to develop problem solving skill? Does it have research support? Why should development of problem solving skill be done through teaching of science? How to do it? How to measure it? The study revealed the answers to the questions.

II. Conceptual Framework

2.1 Adolescent in Secondary School

Adolescence is the span of years of life between childhood and adulthood. According to Mangrulkar (2001) in varied situations adolescent needs to practice new skills with peers and other individuals outside of the family. Some major characteristics of adolescents are stated here that shows the need to design activity based science educational program.

2.1.1 Major Characteristics of adolescents

According to Edlin (2011) the major characteristics of middle age adolescents (ages 14-16) are:

1. Experience restlessness and fatigue due to hormonal changes.
2. Need daily physical activity because of increased energy.
3. Seek to become increasingly independent, searching for adult identity and acceptance and are increasingly concerned about peer acceptance.
4. Are concerned with many major societal issues as personal value systems develop.
5. Are intellectually curious about the world and themselves.
6. Prefer active over passive learning experiences and prefer interaction with peers during learning activities.
7. Respond positively to opportunities to participate in real life situations.

The characteristics of adolescents clearly suggest the investigator to design activity based program to develop problem solving skill.

2.3 Subject Science and its nature

“Science is both a body of knowledge and the process of acquired knowledge” NCERT (2005). Amin (2011) states that science is not just a subject but it is a method to acquire knowledge generate new knowledge and check the existing knowledge with the new observations. The steps of scientific method can lead to scientific attitude that can be a valuable result of the problem-solving approach to learning and develop problem solving skill that is used by the learner in real life.

2.4 Problem Solving Skill

Problem solving skill is one of the generic life skills as reported by World Health Organisation in 1999. Patel (1997) observes that “NCERT workshop at Chandigadh (1971) mentioned in its summary that scientific attitude can be a valuable result of the problem solving approach to learning. It is encouraged when study of a subject is attacked through, i) identifying a problem, ii) making valid observations, iii) drawing objective conclusions, iv) verifying the conclusions to a new but related problem”. Solving problems in orderly manner leads to the development of Scientific attitude that is applicable to many solutions. Helaiya (2010) listed the indicators of problem solving skill as,

1. to be able to recognize that the problem exists and problem solving process is a worthwhile experience.
2. to be able to define the problem i.e. to think about how the current situation is different than what it ought to be,
3. to be able to think of as many possible alternatives as one can, even if some of them may seem to be unrealistic,
4. to be able to verify the result of the solution.
5. to be able to verify the process attempted to solve the problem.

If adolescents are given opportunity to address the problems in the form of activities related to the concepts in science, they may exhibit the use of indicators of problem solving skill.

2.4.1 Problem Solving Skill and its relation to subject Science at Secondary level

According to Ismail (2001) both the science process skills and the thinking skills are interrelated. The researcher concludes the study with a note that through active learning in science, students are able to acquire both the process skills as well as develop their thinking skills. The aims of education direct the teachers of secondary school to develop thinking skills like problem solving. Mangrulkar (2001) observes that, “the science curriculum that is designed in keeping the relation of content with the learner’s real life facilitates development of thinking skills”. Looking into the nature of science it is understood that teaching of science to students should include proposing problems, defining the problem, thinking of many solutions, setting up hypotheses and their testing with controlled experiment, rethinking of new solution, discarding personal opinion in the light of new evidence and suspending judgment in case of conflicting evidence, challenging the principle of authority if needed thus distinguishing between scientific information and popular information.

2.5 Sustainable Development

The 47th session of the UNESCO International Conference on Education in 2004 drew attention of the world to the fact that half the world's population is under the age of 25, forming the largest generation of young people ever. It is estimated that by 2020, 87 per cent of the world's young people will be living in developing countries. India will have majority of adolescents. Hence the responsibility of teachers in secondary schools increases. It asks for quality education, by which the adolescent understand their responsibility towards the environment, natural resources and sustainable development. In this direction the sensitization of adolescent towards sustainable development is essential. Even though textbooks of education boards of secondary schools emphasize on protection of the environment and sustainable development the concept can be easily understood by the students through audio visual means. The term sustainable development was coined by World Commission on Environment and Development (WCED) headed by Brundtland, in the report *Our Common Future*, London (1987). It is defined as development that meets the needs of the present without compromising the ability of the future generation to meet their own needs. Naturalists are of the opinion that, "Education is seen as the process of adjustment to environment; it aims at enabling the individual to be in harmony with and well adapted to his surroundings."

III. Review Of Related Literature

Problem solving skill is necessary to address the problems in daily life as well as environmental problems faced today due to indiscriminate development. Problem solving skill is one of the generic life skills as published by World Health Organisation. Generic Life Skills as explained in the report of WHO for mental health (1999) are the skills that can be developed over a period of time through Integrated Approach i.e. inculcating life skills through teaching of school subjects. WHO (1999) department of Mental Health identified ten life skills giving first priority to problem solving skill. The investigator has reviewed the researches related to

1. Development of problem solving skills through teaching of curricular subject in school.
2. Status of teaching science in Vadodara
3. Study of effectiveness of new methods to teach science.
4. Study of awareness of teachers related to environment

Kamalakanthan (1968) conducted an experimental study of teaching physics by traditional and problem solving method. The study attempted to find out which of the two specific methods, traditional (conventional) or problem solving, provided for students' gain in and retention of knowledge and abilities. The findings of the study reveal that the problem solving method had positive favorable points as compared to the traditional method of teaching.

Umasree (1999) conducted a study entitled science curriculum and its transaction: an exploratory study in secondary schools of Vadodara. The tools consisted of classroom observations, and semi-structured interviews and questionnaires. The data analysis was done through content analysis. The findings of study were i) the sole objective of teaching science in secondary class remained as passing exams, ii) wide gap between science curriculum decided by NCF and actually transacted curriculum.

Das (2003) has observed from his study on teachers perception that most of the teachers realize the importance of greenhouse effect, global warming, deforestation but have very little knowledge of interdependence of all forms of life on earth for existence. It necessitates the development of a specific curriculum.

Vashistha (2006) carried an empirical exploration of life skills relevant to science and technology for adolescent students of various schools of Ajmer. The chi-square value of level of achievement score of students shows that high achievement group students preferred Problem Solving to be major life skill relevant to science and technology. Researcher emphasized that in the present context of overloaded school curriculum one of the potent ways to disseminate these life skills is to infuse them across existing subjects.

Devi (2009) conducted a study titled as "A Study of the Relationship between Problem Solving Ability and Academic Achievement of Secondary School Students" which indicates the scope for development of life skill like problem solving to improve academic achievement. One of the objectives of the study was to investigate the relationship between problem solving ability and academic achievement of IX standard students. Major finding of the study was there is a positive relationship between problem solving and academic achievement of class IX students hence there is a scope to develop problem solving skill in secondary school adolescents through teaching of curricular subject.

3.1 Research gaps and implications for present research

The investigator did not come across studies that,

- Focus on development of life skill like problem solving skill through teaching of science is missing.
- Methods of teaching like role play and use of drama for particular scientific concepts, seminars are not tried in the natural setting of secondary school classroom and their effect in terms of problem solving skill is not measured.
- The effect of new methods of teaching science is measured in terms of achievement score but not in terms of thinking skills.
- Measure awareness of the sustainable development among adolescents.

The review suggests that it is desirable to teach science in secondary school by designing the activity based, environment related program for the adolescents that give scope to develop problem solving skills which can make the adolescents ready to face challenges in daily life.

IV. Rationale For This Study

“People today are faced with fast-changing world where the most important skills are flexibility in adapting to new demands and creativity in taking advantage of new opportunities. Teaching of science and technology can develop such skills” NCERT (2005). Training in the scientific method, inculcation of scientific attitude is needed today especially to meet the challenges posed in daily life of the adolescent due to the characteristics of adolescence, fierce competition, market economy and rapidly developing world and its devastating impact on balance in nature. The 47th session of the UNESCO International Conference on Education in 2004 drew attention of the world to the fact that half the world’s population is under the age of 25, forming the largest generation of young people ever. It is estimated that by 2020, 87 per cent of the world’s young people will be living in developing countries. India will have majority of adolescents. Hence the responsibility of teachers in secondary schools increases. It asks for quality education, by which the adolescent understand their responsibility towards the environment, natural resources and sustainable development. Students of secondary stage which are in the transitional stage of growth and soon will be entering the world of work need to possess thinking skill like problem solving skill at every stage of life. The nature of the subject science gives scope to the teachers to allot activities to the students for continuous and comprehensive evaluation that can help to develop problem solving skills along with other thinking skills. The UN conference on environment and development popularly known as Earth Summit (1992) in its agenda 21 gave importance to education, awareness and training. It stressed reorienting education towards sustainable development.

4.1 Research Questions

1. How to measure existing status of problem solving skills in the adolescents of secondary school?
2. How can problem solving skills be developed while teaching the curriculum of science as prescribed by the state board?
3. How can the development of problem solving skill be tested?
4. What will be the effectiveness of Activity Based Programme on the students of secondary school in terms of indicators of problem solving skill and awareness about sustainable development?

V. Methodology Used For The Present Study

5.1 Statement of the problem

Development of problem solving skill of adolescent through teaching of science for sustainable development

5.2 Objectives of the study

- To study the effectiveness of Activity Based Program on the problem solving skill of the adolescents through teaching of science.
- To study the effectiveness of Activity Based Program on the awareness of adolescents towards Sustainable development in terms of change in behaviour.

5.3 Operationalisation of the term

Effectiveness of the Activity Based Programme

Effectiveness of the Activity Based program is the enhancement in the ability of the students to use problem solving skill. Effectiveness of the Activity Based program was observed by the comparison between the pre test and post test scores. Behavioral change in awareness towards sustainable development was noted by observation diary.

5.3.1 Explanation of the term

Activity Based Program

Activity Based program is a program that consists of series of group activities related to topics like health, energy, natural resources and food resources in particular. The table 1 in annexure shows the program that consists of: name of chapter/topic, indicators of problem solving skill needed, factor affecting sustainable development, method to conduct the activity, material required to conduct and present the activity and time duration required.

5.4 Population for the study

There are 12 Grant-in-aid English Medium secondary schools verified by DEO in Online School registration in Vadodara following the syllabus of Gujarat State Board of Secondary and Higher Secondary Education. These are considered as population for the study.

5.5 Sample for the study

Class IX students of Jeevan Sadhana English Medium High School enrolled for 2011-2012 were selected as the sample. The class strength was 63 but only 40 students showed willingness to participate in group activities determining the sample size as 40. The sample was selected purposively with following criteria,

- the investigator has experience of teaching in the same school
- familiarity of the students of class IX
- their achievement scores of the previous year
- socio-economic background and educational background of parents
- Good computer facilities in school.

5.6 Delimitations

The study was delimited to the problem solving skill out of ten life skills defined by World Health Organization. The study was delimited to the selected content from the text book named 'Science and Technology' that has scope to develop problem solving skill and related to sustainable development. Chapters like why do we fall ill? Work-Energy-Power, Chemical Reactions, Our Natural Resources and Food Resources were shortlisted to design activities that are related to climate change and sustainable development.

5.7 Hypothesis:

To achieve the first objective null hypothesis was framed to study the effectiveness of the Life Skill Education Program designed by the researcher.

H01: There will be no significant difference in the mean scores of Problem Solving skills of the students in pre test and post test with respect to the treatment given through Activity Based program. To achieve the second objective qualitative approach was used. Data collected in observation diary was analyzed qualitatively showing change in behavior of the sample towards sustainable development.

5.8 Design of the study

To achieve first objective, the investigator has used single group pre test-treatment-post test design to develop problem solving skill in the adolescents of class IX through teaching of Science.

The effectiveness of Activity Based Program on awareness about sustainable development is studied qualitatively by observing the change in behaviour during the treatment and later for the next academic year.

5.9 Procedure used for the study

Step 1: Selection of content to design the Activity based program.

Step 2: Construction of pre test and equivalent post test to study the existing status of problem solving skill in the sample on the basis of indicators of the skill, followed by its validation from experts.

Step 3: Designing of Activity Based Program related to the content selected from the science textbook of class IX and its validation.

Step 4: Conducting pre test for data collection.

Step 5: Execution of treatment in the form of Activity Based Program for the academic year 2011-2012.

Step 6: Conducting post test for data collection.

Step 7: Observing the change in behavior of the sample throughout the study and managing the data in observation diary.

Step 8: Analyzing the data quantitatively and qualitatively.

Step 9: Interpreting the data.

Step 10: Writing the report.

5.10 Tools for Data Collection

Pre designed and validated tools are used to collect the data. Pre test and equivalent post test was designed to study the existing status of problem solving skill. It was designed after studying the indicators of presence of problem solving skill. It has five situations and each sample was asked to read those and select the statement from multiple choices. To select any statement one needs to use one or more indicators of problem solving skill. Thus for five questions on one situation maximum score of indicators used is 20. Thus the maximum score of the tool becomes 100. This was converted to out of 10 and then mean standard deviation and correlation coefficient and t-value was calculated.

To study the effectiveness of Activity Based Program on the awareness of adolescents towards sustainable development their behaviour towards use of electricity in school and at home, use of biodegradable and disposable sanitary napkins with incinerators, waste management in school and at home, tree plantation, rain water harvesting were observed for one year during and after treatment and parent's opinion was collected. Observation schedule and observation diary and Opinionnaire were used to study change in behavior towards sustainable development.

VI. Data Analysis

To study effectiveness of Activity Based Program on the existing status of problem solving skill the collected data was statistically treated in the following ways:

- 1) Mean and Standard deviation
- 2) Correlated t-test

To study effectiveness of the program on awareness of adolescents towards sustainable development data was studied qualitatively.

VII. Result And Discussion

In the present study, the investigators used inferential statistics to compare the mean scores of pre test and post test.

Table of Mean, Standard Deviation, r and t value

Sr. No	Test	N	Mean	S.D.	r (Coefficient of Correlation)	t-Value
1	Pre-test	40	64	8.47	0.73	19.2
2	Post-test	40	82	7.47		

For 39 degree of freedom the expected t-value at 0.01level is 2.704. Above table exhibits that the calculated value of t is much greater than the expected t-value at 0.01level of significance. Hence the null hypothesis is rejected at 0.01level of significance. This implies that there is a significant difference between the mean scores of the students on pre test and post test, in favor of the post test.

VIII. Major Findings Of The Study

1. There is a significant difference between the mean scores of the students on pre test and post test, in favour of the post test.
2. By qualitatively analysing the observations of behaviour of the students towards environmental problems during the treatment and for consecutive year after the treatment; Activity Based Program was found to be useful in making them aware of the problems related to sustainable development.

IX. Educational Implications Of The Study And Further Suggestions.

9.1 Implications of the study for secondary school education:

- Activity Based Program is useful to develop problem solving skill in students of secondary school and bring awareness among the adolescents towards sustainable development in the natural settings of the secondary school.
- Integrated Approach can be used by the teachers of secondary school to develop problem solving skill wherein the activities are entwined with the concepts of science and objectives of science education can be achieved up to certain extent.
- The Activity Based program can bring deviation from examination oriented approach.
- Such program can help to bring awareness among the secondary school adolescents towards sustainable development and make them think of environment before every action they do.

9.2 Suggestions for further study:

- Using Activity Based program and integrated approach thinking skills like critical thinking, decision making and creative thinking can be developed by the investigators in students of any level.
- Integrated approach can be used by any subject teacher to develop life skills.
- Effectiveness of Activity Based Program can be studied on achievement score in science of the students.

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