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Aptitude in Science among the Upper Primary Students in Relation to Awareness of Environmental Pollution

KEYWORDS: Pro environmental behavior, Learning to live together, Aptitude in Science, Awareness of Environmental Pollution, Theoretical & Economic values.

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ABSTRACT *For study of the Aptitude in Science in relation to Awareness of Environmental Pollution the authors 'have'drawn the similarity of such Awareness with human values enunciated by E. Spranger and the learning to live together emphasized by J.Delors. The authors have precisely described the techniques of construction of a standardized test in Aptitude in Science in relation to Environmental Pollution. They observed that Aptitude in Science varies due to change of sex of the students and pollution status in neighborhood of theirschools (in WB). As an entry level behavior Aptitude has a very significant effect on the Awareness of Environmental Pollution (AEP) and related activity. Though continuous variable like Aptitude has significant effect on AEP, the discrete or categorical variables like sex or pollution status of the schools hardly has any effect on AEP. The related studies and the other studies of the authors exclusively showed that scientific concepts related to environment, attitude towards environment and different learning activities are very much are pro environmental. The authors strongly recommend the determination of construct validity /concurrent validity of such test in future.*

INTRODUCTION:

Most of the environmental pollutions are manmade and such pollutions are causing attenuation of natural resources and continuous damage to the man andthe society. The causes of such environmental pollutions are *largely* attributed to the excessive craze of man for urban life, selfish activities, greed for unlimited wealth, indifference to ongoing developments in environment and utter disrespect for learning to live together (International Education Commission -1996, UNO). German philosopher Spranger in his book 'Types of men' (1928) mentioned six 'basic values of man' of which three are relevant here: *Economic (Utilitarian)*value & *Aesthetic* value (of course, these two are diametrically opposite), the third one is Theoretical (*Rational*) value. Man having excessive economic values, often, damages environment indiscriminately for material gains but the second type of man devotes for better environment. The third type takes decision scientifically always caring for reason or cause and effect relationship. The last type has many characteristics very much common with one having Aptitude in Science and love and Awareness for Environment. The economic values existing in a person with high Rational Values are likely to be controlled or limited by his/her superior act of reasoning. This reasoning might also be expected from a man with higher 'Aptitude in Science'.

Aptitude is treated as certain specific ability of a person in addition to his intelligence, which helps to achieve success in specific activities. Aptitude is potential in a person to get success in specific works after suitable training (Patel; 2013). It is mostly predictive in nature. Aptitude is partly innate (arising due to heredity) and partly acquired (from environment & culture) - Bandele (2004); Mangal (2005). Cronbach (2002)stated that before 1960, Aptitude was treated as 'Object' but Binet & Piaget held it as process. He reiterated that 'Aptitude' of a *person* is detected by'*the level of performance while at work' and the 'time spent for the work'*. Performance level is influenced by the efficiency of the person which in turn influenced by nature of the task, immediate environment and goals of action.

Researches on 'Aptitude' in India were mainly confined to identifying the dimensions of aptitude test, preparation and standardization of the test. Using such tests Chatterjee, Mukherjee & Mitra (1978) found the relation of science aptitude with achievement in Science. No research could be found on aptitude vis-a-vis awareness related to environment. Aptitude and more particularly science aptitude as an instrument for possible development of environmental pollution awareness does not remain in an individual (Narayana and Suhane: 2010). Some researchers have shown that aptitude of individuals may vary due to sex difference, individual difference and nature of favorite subject of learning etc: Spelke Elizabeth' (2005) observed that boys and male are more apt in mathematics and science in comparison to girls and female counter part from lower to higher level of education including career choice due to different exposures from the beginning of life. Patel (2010) revealed the superiority of the boys,urban students and upper grade students in comparison to their counterparts in Aptitude Test in Chemistry.

The ecosystem in the environment is naturally and scientifically maintained dynamic equilibrium in the environment. When that equilibrium is somehow lost pollution occurs in the environment. Understanding about pollution and its prevention or minimization requires knowledge of concept & process of science. So a student having aptitude in science is expected to develop more awareness about the environmental pollution. 'Here Aptitude might act as Entering Behaviour in the process of development of 'awareness of environmental pollution'. Person having scientific aptitude might view the environment from the standpoint of its structure, composition and process. Similarly, he might

Volume : 5 | Issue : 4 | April 2015 | ISSN - 2249-555X

also recognize environmental pollution in terms of 'cause and effect', and in terms of 'remedial measures' to remove the causes in order to minimize the pollution.

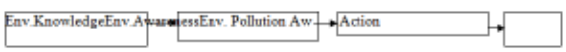
Hungerford & Volk (1990) stated that through Environmental Education learners' behavior can be changed. An environmental study develops Environmental Awareness which in turn develops Pollution Awareness. When proper attitude develops the Pollution Awareness generates action to restore pollutionlessenvironment.

I) Env. Knowledge

II) Env. Awareness

III) Env. Pollution Aw

IV) Action



IV) ActionFig 1: *BehaviouralChange System Through Environmental Education*

Pruneau(2006) has identified three factors in connection with awareness or pro environmental behavior.These are cognitive (individual's own knowledge and action strategies), affective and situational factors (mainly economic and demographic factors). He also attaches more weight on cognitive factors for the development of environmental awareness.

Emergence of the problem:
Narayana and Suhane (2010) found negligible effect of 'Aptitude in Science' on 'Environmental Awareness' but this result apparently contradicts our expectations on theoretical ground. It, therefore, requires further investigation to verify whether science aptitude has at all any effect on awareness for environment and hence for environmental pollution. Furthermore the innate part of Aptitude may be constant in case of an individual but the other part is psychologically subjected to variation depending on the following factors: Study skills, persistence of learning, motivation, and satisfaction derived from learning a subject, Physical development, interests, attitudes etc. [Ediger & Rao (2003)].

Aptitude of a person for a particular thing or practice is also variable being subjected to the effect of educational and environmental factors- Wrightstone et. al. (1956). Scientific aptitude develops with the study of science as a favourite subject (Raja & Shah:2011).Cronbach (2002) mentioned the impact of immediate environment on Aptitude.Patel (2010) studied Aptitude in Chemistry on the basis of some categorical variables like sex, habitat,grade etc. However, these studies did not explicitly consider the variables like Environmental Pollution Awareness, Environmental Pollution in the vicinity of the schools the students read in and the Aptitude in Science of the students. Again these studies did not assign importance on Aptitude in Science as an 'entering behavior' on Environmental Pollution Awareness. A study is therefore necessary to provide answer to the following questions:

- Is there any effect of Aptitude in Science on the development of Environmental Pollution Awareness of the students?
- Does the Aptitude in Science of the students of schools located at pollution and non-pollution zones significantly differ?
- Does the Aptitude in Science of the students significantly vary with sex of the students?
- The questions are also necessary from the standpoint of sustainable development of the environment. So the present study is designed.

II. DEFINITION OF TERMS:
i)Aptitude in Science:
Aptitude being an individual characteristic is mostly cognitive. According to Freeman (1965) Aptitude is the state of readiness and promise for training in a particular field. Person's aptitude gives him an added advantage of gaining more success in a field: any performance or achievement. Intelligence tests and aptitude tests work in a similar fashion in predicting achievement. Sometimes reasoning, prima facie, works similar to Aptitude (Pal,1982). Freeman (1965) mentioned the Scientific (and Engineering) Aptitude Test with the following dimensions: i) Experimental Bent, ii)Clarity of definition, iii) Suspended vs snap judgment,iv) Reasoning, v) Inconsistency, vi)Fallacies, vii) Induction, Deduction, Generalization, viii) Caution and thoroughness, ix) Discrimination of values in selecting and arranging Experimental data, x) Accuracy of Interpretation & xi)Accuracy of observation.

ii)Awareness of Environmental Pollution
Awareness of Environmental Pollution means to acquire sensitivity to the total environment and its allied problems and their implications.

The main goal of many SCHOOLS today is to increase the awareness because that is the only way to develop a more sustainable world. Accordingly, pollution awareness should begin with school education. A student having pollution awareness is expected to have minimum working knowledge about environmental degradation, factors causing environmental degradation and concepts of sustainable development, protection of environment. The Pollution Awareness is preceded by Environmental Awareness and succeeded by developmental Action.

A student having **Pollution Awareness** should have minimum working knowledge about

- *identification of sources of pollution,*
- *their effect on causing pollution,*
- *prevention of pollution,*
- *removal of pollution & development of environment.*

iii) Polluted and non-polluted zones (locations):
Polluting zone, generally, means the area having high density of population and polluting industries with low density of number of trees and plants. Moreover the absence of lichens and moss on trees or old buildings (Santra, 2001) has been taken as another indicator of such zones. Industrial areas of WB (e.g. the Gangetic plateau of Howrah, North 24 Parganas, Hooghly) come under this zone.

Non-Polluted Zone is conspicuous by the presence of lichens and moss on trees or old buildings

Delimitations:
The present study is limited to awareness about **Air, Water and Soil pollutions** only. However the identification of polluted zone would be done on the basis of **air** pollution only.

OBJECTIVES OF THE STUDY:

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1. To find the differences on Aptitude in Science (AS) among the students on the basis of their gender and the pollution status of the locality of their schools.
2. *To find the impact of Aptitude in Science (AS) on Awareness of Environmental Pollution (AEP).*

HYPOTHESES TO BE TESTED:

On aptitude in science:

$^1H_0$: The boys and girls of the schools do not differ in the mean scores on Aptitude in Science.

$^2H_0$: The students of the schools located in polluting &non-polluting zones do not differ in the mean scores on Aptitude in Science.

$^3H_0$: Boys and girls of the schools of polluting zone do not differ in the mean scores on Aptitude in science.

$^4H_0$: Boys and girls of the schools of non-polluting zone do not differ in the mean scores on Aptitude in science.

$^5H_0$: Boys of schools of polluting zone and non-polluting zones do not differ in the mean scores on Aptitude in science.

$^6H_0$: Girls of schools of polluting zone and non-polluting zones do not differ in the mean scores on Aptitude in science.

$^7H_0$: High and low scorer-Groups on aptitude in science test do not differ significantly in their mean scores on Awareness of Environmental Pollution.

III METHODOLOGY:

Population of the study:

Students passing VIII under WBBSE in Bengali medium schools are considered for this study. Class VIII is the terminal stage of upper primary up to which students mostly learn about environment through activity and observation, and up to this stage science and environment education are interwoven and go together.

Sample of the study:

Sampling: Three polluted districts of WB were randomly selected: They were Howrah, Hooghly & North 24 Parganas. Similarly three non-polluted districts of North Bengal i.e. Malda, South Dinajpur & Jalpaiguri were selected. The schools of the concerned districts were selected randomly with the following restrictions: Schools were selected from polluted & non polluted zones, whose % of passes in first division in Secondary Final examinations was between 50 to 75% for the last three years.The distribution of schools of polluted and non-polluted zones is shown in Table-1 below:

Table-1Zones vs. Schools

Zones of Schools	Boys' schools	Girls' schools	Total No. of schools
P zone	3	3	6
NPzone	3	3	6
Total No. of schools	6	6	12

In all 1063 students were selected from theschools (Table-2). The distribution of students of polluted and non-polluted zones is shown below:

Table-2 Zones vs. Students

Zones of Schools	No. of Boys	Girls	Total No of students
P zone	301	243	544
NPzone	180	339	519
Total No.of Students	481	582	1063

Variables of Study:

Independent Variable:

Aptitude in Science

Categorical variables:

2 (Two) categorical variables: Sex and Zones (Locations) of the schools

Dependent variables:

Awareness of Environmental Pollution

Tools:

I. Test (SKMAS).developed by Bhat, De &Sen (2012) on Aptitude in science.

II.Test (SKMAEPT) developed by Bhat, De &Sen (2012) on Pollution Awareness. Only data collected by this tool will be used (shown in Table 7)

Test on *Aptitude in science* contains the following dimensions:

Table-3. Dimensions of Aptitude in Science Test (as per WBBSE, Curriculum, Class-VIII, 2005)

Sl. Number	Dimensions on Aptitude in Scienceon	Number of items
1	Mathematical Ability	09
2	General Experience	01
3	Science Symbol	05
4	Reasoning Ability	08
5	Information	06
6	Observation	03
7	Scientific understanding	04
	Total	36

For developing test items on Aptitude in Science the facts and principles of science operating through environment have been identified from the text book (class VIII,2005) and the common life experience of the students.

Items having Discriminating Index (DI) below 11(i.e.<20%.) were cancelled.

Facility Index (F.I.) of the items (no. of correct responses / total no. of respondents) vary from 11%-85.50%.

On the seven dimensions of the test, 36 items were selected for the preparation of the final test.The content validity of the test was checked by experts on environmental science and education. The reliability of the test was found by test–retest method where reliability coefficient is r=0.7905 ($p<0.05$) for df =132.The internal consistency of the items were found by Bunch-total correlation. Marking Scheme used for scoring was 1 for right answer & 0 for wrong, incomplete or partial answers.

Fig2: 'Freq' Frequency Polygon representing the frequency distribution of the Aptitude in Science scores of the students of entire sample.

Volume : 5 | Issue : 4 | April 2015 | ISSN - 2249-555X

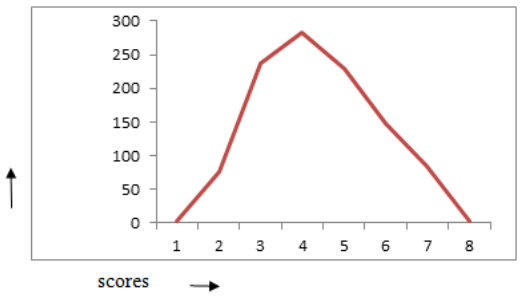

Table -4 Descriptive Statistics of Aptitude in Science test:

	Atot	Ap	Anp	Ab	Ag	Apb	Apg	Anpb	Anpg
N	1063	543	518	480	581	301	243	180	339
Mean	18.7742	19.5617	17.9170	19.8104	17.8847	21.6412	17.0206	16.7833	18.5428
Std. Deviation	6.70285	6.38866	6.91723	6.99623	6.30972	6.93043	4.50569	5.98721	7.30205
Skewness	.264	.384	.238	.145	.324	-.020	.250	.215	.161
Kurtosis	-.699	-.601	-.853	-.854	-.541	-1.026	-.006	-.586	-1.034

Abbreviations:
Atot- Aptitude in Science (AS) scores for total sample,Anp-AS scores of the students of non-pollutedzones,Ap-AS scores of the students of polluted zones,Anpb-AS scores of the boys of non-polluted zone , Anpg-AS scores of girls of non-polluted zones, Ab-AS scores of boys etc.

Analysis:
To find the main effects of 'Location' of schools involving-Pollution and 'Sex' and their interaction, ANOVA was designed for 50 scores selected randomly from each of the 4 (four) cells: Boys, Girls, Polluted and Non-polluted locations of schools.

Table-5.2x2 tables for ANOVA for the Tests of significance of difference of means

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
sex	375.380	1	375.380	8.513	.004(p<0.01)
loc	462.080	1	462.080	10.479	.001(p<0.01)
sex * loc	397.620	1	397.620	9.017	.003(p<0.01)
Error	8642.920	196	44.097		
Total	9878.000	199			

Table-6: t-test for aptitude in science between different groups sex-wise& location-wise

Groups	Mean	SD	SE_D	df	t-value	Significance level (p-value)	Remarks
1. Boys of Pollution Zones	23.11	7.112	1.319	98	4.441	0.000(p<0.01)	Significant
Boys of Non Pollution Zones	17.24	6.039					
2.Girls of Pollution Zones	17.54	4.518	1.336	98	0.165	0.870(p>0.05)	Not significant
Girls of Non Pollution Zones	17.32	8.302					
3. Boys of Pollution Zones	23.10	7.112	1.1953	98	4.666	0.000(p<0.01)	Significant
Girlsof Pollution Zones	17.54	4.518					
4.Boys of non-Pollution Zones	17.24	6.039	1.4518	98	0.055	0.956(p>0.05)	Not significant
Girlsof non-Pollution Zones	17.32	8.301					

Table-7:Descriptive Statistics of the Scores on Awareness of Environmental Pollution (AEP)

	atot	anp	ap	ab	ag	anpb	anpg	apb	apg
N value	1063	515	544	481	582	180	339	301	243
Mean	28.0113	28.1272	27.9007	28.5572	27.5601	27.6222	28.3953	29.1163	26.3951
S.D	6.06430	6.24525	5.89013	5.74614	6.28434	5.22794	6.71504	5.97353	5.43104

50 High(scores>Mean+SD) and 50 Low(scores<Mean-SD) scorer-Groups in Aptitude in Science (AS) were identified and their corresponding AEP scores have been selected. Higher Lower score groups were designated **1&2** respectively**.** In Table-8 it is to examine whether higher and lower score groups in aptitude in science differ significantly on AEP scores**:**

Table-8:Effect of Aptitude in Science on Environmental Pollution Awareness

Groups	N	Mean Scores in AEP	SD	SE_D of Mean AEP	df	t	Sig
1.High Aptitude Gr	50	34.22	4.854	0.9319	98	11.846	p<0.01
2. Low Aptitude Gr	50	23.18	4.457				

In the above two –tailed test p =0.000< 0.01; so difference of means is significant in AEP scores. Therefore, Aptitude in Science as independent Variable has a significant impact on the development of Awareness of Environmental Pollution among students of Pollution and Non pollution Zones.

Analysis and interpretation of the tables

1.0 Table- 5 indicates that

1.1 Boys and girls differ significantly (p<0.01) in the aptitude in science. So hypothesis $^1H_0$ is rejected.

1.2 Students of schools located in pollution & pollu tion zones differ significantly (p<0.01) in the apti tude in science. So the hypothesis $^2H_0$ is rejected.

2.0t –tests of Table-6 show:

2.1 Boys & Girls of Pollution zones significantly (p<0.01) differ in their Aptitude in Science. So Hypothesis $^3H_0$ is rejected.

2.2 Boys and Girls of Non Pollution Zones do not significantly (p>0.01) differ in their Apti tude in Science. So Hypothesis $^4H_0$ is retained

2.3 Boys of Pollution and Non Pollution Zones signif icantly (p<0.01) differ in their Aptitude in Science. So Hypothesis $^5H_0$ is rejected.

2.4 Girls of Pollution and Non Pollution Zones do not significantly (p>0.01) differ in their Aptitude in Science. So Hypothesis $^6H_0$ is retained.

3.0 Table- 8 shows that high and low scorers in Aptitude in Science significantly differ in their mean scores in Environmental Pollution Awareness. Hence $^7H_0$ is rejected.

IV. Findings:

Volume : 5 | Issue : 4 | April 2015 | ISSN - 2249-555X

In the Aptitude in Science Test the following groups

significantly differ:
1. Boys and Girls
2. Students of schools located in pollution &non- pollution zones
3. Boys of pollution and non-pollution Zones
4. Boys & Girls of pollution zones

In the Aptitude in Science Test the following groups

do not significantly differ:
5. Girls of Pollution and non- Pollution Zones
6. Boys and Girls of non -Pollution Zones

Impact of Aptitude in Science on Awareness of Environmental Pollution
7. Aptitude in Science has significant effect on Awareness of Environmental Pollution

V. Limitations of the study:
- The identification of pollution status of a locality is a difficult task. In these days of scientific and technological advancements no habitat is entirely free from all types of pollution.
- In the present research the degree of pollution couldnot be precisely defined.
- In the identification of polluted habitats emphasis has been given on air pollution.
- Tests on Awareness of Environmental Pollution & Aptitudein Science in this research relate to Air, Water & Soil pollution only.
- Industrial areas of some districts have been identified as polluted zones. Furthermore nonexistence of Lichens is also an additional indicator of environmental pollution in terms of air.
- In this research categorical variables have been chosen as sex and location of schools. Other relevant categorical variables could have been used for impact analysis.

Discussion:
The present study on aptitude in science bears some common aims with (i) studies of the authors Bhat,De &Sen(2014a) on the same set of sample regarding effect of concepts in science on the awareness of environmental pollution of the students (ii) a study on contribution of scientific aptitude and attitude on environmentally sensitive practices(Narayana&Suhani, 2010). The combined views might be presented in the following ways:

Firstly:
The present research shows that Aptitude of the students in science differ significantly due to difference of sex as also due to difference of the factor 'Environmental Pollution' surrounding the schools of the students. It was further observed that the impact of environmental pollution on aptitude in science is more in the case of boys. The voluntary participation of the students in different environment related games, activities and behavior might indicate the level of Environmental Awareness & Aptitude in Science of the students (Narayana&Suhani;2010).

Secondly:
In search of factors contributing to Pollution awareness it was observed from the present study that Aptitude of the students in science has significant effect on Pollution Awareness of the students. It was found from the study of Bhat et al.(2014b) that concepts in science has also significant effect on Pollution Awareness of the students. Higher aptitude in science enables a student to participate in different pro environmental activities which may ultimately develop of his/her Environmental Pollution Awareness. Narayan &Suhani's findings were somewhat different.They observed that Aptitude of the students in science has limited effect on the pollution awareness. Aptitude owing to its component 'reasoning' dominates at certain points but scientific attitude of the students has more dominating and lasting effects on pollution awareness.

Awareness is a value laden concept. Its development depends much on Aptitude in Science & Scientific Attitude in a sequence as shown in the following diagram. Here Aptitude in science is in no way inferior.[*Aptitude in Science Scientific Attitude Awareness].*

Thirdly:
In another study on the same sample Bhat,De &Sen(2014b)found the effect of some categorical variables on environmental pollution awareness. It was found that sex of the students and pollution characteristics of the surrounding area of the schools have almost no effect on the environmental pollution awareness of the students.

Arranged hierarchically, the effects of the factors on the environmental pollution awareness are: Scientific Concepts related to Environment, Scientific Attitude, Scientific Aptitude, and Sex of the students & Pollution Characteristics surrounding the schools.

For awareness activities students having higher Aptitude in Science (AS) are preferred because AS is pre learning/ entry level behaviour. However, the ultimate aim of teaching Environmental Studies is to develop pro environmental attitude of the students.

VI.Conclusion:
Environmental Pollution Awareness depends ***more*** on the continuous variables like scientific concepts and aptitude in science related to environment in comparison to discrete or categorical variables. So in the development of environmental practices leadership may be bestowed on the children having higher scientific concepts and aptitude.

Suggestions for Further Research on Aptitude in Science:
1) Impact of different grades, castes, parents' academic status, economic status of family of the students may be considered as categorical variables to study their impacts on Aptitude in Science related to Environment.
2) It is better to find concurrent and/or construct validity of the aptitude in science test over and above finding the content validity of the test or inter raters' agreement on the test.

Volume : 5 | Issue : 4 | April 2015 | ISSN - 2249-555X

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