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Out-of-school experience categories influencing interest in science of upper primary students by gender and locale: Exploration on an Indian sample

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Abstract

In view of student shift away from science at advanced levels, and gender and locale based divergence in interest in studying physics, chemistry and biology, this study explores experience categories that significantly contribute to interest in science on a sample of upper primary school students from Kerala, India. A series of multiple regression analyses, on data from a Likert type scale of Out-of-school Science Experiences and Scale of Interest in Science towards frequency of experience and degree of interest respectively, revealed moderate influence of out-of-school experiences on interest in science. While biology related experiences and chemistry experiments influence interest in science more among girls, physics activity and biology experimentation influenced boys' interest more. Simple experimental acts are more influential on interest in science for girls than boys. Urban students' enhanced interest in science over their rural counterparts is attributable to the former's more indirect, vicarious experiences, including observation.

Key words: *interest in science, out-of-school experience, biology related experience, physics related experience, gender*

Introduction of science education in Indian schools

The trend of a decreasing proportion of science and technology students during the last two decades (Organization for Economic Co-operation and Development [OECD], 2006) is a fact for India too. There is a shift away from science at plus-two and under-graduate levels (Patil, 2003) as students have no interest in science; about a third of the students said they did not study science as they did not feel motivated enough (Shukla, 2005).

In India, since Independence in 1947, the model of economic development aimed at national progress with the help of science and technology. But, the country fell short in developing a strong indigenous science and technology base, especially at the ground level; though science education at university or college level evolved in keeping with contemporary global trends (Sharma, 2000). Nevertheless, the school science curriculum in India has undergone several

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changes, both in approach and content, during the past decades. The instructional material developed by the National Council of Educational Research and Training (NCERT) under a UNICEF aided project during 1967-70, was based on an activity-based approach. Compulsory teaching of science of a uniform pattern is part of general school education up to Class VII or VIII as from 1975, with the syllabus and textbooks of science prescribed by the respective state agencies with variation from one state to another. The national pattern of education with the inception of Environmental Studies, at present, employs an integrated approach, as opposed to a disciplinary approach that was in vogue, and attempts to link the teaching of scientific principles with daily life experiences of the learners.

The present National Curriculum Framework (NCF, 2005) in policy discourages rote learning while inquiry skills are supported and strengthened. The NCF emphasizes co-curricular and extracurricular elements aimed at stimulating investigative ability, inventiveness and creativity, irrespective of the examination system. This framework exhorts teachers that children of 6-11 in age are to be engaged in joyfully exploring the world around them and harmonizing with it to nurture their curiosity about the world, and to have exploratory and hands on activities to acquire the basic cognitive and psychomotor skills through observation, classification, and inference. At the upper primary stage, children (11-14 years old) should be engaged in learning the principles of science through familiar experiences, working with their hands to design simple technological units and modules and to learn more on environment and health through activities and surveys. Concepts are to be arrived at mainly through activities and experiments. Group activity, discussions with peers and teachers, surveys, organization of data and their display through exhibitions in schools and neighborhood are to be an important component of pedagogy (NCERT, 2005).

In spite of all these ideals, quality of science teaching in schools desires much, mainly due to dilution of inputs at every stage of implementation. The emphasis is on drill and rote learning and little emphasis is placed on observation, design, analysis, and argumentation and process skills and, in general, there is more public concern about the attainment levels of students in external examinations. The gap between recommendations of various commissions and committees and actual practice is visible. It is in this context that this research explores experience categories which are significantly contributive to interest in science on a sample of upper primary school students in Kerala, India, especially as exploration in the field of influence of out-of-school science experiences on interest in science is not substantial in India.

Literature review

Factors influencing interest in science

Students' interest in science is quite malleable (Kelly, 1988) particularly early in life (Gardner, 1975). Waning interest in science during later years of life can be tackled to some extent by providing factors conducive to development of such interest from the early years. Many factors influence students' interest in science. Gender is one among them. Apparent contradictions in the observed higher interest for boys in the 13 and above age group (Kahle, 2004), and that for girls in the 18 and above age group (Singh, 1999) is explicable in terms of gender role socialization (Jones & Kirk, 1990). Besides, a reversal of interest patterns of boys and girls as they move from primary to secondary school is reported. Elementary girls liked science more than boys, while the relationship is reversed in high school (Greenfield, 1997).

Gender difference in interest in science is more qualitative than quantitative (Tsabari&Yarden, 2005; Trumper, 2006). Physics is more popular with younger groups. Generally, girls are more interested in biology. Boys prefer factual and methodological concepts. Girls prefer explanatory and applicative types of information. Generally, life oriented topics and those that help in real life situations are preferred (Tsabari & Yarden, 2005). Better interest of girls in biology, corroborated by other researchers (Uitto, Juuti, Lavonen, & Meisalo, 2006), is attributed to girls' higher interest in people and life-oriented aspects of science (Miller, Blessing, & Schwartz, 2006). Boys are more interested in physics (Christdou, 2006; Gafoor & Smitha, 2010). The change in science interest from middle school to 14 and above is caused by teacher effects, perception of difficulty, preference for practical work and gender (Bottomley & Omerod, 1981).

An opportunity for practical activities (Lindemann-Matthies, 2006), student autonomy (Hanrahan, 1998), educational aspiration, parental and peer influence were also found to influence the development of interest. Having peers to share science interest enhanced both boys' and girls' interest (Stake & Nickens, 2005). Social variables such as ethnic origin (Taylor, 1993) also have an effect. School based difference in science interest with public school pupils favouring biology, physics and chemistry and private school pupils favouring space science is attributed to socio-economic status (Talisayon, Guznan, & Balbin, 2004). As achievement increased, pupils became more interested and this in turn enhanced their self-confidence. Conversely, pupils who were more interested in science obtained better scores (Chang & Cheng, 2007).

Out-of-school experience: Interest relationship in science learning

Learning from daily experience is learning without compulsion by selective attention to experiences that satisfy an individual's need. Interest is the inclination to attend to and seek certain stimuli and to indulge in certain activities. Moreover, one who has interest become absorbed in the experience and endeavors to continue it. As interest become internalized the person become increasingly willing to respond to the phenomenon, begins to seek it out and finally, become absorbed in it (Bloom, Krathwohl, & Bertram, 1964). The experience-interest relation is cyclic (Krapp, 2002) with one supporting the other.

Studies attribute lack of interest in science to science being less intrinsically motivating (OECD, 2006; Shukla, 2005), being cut-off from the real world and being overloaded with matters unrelated to students' lives (Osborne & Collins, 2001). There are other causes for students' lack of interest in science. Initially, students do not have a well-formed appreciation of the nature of science and the work that scientists undertake (Jones & Kirk, 1990). Next, there is alienation towards the theoretical version of school science by society (Ebenezer & Zoller, 1993). Then, there is lack of confidence, stemmed from insecurity in understanding science. This is caused by a lack of discussion of topics of interest, lack of creative expression, and teaching science as an isolated subject (Osborne & Collins, 2001).

In developing interest in science, a major role is attributed to out-of- school science related experiences (Joyce &Farenga, 1999; Sjoberg, 2000; Christdou, 2006) as there are some positive attributes. School science is compulsory, teacher centered, extrinsically motivating and most often undertaken to obtain good grades. Out-of-school learning is voluntary, pupil centered, intrinsically motivating and done out of their own choice and interest. Out-of-school nature experiences are the most important factor that determined interest in biology; and, as girls gain more nature experiences, they show more interest in biology (Uitto et al., 2006).

Out-of-school experiences require social participation that offers students social support, whereas school-based experiences do not (Melnick, 1991). Allowing social interaction creates real interest in the topic and a desire to learn, besides cognitive gains (Koosimile, 2004). In contrast, alienation of school science from society results in its de-contextualization (Ebenezer & Zoller, 1993).

Out-of- school experiences differ by gender and locale

Out-of-school experiences too are not uniformly distributed among students. In all countries boys have had more experience in mechanical activities, whereas girls have had more nature related activities (Sjoberg, 2000). In India too, out-of-school science experiences are more for boys than girls (Gafoor & Smitha, 2010). Boys have more experience in tinkering activities associated with physics and girls are more involved in domestic and nature study activities. In the case of boys, these experiences are reinforced by reading and watching TV (Johnson, 1987). However, the effect of out-of-school experiences on interest is not uniform through all the fields of sciences. The effect of early life science experiences on life science interest is not as pronounced as in the case of physical science experiences and hence interest in physics (Joyce & Farenga, 1999). Boys engage more in manual work and using computers and are more interested in the social dimensions and threatening aspects of science and technology (Christdou, 2006). Studies suggest also that there are urban-rural differences in experiential basis (Coley, Vitkin, & Kane, 2005; Gafoor & Smitha, 2010) and that these differences have differing impacts on learning (Brown, 2007).

Significance of identifying experiences influencing interest

Contextualizing science instruction involves utilizing children's prior knowledge and everyday experience as a catalyst to understand the challenging concepts in science (Rivet & Krajcik, 2008). Carefully planned and designed out-of-school experiential programmes have the potential to broaden students’ experiences of science and are helpful to bridge school science with students’ experience (Luehmann, 2009). In order for teachers to efficiently incorporate out-of-school experiences in their plan for teaching and thus to enhance students interest and achievement in science, it will be highly helpful if experiences that are the most significant in developing student interest during primary school years are identified.

Objective of the study

This study estimates percentage influence of out-of-school experience categories on interest in science and thus, tries to pinpoint experience categories which are significantly contributive to interest in science among upper primary school students. It traces such experience categories which are significantly contributive to the interest in science among the subsamples based on gender and locale.

Methodology

Sample

The sample comprised standard 5-7 students from 14 schools in the Kozhikode district in Kerala, (India) drawn using proportionate stratified randomization technique giving due weightage to students’ gender (boys, 808; girls, 653) and school locality (rural, 1108; urban, 353). Due representation is given to pupils from government, aided and unaided schools.

Measures

A Scale of Out-of-school Science Experiences (SOSSE) and a Scale of Interest in Science (SIS) (Gafoor & Smitha, 2008) were used.

SOSSE included 89 out-of-school experiences chosen after informal interviews with children of the age group 10-14 years, from varying socio-economic and home backgrounds. Four categories of experiences viz., Observation, Collection, Activity and Experimentation are included in the scale. The levels identify an increase in student involvement from observation to experimentation. 'Observation' requires pupil to show merely an inclination to attend carefully to surrounding phenomena while 'Collection' implies a tendency to respond and acquire the objects that have captured their attention. 'Activity' involves taking active participation in an event that satisfies them without being much aware of their implications. 'Experimentation' involves attempts to actively explore the underlying causes of a phenomenon. SOSSE consisted of items related to the fields of biology, physics and chemistry.

SIS included 63 topics selected after thorough analysis of the content in science textbooks of standards III to VII with which students are already familiar. Topics included in the scale pertain to various aspects of science like science and technology, space and the sky, human biology, plant and animal life, light and sound and dangerous aspects of science and technology.

The items in SOSSE and SIS were rated on a three-point Likert scale indicating the frequency of experience and degree of interest respectively. For SOSSE, the total score, scores on experiences relatable to three fields of science and scores on categories of experiences viz., observation, collection, activity and experimentation in each subject area, were obtained. For SIS, total scores were obtained. The final scores, total and category-wise, were obtained by dividing the sum of item scores with the number of items.

The test-retest coefficient of correlation of SOSSE was 0.78 and that of SIS was 0.70. Split-half coefficients of correlation for the scales and the sub-scales were calculated: SOSSE (r = 0.88), observation (r = 0.75), collection (r = 0.68), activity (r = 0.70), experimentation (r = 0.81), SIS (r = 0.70). Sufficiently high factorial validity was obtained during a confirmatory factor analysis for SOSSE categories.

Internal consistency was examined using the Cronbach alpha coefficient of homogeneity for both the scales and sub-scales: SOSSE (r = 0.93), observation (r = 0.80), collection (r = 0.73), activity (r = 0.82), experimentation (r = 0.81), and SIS (r = 0.95). SIS has a substantial positive correlation of 0.56 with the grades that pupils obtained in science. This can be taken as an index of concurrent validity of the scale.

Results

Relationship between science experiences and interest in science

Pearson's r between each of the twelve categories of science experiences (observation, collection, activity and experimentation in the three fields-physics, chemistry and biology) and interest in science was determined (Table 1).

Table 1.Pearson's *r* between categories out-of school experiences related to three fields of science and interest in science

Out-of-school Experientialcategory	Sample				
	Total	Boys	Girls	Urban	Rural
Biology observation	0.35	0.35	0.35	0.46	0.31
Physics activity	0.34	0.4	0.30	0.44	0.30
Biology experimentation	0.34	0.37	0.31	0.49	0.30
Physics experimentation	0.33	0.34	0.35	0.41	0.30
Physics collection	0.32	0.32	0.31	0.39	0.29
Physics observation	0.31	0.33	0.30	0.52	0.24
Chemistry experiment	0.31	0.29	0.34	0.39	0.28
Biology collection	0.30	0.32	0.28	0.43	0.26
Biology activity	0.29	0.32	0.26	0.43	0.23
Chemistry observation	0.28	0.28	0.28	0.45	0.23
Chemistry collection	0.20	0.21	0.21	0.27	0.18
Chemistry activity	0.18	0.23	0.13	0.33	0.14

* All the *r*'s are significant greater than zero, $p < .01$

The obtained positive *r*'s ranged between 0.35-0.18 in the total sample, between 0.21-0.40 in the boys' sampled, between 0.13-0.35 in the girls' sampled, between 0.27-0.52 in the urban sample, and between 0.15-0.31 in the rural sample. In the total sample and among girls all the experience categories except activity in chemistry (slight) have low positive correlation with interest in science. In the boys' sampled, the experience category correlated highest with interest in physics activity ($r = 0.40$) followed by biology experimentation ($r = 0.37$); all other experiential categories have only low correlation with interest in science. In the urban sample, except for chemistry related collection, activity, experiment and physics collection (low *r*'s), all other categories of experiences have moderate correlation with interest in science. But in the rural sample, the experience categories, other than chemistry activity and collection (slight *r*'s), have low correlation with interest in science. For all the groups, while biology observation consistently produced one of the top three correlations, chemistry collection consistently returned one of the least three correlations with interest in science. Physics observation has significant, but low correlation with interest in science in all samples; but, in the urban sample it produced a substantial and the highest correlation. Chemistry experiment was one of the highest correlates with interest in science among girls, but not in any other group.

Influence of science experiences on interest in science

Multiple regression analysis was conducted to examine the influence of out-of-school experience categories on interest in science of upper primary school students (Table 1). Percentage influence of each significant category of experience on interest in science (β × *r* × 100) was then estimated to quantify the influence of the category of experience on interest in science (Table 2).

Table 2.Results of Multiple Regression Analyses for Interest in Science using Categories of Out-of-School Experiences of Upper Primary School Students in the Total Sample and in the Subsamples

Sample	Predictors	r r^2 % F	B	t	SE	β	r	β × r × 100
Total	(Constant)	0.46 21.26% (Adj. r^2 = 21.00%) 78.60**	0.87	25.12**	0.03			
	Bi observation		0.16	6.20**	0.03	0.17	0.35	5.86
	Bi Experiment.		0.12	5.26**	0.02	0.15	0.34	5.22
	Ph collection		0.09	5.35**	0.02	0.14	0.32	4.49
	Ph activity		0.10	3.31**	0.03	0.10	0.34	3.46
	Ph Experiment.		0.05	2.12*	0.02	0.07	0.33	2.24
Boy	(Constant)	0.49 24.40% (Adj. r^2 = 24.03%) 64.82**	0.82	18.22**	0.04			
	Ph activity		0.19	5.32**	0.04	0.20	0.40	7.99
	Bi Experiment.		0.12	4.65**	0.03	0.17	0.37	6.28
	Bi observation		0.14	4.37**	0.03	0.15	0.35	5.40
	Ph collection		0.08	4.36**	0.02	0.15	0.32	4.74
Girl	(Constant)	0. 45 20.43% (Adj. r^2 = 19.70%) 27.66**	0.96	17.62**	0.05			
	Ph Experiment.		0.11	2.63**	0.04	0.13	0.35	4.59
	Bi observation		0.18	4.07**	0.04	0.17	0.35	
	Ph collection		0.08	2.96**	0.03	0.12	0.31	3.84
	Bi Experiment.		0.09	2.58**	0.03	0.11	0.31	3.47
	Ch experiment		0.08	2.23*	0.03	0.11	0.34	3.67
	Ch activity		-0.06	-2.22*	0.03	-0.09	0.13	-1.14
Urban	(Constant)	0.62 37.99% (Adj. r^2 = 37.28%) 53.31**	0.83	15.46**	0.05			
	Ph observation		0.21	4.75**	0.04	0. 26	0.52	13.51
	Bi Experiment.		0.17	5.10**	0.03	0.26	0.49	12.56
	Ph collection		0.07	2.93**	0.02	0.14	0.39	5.53
	Bi observation		0.11	2.51**	0.04	0.14	0.46	6.39
Rural	(Constant)	0. 41 17.15% (Adj. r^2 = 16.85%) 57.08**	0.88	20.31**	0.04			
	Bi observation		0.16	5.04**	0.03	0. 16	0.31	4.8
	Bi Experiment.		0.12	4.82**	0.02	0.15	0.30	4.46
	Ph collection		0.09	4.57**	0.02	0.14	0.29	4.17
	Ph activity		0.12	3.74**	0.03	0.12	0.30	3.72

** denotes $p < .01$ and * denotes $p < .05$; Ph, Bi, and Ch stand respectively for physics, biology and chemistry

In total five categories of experiences together significantly predict 21.26% variance of interest in science ($r = 0.46$, $F(5, 1455) = 78.60$, $p < .05$). In the total sample, the influence on science interest is equal from biology and physics relatable experiences (~10%). Influence of experimental experiences (7.46%) on interest in science is the highest, followed by observation, collection and activity.

In the boys sampled, four categories of experiences together significantly predict 24.03% variance of interest in science ($r = 0.49$, $F(4, 803) = 64.82$, $p < .01$). As in the total sample, in the boys' sampled, influence on science interest is equal from biology and physics relatable experiences (~11.5%). Influence of activity experiences is the highest, followed by experimentation, observation and collection.

Among girls, six categories of experiences together significantly predict 20.43% variance of interest in science ($r = 0.45$, $F(6, 646) = 27.66$, $p < .01$). Influence on science interest is attributable to experiences relatable to all fields of science - biology (9.47%), physics (8.43%) and chemistry (2.53%). The role of chemistry activity experience on enhancement of interest in science is found to be negative. Influence of chemistry relatable experiences is nil in samples other than girls. Experimental experiences contribute more than half the influence of out-of-school experiences (11.73%), followed by observation and collection.

In the urban sample, four categories of experiences together significantly predict 37.99% variance of interest in science ($r = 0.62$, $F(4,348) = 53.31$, $p < .01$). In the urban sample, influence on science interest is equal from biology and physics relatable experiences (~19%). Observational experiences contribute more than half the influence of out-of-school experiences (~20%) on interest in science, followed by experimentation and collection.

In the rural sample, four categories of experiences together significantly predict 16.85% variance of interest in science ($r = 0.41$, $F(4, 1103) = 57.08$, $p < .01$). Observational, experimental, collection and activity experiences influence interest in science almost equally.

Categories of out-of-school experiences that influence interest in science more

In order to know the influence of observation, visits, collection, activity and experimentation related to biological and physical sciences on interest in science of the students, percentage influence ($\beta \times r \times 100$) of the relevant categories were added together, and are presented in Table 3.

The categories of out-of-school experiences most influential on interest in science irrespective of the strata of upper primary students are biology related observation and experimentation, and physics related collection. Student interest in science, in the total sample and among boys and urban students, biological and physics related experiences have almost equal influence. Biology related experiences have slightly more influence than physics related experiences on interest in science among girls and rural students. Except among urban students and girls, experiences from experiments have slightly more influence than that from observation. Urban students' interest in science is influenced more by observation than experimental experiences; whereas on interest in science among girls, the influence of experimental experiences is almost twice that of observation. Interest in science among urban students, is influenced by physics observation more than the other categories of experience. The influence of chemistry observation and chemistry collection on interest in science is found to be zero. Among girls, chemistry related experiments influence interest in science more than biology related experiments.

Table 3. Summary of Percentage Influence (β × *r* × 100) of Experiential Categories on Interest in Science

Experiential category	Sample				
	Total	Boys	Girls	Urban	Rural
Biology observation	5.86	5.40	6.00	6.39	4.80
Physics observation	-	-	-	13.51	-
Chemistry observation	-	-	-	-	-
Biology collection	-	-	-	-	-
Physics collection	4.48	4.74	3.84	5.53	4.17
Chemistry collection	-	-	-	-	-
Biology activity	-	-	-	-	-
Physics activity	3.46	7.99	-	-	3.72
Chemistry activity	-	-	-1.14	-	-
Biology experimentation	5.22	6.28	3.47	12.56	4.46
Physics experimentation	2.24	-	4.59	-	-
Chemistry experimentation	-	-	3.67	-	-
Biology related experiences	11.08	11.68	9.47	18.95	9.26
Physics related experiences	10.18	12.73	8.43	19.04	7.89
Chemistry related experiences	-	-	2.33	-	-
Observation	5.86	5.40	6.00	19.90	4.80
Collection	4.48	4.74	3.84	5.53	4.17
Activity	3.46	7.99	-	-	3.72
Experimentation	7.46	6.28	11.73	12.56	4.46
Total	21.27	24.41	20.44	37.99	17.15

The mark '-' indicates that percentage influence of the category of experience is nil.

Conclusions

Out-of-school experiences decidedly influence interest in science

Percentage influence of out-of-school experiences on interest in science is in the range of 17.5-38% among upper primary students. This accords with findings of earlier studies that show there is significant effect of out-of-school experiences on development of interest in science (Joyce &Farenga, 1999; Sjoberg, 2000; Christdou, 2006). Biology and physics relatable experiences contribute equally to interest in science, contrary to the belief that generally life oriented topics are preferred by students (Tsabari&Yarden, 2005).

Biology related experiences and chemistry experiments influence interest in science more among girls than among boys

There is a gender difference in the influence of experience on interest. Within the sample among girls, the influence of biology related experiences are a little more than that of physics related experiences. Chemistry related experiments influence interest in science of girls and this inclination was observed in an earlier study (Johnson, 1987).Increased interest of girls in biology is generally attributed to girls' higher interest in people and life-oriented aspects of science (Miller et al, 2006). But the observation that 'as girls had more nature experiences, they showed more interest in biology' (Uitto et al., 2006), could not be confirmed. The two most influential categories of biology related experiences viz., biology observation (boys: $M = 1.22$, $SD = 0.32$; girls: $M = 1.21$, $SD = 0.31$; $t = 1.02$, $p > .05$) and biology experimentation (boys: *M* = 1.38, *SD* = 0.41; girls: *M* = 1.39, *SD* = 0.39; $t = -.057$, $p > .05$) and the total biology related experience (boys: *M* = 1.37, *SD* = 0.27; girls: *M* = 1.38, *SD* = 0.26; $t = 0.49$, $p > .05$) are not significantly different between girls and boys.

Boys' interest in science influenced more by experience from physics activity and biology experimentation

Boys' interest in science is contributed by their enhanced activity and experimentation. Interest in out-of school physics activity (boys: *M* = 1.30, *SD* = 0.31; girls: *M* = 1.17, *SD*= 0.32; $t = 7.86$, $p < .01$, effect size = 0.42) and physics experimentation (boys: *M* = 1.19, *SD*= 0.37; girls: *M* = 1.07, *SD* = 0.37; $t = 6.21$, $p < .01$, effect size = 0.32) is greater for the boys sampled, than the girls. These influence their interest in science for the better. Experiences such as floating paper boats in water, blowing soap bubbles, flying kites, measuring height using a measuring tape, repairing things, using the internet, mobile phones ortape recorder etc. are male stereotype activities. No wonder they influence boys' interest more. Boys' greater exposure to experiences in tinkering activities associated with physics (Johnson, 1987) is reported earlier too.

Influenceof experience from simple experimental acts is more on interest in science among girls than boys

There are some findings contrary to general belief about gender difference in out-of-school experiences. The influence of experience from experimentation (11.73%) is found to be greater than that of observation (6%) for girls' interest in science. Physics collection, a category of experience which contributes to interest in science among all the subsamples, is more for girls (boys: *M* = 1.27, *SD* = 0.51; girls: *M* = 1.33, *SD* = 0.48; $t = 2.05$, $p < .05$, effect size = 0.12). Chemistry experiments are found to influence girls' interest in science, but not of others. Mixing colours, mixing oil and water, removing paint using kerosene, making models using clay and absorbing ink using chalk are activities taken as part domestic chores and related to everyday life (Johnson, 1987). No wonder such experiences generate more interest in science among girls.

Urban students' interest in science is enhanced by having more indirect, vicarious experiences, including observation

Among urban students, physics observation influences students' interest in science (13.5%) more than other categories of experience. Biological observations also contribute to their science interest, more than for rural students. Rural students might be nearer to biological nature, but do not seem to optimize their observational experience for developing interest. Both biology (Rural: *M* = 1.20, *SD* = 0.31; Urban: *M* = 1.26, *SD* = 0.35; $t = 3.10$, $p < .01$, effect size = 0.19) and physics (Rural: *M* = 1.26, *SD* = 0.32; Urban: *M* = 1.37, *SD* = 0.35; $t = 5.39$, $p < .01$, effect size = 0.33) observations have greater influence on interest among urban students. Nevertheless, in the rural sample, influence of biology related experiences on interest is more than physics related experiences. Urban students' interest in science is influenced by observation (19.9%) more than experimentation (12.56%). Physics activity, including the use of internet, mobile phone and tape recorder among others (Rural: *M* = 1.23, *SD* = 0.32; Urban: *M* = 1.29, *SD* = 0.35; $t = 3.16$, $p < .01$, effect size = 0.18) and visits and watching of TV are expected to be greater for urban students; as wide disparities exist in level of availability of these essential amenities for science teaching in rural and urban secondary schools (Santra & Basumallick, 2003). Hence the latter have more exposure to activities through indirect and vicarious means that enrich the science experiences that they get through other means. This also helps them utilize concrete experiences better and to develop a stronger interest in science.

Interest in science requires experiences beyond observation and collection

The influence of biological observationson interest in science among upper primary students is more than other categories of experiences. However, experiences from experiments related to biology, physics and chemistry together have a slightly higher influence than that from observation in these fields, except in urban samples. Observation needs to encourage thinking, conceptual understanding, and active manipulation of the environment. Physics collection—pictures of space travelers, batteries, etc.—is more for girls. Physics collection especially is influential on interest in science among allgroups. But in spite of them having more involvement in physics collection, girls as a group are the least influenced. In the same vein, biology collections—of leaves, feathers, and pictures of animals, birds, and extinct species—are more for girls. But this had little effect on their interest in science. Girls collect more, but do not develop interest in studying science through what they collect. The effect of structuring of experiences on development of student interest is evidenced also in the influence of school encouragement and direction (physics experimentation) on activities such as melting ice using heat, changing the length of shadow by changing the distance from the source of light, reflecting sunlight using a mirror, attracting iron using a magnet, making sound by vibrating a stretched rubber-band and applying oil on paper to make tracing-paper. Though girls experience less physics experimentation, this category contributes to girls' interest in science.

Educational implications

1.Link school science with students' out-of-school science experiences. Linking science with students' out-of-school science experiences to enhance student interest in science requires re-examination of traditional school science in terms of content, instructional practices, textbooks and support facilities, teacher preparation, and assessment and further research.

2. Early science learning to be an expansion of children's natural activities of observation and exploration. Exploring the living and non-living things and playfully interacting with their environment help children learn. Encouraging the collecting of information about primary qualities like location, dimension, mass, number and secondary qualities like colour, smell or sound is recommended.

3. Arrange less formal but structured learning experiences. Bridging classrooms with media - Movies, television, magazines, newspapers, books, and computer—can bring in a lot of experiences into the classroom and thus, generate interest in science. Whenever possible, conducting field—visits is to be recommended.

4. Place a school museum devoted to science. This will help students to structure the experience from collection better and to trigger students' science activities and experimentation based on their collections.

5. Localize the curriculum. For every unit, decide the major concepts and identify the corresponding locally available experiences out-of-school. For achieving the affective goals of education the most appropriate, responsive, relevant, and reliable curriculum is a local one.

6. Reduce the urban-rural disparity. **S**ymposia, science centres, puzzles, field-based scientific investigations, and garden-based-activities may help enhance discussion and sharing of individual experiences among children, and help to contextualize science.

7. Further modify textbooks. Make textbooks an extension of out-of-school experiences with interesting ideas, references and activities, rather than words to be memorized. On topics that cannot be studied in depth, or for which a hands-on approach is not possible, the chapters needs to be useful to read as summaries.

8. Think beyond stereotypes and identify what students bring to the classroom. It is no longer possible to predict what the student interests are. Boys may be better observers, girls may be having their lessons from experimentations, and girls prefer activity as much as boys, urban pupil are deriving more experiences than rural pupil on biological and physical nature. Knowing students' experiences assists in providing those experiences that students lack. Know and interact with how students use science in their daily life.

9. Go beyond observation and collection. Learners need to see and their teachers need to help their students see the meaning and significance of daily experiences in understanding what they learn and do at school. It is not enough to have the opportunity, students need to know how to utilize observation. Dissection, microscopic observation, long-term assignments which are monitored for their completion and the like may sharpen the experiences. Likewise, collection needs to lead to thoughts, raising question, understanding relationships and the like.

10. Relate classroom chemistry with pupils' life. Teaching of chemistry needs to profusely use experiences from around the life of the student. The world of colours and paints, solutions, solvents, and mixtures, fossil fuels, detergents, food and preservatives, medicines, etc. will help connect real life with chemistry.

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