Influence of Out-Of-School Experiences and Learning Styles on Interest in Biology, Chemistry and Physics among Higher Secondary Boys and Girls in Kerala

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Abstract

Adopting an experiential learning explanation for varying student interest in the three sciences, out-of-school experience questionnaire, scale of interest in science and Kolb's learning style inventory were administered on 775 higher secondary students in Kerala. Despite their similar achievement levels, boys had higher interest in physics, and girls had higher interest in biology and chemistry. Higher interest of girls in biology relate to their more out-of-school experiences (OSE) like observation of animal, insects and birds as well as with domestic medicine, and gardening related experiences. Girls' higher interest in chemistry associated with their OSEs in domestic cleaning using chemicals and experiences from cooking. Likewise, higher interest of boys in physics is related with their higher experiences with electronic gadgets, electricity, batteries, magnets, mobile phones and domestic tools. The advantage of girls in biology through OSEs is more for convergers and assimilators. In chemistry backing from OSEs is more for converger girls. Girls with divergent or accommodating styles are able to some extent compensate their disadvantage in physics through their OSEs. The findings further highlight the significance of relating science topics with life experiences, in consideration of student learning styles. The findings indicate the ways for curricula to avoid gender stereotyping of the topics by pointing to examples, illustrations, assignments and the like that apply equally for boys and girls.

Keywords: Out-of-school Experiences, Interest in science, Physics, chemistry, Biology Convergers, Divergers, Accommodators, Assimilators.

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Context: Declining Student Interest in Science

Gender differences in science achievement which gains attention of researchers at present in view of the recent thrust on inclusive education may be due to differences in boys' and girls' participation in science within and outside the school though the innate differences in visual-spatial abilities, socialization experiences at home and at school, role stereotypes, are not of any less significance (Jones & Wheatley, 1989). There is as much raising concern among educators in the substantial decline in interest in science as students move from elementary to secondary education being reported by studies from abroad (Tröbst, Kleickmann, Lange-Schubert, Rothkopf, & Möller, 2016; van Griethuijsen, Rvan Eijck, Haste, den Brok, Skinner, Mansour,... & BouJaoude, 2015) as well as from India (Gafoor, 2011). However, decline in interest in science is evident as the students, especially girls, get older; though irrespective of gender, interest in science topics is highest during primary than secondary schooling (Gafoor, 2011). By secondary schools further modification in science interest appears as subject specific interests. During upper primary stage, though boys have more interest in biology than physical sciences, interests in both physical and biological sciences are equal among girls. During secondary schooling the difference between interests in biological and physical sciences for girls become more pronounced, and a reversal of interests in physical and biological sciences for boys is also observed. As the girls reach higher secondary level disparity between their interest in biological and physical sciences becomes clearer. Accordingly, chemistry is the least liked science irrespective of gender, but girls like physics only as much as chemistry; while boys prefer physics much more than chemistry (Gafoor 2011).

Interest in Science, Out-Of-School Experience and Learning Style

Studies reveal that science related experience in (Gafoor, 2009) and out-of-school influence on interest (Sjoberg, 2000; Gafoor & Smitha, 2010) and the related attitudes and beliefs. Boys than girls sought to know more about physics topics while girls' interests was in the biological sciences; and younger students conveyed more positive attitudes toward science than did older students (Greenfield, 1997). Physics topics has abstract concepts that appeal girls less; but boys are more interested in physics (Tsabari & Yarden, 2005; Gafoor & Smitha, 2010). Students of teachers with high interest in the definite fields - biology, chemistry and physics- had greater interest in biology, chemistry and physics respectively (Gafoor, 2009). Not only do related experiences enhance interest in specific science subjects but the type of such experiences are

influential over particular interests. For example, 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 (Gafoor & Smitha 2012). Girls involve in much less out-of-school experience, than boys, many of which later serve to enhance their interest and success in science (Rennie, 1987, as cited in Greenfield, 1996). Others held that leisure-time science activities, but not gender, associate with increased interest in school science (Jocz, Zhai, & Tan, 2014). One possible account for the differential impact of experiences on interest in the three sciences by gender is sought through learning styles. While no difference among the test scores of students were observed by learning styles or gender, significant interaction was observed between gender and learning styles on students' kinematics graphing skills. Accommodator female students' kinematics graphing skills was higher than that of female students having other learning styles and converger male students' kinematics graphing skills was higher than that of male students having other learning styles on kinematics graphing skills (Delialioglu, 2003). Sociocultural approach to teaching and learning underline that students bring their own subjectivities and that children's early science interest begins well before middle school (Chakraverty & Tai, 2013). Situated learning theory enhances the learning space concept by adding learning spaces that spread beyond the teacher and the classroom.

Experiential Learning Theory (ELT) (Kolb 1981, 2014) holds that learning is the process whereby knowledge is created through transformation of experience and knowledge results from the combination of grasping and transforming experience. To be effective, a learner need four different kinds of abilities namely two dialectically related modes of grasping experience—Concrete Experience (CE) and Abstract Conceptualization (AC) (perception mode)—and two dialectically related modes of transforming experience— Reflective Observation (RO) and Active Experimentation (AE) (information-processing mode). However, in practice every learner young or old has preferences and inclinations towards certain life experiences. It is in this context this study investigate significant correlates of interest in physics chemistry and biology of boys and girls with different learning style in senior secondary schools in Kerala?

Method

Adopting an experiential learning explanation for the variable student interest in the three sciences, this study administered an OSE questionnaire (items are evidenced in results section),

scale of interest in science and Kolb's learning style inventory on 775 higher secondary student in Kerala.

Results and Discussion

First, the study examined did the boys and girls in the study sample differ in their achievement in Physics, Chemistry and Biology (Table 1).

Table 1

Cross Tabulation of Gender and Level of Achievement in Three Sciences

Level of achievement		Gender		Total (775)	Chi square
		Boy (n=353)	Girl (n=422)		
Physics	Low	38 (10.8%)	58 (13.7%)	96 (12.4%)	1.73
	Average	171 (48.4%)	192(45.5%)	363(46.8%)	df=2
	High	144(40.8%)	172(40.8%)	316(40.85)	p=.42
Chemistry	Low	47(13.3%)	64(15.2%)	111(14.3%)	3.40
	Average	168(47.6%)	17341.0%)	341(44.0%)	df=2
	High	138(39.1%)	185(43.8%)	323(41.7%)	p=.18
Biology	Low	42 (11.9%)	32_b (7.6%)	74(9.5%)	4.28
	Average	109(30.9%)	142 (33.6%)	251(32.4%)	(df=2)
	High	202 (57.2%)	248 (58.8%)	450(58.1%)	p=.12

Table 1 shows that level of achievement in none of the three sciences Physics, Chemistry or Biology vary by gender (p>.01). Preference for the four learning styles by gender is cross-tabulated in Table 2.

Table 2.

Cross Tabulations of Gender and Preference for four Learning Styles

Learning style preference	Gender		Total (775)	Chi square
	Boy (n=353)	Girl (n=422)		
Converger	92(26.1%)	105(24.9%)	197(25.4%)	.141
Others	261 (73.9%)	317(75.1%)	578(74.6%)	df=1,p=.707
Assimilator	68(19.3%)	118(28.0%)	186(24.0%)	7.97
Others	285 (80.7%)	304(72.0%)	589(76.0%)	df=1,p=.005
Accommodator	97 (27.5%)	78(18.5%)	175(22.6%)	8.897
Others	256 (72.5%)	344 (81.5%)	600 (77.4%)	df=1,p=.003
Diverger	96(27.2%)	121(28.7%)	217(28.0%)	.208
Others	257(72.8%)	301(71.3%)	558(72.0%)	df=1,p=..648

Chi square analyses (Table 2) shows that preferences for converger style and diverger style do not vary by gender (df=1, p>.05). However, boys tend to prefer accommodator style more than girls (Chi square = 8.90, df=1, p<.05) and girls tend to prefer assimilator style more than boys (Chi square = 8.90, df=1, p<.05).

Three separate 2x4 analyses of variances examined whether gender, and learning styles alone and in interaction has significant effect on interests in biology, chemistry and physics respectively of senior secondary students. Gender and learning styles do not have significant interaction effect on interests in biology, physics, or chemistry (p>.05).

Main effect analyses on effect of gender on student interest showed that gender significantly affects interests in biology, physics, and chemistry (p<.01). Follow-up comparison of means, revealed significant gender based difference in favour of girls, both on interest in biology (Boy: N=353, M=24.32, SD=6.72; Girl: N=422, M=26.46, SD=6.63)[t=4.46, p<.01] and on interest in chemistry (Boy: N=353, M=19.89, SD=7.84; Girl: N=422, M=21.49, SD=8.10)[t=2.76, p<.01]. But, gender based difference on interest in physics is in favour of boys (Boy: N=353, M=24.16, SD=7.44; Girl: N=422, M=21.36, SD=7.76) [t=5.11, p<.01]. Thus, despite their similar achievement levels, boys had higher interest in physics, and girls had higher interests in biology and chemistry.

Main effect analyses on effect of learning style preferences on student interests revealed significant effects of learning style preferences on interest in biology (p<.01), and interest in physics (p<.05), but not on interest in chemistry (p<.05). Table 3 shows means, along with respective SDs and sample size of interests in biology, and physics by the four learning styles.

Table 3
ANOVA of Interests in Biology, And Physics by Learning Styles

Dependent Variable	Learning Style	N	Mean	SD	F
Interest In Biology	Converger	197	26.97	6.36	4.842 df= 3,771, p=.002
	Assimilator	186	25.39	6.48	
	Accommodator	175	25.08	7.04	
	Diverger	217	24.55	6.92	
Interest In Physics	Converger	197	23.74	7.83	2.773 df= 3,771, p=.041
	Assimilator	186	22.15	8.36	
	Accommodator	175	23.04	7.26	
	Diverger	217	21.72	7.36	

Pairwise comparison of mean scores (Table 3) of interest in biology by the four learning styles revealed that convergers had significantly higher interest both in biology and physics, in

comparison to their peers with diverger style (p<.05). However, interests in biology and physics of Assimilators and Accommodators did not differ significantly neither in comparison to each other nor in comparison against convergers or divergers (p>.05).

Table 4.

Summary of Multiple Correlation Analyses of Significant Out-Of-School Experience Correlates with Interest in Biology of Secondary Boys and Girls by Their Learning Styles

OSEs	Convegers		Accommodators		Assimilators		Divergers	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
	Beta weights of Significant OSEs with Interest in Biology							
o river side plants		.262				.218	.279	
o animal movements		.167					.202	
o animal predation		.245			.324	.201		
o pupa			.267			.205	.244	
o tasting						.184		
c extinct species	.241	.173		.331				
c natural disasters						.157		
d bird watching	.241	.283		.228	.237			
d cleaning wound	.262	.183						.293
d preventive medicine	.293	.265						
x dissecting floral parts			.225		.361		.255	.169
x touch-me-leaves					.242	.237		.261
x sprouting the seeds			.299					.211
R	.495	.648	.496	.431	.660	.593	.563	.481
R^2	.245	.420	.246	.186	.436	.352	.317	.232
Adjusted R^2	.210	.378	.221	.164	.400	.317	.287	.205
F**	26.88	10.04	10.01	8.55	12.16	9.97	10.55	8.75
df	1, 89	7, 97	3, 93	2, 75	4,63	5,110	4, 91	4,116

**All F values significant (p<.01)
[a] o, c, d and x stands for observation,, collection, doing and experimenting respectively

Interest in biology correlated significantly with out-of-school experiences among both boys and girls irrespective of learning styles. However, the correlation is high among converger girls, and assimilator boys, and of moderate level among boys and girls with other learning styles. The advantage of converger girls appears to be emanating from their experiential base especially from observation of biological phenomena like tropism of river side plants, animal movements and predation. Likewise assimilator boys' interest in biology is found associating with their doing bird watching and dissecting floral parts. Observations of river side plants, animal predation, pupa, collection of photos of extinct species, bird watching, dissecting floral parts and tinkering with touch-me-leaves associate with biology interest better than other sorts of experiences. Further chi square analyses revealed that observations of pupa, collection of

photos of extinct species, bird watching, dissecting floral parts and tinkering with touching me leaves are all more for girls than boys (df=2, p<.05).

Table 5.

Summary of Multiple Correlation Analyses of Significant Out-Of-School Experience Correlates with Interest in Physics of Secondary Boys and Girls by Their Learning Styles

OSEs	Convegers		Accommodators		Assimilators		Divergers	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
	Beta weights of Significant OSEs with Interest in Physics							
o phases of moon								.266
o trajectory of rain drops				.250				
o rainbow			.219					
o mobile phone towers					.271	.184		
c battery cells					.346	.248		
c photos of astronauts			.281	.450				
d making bubbles in water				.201				
d oiling a pulley				.239				
d dismantling equipment		.264						
d repairing electronic gadgets	.482			.357		.216		
d fixing electric fuse		.302			.399			
d measuring height by tape		.251						.296
x rainbow by spraying water			.273		.257			
x reflecting sunlight by mirror								.232
x magnets						.254		
x mixing oil and water		.199					.234	
R	.482	.592	.485	.607	.637	.502	.234	.529
R^2	.232	.350	.236	.368	.405	.252	.055	.280
Adjusted R^2	.223	.324	.211	.324	.368	.225	.045	.262
F**	26.88	13.617	9.56	8.39	10.74	9.41	5.44	15.165
df	1, 89	4, 99	3, 93	5, 72	4, 63	4, 112	1, 94	3, 117

**All F values significant (p<.05)
[a] o, c, d and x stands for observation,, collection, doing and experimenting respectively

Interest in physics significantly correlated with OSEs among both boys and girls irrespective of learning styles. However, the correlation is high among accommodator girls, and assimilator boys, and of small size among diverger boys. It is of moderate level among boys and girls with other learning styles. The advantage of accommodator girls relate to their experiential base especially of collection of photos of astronauts, making bubbles in water, oiling pulley, and repairing electronic gadgets. Physics interest among assimilator boys

likewise are enhanced by fixing electric fuse, experimenting rainbow by spraying water. Physics related out-of school experiences is least associated with interest in physics of divergent boys. Experiences like observing mobile phone towers, collecting battery cells and photos of astronauts, repairing electronic gadgets, mixing oil and water and fixing electric fuse are found associated with better interest in physics. Chi square analysis revealed that among these, observing mobile phone towers, collecting battery cells and repairing electronic gadgets, and fixing electric fuse are all done significantly more by boys than girls.

Table 6

Summary of Multiple Correlation Analyses of Significant Out-Of-School Experience Correlates with Interest in Chemistry of Secondary Boys and Girls by Their Learning Styles

OSEs[a]	Convegers		Accommodators		Assimilators		Divergers	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
	Beta weights of Significant OSE with Interest in Chemistry							
o tasting							.250	
o application of pesticides							.217	
o corrosion of iron			.197				.192.	.116
c soil and stones			.274					
c dyes							.293	
c cosmetics perfumes				.242		.245		
d fermenting dough				.294				
d cooking					.411			.260
d cleaning wound								
d bleaching powder								.170
d removing stains with kerosene								.302
d applying carbon in wells								.328
d tamarind to clean utensils			.224			.263		.217
x applying oil on paper			.210					
x mixing oil and water		.279						
x choosing soil for clay modelling					.233			
R		.279	.455	.403	.483	.318	.499	.534
R^2		.078	.207	.162	.234	.101	.249	.285
Adjusted R^2		.068	.173	.139	.210	.085	.216	.247
F**		8.34	5.96	6.972	9.75	6.355	7.388	7.521
df		1,99	3, 92	2, 72	2,64	2,113	4, 89	6,113

**All F values significant (p<.01)
[a] o, c, d and x stands for observation,, collection, doing and experimenting respectively

Interest in chemistry correlated significantly with OSEs among both boys and girls irrespective of learning styles. However, the correlation is moderate among accommodator and

divergent boys and girls, and assimilator boys. It is of small size among convergent girls and assimilator girls. Out-of school experiences have no significant correlation with chemistry interest in convergent boys. The advantage of accommodator girls appears to be emanating from their experiential base especially from collection of photos of astronauts, making bubbles in water, oiling pulley, and repairing electronic gadgets. Observing corrosion of iron, collecting cosmetics perfumes, cooking, using tamarind to clean utensils, relates to interest in chemistry of more than one group. Further chi square analysis revealed that experiences like collecting cosmetics perfumes, cooking, and using tamarind to clean utensils are done significantly more by girls than boys ($df=2$, $p<.05$).

Conclusions and Implications

Having converging styles is beneficial for biology and physics interest. Convergent girls do more than their counterparts with other learning styles activities like collection of photos of astronauts, oiling pulley, dismantling equipment, dissecting floral parts, making rainbow by spraying water and the like which are usually boy preferred activities. Higher interest of girls in biology significantly relate to their more OSEs like observation of animal, insects and birds as well as with domestic medicine, and gardening related experiences. Girls' higher interest in chemistry is found significantly associated with their OSEs in domestic cleaning using chemicals and experiences from cooking. Likewise, higher interest of boys in physics is significantly related with their higher experiences with electronic gadgets, electricity, batteries, magnets, mobile phones and domestic tools. The advantage of girls in biology through OSEs is more for convergers and assimilators. In chemistry backing from OSEs is more for diverger girls. Diverger or accommodator girls are able to some extent compensate their disadvantage in physics through their OSEs.

The findings that there are significant gender differences with regard to interest in sciences and interest in activities echoes that of previous studies. For example, girls were more interested in "artistic" and "realistic" activities among most contexts and generally in the biological context and boys were more interested in "social" physics activities than girls (Blankenburg, Höffler, & Parchmann, 2015) matches with finding that girls do more of collection of photos of extinct species, bird watching, dissecting floral parts and boys do more of repairing electronic gadgets, and fixing electric fuse. Kolb's (1981, 2014) suggestion that diverges often prefer social sciences or humanities and convergers prefer physical sciences is also reflected in the finding that divergers have least interest in sciences and convergers having

high interest in physics. While these activities are viewed as fun and interesting, connecting learning to real-life and deliberating percepts with their peers impact student interest in school science better (Jocz, Zhai, & Tan, 2014). To gauge and foster interest in science is to understand the ways in which students express curiosity in the world around (Luce, & Hsi, 2015). This also means that family interest in science facilitates earlier initial interest in science (Dabney, Chakraverty, & Tai, 2013). Interestingly, science activities, not gender significantly associated with an increased interest in school science. The findings further highlight the significance of relating science topics with life experiences. This should be in consideration of student learning styles. The findings indicate the ways for curricula to avoid gender stereotyping of the topics by pointing to examples, illustrations, assignments and the like that apply equally for boys and girls.

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