Differences in Students' Interest in Physics by Gender and Stage of Schooling in Kerala

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Abstract

Amid worldwide studies indicating declining students' interest in physics during secondary stage especially among girls, this study explores boys' and girls' interest in physics and changes thereof as students go up the educational ladder, on a sample of 1509 boys and 1727 girls in upper primary to higher secondary schools in Kerala. It employed a combination of cross-sectional and longitudinal designs of survey. Interest in physics was measured as sum of preference scores on a set of physics topics at upper primary, high school and higher secondary stages. Irrespective of gender, interest in physics topics is highest at the upper primary stage, with a slight advantage for girls. In general, by high school, there is 12% decline in interest in physics and a further 14% decline by higher secondary stage; decline being more among girls than boys. Decline in interest of girls is more in physics than interest in science in general; decline in interest of boys is less in physics than interest in science in general. The findings are discussed in view of self-related knowledge of students, achievement and instructional practices.

Introduction

National Curriculum Framework (NCERT, 2005) stressed fundamental shifts and changes in interests of students and wanted assessment to encompass attitudes to learning and interest. Investigation of students' attitudes towards studying science has been a substantive feature of research in science education for the past 30–40 years (Osborne *et al.*, 2003, p. 1049). Research in that area is still a subject

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of significance (Trumper, 2006**)** owing to persistent decline in post-compulsory high school science enrollment over the last two decades, which has generated concern in many countries, including India (Garg & Gupta, 2003). In search of an answer for the globally alarming situation, many science educators have given greater importance to the affective domain (Gardner, 1985, 1998; Oh & Yager, 2004), especially attitudes and interests.

Students' originally positive attitudes toward science subjects change markedly in the upper grades, especially in chemistry and physics (Graber, 1993; Greenfield, 1997). Studies indicate that students' interest in physics declines during secondary stage and that girls are less interested in physics than boys (Gardner 1985, 1998; Ormerod & Duckworth, 1975). Students considered physics and chemistry to be the most difficult of science courses, and generally more difficult than most other subjects (Lyons, 2004).

Combining cross-sectional and longitudinal designs on about 8000 students in German schools, Hoffmann (2002) revealed that girls find physics less and less interesting as they grow older; and, by the end of the 5th grade, well before the majority of classes begin to study physics, girls generally show markedly less interest than boys in most of the areas of physics. Moreover, girls generally regard physics as belonging to the group of the least interesting subjects; and, boys to those that are the most interesting. Distinct reduction in interest in the majority of areas in physics, more marked in girls than in boys, was seen in the 7th grade when the majority of classes begin to study physics (Hoffmann, 2002). In U.S. too, while male and female 7th and 10th graders have similar positive attitudes toward science, high school seniors show a greater difference in these attitudes (U.S Department of Education, 1997).

In Kerala also, gender difference in physics learning is reported. Out of the 63 concepts in Physics that show gender difference in misconceptions, 37 concepts have higher rate of misconception among girls than boys. Only 26 concepts in Physics have higher rate of misconceptions among boys, than in girls (Gafoor & Akhilesh, 2008). Like the global pattern, in Kerala higher secondary stage girls have more interest in biology and less interest in physical science than boys (Gafoor, 2011) do. Elsewhere, Halpern et al. (2007) also observed that girls, particularly as they move out of elementary school and into middle and high school and beyond, often underestimate their abilities in science. British girls in primary classes expressed more interest in studying further school science topics than the boys; by high school the level of interest amongst the girls dropped considerably so that the girls who had greatest primary science experience now gave the lowest response to questions about interest in future school science topics (Craig & Ayres, 1988 p. 423). In Germany too, Haussler (1987) confirmed the general trend found in many other studies; overall interest in physics decreases as students grow older and that boys are more interested than girls. However, this study found the drop in interest rather moderate; which was

most pronounced during the interval between 12 and 13 years of age, the age when formal instruction in physics starts, and was fairly level afterwards. As interest is a medium supporting learning processes (Krapp, Hidi, & Renninger, 1992; Nenniger, 1992), it is necessary to find out what boys' and girls' interest in physics is, and how does it change as students go up the educational ladder.

Interest in physics

The term 'interest' usually refers to preference to engage in some types of activities rather than others. An interest is a highly specific type of attitude. When one is interested in a particular phenomenon or activity, s/he is favourably inclined to attend to it and give time to it (Gardner & Tamir, 1989 p. 410). Interest emerges from an individual's interaction with environment (Renninger, Hoffmann, & Krapp, 1998). Interest in physics is a psychological construct understood as the relation of a student to physical matters (Hoffmann, 2002) determined among other things by the knowledge a student has in the field, his or her physics related self-concept, experience of competence, and self-determined engagement, and various emotional and affective components (Renninger, 1992). A distinction between general interest in physical matters and interest in physics as a school subject is possible (Hoffmann, 2002). General interest in physical matters is as individual interest in physics, an enduring personal disposition to engage with different areas of physics (Krapp, Hidi, & Renninger, 1992). Interest in physics as a school subject is a combination of individual interest in physics, and short-term interest in certain topics of physics produced by instructional factors (Hidi & Andersen, 1992).

Objectives

This study investigates interest in physics topics among school students in Kerala and the differences therein by stage of schooling and gender. This study has the following specific objectives, viz., 1) To estimate the extent of interest in physics among upper primary, high school and higher secondary school students of Kerala, and to contrast it against the extent of interest in science in general of these students; 2) To depict the changes in extent of interest in physics as the students go from upper through high school to higher secondary stages; and, 3) To reveal the extent of changes in interest in physics by gender and stage of schooling.

Methodology

This study employed a combination of cross-sectional and longitudinal designs of survey. Three cross-sectional sets of data pertaining to upper primary, high school and higher secondary school students were derived. There were intervals, of two years between the data collection of upper primary and high school stages; and, of three years between high school and higher secondary stages. This ensured that data collected in subsequent stages pertained to the same group, though not same individuals. All the three cross-sectional samples were drawn using stratified random procedures from

Kozhikode revenue district of Kerala, ensuring representativeness to the population of students (of their respective school stage) in Kerala. It is significant to note that all higher secondary school students sampled are science students, and hence possibly represents students with highest science related interest in that stage. In total, there were 1,509 boys and 1,727 girls (see Table 1 for details).

Table 1
Size and attributes of the samples used as source of data for the study

	Upper Primary			*High School*		*Higher Secondary*
Grade	V	VI	VII	VIII	IX	XII
Boys	216	229	208	272	231	353
Girls	243	279	286	259	238	422
Total	459	508	494	531	469	775

Interest in physics was scored as the sum of preference scores on a large set of topics on a 3-point Likert scale. There were 42, 30, and 20 physics topics in the measures meant for upper primary, high school and higher secondary school students respectively. The number of physics topics is higher in the lower stages in order to facilitate comprehension of the intended topic by younger students; number of topics could be progressively reduced as students go up the school and acquire more inclusive but precise terms to denote the areas in physics. Scores on select topics were averaged, and then converted to a derived score with a range, 0 to 1, to facilitate comparison among the data from the three stages. Test-retest reliability and Cronbach's alpha of the three measures were >.80. Measure of interest in school subjects in terms of preference for topics are more valid than the interest measures obtained from frequently used interest scales which employs attitudinal type statements. Further, these measures are more realistic as they are derived from the students' preference for topics they are studying at their stage of schooling, rather than a desirable state that the students wish to.

Interest in science scores are derived from the same three samples by employing similar aggregation of the preferences on topics from the three science streams – biology, chemistry, and physics.

Results

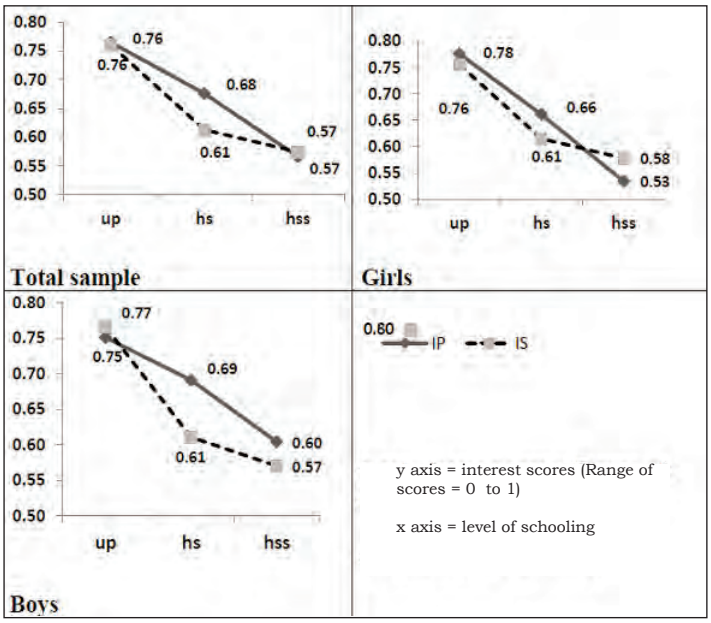
Extent of interest of students in physics at school

The scores on interest in physics that can range between 0 and 1 were derived for students at the three stages of schooling in total and by students' gender (Table 2).

Table 2
Derived mean score of interest in physics and interest in science among students at three stages of schooling

	Interest in Physics			*Interest in Science*		
	UP[a]	HS[b]	HSS[c]	UP	HS	HSS
Total	0.76	0.68	0.57	0.76	0.61	0.57
Boys	0.75	0.69	0.60	0.77	0.61	0.57
Girls	0.78	0.66	0.53	0.76	0.61	0.58

a, b, c denotes SD=0.17(.19), SD=0.22, and SD=0.19 respectively



Interest in physics topics is highest at the upper primary stage, for both boys and girls. It shows significant decline of nearly 0.5 standard deviations as the students reach high school and further decline of another 0.5 standard deviation as they reach higher secondary school. In tune with the observations of Gafoor and Smitha (2010), and Deepak (2010) about interest in science in general, interest in physics topics also decreases as the students go up the school stages, irrespective of the gender. This trend is visible in figure1.

Figure 1: Comparison of (decline in) interest in science (IS) and interest in physics (IP) of students (total, boy and girl samples) as they go from upper primary (UP) school through high school (HS) to Higher secondary (HSS).

Figure1 and Table 1 demonstrate the following. The decline in interest of girls is sharper in physics than interest in science in general; and, decline in interest of boys is less in physics than interest in science in general. Since the interest scores of higher secondary students plotted here pertains to science students only, the score of .53 to .60 (out of maximum of 1) can be considered moderate only and hence reason for students' low interest in physics has to be probed into.

Extent of changes in interest in physics by gender

Figure 2 shows that initially, at upper primary stage, girls (M= .78, SD= .17) had a little higher (3% score) interest in physics than boys (M= .75, SD= .19) [t= 2.70, p<.01]; but at the high school stage the relation is reversed with boys (M= .69, SD= .22) being a little more interested (3% score) in physics than girls (M= .66, SD= .22), [t= 2.11, p<.05]. In addition, at higher secondary stage the gender difference in interest in physics becomes clearly pronounced with boys being significantly higher (M= .60, SD= .19) on it than girls (M= .53, SD= .19) [t= 5.01, p<.01, (Effect Size= .39)]. Figure 2 shows that drop in interest in physics from upper primary stage to higher secondary stage is more acute among girls than boys.

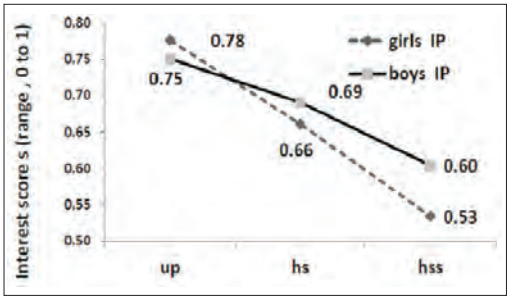
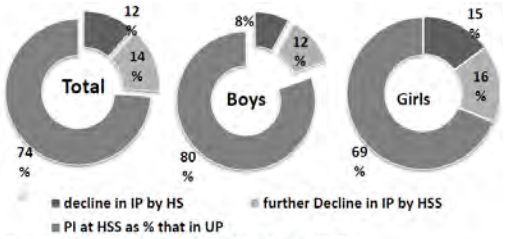


Figure 2: Comparison of decline in interest in physics of boys and girls as they go from upper primary (UP) school through high school (HS) to higher secondary (HSS) [Range of scores= 0 to 1]

Extent of changes in interest in physics by students' stage of schooling

In order to quantify the extent of decline in interest in physics by the stage of school, the interest in physics of the students at upper primary stage was considered maximum (100%) and the interest scores of the latter stages were proportionally amplified by multiplying them also with the same ratio. Then, the percentage decline in interest in physics by high school and higher secondary school was computed by subtracting the latter values from 100. Figure 3 shows the decline of interest in physics of the samples.



(Note: interest in physics at UP level is taken as 100%, and break away fraction represents % decline in the interest by HS and HSS stage)

Figure 3: Reduction in interest in physics (IP) of students as they go from upper primary UP school through high school (HS) to higher secondary (HSS)

Figure 3 shows that in percentage terms, in total sample, there is 12% decline in interest in physics of high school students, in comparison to the

interest in physics of upper primary school students. Higher secondary school students' interest in physics is 14% further lower than that of high school students (26% less than the interest in physics of upper primary students). In higher secondary boy samples, thus, there is 20% less interest in physics than what the boys at upper primary stage have; of this 8% of interest is lost by high school stage, and 12% interest is lost by the higher secondary stage. In comparison to this, decline in interest in physics among girls is larger; there is 31% less interest in physics than what the girls at upper primary stage have; a reduction of 15% by high school stage and a further 16% interest is lost by the higher secondary stage. Drop in interest in physics is more in the transition from high school to higher secondary school, than during the transition from primary to high school.

Conclusions

The findings clearly demonstrate the decline in interest in physics among students as they move from upper primary through high school to senior secondary stages. This decline is more among girls than boys. Initially, girls had a little higher interest in physics than boys but at the high school stage, the relation is reversed with boys being a little more interested in physics than girls; by higher secondary stage the gender difference in interest in physics become clearly pronounced with boys being significantly higher on it than girls. Comparing the decline in interest in physics with decline in interest in science in general, among girls, it is observed that physics is less preferred than science in general; decline in interest of boys is less in physics than interest in science in general. Against the findings by Haussler (1987), that drop in interest in physics was most pronounced during the interval between 12 and 13 years of age, which is, level afterwards; this study found that drop in interest in physics was more pronounced during the transition from high school to higher secondary school. Girls' reduced interest in scientific and technical education is reported as beginning before and outside school (Hannover, 1998). In pre-school and outside school, trends appear which are then reinforced by school and by lessons in physics, chemistry and technology. Hence, interest oriented physics instruction is especially important for girls. Interests are mental representations that are strongly linked to self-related knowledge (Hannover 1998); interests are used to regulate self-esteem; interests and self-concept mutually influence each other. Gender difference in interest in physics seems to be mainly explained by gender differences in physics-related self-concept. Giving girls a better chance in physics means supporting them in developing a positive physics-related self-concept (Hoffmann, 1999); this is one condition for developing general interest in physics and higher physics achievement. Achievement and interest in physics are positively related, though not in equal terms for boys and girls. A meta-analysis of the relation between subject-matter-related interest and school achievement (Schiefele, Krapp, & Schreyer, 1993) found a mean correlation of 0.31 for physics and

science in general; the interest–achievement correlations for male students were significantly higher than for female students. Kelly (1978) assumes that the traditional gender stereotypes lead to generally less interest in the sciences among girls and that the reduced variance of girls' interest scores leads to lower correlation with the achievement indicators. Another attempt to explain lower achievement-interest relation assumes that girls behave with more conformity than boys do. Girls are willing to do what school expects of them; therefore, they have good grades even in those classes where their interest is limited (Baretti-Fuchs & Meadows, 1976).

A possible interpretation of decreasing interest in physics by increasing grade would be that prior to any physics instruction students have high expectations with respect to physics, which are not quite met by the kind of physics lessons they experience later in school. Hence, the findings suggest adding to the physics courses the topics that interest both girls and boys. Interest in physics can be enhanced, among other things, by introducing several topics using the history of science (Seker, 2005), and by using inquiry based instruction that provide opportunities for students to explore, manipulate, and experience how science knowledge is constructed (Tai & Tuan, 2005). In the specific context of Kerala, the gap in interest between boys and girls may be closed if physics is treated not solely as a scientific enterprise but also in its connection to our society; as individual teachers have a major effect on both overall science-interest and on specific topic related interests (Gafoor, 2009). As National Curriculum Framework (2005) advocates, learning in the early years must be directed by the child's interests and priorities, and should be contextualised by their experiences rather than being structured formally.

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