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Methods to motivate students in taking physics at higher studies -an econometric interpretation

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Abstract
The question "how to improve the interest of students to study physics" has been discussed in this paper. Within the existing framework of physics learning and teaching various new interdisciplinary projects as crime scene investigation, physics in the kitchen etc. can be attempted to demonstrate how inventions in physics are used in everyday life with simple experiments. Low family education & weak income background, is retreating them to learn physics as it is taught now. Student friendly topics and experiments will induce students more to learn physics in higher studies than the existing situation.

Keywords: physics, economic factors, social factors, interdisciplinary, motivation

Introduction
The framework of educational programme for basic and high school education is based on a education strategy, stressing the application of acquired knowledge and skills in practical life. It is important that the programme promotes the educational autonomy of schools as well as teachers' professional responsibility for the outcomes of the educational process. The programme offers a broader range of obligatory optional subjects for the development of pupils' interests and individual potential.
The educational area of humans and nature includes a range of topics associated with the study of nature. It streams pupils to learn the tools and methods for a deeper understanding of natural phenomena and natural laws. It also gives them the necessary foundation for a better understanding and use of contemporary technology and helps them better orient themselves in everyday life. The aim is to help students to learn asking questions "how?", "why?", and "what will happen if?" and to seek to answer them, to explain observed phenomena, to seek out and solve cognitive or practical problems, and to use their knowledge of the laws of natural processes in order to predict or influence them.
Science educators have focused much energy on developing high-quality curricular materials that science educators will adept them. The adoption is problematic, the process is complicated and the majority of teachers is not able to use the advantages of new materials. Misunderstanding of basic phenomena leads to developing negative attitudes towards science.
The task of this research activity is formulated as how we can change the course to promote students understanding and motivation in physics. The questions are: how to change the course content, what instructional methods can be used, how to teach problem-solving, and how to create the relation to the outside world.

Research Focus
It was found that there are some subjects in physics of low preference; on the other hand, some subjects are interesting for students. Low preference has subject molecular physics, waves, about molecules and atoms. On the top of interest are subjects, such as optics, astrophysics, sound, and energy. Students are interested in problems of how mobile phones works and why a steel boat can float and questions about the universe. Lack of interest were shown to information about eminent physicist, how can be physical problems described with mathematic formulas? Solving numerical tasks is the most boring activity during physics lessons. On the other hand, what most motivating are experiments that students are doing by own and using computers and the Internet in physics lessons.
It was also found out that the structure of physics lessons is still mostly the same. The main part in most lessons is the presentation of the teacher. About 70% of lessons contain revision, and about 50% of lessons of the first part of the lesson are followed by solving tasks. More common (about 50%) are now demonstrations of the teacher and about one third of lessons contain experiments performed by students. Video and the Internet are used rarely.
The aim of this research is to prepare new methods for teaching and learning physics with the focus on problems related to common life, modern technology and findings, and the own activity of students.

Data & Methodology
Primary data were collected from 122 science students at (10+2) level, from 14 different schools at Purulia & Bankura districts of West Bengal. We followed multistage purposive & random sampling method to select data points. Out of total science schools we selected fourteen schools and then sorted purposively science students in those and then selected proportionately students at random out of the total science students at the school. Descriptive analysis of the dataset was followed by suitable regression analysis using Eviews6 software.

Modelling & Empirical Findings
Studying physics in higher education is becoming rare nowadays. Very few students are opting physics in degree education unless it is made compulsory with other subjects. The decision to opt physics as one of the subjects (WTPHE) depends among many other thing on average monthly family

income (AVMFI), Percentage of physics theory classes out of total science classes (PPTCOT), Percentage of physics practical classes out of total physics classes (PPROTPC), Number of Experiments done at home (NXDH), Sex, Peers educational Background (PEERBG), Participation on science fairs (PSF), Awareness of career option with physics (ACOWP).

We have specified our econometric model as per objective of the study as follows,

$$WTPHE = \beta_0 + \beta_1 SEX + \beta_2 AVMFI + \beta_3 PEERBG + \beta_4 PPTCOT + \beta_5 PPROTPC + \beta_6 NXDH + \beta_7 PSF + \beta_8 ACOWP + U$$

We set the following hypothesis for our research work.

1. **SEX:** Sex is expected to reduce participation in physics studies. It is observed that most of the girl students opt for biological sciences in degree education. So we set our null hypothesis as $\beta_1 = 0$ against $\beta_1 < 0$.
2. **AVMFI:** Average monthly family income is a expected to induce physics study in higher education. High average family income is required to opt physics as one of the chosen subject. So our null hypothesis is set as $\beta_2 = 0$ against $\beta_2 \neq 0$.
3. **PEERBG:** Peers background is expected to put strong impact on the subject choice of the students. Science background with up to date knowledge on science studies and inventions are expected to increase participation in physics study against poor academic background and or non science academic background. So we set our null hypothesis as $\beta_3 = 0$ against, $\beta_3 > 0$.
4. **PPTCOT:** Percentage of physics theoretical classes out of total science classes is expected to induce positively the choice of physics as a chosen subject at higher education. We set null hypothesis as $\beta_4 = 0$ against, $\beta_4 > 0$.
5. **PPROTPC:** High percentage of physics practical classes out of total physics is expected to increase interest in physics study. Our null hypothesis is $\beta_5 = 0$ against, $\beta_5 > 0$.
6. **NXDH:** Number of experiments done at home strongly motivates students to learn more about the subject. So it is expected that more experiments at home will end up more choice of the subject at higher education. We set null hypothesis at $\beta_6 = 0$ against, $\beta_6 > 0$.
7. **PSF:** Participation in science fairs and like events increase interest in the subject. Our null hypothesis is $\beta_7 = 0$ against $\beta_7 > 0$
8. **ACOWP:** A better aware student about career options with physics in future is likely to choose physics more confidently in higher student than a less aware student. So our null hypothesis is $\beta_8 = 0$ against, $\beta_8 > 0$.

Our results of the descriptive analysis of the data points are shown in table 1 and in table 2. Table 1 summarises quantitative characteristics of the data set where as table 2 summarises qualitative aspects of the data points. Average monthly family income of the data set is Rs.17.68 thousand. Maximum income is Rs.55 thousand and minimum income is Rs. 2 thousand. So the data points show it is a middle and lower middle class income society whose children are studying science at different schools. Coefficient of variation is moderately high implies there exist variability among the families with respect to average monthly income. In 10 + 2 level science students usually study four science subjects as physics, chemistry, mathematics and biology/ others. So it is expected that out of total science classes at least twenty five percent classes will be there for physics. Data shows only 21.17 percent physics classes were held out of all science classes at different schools. It is appeared that schools are not careful in allotting or monitoring proportion and number of classes of different science subjects. Maximum percentage of physics classes is observed as 35 percent where as at some school it is as low as 8 percent. CV measured, as 33.81 implies this is a regular feature across schools.

Table 1: Quantitative Aspect of the Data Set

	Avmfi	Pptcot	Pprotpc	Nxdh
Mean	17.68	21.17	8.30	1.98
Median	15	22	8	1
Maximum	55	35	14	8
Minimum	2	8	2	0
Std. Dev.	11.37	7.16	3.40	2.10
Skewness	0.84	0.05	-0.19	0.89
Kurtosis	3.39	2.04	2.27	2.62
CV	64.29	33.81	41.03	105.90
Observations	122	122	122	122

Source: Authors own calculations from primary survey.

In the syllabus nearly thirty percent belongs to practical classes. So it is required to allot thirty percent of total physics classes on practical experiments but it is seen that only 8.30 percent of physics classes are taken as practical classes which is far below than the desired number. Maximum number of practical classes observed is 14 and minimum class percentage is only 2 percent. So in the sample area schools are very reluctant in arranging or allotting physics practical classes. This is quite a regular feature across schools as it has a moderate coefficient of variation amounting 41.03. Out of different experiments of physics which can be done at home, only 2 experiments are practised by the children, which is very low. Maximum number of experiments done at home is 8 and minimum is zero.

Table 2: Qualitative Aspect of the Data Set

	Sex	PEERBG	PSF	ACOWP	WTPHE
Mean	0.45	0.39	0.35	0.29	0.35
Median	0	0	0	0	0
Maximum	1	1	1	1	1
Minimum	0	0	0	0	0
Std. Dev.	0.50	0.49	0.48	0.45	0.48
Skewness	0.20	0.47	0.62	0.94	0.62
Kurtosis	1.04	1.22	1.38	1.89	1.38
CV	110.83	126.84	136.10	158.31	136.10
Observations	122	122	122	122	122

Source: Authors own calculations from primary survey.

Table 2 summarises qualitative aspects of our data set. Girls are opting physics in less number. Average value is only 0.45. Peers background is not excellent. Only 39 percent of the respondents are having a good Peers background. Only 35 percent of the respondents have taken part in science fairs or like events where as only 29 percent of the respondents have awareness about career options with physics which is very low. In the total dataset 35 percent respondents are willing to take physics as a subject in their higher studies. In all the cases coefficient of variation is high indicating high variation among responses from the respondents.

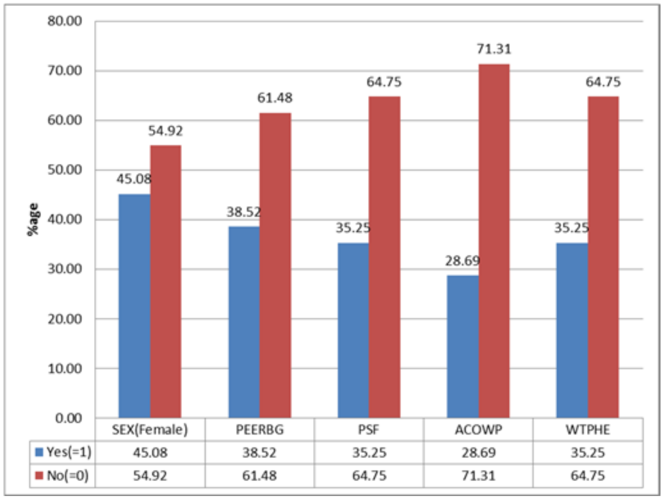

Fig 1: Qualitative Features

Different qualitative features are plotted in figure 1. Nearly 55 percent respondents are male and more than 61 percent of the students are with peers whose backgrounds are not good. Two third of the respondents are not participating or not having any opportunity to participate in science fair or likewise events during their period of study. More than 70 percent of students do not know what the future study options with physics are or what the expected career options if studied with physics are. It clearly indicates that students are not taking their decisions or their academic decisions are mostly taken by their peers. With low peer background low participation in science fair or likewise events and very low awareness regarding future career options with physics only 35 percent students are willing to take physics at their higher studies and nearly 65 percent students are not willing to opt physics as future subject of study.

Results of the empirical estimates are given in table 3 below. We have estimated a probabilistic (Binary Logit) regression model taking whether to study physics in higher education or not as the dependent variable and seven other dependent variables discussed earlier. As per estimated model sex is not a statistically significant explanatory variable. The estimated coefficient is positive implying for girls' probability of opting physics is strongly positive. We accept our null hypothesis.

Table 3: Empirical estimates of the regression equation

Dependent Variable: WTPHE				
Method: ML - Binary Logit (Quadratic hill climbing)				
Date: 12/17/15 **Time:** 20:41				
Sample: 1 122				
Included observations: 122				
Convergence achieved after 6 iterations				
Covariance matrix computed using second derivatives				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	-14.44555	3.813316	-3.788186	0.0002
Sex	0.753030	0.998652	0.754046	0.4508
AVMFI	0.103905	0.049847	2.084489	0.0371
PEERBG	2.845403	1.113422	2.555548	0.0106
PPTCOT	0.197465	0.076540	2.579900	0.0099
PPROTPC	0.048902	0.139857	0.349655	0.7266
NXDH	1.810832	0.459087	3.944422	0.0001
PSF	1.675046	1.035144	1.618176	0.1056
ACOWP	2.951719	1.308187	2.256344	0.0240
McFadden R-squared	0.799242	Mean dependent var		0.352459
S.D. dependent var	0.479706	S.E. of regression		0.208309
Akaike info criterion	0.408107	Sum squared resid		4.903370
Schwarz criterion	0.614961	Log likelihood		-15.89454
Hannan-Quinn criter.	0.492125	Restr. log likelihood		-79.17258
LR statistic	126.5561	Avg. log likelihood		-0.130283
Prob(LR statistic)	0.000000			
Obs with Dep=0	79	Total obs		122
Obs with Dep=1	43			

Source: Authors own calculations from primary survey.

Average monthly family income is a significant explanatory variable in our analysis at 5% level. The coefficient is with positive sign implying that for 100 per cent increasing in income probability of opting physics in higher studies increases by 10 percent. So we reject our null hypothesis and accept the alternative hypothesis. Peer's background is found to have a positive coefficient amounting 2.845 which is statistically significant at 5% level of significance. This implies with Peers good background chances of opting physics increases at a high rate. We reject the null hypothesis and accept the alternative one. Percentage of theoretical classes out of total science classes is also a significant variable at 5% level of significance. Estimated coefficient is 0.1974. This implies if number of classes increases by 100 percent then the probability of taking physics increases by 19.74 percent. So we reject the null hypothesis and accept the alternative one. Percentage of practical classes out of total physics classes is not significant variable at 5% level of significance. Estimated coefficient is 0.0489. This implies if number of classes increases by 100 percent then the probability of taking physics increases only by 4.89 percent. So we accept the null hypothesis. Number of experiments done at home is found to be very important explanatory variable and significant at 5% level too. Estimated coefficient is positive implying with more experiments at home chances of studying physics increases at a high rate. We reject the null hypothesis and accept the alternative one. Participation at science fairs is not significantly explaining the probability of taking physics at higher studies. Estimated coefficient is 1.675 which is not significant at 5% level of significance. This implies if students participate in science fairs or likewise events during their period of study their chances of taking physics increases but not so significantly. So we accept the null hypothesis and reject the alternative one. Career awareness with physics is also found as a strong explanatory variable of the decision of taking physics at higher education. Estimated value is 2.95 and it is statistically significant at 5% level of significance so we reject the null hypothesis and accept the alternative one.

Conclusions

It is found from our analysis that average monthly family income, peers background, number of physics classes out of total science classes, number of experiments done at home, participation at science fairs and career awareness with physics are significant explanatory variables of the probability of taking physics at higher education. We recommend the following measures to increase the participation of physics studies at higher education.

1. Cost of physics studies to be reduced by providing books and instruments at subsidised rates to enable students to collect materials at affordable cost. Library facilities, computers along with laboratory facilities are to be increased at school level to do the experiments.
2. To improve peer's background in academic decision making of the student time to time counselling programmes to be done at guardians meeting at schools or by NGOs especially at rural pockets.
3. School infrastructure has to be improved in terms of physical capital and human capital along with proper and scientific allocation of subject wise classes and monitoring of the same.
4. More experiments at home induce students study physics and opt the subject in their higher studies. So teaching learning methodologies are to be designed in such a way that they can do simple experiments mostly at home for better understanding of the subject.
5. Schools to organize regular visit to science fairs, museums etc and encourage students to participate in such activities.
6. Career counselling programmes on physics are to be organised regularly to motivate students and their peers to make them know future opportunities with the subject.

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