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A Perspective Interrogation of Students' Epistemological Beliefs And Anticipations of Studying Physics as an Introductory Course in Computer Science Engineering

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Abstract*: *Physics is ruminated to be the backbone of every Engineering stream. However, students pursuing computer science Engineering have an altogether different perception of the subject in terms of nature of knowledge and its future implications in their field of study. They are very apprehensive in stipulated learning of the subject as there exists a common belief that algorithm and program designing requires no prior knowledge of Physics or Physics laboratory and it is merely a superfluous subject laden upon them in their introductory year of Engineering. In this present manuscript, efforts are being made to explore their epistemological beliefs and expectations about the subject. In order to explore the anticipations and attitudes in learning Physics by these students, the Maryland Physics Expectation Survey (MPEX Survey) and the Engineering Physics Survey (EP Survey) has been tested for both their rationality and dependability. The EP Survey is specifically designed by the one author (N.H.) to determine the perceptions, beliefs and expectations of Computer Science Engineering students from the subject Engineering Physics. Parametric and non-parametric tests were applied to the clusters. A deep cluster wise analysis of all the items in both the surveys clearly pointed out to the fact that the students who liked Physics at school level have positive responses which are similar to that of experts and are highly motivated in learning the subject. However, the percentage of these students is quite low. Conversely, students who disliked Physics at school level carry the same perception while pursuing Engineering as well and they find no rationale in understanding the importance of this subject. Thus, the role of a school Physics teacher is pivotal in generating interest amongst students for the subject as otherwise the long –term implications at higher levels of study turn out to be very severe.

Keywords* : : *Independence, Coherence, Concept, Math link

I. INTRODUCTION

The role of Physics in Engineering in general is quite a dynamic and generic one.

The nineteenth and twentieth centuries witnessed a revolution in both the fields which perhaps mutually reciprocate each other in present scenario. In ancient times, Engineering was basically an art which relied solely on the genius and skill of the inventor. On the other hand, physicists during 19^{th} and early 20^{th} centuries had limited resources and by using very simple devices made great discoveries such as X-rays, radioactivity, relativity, nuclear fission etc. and this in todays' times is leading to an avalanche of new discoveries and inventions. The role of Physics in the development and advancement of Engineering is monumental and consequently now engineers have become responsible for research in all fields of sciences. So, it is pivotal to point out that both Engineering and Physics are walking hand in hand for mutual enhancement and development.

It is imperative to mention that Engineering evolved into a systematic disciplined field of education in the early nineteenth century. Initially it was sought as a two year program. However, by the end of the twentieth it grew up as a four year study program. Traditionally, a few core branches of Engineering were developed such as Mechanical Engineering, Electrical Engineering, Civil Engineering, Chemical Engineering and Aeronautical Engineering. While outlaying the curricula of all the mentioned Engineering streams, Physics was sought as a common introductory subject at the first year level [1]. However, the entire humungous content of modern physics was not relevant for Engineering students and a careful scrutiny was performed by experts wherein Engineering relevant curriculum was designed for Engineering Physics.

With the advent of Computers and their unimaginable scope of revolutionizing mankind, educators evidently started a new branch of Engineering termed as Computer Science Engineering (CSE). However, contrary to other core branches of Engineering, CSE is altogether different in terms of technicalities and the required key skills.

In India, Engineering Physics is a mandatory subject to be studied by all Engineering streams during the first year of the course along with Engineering Mathematics and Engineering Chemistry amongst the Basic Sciences. Along with the theory, the student is also enrolled to take a mandatory Physics Laboratory subject during same year itself.

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Students who have the combination of Physics, Chemistry and Mathematics at 10+2 level (last year of high school) and have successfully passed this level can opt for Engineering stream.

The admission in Engineering is based upon clearing Joint Entrance Examination (JEE). JEE is an all India common Engineering entrance examination conducted for those seeking admission to various Engineering colleges and universities all over the country. This is a two stage exam, that is JEE Main and the JEE Advanced. Both the exams are of the objective pattern (multiple choice test questions). After clearing the JEE Main exam, the student becomes eligible to appear for JEE Advanced. JEE Advanced is considered internationally as one of the most challenging and rigorous Engineering admission tests. Physics, Mathematics and Chemistry are the subjects on which the JEE exam is based, with a syllabus of up to 10+2 level. A general aptitude test is also a part of the exam.

It has been consistently observed that male students outperform the female students when it comes to clearing the JEE exam [2]. 72.2% boys and 27.8% girls registered for taking the exam in the year 2017. When the results were declared, 79.2% boys cleared JEE Main as against 20.8% girls. Among the successful candidates, 93.2% boys made it to the top 1000 versus 6.8% girls. This humungous gap clearly signifies the fact that girl students fair badly when it comes to logical reasoning. However, the girls always outperform the boys in clearing the high school board exams wherein the student appears for same major subjects i.e. Physics, Mathematics and Chemistry [3,4]. In India, board examinations basically refer to the public examinations taken by students to clear high school. In the board exam, the pattern of the paper is majorly subjective with and requires an in depth knowledge of the curriculum and marks are given according to the steps in which the student has attempted the exam. Thus memory retention and expression skills are a requisite for performing well in the board exams. However, the JEE exam offers to test the application based logical reasoning, wherein the boys outshine the girls. Another reason for this difference might be the fact that in India, Engineering is a male dominated discipline and thereby fewer girls are actually interested in putting serious efforts for opting Engineering.

India already has a low female literacy rate and such a skewed gender distribution in Engineering is not an exception [5]. However, women are no strangers to Engineering even though their numbers are few. There is a consistent improvement in this number which is revealed from the Ministry of human resource and development (MHRD) data [6]. In 1970-71, there were only 2% women enrolled in Engineering and by the end of the 20^{th} century, this number had reached to 23%. Women Engineers in India have displayed remarkable successes in their career [7]. They are no less than their male counterparts and have excelled academically as well as professionally.

II. IMPORTANCE OF PHYSICS IN COMPUTER SCIENCE ENGINEERING

The role of Physics in all branches of Engineering is very pivotal. However, Computer Science Engineering is very different from all other branches in terms of the skills and technicalities involved. It does not adhere to a typical Engineering format wherein an in depth knowledge Physics is employed in every technical detail right from the scratch [8]. However, Physics plays a very vital role in computing. It is viable to say that Computer Engineering is to a certain extend Electronic Engineering which enables to understand how a computer works and provides interface to the real world. In fact, Computers were first designed for physics computations, thereby serving to be its pedigree. In fact Physics computations aptly enable to determine the right design of the processor and helps in understanding the hardware and providing information about background applications. The understanding of how hardware works is of paramount importance, even if you only work with software, for example if one is dealing with memory limits or memory hierarchy. If one wants to become a Computer Science Engineer and not just a programmer, knowledge of Physics is an utmost necessity.

Traditional Physics is absolutely necessary for all sorts of game programming, simulations, robotics, physical modelling and many more. For all this, understanding of mechanics, kinematics and ballistics, wherein knowledge of the forces, energy and motions is involved is a requisite condition. For a game programmer, the knowledge of mechanics is very important as game companies want people who understand Physics and could thus put more realistic models into their games. Furthermore, for graphic designing deep realism is required, which can only be obtained if one understands the underlying Physics. One needs to have immense knowledge of inverse kinematics for designing software to control the motion of several automated objects such as cars, robots etc. For rendering special effects and digital imaging for a movie, the software which is to be designed requires information about the scene to create the image. This involves a lot of Physics such as understanding of optics.

III. ENGINEERING PHYSICS COURSE CURRICULUM

The course curriculum of Engineering Physics for Computer Science Engineering at University of Petroleum and Energy Studies (UPES), where the authors (NH and AA) are Assistant Professors, is a specifically designed one and differs from the Engineering Physics syllabus of other core Engineering branches. UPES is the largest core sector University of India and offers industry focused Engineering programs with specialization in Energy, Infrastructure, Transportation, Information Technology, and Legal Process. The syllabus here is aptly relevant from a Computer Science Engineering perspective. The Engineering Physics curriculum at UPES is designed from some very interesting topics of Modern Physics, which have been divided into 5 units. The first unit is lasers, holography and fiber optics. The second unit is vector calculus and electromagnetic theory.

The third unit is special theory of relativity followed by quantum mechanics as the fourth unit. All the mentioned topics serve high degree of relevance to cater the future needs of a computer science Engineering student.

Most of the institutes follow almost the same curriculum for Computer Science Engineering students.

Some institutes also consider optics, free electron theory of solids, band theory of solids and statistical mechanics as a part of their curriculum. However, units such as Quantum Mechanics, electromagnetic theory and special theory of relativity always find their place in the curriculum of almost all Engineering institutes.

IV. MPEX SURVEY AND ENGINEERING PHYSICS SURVEY

The success of a particular subject depends upon several factors. The learner's expectation, aptitude, interest, epistemological beliefs and past experiences inherently manipulate the approach towards the subject [9, 10, 11, 12, 13, 14]. A number of consistent and reliable surveys have been developed to measure students' beliefs about Physics [15]. The Colorado Learning Attitudes About Science Survey (CLASS) is a commonly used survey, which was developed by Adams et al [16]. Halloun and Hestenes developed the View About Science Survey (VASS) [17]. Elby et al developed the Epistemological Beliefs Assessment for Physics Science Survey (EBAPS) [18]. Thinking about Science Survey Instrument (TSSO) was developed by W.W. Cobern [19]. N.G. Lederman et al developed the Views of Nature of Science Questionnaire (VNOS) [20]. The Maryland Physics Expectation (MPEX) Survey was developed by Redish et al. We specifically focused on the MPEX survey for our analysis [21].

The Maryland Physics Expectation (MPEX) survey is considered to be a very standard and reliable survey to measure the influence of above mentioned factors on the learning of Physics [21]. It has been validated by the Maryland Physics Education research group by studying the results obtained from a selected group of students after conducting student interviews for more than 120 hours. This survey has also been validated by another group (Christopher J. Omasits and DJ Wagner) [22]. Cronbach's alpha for MPEX survey is 0.81, thus making the survey very consistent [10]. The MPEX survey is basically a statement based five point Likert scale survey which aptly aims towards studying the learner's attitude towards studying Physics based upon several attributes. The responses of the students' are categorized as favorable or unfavorable based upon expert opinion response set. The favorable answer is the one which agrees with mature scientist and the unfavorable is the one which agrees with beginner student who is a novice. This survey comprises of 34 items which are grouped into six different clusters to probe the learners' epistemological beliefs about Physics [21].

In order to investigate the learners' attitudes and beliefs, the MPEX survey is categorized into these clusters: independence, coherence, concept, reality link, math link and effort link [10, 21]. The independence cluster deals with the beliefs about learning Physics. It literally refers to taking responsibility for constructing and understanding knowledge through one's own self. Coherence cluster refers to scaffolding and clustering of Physics knowledge as a comprehensive framework. The concept cluster deals with the understanding of underlying perceptions and ideas of the knowledge. The reality link focusses on the ability to perceive the connection between Physics and reality as a synchronized framework. The math link deals with the ability of the learner to perceive Mathematics as a rigorous tool to represent and understand the physical phenomena. The effort link focusses on the introspection of individuals to put in self-efforts and practice in understanding the available content.

The MPEX survey is a very comprehensive and detailed survey leading to a very deep introspection of students' beliefs, apprehensions and perspectives about learning Physics [23, 24, 25]. However, the authors have a lot of experience in teaching Engineering students in different universities in India. The authors [NH and AA] have taught many branches of Engineering and a very strange pattern was always observed. Contrary to other core Engineering streams, the first year students of Computer Science Engineering showed very little or no interest in learning Physics, which is a mandatory course for them. However, students of other core branches such as Mechanical Engineering, Electrical Engineering, Civil Engineering, Chemical Engineering and Aeronautical Engineering showed deep interest in Physics and admired it immensely. This is a very alarming situation and the root cause of it needs to found out. When interviewed, the Computer Science Engineering students revealed the fact that they are not interested in learning Physics as they feel that it is not going to help them in their career. They merely feel the subject to be a burden and a very difficult course to pass. They simply have a trend of discarding the importance of Physics and they merely study it for the purpose of clearing it with laying little emphasis on getting good grades. The situation is even worse for the compulsory Physics laboratory course, wherein the student physically performs experiments. Computer Science Engineering students are least interested in this laboratory course and they feel that this course will never benefit them in any way in their careers. Thereby, the author felt the need of designing a very specific survey for Engineering students to get an insight of their beliefs, apprehensions and anticipations of studying Physics. As mentioned earlier, this survey was entitled Engineering Physics survey (EP survey). The EP survey is enlisted at the end of this manuscript.

The survey comprises of 11 items wherein the preliminary question in the survey is a true or false type and is a very basic one. It simply inquire about the fact that the student liked or disliked Physics at 10+2 level, where it is a compulsory subject for all Engineering aspirants in India. The next 10 items are statement based, which are adjudged with a five point Likert scale, just as in the MPEX survey. The surveyed group was 120 undergraduate (B.Tech-First year) Computer Science Engineering students from the UPES Dehradun, India. The cluster-wise allotment of the MPEX and EP survey items is depicted in Table I.

While conducting the sampling, principles of research ethics were incorporated. Informed consent was taken from the participants before filling the survey. The participants were made to understand that they are taking part in a research and this survey was not intended to harm any participant.

The anonymity and confidentiality of the participants was completely protected. Permission was duly sought by the head of department of Physics, UPES to conduct this survey. The participants were not informed about any prejudices regarding the questions in survey, as this could alter their natural responses. The participants were not monitored while filling in the survey as this could have led them to respond in a different way. Furthermore, the participants were informed that they had a right to withdraw from the survey at any point of time.

Table 1:Cluster-wise allotment of MPEX and EP survey items

Clusters	MPEX survey items	EP survey items
Independence	1,8,13,14,17,27	5,6
Coherence	12,15,16,21,29	2,4
Concept	4,14,19,23,26,27	10
Reality link	10,18,22,25	8,11
Math link	2,6,8,16,20	9
Effort link	3,6,7,24,31	7

V. STATISTICAL ANALYSIS: METHOD AND RESULTS

Cluster-wise analysis: As mentioned previously, the responses which are chosen by experts are termed as favorable and the other ones are termed as unfavorable [10, 21]. The Likert scale is a five point scale with the options: 1) Strongly Disagree 2) Disagree 3) Neutral 4) Agree 5) Strongly Agree**.** A choice of option 1 and 2 is collectively considered for disagreement and the option 4 and 5 is collectively considered for agreement. Option 3 is neutral, that is neither agreement not disagreement. The favorable statement of the expert could either be a disagreement or an agreement.

In order to get a quick grasp of the feedback of the two surveys, we have plotted agree-disagree (A-D) graphs for all the six clusters (Figure 1). The graph is plotted between percentages of candidates to answer favorably (y-axis) to percentages of those who answer unfavorably (x-axis). The sum of all the candidates who answer favorably and unfavorably should add up to 100%. Thereby the feedback should lie within the lower triangle having co-ordinates (0,0), (100,0) and (0,100). The distance of a point away from the diagonal line is a typical measure of the number of students who have opted for the neutral choice. The expert verdict lies on the top left corner of the diagonal and it obviously corresponds to favorable answer. The closer the point to the upper diagonal simply refers to those students whose answer is in coherence with that of the experts.

The students have been divided into groups based upon first item of the EP survey which is basically a query call as to whether the learner liked or disliked Physics subject at 10+2 level. Physics, as already mentioned is a compulsory subject for any Engineering student to be taken during the last two years of high school.

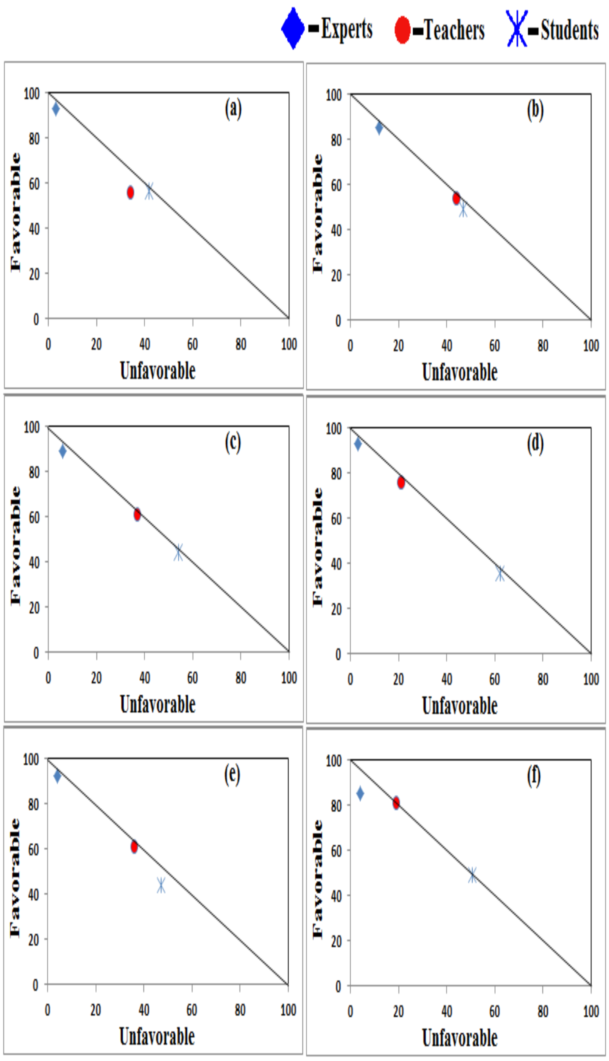

Figure 1: Agree-disagree plots for (a) Independence, (b) Coherence, (c) Concept, (d) Reality Link, (e) Math Link and (f) Effort Link cluster of Experts, Teachers and Students.

Furthermore, analysis of the survey data was also done by resolving the ratio of favorable to unfavorable responses for all the clusters for the groups that were under consideration (Table II). The first three groups are the experts, teachers and computer science Engineering students. The expert data for MPEX survey items was taken directly from P. K. Ahluwalia et al [10] and was clubbed with expert data for EP survey. The EP expert data was retrieved from a number of senior physics professors teaching at Indian universities. Similarly the teacher data for MPEX items was taken from Sapna et al [9] which were administered on college and university teachers during a refresher course in Physics at Academic Staff College, Himachal Pradesh University, Shimla, India. This was clubbed with EP teacher data which was administered on faculties teaching in Engineering colleges and universities in India. The fourth group is a subset of these students itself who either liked or disliked physics at 10+2 level and the last group belongs to male and female candidates amongst these aforementioned students.

From the table itself it is evident that the students, who liked physics at 10+2 level, have their responses very close to expert opinion. This clearly establishes the fact that generating interest in Physics amongst school going students is a paradigm shifting event which admirably harnesses positive interest in the subject during higher level engineering studies. So, the role of a school Physics teacher is pivotal in building interest amongst the students as repercussions are far flung [26,27].

Table- II: Percentage wise response ratio students, teachers, experts, like-dislike groups, male-female groups of favorable to unfavorable for all clusters

Groups	Overall	Independence	Coherence	Concept	Reality Link	Math Link	Effort Link	N
Experts	89/5	92/3	84/11	88/7	93/3	92/4	86/4	25
Teacher	65/32	56/34	54/44	61/37	76/21	61/36	81/9	50
Students	48/52	56/42	49/47	44/54	36/62	43/47	49/51	120
Like	60/39	63/35	69/24	52/47	56/42	55/35	59/40	51
Dislike	36/59	39/46	35/60	39/59	20/77	36/56	42/51	69
Female	51/50	59/40	63/34	46/53	32/67	45/46	53/46	32
Male	40/52	49/42	42/48	38/54	29/60	41/47	36/52	88

With a purpose of statistical analysis of the data and to witness the correlation within and across the aforementioned groups, we have plotted normal quantile Q-Q plots for all the clusters (Figure 2). The skewness values have also been checked for all clusters. Distributions such as concept link, reality link and effort link cluster are highly skewed having skewness values 1.39, 2.12 and 2.15 respectively. The independence and coherence cluster distribution is moderately skewed having skewness values 0.59 and 0.8, respectively. The value of skewness in math link distribution is 0.45 i.e., lies between - 0.5 and 0.5, henceforth math link distribution is approximately symmetric. It has been observed that the "independence", "coherence", "concept" and "math link" clusters showed normal distribution, whereas the "reality" and "effort link" showed non-normal distributions. Thereby, we applied a parametric test ANOVA. This test was applied to witness the level of significant difference between the four categories, i.e., Independence, Coherence, Concept and Math Link for these four clusters. The results of ANOVA are depicted in Table III. However, high value of significance was not observed in the results as none of the clusters showed p value less than 0.05. However, the coherence cluster depicted the highest value of significance ($p=0.05$). The effect size of the ANOVA test was determined between groups for the different clusters. Effect size basically is a quantitative measure of the magnitude of effect of an assessment. Effect size can categorized as small, medium and large. For ANOVA test, we determined the effect size by calculating the value of $\eta 2$. The Independence, Coherence, and Math link depicted large effect size values. However, the Concept link depicted medium effect size value.

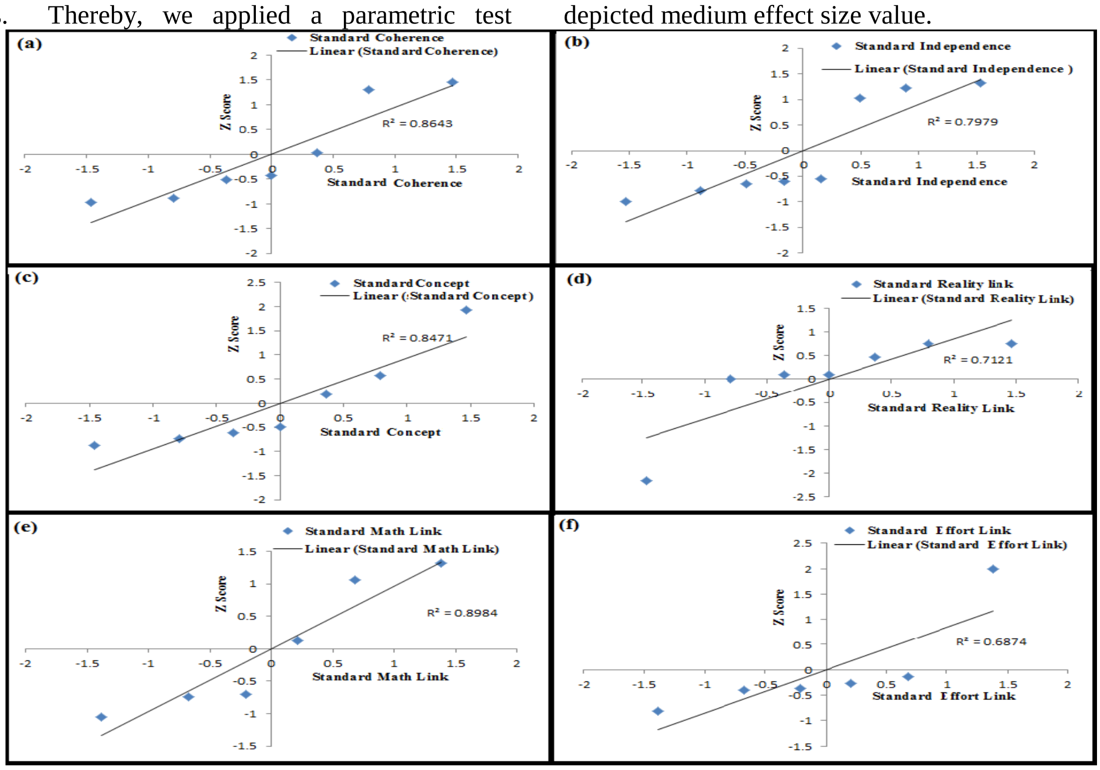

Figure 2: Q-Q plot for (a) Independence, (b) Coherence, (c) Concept, (d) Reality Link, (e) Math Link and (f) Effort Link cluster.

Table 3: Analysis of variance for independence, coherence, concept and math link clusters.

Cluster	Source of Variation	Sum of Square	d.o.f	Mean square	Effect Size (η^2)	F	p-value
Independence	Between groups	2368.932	1	2368.932	0.116	1.846	0.19577964
	Within groups	17969.401	14	1283.529			
	Total	20338.333	15				
Coherence	Between groups	4009.157	1	4009.157	0.283	4.726	0.05042909
	Within groups	10178.868	12	848.239			
	Total	14188.025	13				
Concept	Between groups	601.036	1	601.036	0.044	0.556	0.47042303
	Within groups	12983.488	12	1081.957			
	Total	13584.524	13				
Math Link	Between groups	1564.064	1	1564.064	0.147	1.730	0.21782454
	Within groups	9043.142	10	904.314			
	Total	10607.206	11				

Since, the results of the ANOVA test were quite insignificant, t –test was applied for all the clusters irrespective of their normal or non-normal distributions based upon feedbacks by male and female candidates. To understand the significance level for the difference of opinion amongst the male and female students, t-test was used. The results of the t-test are depicted in Table IV. Under the t-test analysis, results are considered to be significant if the value of $p \leq 0.05$. From the table itself, it is clear that the reality link cluster displays the least significance followed by math link cluster and concept link cluster. The effort link cluster depicts the highest significance (p=0.01) which clearly implies that the male and the female student counterparts show prominent difference of opinion when it comes to efforts. The coherence cluster (p=0.02) and independence cluster (p=0.04) also depict pronounced significance. In paired t- test, we have determined the effect size by calculating the Cohen's 'd' value. The Independence, Coherence, Concept, Math link and Effort link have large effect size in comparison to Reality link.

Table 4: Paired t-test for comparison between male and female for different categories.

Cluster	Source of Variation	Sum of Square	d.o.f	Mean square	Effect Size (η^2)	F	p-value
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	Within groups	9043.142	10	904.314			
	Total	10607.206	11				

Since the Reality link and Effort link clusters displayed a non-normal distribution, we applied a non-parametric Mann-Whitney test on them. This test was performed amongst the groups who liked and disliked Physics at 10+2 level. The result of the Mann- Whitney test is depicted in Table V. A positive Z value depicts the fact that the original value is above the median and the negative Z value depicts that the original value is below the median value. For both the clusters, the value is turning out to be positive and this implies that the original value of the sample under study is above the median for both Reality link and Effort link clusters.

Table 5: Mann-Whitney test for comparison between category of students who liked and disliked students at 10+2 level

Cluster	Category	Z value	p value
Reality Link	Students who like Physics versus who do not like Physics at 10+2 level	3.130495	0.00174
Effort Link	Students who like Physics versus who do not like Physics at 10+2 level	2.56205	0.01040

A. *Independence Cluster*

There are 8 items in this survey, wherein 6 items are incorporated from the MPEX survey and 2 items are taken from the EP survey. 56% students have responded favorably and 42% have answered unfavorably. The female students have a slight edge over responding favorably (59% favorable) as compared to the male students (49% favorable). However, the students who liked Physics at 10+2 level displayed a 63% favorable response as compared to those who did not like displayed a 39% favorable response. The teacher favorable response is same as that of the students.

B. *Coherence Cluster*

In all there are 8 items in the Coherence cluster, wherein 6 are taken from the MPEX survey and 2 are from the EP survey. 49% of the students have answered favorably, whereas 47% have answered unfavorably. The female students' edge way past the male students in answering favorably with a 63% favorable response as compared 42% favorable male candidate response. As expected, the like category displayed a 69% favorable response as compared 35% favorable response given by the dislike category. The teacher favorable response is observed to be 54%.

C. *Concept Cluster*

There are 7 items in this cluster, wherein 6 from the MPEX survey and 1 from the EP survey. Except for the teachers, the favorable response in this particular cluster is observed to be comparatively lower. The teachers exhibit 61% favorable response. However, 44% of the students answered favorably, whereas 54% answered unfavorably. The like category and dislike category had a 52% and 39% favorable response, whereas the female and male candidates provided with a 46% and 38% favorable response.

D. *Reality link Cluster*

This cluster had in all 6 items, out of which 4 are picked from the MPEX survey and 2 are picked from the EP survey. In this particular cluster the students have depicted the least favorable responses. 36% percent of the students have answered favorably and a huge 62% have answered unfavorably. This is an alarming situation and requires much introspection. The like category has displayed a 52% favorable response as compared to a 20% favorable response by the dislike category. The female and male favorable response is 32% and 29% respectively and 76% teachers have given favorable response under this cluster.

E. *Math link Cluster*

This cluster has 6 items, 5 are from the MPEX survey and 1 from the EP survey. The student favorable response is 43% and the unfavorable is 47%. The like category and dislike category favorable responses are 55% and 35% respectively. The male favorable response is 41% and is almost similar to the female favorable response which is 45%. The teacher favorable response is 61%.

F. *Effort link Cluster*

There are 6 items in this cluster, wherein 5 are picked from the MPEX survey and 1 from the EP survey. This survey depicts a teacher favorable response of 81%. The student favorable to unfavorable response stands at 49% and 51%, respectively. The like category and the dislike category favorable responses are 59% and 42%, respectively. The male favorable response stands at 36% and the female favorable response stands at 53%.

VI. INNOVATIVE TECHNIQUES USED IN TEACHING ENGINEERING PHYSICS TO COMPUTER SCIENCE ENGINEERING STUDENTS

As the authors were aware of the fact that Computer Science students show vey less interest in studying Physics, exclusive efforts were made to make the subject interesting and intriguing. Moreover, UPES has designed an altogether separate curriculum for Computer Science Engineering students to specifically cater to their needs. This is completely in contrast to other institutes and universities where all branches of Engineering have the same common curriculum for the Physics course. Engineering Physics course in this University is a one semester course of 4 credits along with 1 credit Physics laboratory course. However, for all other branches, it is a two semester course of 4 credits each along with1 credit Physics laboratory course in both the semesters.

The Engineering Physics course syllabus for Computer Science Engineering students is quite a comprehensive one and the teacher needs to devote a minimum of 42 hour lectures and 12 hour tutorial classes in the semester itself. The tutorial classes are comprehensively designed for problem solving, application analysis and catering a smaller batch of approximately 30 students at a time. Thus, the teacher gets insight of the learning done by each and every individual student and can put special stress to the hard topics and other problems faced by the students[28, 29]. UPES has specifically designed detailed tutorial sheets for each and every unit in Engineering Physics. Each tutorial sheet has all the key-points and important formulae of the unit. It is followed by multiple choice type questions. Thereafter, all types of numerical which are to be solved in the tutorial class are listed. The last portion of the tutorial sheet has all the important comprehensive questions. Each student is provided with these tutorial sheets beforehand. Furthermore, for the benefit of students, detailed power point presentations have been prepared by the department of Department of Physics for each and every unit. Furthermore, very tricky assignments are also given to the students. All the study material is uploaded on the Blackboard, which is an embedded interface for content delivery for the students.

It has been observed that students display problems in operative acquisition, retention and retrieval of Physics problems [30]. The development of automatic skills required in the aforementioned issues requires a lot of time. On the contrary, most Computer Science Engineering students fail to achieve these skills for Physics as it is a one semester course and moreover they are enrolled in a large domain of several other subjects as well which leaves them with very little time for self-study.

Thereby, the authors tried to develop various innovative techniques to teach the students to improve their learning skills. One such technique is the introduction of Flipped classes [31, 32, 33]. Basically, Flipped classroom is pedagogical model of blended learning wherein there is reversal of role of lecture and homework element. The teacher prepares short video lectures of the topics and they are viewed by the students themselves before the class session. Thereby, the class time is devoted in discussions and other exercises pertaining to the course content. This is a time saving task and provides the student with the well prepared study material and the interaction lecture thereafter tends to clear doubts and provides extra time for conceptual analysis. This perhaps increases the effective learning by the student with less input effort.

One of the authors (NH) implemented this concept of flipped classroom for few topics while teaching. It did prove fruitful and the feedback of the student regarding it was taken through the EP survey as item number 6. The students displayed utmost interest in this particular learning technique as most of the students favored it tremendously. This exercise was limited to only two lectures and is planned for a larger extent in the near future. Thus, we can say that innovation in teaching is the need of the hour and it does generate interest amongst the students to a certain extent. This interest generation is the biggest problem which is being faced by all Engineering Physics teachers.

VII. DISCUSSION AND CONCLUSIONS

From the present study, it is imperative to conclude that students epistemological beliefs and anticipations of studying Physics as an introductory course in Computer Science Engineering is inherently connected to their previous perception of the subject at school level. The more they are interested in Physics at school level; the better is their interest in understanding it while pursuing Computer Science Engineering and vice-versa. This study clearly reveals the fact that there is a significant difference in expectations of students from Physics and this in turn deeply affects their motivation towards learning the subject and determining the success of the subject. The success of the subject literally means to understand its importance and repercussions in Engineering and not just simply passing it for the sake of formality as it is a compulsory course.

From the cluster-wise analysis which was proposed by Redish et al [21,23,25], it is prominently evident that students who liked Physics at school level stand way apart in terms of their responses which are very much expert-like. Thus, those students who have initial interest in Physics tend to retain at Engineering level as well. Despite the fact that a number of students have previous negative perception of Physics at school level, they must be molded by the Engineering Physics faculties to generate interest in this subject. These faculty members should devote introductory lectures to outline importance of Physics in Computer Science Engineering and must explain how every unit of Physics course has far spread implications in understanding the concepts of Engineering.

Furthermore, when it comes to differentiating amongst the male student and female student responses, it was observed that for independence, coherence and effort link cluster, the female students showed a much favorable response as compared to the male students. However, when it comes to concept, reality link and math link clusters, the male and the female counterparts displayed almost similar responses.

This study is a wakeup call for the Physics teaching community as these Computer Science Engineers, who are considered to be the nation builders are drifting away from learning the importance of Physics which in itself is basic pillar of learning for them to excel in their stream. It is the need of the hour to bring in a paradigm shifting venture by the faculty wherein students' attitudes, viewpoints, and expectations are shifted from a novice-like view to an expert-like view. This can be brought by employing innovative teaching methods such as Flipped classroom, PER stratagems such as bringing concept based tests and interactive lecture illustrations. These have proven to be beneficial to Physics students worldwide and the same should be applicable to Engineering Physics students as well.

Engineering Physics (EP) SURVEY

Question 1: Did you like Physics at 10+2 level? YES or NO

Here are 10 statements which may or may not describe your beliefs about this course. You are asked to rate each statement by circling a number between 1 and 5 where the numbers mean the following:

1: Strongly Disagree 2: Disagree 3: Neutral 4: Agree 5: Strongly Agree

Answer the questions by circling the number that best expresses your feeling. Work quickly. Don't overelaborate the meaning of each statement. They are meant to be taken as straightforward and simple. If you don't understand a statement, leave it blank. If you understand, but have no strong opinion, circle 3. If an item combines two statements and you disagree with either one, choose 1 or 2.

2. My pre-requisite knowledge of Physics at 10+2 level really helps me in the understanding of Engineering Physics.	**1 2 3 4 5**
3. I find all the units taught in Engineering Physics to be useful from general Engineering perspective.	**1 2 3 4 5**
4. I do not actually understand the specific role of every unit of Physics course for the branch of Engineering which I am pursuing.	**1 2 3 4 5**
5. I find Engineering Physics to be a difficult course as compared to my core Engineering subjects.	**1 2 3 4 5**
6. I find Flip classes useful and this alternate method of teaching should be turned into a regular practice for some of the lectures.	**1 2 3 4 5**
7. I find Physics assignments just a burden and I merely copy it from my fellow classmates to gain marks in internal assessment.	**1 2 3 4 5**
8. Engineering Physics Tutorials provide me with a deep insight to real applications of the theory explained in the lecture.	**1 2 3 4 5**
9. I find lengthy derivations in Physics very boring and they drift away my interest in the subject.	**1 2 3 4 5**
10. I enjoy performing experiments in the Physics Laboratory as they help me to understand concepts in a better manner.	**1 2 3 4 5**
11. I indeed find the virtual Physics Laboratory experiments as informative as the actual physical experiments.	**1 2 3 4 5**

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