

ISSN No-2031-5063**Correlations between Concepts of Electricity and Magnetism with Physics Expectancies:****A Cognitive approach.**J. K. Pendharkar^a; M. N. Nyayate^b*a K J Somaiya Science and Commerce College, Vidyavihar, Mumbai, India, 400077**b B N Banodkar College of Science, Thane, India, 400601***Abstract:**

The conceptual understanding of fundamental subject like electromagnetism in Physics is much depends upon cognitive developments of students. These cognitive beliefs affect the conceptual understanding of such fundamental subject. This research was survey and co relational type research. The learner's characteristics of undergraduate students were quantified using different techniques. The students were undergraduate students studying basic sciences having physics as there one of major subject in 10+2+3 pattern in Mumbai University, India.

After survey co relations were found between many parameters like conceptual understanding, cognitive beliefs in physics, effect of gender, computer knowledge and entry level performance. The quantification of such co relations will be important in identifying complex nature of learner's characteristics and hence deciding strategies in communication methods in teaching of physics at undergraduate level.

Objectives:

Every survey intends to find relations in quantifying form so that some new correlations can be derived from it. In this survey the students filled three types of forms. Firstly the basic information form, secondly the questioner which tests their conceptual understanding, which is objectives type of test and lastly *MPEX test* on physics expectancies, developed by Department of Physics, *Maryland University*. Maryland physics education group: <http://www.physics.umd.edu/perg>

From these observations following Objectives were set.

- (i) To determine correlations between conceptual understanding in electricity and magnetism and physics expectancies (cognitive domains) of students at undergraduate level.
- (ii) To determine to check the gender sensitiveness of conceptual understanding in electricity and magnetism.
- (iii) To determine to check the gender sensitiveness of conceptual understanding in electricity and magnetism.

- (iv) To compare the cognitive beliefs or domains with respect to Gender.
- (v) Comparison of conceptual understanding in terms of their entry level and also in terms of computer knowledge.
- (vi) Comparison of student's entry level and computer knowledge with cognitive beliefs.
- (vii) To observe their overall cognitive beliefs, using expectancy test.

Methodology and tools used:

This was survey and co relational type of research.

- (i) The information like entry level performance, gender, language of instruction up to entry level (that is up to 12th standard), knowledge of computers etc was obtained from basic information form, filled by the students in the respective classes.
- (ii) From MPEX (*Maryland Physics Expectancies*) survey taken student's cognitive beliefs in physics were quantified.

MPEX test tool: <http://www.physics.umd.edu/rgroups/ripe/perg/experts/mpex.htm>

Thus development of student's cognitive domains like, Independence, Coherence, Reality link, Mathematics link, ability and interest in taking efforts, were quantified.

From clusters or domains, one can extract whether their answers were favorable or unfavorable for particular domain that is for a particular cognitive belief, in *reference to responses given by experts*. One can gauge whether current status of students are more towards *experts* or towards *novice like*. It can be clearly seen that which particular domain was unfavorable and how much. Accordingly it is possible to suggest particular remedy in the novice like belief.

Conceptual test on Electricity and magnetism:

This particular test was constructed its validity was checked by subject experts. It was composed of 20 multiple choice questions. Out of four responses given for each question only one response was designed to be correct. Students were expected to select one alternative. Each correct answer was given one mark. The students were categorized in to three possible slots of marks. That is from 0 to 6, 7 to 14, and from 15 to 20 marks.

The test particularly checks their knowledge, comprehension, ability of applying knowledge, analyzing ability, ability to solve problems, capacity of evaluation of certain basic concepts etc.

Following are the variables which were considered for finding co relations:

D1: Independence. D2: coherence. D3: concepts. D4: reality link. D5: mathematics link.

D6: Effort. **EM marks:** marks obtained in the test of Electricity and Magnetism

Gender: F/M. **Entry level performance:** class obtained in 12th standard

Computer savvy: Computer knowledge.

Selection of sample:

The survey was implemented for finding the co relations. The attempt was made for finding reasons for the poor response obtained by students at undergraduate level. Since electricity and

magnetism is one of the important topics in physics, the test on it was selected as a probe to check the conceptual understanding of physics. The results were then compared with the cognitive beliefs of students so that one can find exactly which beliefs were weak and corrective measures can be directed accordingly.

For this project, the sample used was the undergraduate students at FYBSC and SYBSC standard, of K J Somaiya college of Science and commerce, Vidyavihar, Mumbai, India.

In all 127 students were examined.

Analysis of response:

(A) Analysis of the response of the test on **Electricity and Magnetism**:

It was test of objective types of questions. There were 20 such questions. Each correct answer was given one mark. As a result the maximum marks that can be obtained in this test were 20.

The total number of students=127

Sample= undergraduate students.

Number of girls= 69

Number of boys=58

(1) Conceptual profile: Marks Vs number of students was as follows:

Marks	0	1	2	3	4	5	6	7	8	9	10
Number of students	1	0	9	6	20	17	21	17	18	10	3
Marks	11	12	13	14	15	16	17	18	19	20	
Number of students	3	0	1	1	0	0	0	0	0	0	

(2) Response obtained from students with respect to gender, entry level performance (class obtained at 12 standards), and knowledge of computers was found to be very poor, also T test showed that there was no significant difference in the marks obtained, as shown.

(Number of students received marks less than 6/20 =74/127

Number of students received marks between 7 and 14/20=53/127

Number of students received marks above 14/20=00/127)

Parameters	Marks obtained/20	T test	conclusion
Gender	Female=5.9	T=0.92	No significant difference in the marks obtained.
	Male=6.3		
Entry level performance	I Class = 6.3	T= 1.16	No significant difference in the marks obtained.
	II/III, Class= 5.8		

Knowledge of computers	YES=5.9	T=1.36	No significant difference in the marks obtained.
	NO=6.7		

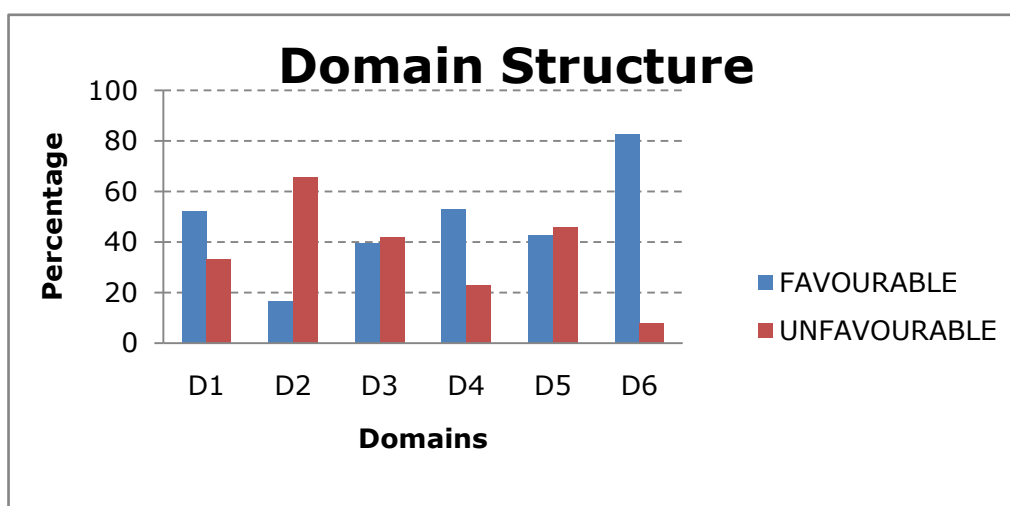
(B) Analysis of Cognitive beliefs in relation with conceptual understanding of Electricity and magnetism and other parameters:

If the students were showed favorable response more than 80% that domain was considered to be developed that is to say that the students were Expert like in that particular domain.

Let us consider the responses of students in each domain and its relationship with conceptual understanding of electricity and magnetism and other parameters.

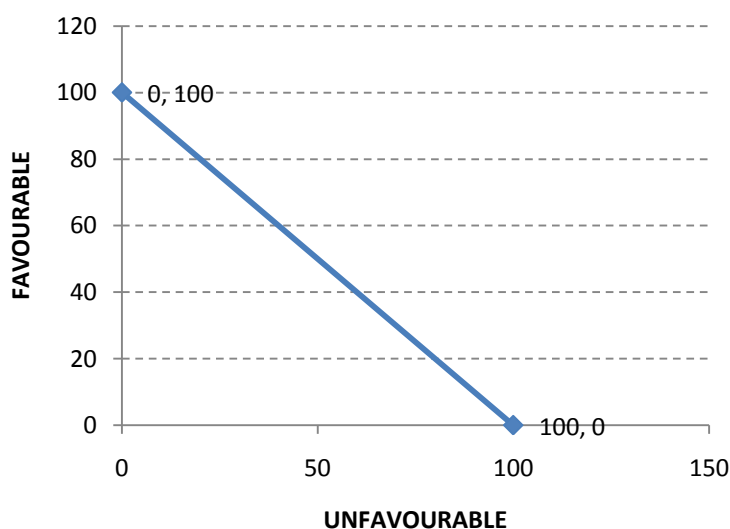
DOMAIN STRUCTURE IN PERCENTAGE

Domain	FAVOURABLE	UNFAVOURABLE	NEUTRAL
D1	51.96	33.07	14.96
D2	16.53	65.35	18.11
D3	39.37	41.73	18.89
D4	52.74	22.83	24.4
D5	42.52	45.67	11.81
D6	82.67	7.87	9.44



Learner's response of cognitive beliefs in different perspectives:

Parameter	Sub categories	D1(F/U)	D2(F/U)	D3(F/U)	D4(F/U)	D5(F/U)	D6(F/U)
Marks in EM test	0 – 6	73/14	22/50	38/45	51/23	46/43	87/10
	7 – 14	23/60	9/ 87	42/36	55/23	38/49	77/6
	15- 20	NA	NA	NA	NA	NA	NA
Gender	Female	51/36	15/73	41/42	55/22	41/48	84/9
	Male	53/29	19/57	38/41	66/24	45/43	81/7
Computer knowledge	Yes	57/28	14/65	41/39	53/22	45/45	84/7
	No	25/60	30/70	30/55	50/30	30/50	75/15
Marks at entry level	I class	52/35	14/70	44/37	62/22	44/49	87/5
	II/III class	52/31	19/61	34/47	44/23	41/42	78/11
Over all	F/U	52/33	17/65	39/42	53/23	43/46	83/8



If the favorable response is towards upper left corner that is above 80% for favorable it can considered as EXPERT like response.

Note that only D6: Effort domain showed this development. This implies other domain also can be improved by proper teaching techniques.

Analysis of the Test on Electricity and magnetism:

- (i) The conceptual profiles clearly suggest that the conceptual understanding of undergraduate students was *very poor*, in the topic like electricity and magnetism. This was because around 60% students scored *less than 7 marks* out of 20, which implies around 60% students received less than 35% in this test. The average marks obtained was around 6 out of 20 marks.
- The test was testing their *cognitive abilities* like Knowledge, comprehension, application, analysis, synthesis, and evaluation. Remaining 40% students also could not get more than 14 marks out of 20 in the above test.
- This implies students were *lagging* in the topic like electricity and magnetism. This was the impact of undeveloped cognitive beliefs in them and it is important that teachers should direct their efforts in those directions.

- (ii) The average mark obtained by boys was 6.3 while that of by girls was 5.9. After applying t test for finding whether there was significant difference in those marks. It was found that t test showed the value 0.92, and it was less than the table value necessary for the rejection of null hypothesis at 0.05 levels for degree of freedom 125, the *null hypothesis was accepted* and it may be concluded that there was no significant difference. This implied that the conceptual understanding was *gender insensitive* and also poor.
- (iii) The average marks obtained by the students having first class at the entry level that is at HSC level was 6.3 while that of by the students having second or third class was 5.8 in the test of electricity and magnetism. After applying t test for finding whether there was significant difference in those marks. It was found that t test showed the value 1.162, and it was less than the table value necessary for the rejection of null hypothesis at 0.05 levels for degree of freedom 125, the *null hypothesis was accepted* and it may be concluded that there was no significant difference. This implied that the conceptual understanding of students in electricity and magnetism were independent of class obtained at HSC level.
- (iv) The average mark obtained by the students having computer knowledge was 5.9 and the students not having any computer knowledge was 6.7. After applying t test for finding whether there was significant difference in those marks. It was found that t test showed the value 1.367, and it was less than the table value necessary for the rejection of null hypothesis at 0.05 levels for degree of freedom 125, the null hypothesis was accepted and it may be concluded that there was no significant difference.

Analysis of cognitive beliefs with respect to conceptual understanding and other parameters:

Consider domain D1: Domain of Independence.

For this domain 52% of students showed favorable response while 33% of the students showed unfavorable response, as a result of which the status of this domain in the graph was in the middle. This represents that their Independence domain was moderately developed. It was in between Novice like and Expert like.

The effect of this undeveloped domain was clearly visible on the conceptual test of electricity and magnetism..

There was marginal difference in the favorable response with respect to gender, this domain was gender insensitive. Also conceptual understanding of electricity and magnetism was gender insensitive.

The development of this domain was independent of entry level performance that is independent of class obtained at HSC level. Students earned the respective marks without substantial development of this domain.

There was substantial rise in Favorable response percentage for the students who were having knowledge of computers. Percentage of favorable response for students having knowledge of computers was 57% while that for students not having knowledge of computers was only 25%. This implied that knowledge of computers was conducive for the development of Independence belief.

Consider domain D2: Domain of Coherence.

For this domain only 16% students showed favorable response while 65% students showed unfavorable response. As a result, the position of this belief was at the lower right corner. This clearly indicates that the students were showed Novice like belief in this domain. This belief of coherence was very important in the conceptual understanding of physics. As a result of such novice like belief students conceptual understanding was found to be poor.

There was marginal difference between the percentage of favorable responses given by boys and girls hence one can conclude that the Coherence belief was Gender insensitive.

The development of this domain was independent of entry level performance that is independent of class obtained at HSC level. Students earned the respective marks without substantial development of this domain.

Consider domain D3: Domain of Concepts.

For this domain 39% students showed favorable response while 42% students showed unfavorable response. As a result of which the position of this domain was near middle of the graph. This implied that this belief was moderately developed. Student's belief was in between novice and expert like.

Since there was marginal difference in the percentage of favorable responses with respect to gender, the domain of concept was considered as the Gender insensitive.

Consider the domain D4: Domain of Reality link.

For this domain 53% students showed the favorable response while 23% students showed unfavorable response. The position of this domain was near middle but towards the expert like belief. This domain was little better but should considered as Novice like. The students were attempting to correlate the physics with external reality, but still overall status was novice like.

The percentage favorable responses by boys were 66% while that of girls were 55%. This indicates even if both were showed novice like belief, this belief was more developed in boys than girls.

The reality link domain was more developed by the students who obtained first class than the students who obtained second or third class. The difference in favorable percentage was 18% among them.

There was marginal difference in the percentage of favorable responses between the students having knowledge of computers and between students not having the knowledge of computers.

Consider the domain D5: Domain of Mathematics link.

For this domain 43% of the students were showed favorable response while 46% of the students were showed unfavorable response. As a result the position of this domain was near middle. That is to say this domain was moderately developed in the students. Student's mathematics belief was in between Novice like and Expert's like.

The effect of this domain was observed to be gender insensitive.

There was no significant difference between the percentages of favorable responses given by students having first class or any other class at HSC level. Irrespective of the marks obtained at HSC level, the development of this domain was novice like.

Mathematics link was more developed by the students having knowledge of computers. The difference observed was around 15%. Thus knowledge of computers was conducive for the development of mathematics link.

Consider the Domain D6: Domain of Effort.

For this domain 83% students shoed favorable response while only 8% students showed unfavorable response. As a result the position of this domain was at upper right corner. This was the only domain where students showed Expert's like belief.

The effect of this domain was Gender insensitive, that is to say both boys and girls showed Expert like belief in this Effort belief.

This domain was more developed in the students having first class at HSC than those students having either second or third class.

Conclusions:

Following are the conclusion drawn based on the test on Electricity and magnetism which tests student's conceptual understanding in it and MPEX survey.

- (1) This indicates that conceptual understanding of students was poor.
- (2) Conceptual understanding of Electricity and magnetism was found to be Gender insensitive, as proved by the t test.
- (3) Conceptual understanding of Electricity and magnetism was found to be independent of class obtained in HSC, as proved by t test.
- (4) Conceptual understanding of Electricity and magnetism was found to be independent of knowledge of computers, as proved by t test.
- (5) The Domains D1 (Independence), D3 (Concepts), D4 (Reality link), D5 (Mathematics link) were moderately developed. That is students cognitive beliefs were in between Novice like beliefs and Expert like beliefs.

While domain D2 (Coherence) was highly undeveloped. About Coherence student's belief was Novice like. The domain of Effort was highly developed. About Effort student's belief was Expert's like.

(6) Except D4 (Reality link) all other domains were Gender insensitive. This showed that this cognitive belief was more developed (10% more favorable response) in boys than girls.

(7) Students who obtained first class at HSC level showed better favorable response in the cognitive domains like D3 (Concepts), D4 (Reality link), D6(Effort).

(8) Knowledge of computers was found to be conducive for domains like D1 (Independent), D3 (Concept), D5 (Mathematics link), D6 (Effort).

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