

## Exploring the Impact of Students' School Life Experiences on their Conceptual Learning in Physics at Secondary Schools

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### Abstract

*The conceptual learning of the secondary level science students (N=1840) in the subject of physics assessed on the concept application ability test (CAAT) was low up to 33 %. Views of the same students about learning and assessment at the school investigated through questionnaire were considered as one of the possible factors affecting the conceptual learning of the students. Sample of the survey among the selective male and female Secondary school science students was chosen randomly through the Cluster sampling technique. Correlation and regression analysis were used to explore the relationships. The combined views of all students towards their entire learning and assessment experiences at school were highly satisfactory. A positive correlation was explored between students under consideration. Experiences and their score on the test (CAAT) and the multiple regressions predicted the concerning experiences of the students as a significantly contributing factor to their conceptual learning in terms of the application of physics' concepts in problem situation and life.*

### Key Words:

Conceptual  
Learning,  
Application  
Abilities,  
Physics  
Concepts

### Introduction

Science education considers the means to enhance science-related learning experiences and the development of students. It makes links among curriculum, assessment, pedagogy, and pedagogical content knowledge. Science education is the delivery of science content in terms of knowledge, attitude, and skills and has aimed to transfer Science process skills, scientific literacy, scientific attitude, and scientific thinking through scientific method among the learners and the community.

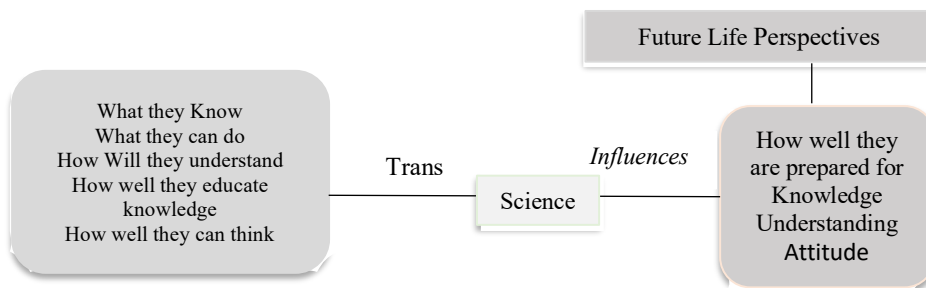
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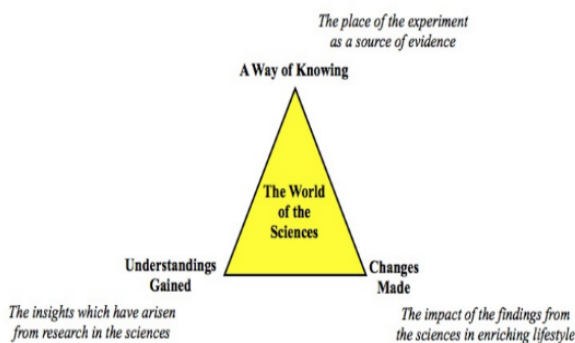
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It puts the efforts to understand science as a process, method of study, and a minds-on doing activity, not to merely fill the head of students with information to be memorized and recalled in the examination.



**Figure I: Impact of Science Education on students learning (Source Authors)**

Learning is gradual changes to know, understand, and to do and apply the understandings to equip the learners to cope with life ahead. The curriculum shall promote creativity, inquiry, and thinking (EFA, 2003). The students were not able to practically apply the concepts of physics in everyday life (EdQual, 2007). It is to motivate the humans to make sense of the material and living world and bring great benefits to human being Thus science needs to be seen in terms of three aspects: A way of knowing which uses experiment as a source of evidence (process nature), understanding the insight gain from research (product nature), and the useful application of the findings in enriching the lifestyle.



**Figure 2: Three Aspects of the Sciences (Source Authors)**

Several antecedents and elements can affect the students learning achievements and performance. Khan (2015) grouped them into eight components and ultimately summarized it into three broader elements; students related, teacher-related, and school-related influencing agents. The language and specific use of

terminology used in the sciences curriculum may cause difficulty for beginner learners in science (Alahmadi, 2008; Richa and Bisvajit, 2007). The improved learning environment (Govt. of Pakistan, 2008) and teacher competencies are instrumental in the development of students' critical thinking (Balsiri, 2010), and the parents' qualifications may positively affect the achievements of students (Government of Pakistan, 2002). The role of continuous assessment in the teaching of physics is positively effective for retaining learning particularly in girls (Femi, 2010). Malik (2002) revealed that examination is text-based and the course books are lacking the qualities to develop conceptual understanding among the students. Attitude about the subject, habits of study and supplementary study, process skills, and thinking critically are helpful for student's understanding (Knungnit, Ngamnit, Kongsak and Preechak, 2004). The performance of students in science can be affected by their characteristics and school environment (Bloom, 1976). Difficulties faced in conceptual understanding are Examination system, factual nature of teaching, quality of the text, and curriculum (Siddiqi, 2007; Hillel, 2005; Afolabi & Akinyemi, 2009). UNESCO (2002) highlighted the input, that "the student brings to school from home and the surrounding environment in terms of intellectual, social and emotional frame of thoughts and they are consequently promoted or modified as a result of the interaction of students, teachers, management and activities"

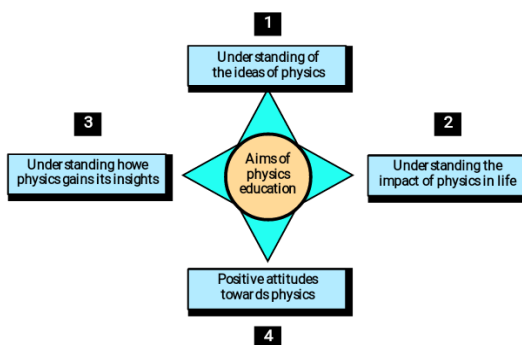
Perception takes place through experiences and senses, and conception is the abstraction of series of experiences and cognitive processes, takes place as a result of interaction with society, home, and community (Woolfolk, 2008). The concept is a set of rules and characteristics to classify together or set apart two things. The concept is an idea of an object or event (Huit, 2003; Dresel, 1960). Safder (2010) noted that Concept formation is ensured when one can apply it, Rebello and Zolman, (2005) also stated that when the student can apply the concept in a varying context, then it is claimed that the student has understood the concept. White (1998) added that when some piece of knowledge can be recalled but neither cannot be applied nor can relate the real and model, called it as 'inert knowledge' while Nedim (2010) named it as the unit of knowledge in science, which has a unique role to explain natural phenomenon. Conceptual knowledge was counted as understanding (Aufschnaiter, 2006). According to Savimainen (2004), the student community in class, the student's individual role and motivation may hinder or facilitate their conceptual change.

In the study of physics and chemistry, there are three aspects, the macro, the micro, and the symbolic which explore the physical world around us. The students are sometimes compelled to comprehend at the three levels simultaneously and resultantly go through memorization. Concept development is the major task in the study of Physics which makes it distinguishable. Conceptual understanding in Physics is very rare if the instruction is just to drill the problems in a very conventional way, simply the sign is to learn instead of the conceptualization

which produces a gap between understanding through the scientific method and mechanical rote learning (Dayal, Bhut & Ray, 2007). As a result, the Students cannot harmonize the Physics, the world, their way of thinking and what the teacher, as well as the text, say (Brian, 2009).

Physics is a highly conceptual subject. A concept can be seen as an idea or model, which brings together numerous observations and experiences. It can be seen as an abstraction drawn from a particular experience, it represents a class of common characteristics in general and the specific qualities differentiate within the class (Sharma, 2007). Thus, the concept of the flower is easily broken down into the many groups of flower types. Physics is full of concepts. The danger lies in introducing these at too young an age, a point made by Zapiti (1999). Thus, we have the concept of force, acceleration, density, atom, energy - all of which tend to be taught quite early, generating major problems in understanding. Concepts are not necessarily fixed. They are open to expansion and modification as new evidence emerges. Indeed, a conceptual understanding grows with age and experience, not always in the directions desired by the teacher.

It is possible to consider the aims of physics education visually:



**Figure 3: Aims of Physics Education (source authors)**

The aim is that school students should understand some of the ideas of physics (aim 1). By understanding, the student should be able to apply the ideas of physics in novel situations with some prospect of success. However, this is likely to allow them to see the impact of physics on life (aim 2) where the findings from physics research have transformed societies (anything from TV, communication media, travel, to medical advances and space exploration which led to the microchip).

Physics gains its insights by the experimental approach and a grasp of the role of the experiment in taking knowledge forward, developing, and challenging hypotheses is important (aim 3). The work of Al-Ahmadi (2008) suggests that there are important developmental aspects to this as well as the need for a correct learning environment. Finally (Aim 4), students should develop positive attitudes towards physics whether they opt for further study or not.

## Method and Procedure

This study was a comparative cum causal-comparative descriptive type survey. Sample of the Secondary school science students numbering 1840 from all the secondary level Govt. and private (Male and Female) in the sampled Five districts out of Twenty-five districts of Khyber-Pakhtunkhwa (province of Pakistan) was chosen randomly through Cluster sampling technique. The data regarding students' conceptual learning (in terms of abilities to which they can apply the physics content, principles and laws in observed phenomena or some problem situation relating to everyday life) were measured on the ability test (CAAT) this test included 30 items of different objective type tests (multiple-choice questions, the information grid type items, and short answers Questions). The main author has a 22 years long experience of teaching Physics to secondary and higher secondary classes, after multiple discussions with experts and study of literature reviews the researcher finally developed 15 items out of 30 of the CAAT and the rest of the items were adopted by Al- Ahmadi (2008) with acknowledgment and proper permission of her supervisor. The test items were properly validated by experts and subject teachers on a tool by the author the Cronbach's alpha reliability coefficient of the test items was 0.7. The researchers personally administered the test among the students of all the randomly chosen 80 schools (16 from each district in the sampled 5 districts, Malakand, Mardan, Peshawar, Kohat, and DI Khan). The questionnaire for seeking the students' views regarding their life and assessment experiences at the school was developed by the authors and properly validated by experts in the field. The students' Questionnaires were also administered and distributed among the same students in the sampled unit schools to investigate their views on their life and experience about learning and assessment in the school. Mean and independent sample one-way and two-way t-test was used for the analysis of the data collected through CAAT. To know the students' views, five points Likert scale was used for data collection through the questionnaire, two ways a contingency test was used to analyze and compare the views. The point values for (SA, A, N, DA, and SDA) were (5, 4, 3, 2, and 1). The relationship between students' physics concepts application abilities integer data and their views collected through questionnaire was explored by using Pearson correlation, Tau-b correlation, and multiple regressions.

## Results

**Table 1. The score of Secondary level Science Students on CAAT**

N	Total Test score	Mean	Std. Deviation	t	Sig. (p)
1846	30	10.1	3.4	-60.75	< 0.01

Table 1 highlights the data about the main objective of the research study, which was to investigate the students' abilities to which they can think and apply the concepts learned in studying physics at the secondary level, in familiar or unfamiliar problem situation relating to everyday life and natural phenomena. The mean score performance, 10 out of 30 on the concept application ability test (CAAT) showed that the students can apply the Physics concepts up to 33 percent in the problem situation, targeted in the test. According to the one-sample two ways t-test, the conceptual learning achievements of secondary school science students is significantly less than the 50% of total test score at significance level 0.01 which is remarkably low performance.

**Table 2. Score of Govt. and private Secondary Level Science Students**

School Type	N	Mean	Std. Deviation	Mean Difference	T	Sig. (p)
Public	910	9.4	3.0	-1.5	-9.86	< 0.01
Private	936	10.9	3.7			

According to table 4.1, the comparison among male and female students score obtained through CAAT delineates significantly better performance of the students from private sector schools. The Govt. and private school systems are two different systems concerning a number of the factors, management, facilities, teachers, and students' background.

**Table 3. Score of Male and Female Secondary Level Science Students**

Gender	N	Mean	Std. Deviation	Mean Difference	t	Sig. (p)
Male	1401	10.2	3.7	0.27	1.42	n.s
Female	445	9.9	2.6			

Table 3 shows that the mean score of male secondary school science students is better on the CAAT than the female students, and the difference is not-significant at significance level 0.01. It is highly encouraging that female students can apply Physics concepts in the capacity comparable to male students.

**Table 4. Views of Public & Private Secondary Level Science Students (N Public = 566, N Private = 508) about their Experiences at School**

Items	Sector	A	A	N	D	SDA	$\chi^2$ (df)	Sig.
I enjoy doing physics experiments myself	Public	38	54	6	4	2	10.9 (4)	< 0.05
	Private	34	47	10	7	3		
	Total	34	50	8	5	3		
I like examinations where I can explain things	Public	42	42	7	6	4	7.5 (4)	n.s
	Private	38	39	11	7	4		
	Total	40	41	9	6	4		
	Public	6	15	7	33	38	49.7 (4)	< 0.001
	Private	16	16	15	25	28		

I pass examinations by memorizing the selective content of physics	Total	11	15	11	29	34		
My teacher tells me what to memorize	Public	8	7	7	36	42	16.6 (4)	< 0.01
	Private	13	10	11	33	34		
	Total	10	9	9	34	38		
There is not enough apparatus in the laboratories	Public	13	16	13	35	24	6.8 (4)	n.s
	Private	19	16	12	31	23		
	Total	16	16	13	33	23		
I find physics related to my life	Public	49	42	5	2	2	2.9 (2)	n.s
	Private	46	42	5	3	4		
	Total	48	42	5	3	3		
I am never satisfied unless I understand what I am taught	Public	44	42	7	4	3	6.5 (3)	n.s
	Private	45	36	10	5	5		
	Total	45	39	8	4	4		
I prefer examinations with multiple-choice questions	Public	6	9	7	44	34	36.2 (4)	< 0.001
	Private	5	10	19	32	34		
	Total	6	10	12	38	34		
I enjoy reading books	Public	49	39	6	2	4	18.4 (4)	< 0.01
	Private	42	37	10	7	4		
	Total	46	38	8	5	4		
Understanding is more important than memorizing	Public	63	31	2	2	2	4.5 (2)	n.s
	Private	63	27	4	2	4		
	Total	63	29	3	2	3		

According to the data shown in table 4, the combined views of all the students, both from Govt. and private sector about their learning and assessment experiences during their life in school is positive. Specifically, students of Govt. sector schools have more positive views as compared to private school students. Students of both sectors, particularly, public sector students dislike memorization and appreciate the worth of understanding. Both sector students are not satisfied with their laboratory facilities. The students agree with the phenomenological and everyday related nature of Physics. The students' views are consistently positive throughout the items of this questionnaire.

**Table 5. Views of Secondary Level Science Students (Boys & Girls, N boys = 829, N girls = 245) about their Experiences at School**

Items	Gender	SA	A	N	D	SDA	$\chi^2$ (df)	Sig. (p)
I enjoy doing physics experiments myself	Boys	33	50	8	5	3	6.4 (2)	< 0.05
	Girls	37	52	7	4	0		
	Total	34	50	8	5	3		
I like examinations where I can explain things	Boys	41	39	8	7	5	9.2 (3)	< 0.05
	Girls	37	46	11	4	2		
	Total	40	41	9	6	4		
	Boys	10	13	12	29	35	10 (4)	< 0.05

I pass my examinations by memorizing the important things	Girls	11	21	8	28	32		
	Total	11	15	11	29	34		
My teacher tells me what to memorize	Boys	9	8	10	35	39	15.5 (4)	< 0.01
	Girls	15	11	5	33	35		
	Total	10	9	9	34	38		
There is not enough apparatus in the laboratories	Boys	15	15	13	32	24	3.6 (4)	n.s
	Girls	16	17	11	37	20		
	Total	16	16	13	33	23		
I find physics related to my life	Boy	49	40	5	3	3	3.1 (2)	n.s
	Girls	45	48	4	1	2		
	Total	48	42	5	3	3		
I am never satisfied unless I understand what I am taught	Boys	44	38	9	5	4	6.5 (3)	n.s
	Girls	47	42	5	3	3		
	Total	44	39	8	4	4		
I prefer examinations with multiple-choice questions	Boys	6	8	13	37	36	10.6 (3)	< 0.05
	Girls	3	15	11	42	28		
	Total	6	10	12	38	34		
I enjoy reading books	Boys	45	38	9	4	4	14.9 (3)	< 0.01
	Girls	50	39	3	6	2		
	Total	46	38	8	5	4		
Understanding is more important than memorizing	Boys	61	30	4	2	3	2.4 (2)	n.s
	Girls	69	25	2	2	2		
	Total	63	29	3	2	3		

Table 5 makes it known that the views of female students in the light of their entire experience towards their involvement in various activities of learning and assessment in school life are significantly better than the boy students, in experiments, nature of examination, discouragement of memorization, disliking of multiple-choice questions and reading reference books. The strong rejection of multiple-choice testing is consistent with the findings of Friel and Johnstone (1978a, 1978b, 1988). Enjoyment in laboratory classes is well known (Shah et al., 2006). This is very interesting that the student finds understanding as more important than memorization. They also know Physics is closely related to everyday life, which is in line with the finding of Reid and Skryabina (2000). The students are satisfied with the apparatus in the laboratories, which is against the ground realities, specifically in the public and low standard private schools.

**Table 6. Correlation Between Secondary Level Science Students (N = 951) Views about their Lives at School, and their Score on CAAT**

Items	Correlation Coefficient	Sig. (p)
I enjoy doing physics experiments myself	0.02	n.s
I like examinations where I can explain things	0.00	n.s



I pass examinations by memorizing the selective content in physics	0.10	< 0.01
My teacher tells me what to memorize	0.07	< 0.01
There is not enough apparatus in the laboratories	0.00	n.s
I find physics related to my life	0.03	n.s
I am never satisfied unless I understand what I am taught	0.02	n.s
I prefer examinations with multiple-choice questions	0.03	n.s
I enjoy reading books	-0.04	n.s
Understanding is more important than memorizing	0.06	< 0.05

Table 6 explains that the views of students who enjoy reading are negatively correlated with their test score and this is discouraging. Either the students have carelessly selected the choice or they are fond of light reading and not giving more attention to Physics. The views of the students who rely on memorization are positively and remarkably correlated with their score on CAAT, which is not a test of memory and recall. This is perhaps due to a lack of knowledge of students about the meaning of the term 'memorize' and they take it in the meaning of study in general. The views of Secondary level science students on the remaining items of the tool are positively correlated with their score on CAAT and this is a valid relationship. The views of the SSSS on the statement 'understanding is important than memorization' have a positive significant relationship with their score on the test which is contradictory to the statement related to memorization.

**Table 7. Causal Relation between Secondary level Science Students' views about their Experiences at School, and their Score on C AAT**

Predictors	Std. Error	Beta	t	Sig.	R	R-Square	F	Sig.
I enjoy doing physics experiments myself	0.15	0.00	0.08	0.93	0.19	0.04	2.36	0.01
I like examinations where I can explain things	0.13	0.04	1.03	0.30				
I pass my examinations by memorizing the important things	0.11	0.09	2.11	0.04				

My teacher tells me what to memorize	0.11	0.07	1.60	0.11				
There is not enough apparatus in the laboratories	0.10	-0.06	-1.43	0.15				
I find physics is related to my life	0.16	0.02	0.58	0.56				
I am never satisfied unless I understand what I am taught	0.14	-0.01	-0.27	0.79				
I prefer examinations with multiple-choice questions	0.12	0.06	1.36	0.17				
I enjoy reading books	0.14	-0.06	-1.37	0.17				
Understanding is more important than memorizing	0.15	0.07	1.69	0.09				

*Dependent Variable: Test Score (30)*

According to Table 7, the R-Square value of 0.04, students' general views about their experience in school regarding learning and assessment are four percent accounted for variation in the score on Physics' concept application ability test (CAAT).  $F(10, 1074) = 2.36$ ,  $p = 0.01$  shows that these predictors related to students' experiential views positively contributed to students' conceptual learning in terms of application abilities.

## **Discussion**

The conceptual learning of the science students in the subject of physics assessed on concept application ability test (CAAT) was significantly low as 33 %. The test was not an ordinary achievement test; it was testing the conceptual understanding of secondary stage Physics content in terms of the concept application abilities in problem situations relating to natural phenomena and everyday life. Hillel (2005) found that most of the students cannot get a functional understanding of Physics concepts. Malik and Iqbal are from the local community and reported that the

teaching does not focus on concept clarification Malik (2002), and thinking development (Iqbal, 1993). The curriculum analysis of Tahir and Ullah, (2010) showed that implemented National curriculum (2000) for Physics grade 9&10 were reserved 10% contents for the development of students' concepts application abilities, and 55% for knowledge level contents. Al-Ahmadi (2008) worked on the testing of students' scientific thinking in the subjects of secondary level physics and chemistry and she found that it is not possible to develop students' scientific thinking up to the age of 18 years at the secondary level even in higher classes without targeted teaching. The findings of this study regarding outreach of the private school students on the test (CAAT), and no significant difference found between the performance of male and female students on the same test are agreed with (Yucel, 2007) and at the same time got against the finding of (Adeoye, 2010) which revealed the significantly better performance of girls than boys Knowledge of Physics concepts. While the multiple regression analysis showed the contributive predicting role of students' school experience related views to their conceptual learning in terms of application ability which is matching with results of certain studies in the area concerned (Lacap, 2015; Macmillan, 2012; Tadele, 2016, Xavier and Croix, 2016).

## **Conclusions**

The overall combined performance of the students on concept application ability test regarding conceptual learning in physics is low and there is some selective outreach in favor of private-sector students while the gender differences are not different remarkably. Most of the aspects of influencing factors, students' views regarding their life, and experience in school showed a positive correlation with their score on the concept application ability test. The multiple regression analysis also revealed a positive contribution to students' conceptual learning in terms of score obtained in the test for the application of physics concepts. Keeping in view the lower performance of students and experiences of the authors it is recommended that nature of science and Physics, scientific method, science process skills, scientific literacy, and scientific thinking like issues should be inculcated among science students through the exhibition, seminars, related literature, modules, constructivist and co-operative learning strategies which will provide input to the development of conceptual learning of students. Moreover, the prevailing system of assessment should be shifted from facts recalling to a performance-based approach. Curriculum and pedagogy should be activity-based and student-centered.

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