



## INTERACTIVE MULTIMEDIA COURSEWARE: AN EFFECTIVE TECHNO-PEDAGOGICAL TOOL FOR DEVELOPING BASIC CONCEPTS OF ORGANIC CHEMISTRY

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### ABSTRACT

*Integration of technology in the classroom is a prime requirement in the present technological era. Computer based modern Multimedia presentation is a good teaching learning tool. Again if this type of presentation becomes interactive with the learners then it transforms to an effective techno-pedagogical tool for developing symbolic chemical concepts for all kind of learners. This symbolic chemical concept is abstract, the most important and difficult one to realize of the three chemical concepts: macro, micro and symbolic or representative. In this experiment we are to investigate the effectiveness and successful implementation of interactive multimedia courseware as techno-pedagogical tool for developing the basic abstract concepts in Organic Chemistry of class XI-XII students.*

**KEYWORDS:** *Integration of Technology in Classroom, Techno-pedagogical Tool, Interactive Multimedia Courseware, Basic Concepts of Organic Chemistry.*

### INTRODUCTION

Chemistry is always a difficult and mysterious subject. It is in general a tedious task to comprehend the abstract chemical concepts specifically those of organic chemistry. It is again very difficult for average merit students to realize the symbolic dimension of the triplet model of chemical concepts viz. macro, sub-micro and symbolic (Johnstone, 1982; Gabel, 1999 and Talanquer, 2010). To understand and visualize the chemical concepts better specifically abstract symbolic part the traditional classroom interaction is not adequate (Gilbert, 2005, 2009). So, introduction and integration of technology in the classroom is a general demand in the modern technological era for appropriate learning outcome during the chemistry teaching (Abitt, 2011; Chai, et.al.2011; Young, et. al. 2012; Sathiyaraj, et.al. 2013).

Nowadays the Information Communication Technology (ICT) is very much improved and wide spread media component with the help of computer based multimedia technology. Hence, compilation of computer based multimedia teaching aids is very much important in the chemistry teaching learning process for enhanced comprehension of the abstract chemical concepts. Proper compilation of technology with teaching learning process i.e. Pedagogy and Content leads to a new educational framework; (Shulman, 1987; Harris, et.al. 2009; and Koehler, et. al. 2012, 2013) Techno-Pedagogical Content Knowledge (TPACK). Thus, computer based multimedia course material and more precisely spoken courseware is a good techno-pedagogical tool. If this multimedia courseware becomes user interactive, then it provides multisensory responses by facilitating critical, creative, analytical and innovative thinking through challenging



and thrilling experiences. Again it also can reduce the learning time with reference to input variables concerned (Ng, et.al., 2000; Hofstetter, 1995). So an interactive multimedia courseware is a strong techno-pedagogical tool for constructing abstract symbolic chemical concepts like isomerism, fundamental chemical effects, reaction mechanism etc. The interactive nature of these technologies offers new insight i.e. introspection into the learning procedure by facilitating independent learning to achieve high self esteem (Neo, and Neo, 20010).

## METHODOLOGY

The effectiveness of any course is directly related to the outcome of the course i.e. the performance of the students after implementation. The keyobject of this study is to identify the effectiveness and the usability aspect of the multimedia courseware through a suitable post-test experimental design. A complete interactive multimedia courseware in organic chemistry for higher secondary students was developed using Photoshop, Flash and Autodesk Maya. To assess the efficiency of the interactive multimedia courseware it was employed to the students of class XI in the two reputed schools of two different boards of the Higher Secondary Education namely WBCHSE and CBSE in the Burdwan town, West Bengal, India. For this purpose two equivalent groups of students from each school were structured by matched pair design namely i) Control Group of students and ii) Experimental Group of students according to their results in chemistry in their school's Test. The Students of Control group were taught organic chemistry by traditional chalk and talk method, while the students of the experimental group were interacted with the multimedia courseware in presence of the teachers and consulted with them. Finally an achievement test was administered on both the groups separately and the data was collected for both the schools and compared (Figure 1). In addition the students of both the groups were again categorized into intelligent and average students group by applying Cattell's culture fair intelligent test (Cattell, R.B. 1949 and 1963).

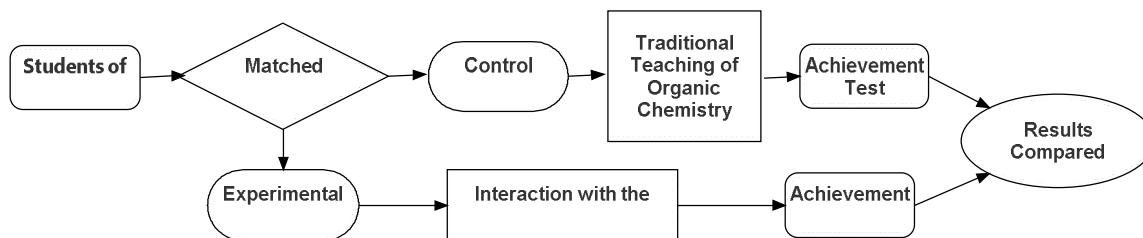


Figure 1: Flow Chart of the Experimental Design

## HYPOTHESES OF THE STUDY

**Null Hypothesis 1 (H<sub>0</sub>1):** There is no significant difference in post-test scores in the achievement of organic chemistry between the Control (X<sub>1</sub>) and the Experimental (X<sub>2</sub>) Groups (Students of CBSE).

**Null Hypothesis 2 (H<sub>0</sub>2):** There is no significant difference in post-test scores in the achievement of organic chemistry between the Control (X<sub>b1</sub>) and the Experimental (X<sub>b2</sub>) Groupsof boys.

**Null Hypothesis 3 (H<sub>0</sub>3):** There is no significant difference in post-test scores in the achievement of organic chemistry between the Control (X<sub>g1</sub>) and the Experimental (X<sub>g2</sub>) Groupsof girls.

**Null Hypothesis 4 (H<sub>0</sub>4):** There is no significant difference in post-test scores in the achievement of organic chemistry between the girls and boys.

**Null Hypothesis 5 (H<sub>0</sub>5):** There is no significant difference in post-test scores in the achievement of organic chemistry between the Control (X<sub>a1</sub>) and the Experimental (X<sub>a2</sub>) Groups of the average students.

**Null Hypothesis 6 (H<sub>0</sub>6):** There is no significant difference in post-test scores in the achievement of organic chemistry between the Control (X<sub>i1</sub>) and the Experimental (X<sub>i2</sub>) Groups of the intelligent students.

**Null Hypothesis 7 (H<sub>0</sub>7):** There is no significant difference in enhancement of scores in the achievement of organic chemistry between the intelligent and average students (categorized using Cattell's culture fair intelligent test).

**Null Hypothesis 8 (H<sub>0</sub>8):** There is no significant difference in post-test scores in the achievement of organic chemistry between the Control (X<sub>1</sub>) and the Experimental (X<sub>2</sub>) Groups (Students of WBCHSE).

**Null Hypothesis 9 (H<sub>0</sub>9):** There is no significant difference in the enhancement of scores in the achievement of organic chemistry between the students of WBCHSE and the students of CBSE.

## RESULTS AND DISCUSSION

In general, the students of both schools apart from gender or intelligence or different board/council, they enjoyed the Interactive Multimedia Courseware and responded in the class very well with a positive attitude in a technology oriented environment. They were very motivated, enjoyed being challenged and able to have creative input through critical thinking about the topic and use multimedia technology based software. The quantitative data collected through the post-test experimental design were statistically analyzed.

### Statistics for the Analysis of Null Hypotheses

**Table 1: Paired Samples Statistics**

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Experimental Group	69.7222	36	9.25398	1.54232
Control Group (CBSE)	39.0278	36	8.68656	1.44776
Pair 2 Experimental Group Boys	69.8000	25	9.51753	1.90351
Control Group Boys	42.2000	25	10.21437	2.04287
Pair 3 Experimental Group Girls	68.1818	11	11.01652	3.32160
Control Group Girls	34.5455	11	6.10514	1.84077
Pair 4 Boys' Scores	70.9091	11	11.36182	3.42572
Girls' Scores	68.1818	11	11.01652	3.32160
Pair 5 Experimental Group Average students	63.0952	21	8.28797	1.80858
Control Group Average students	33.5714	21	5.27799	1.15175
Pair 6 Experimental Group Intelligent students	77.6667	15	3.19970	0.82616
Control Group Intelligent students	50.3333	15	5.49892	1.41981
Pair 7 Enhancement of scores of Average students	28.0000	15	8.40918	2.17124
Enhancement of scores of Intelligent students	27.3333	15	7.03732	1.81703
Pair 8 Experimental Group	59.5000	30	6.99137	1.27644
Control Group (WBCHSE)	37.1667	30	7.39097	1.34940
Pair 9 Enhancement of scores of students of WBCHSE	29.6667	30	12.45221	2.27345
Enhancement of scores of students of CBSE	22.3333	30	9.71431	1.77358

**Table 2: Paired Samples Correlations**

	N	Correlation	Sig.
Pair 1 Experimental Group & Control Group (CBSE)	36	0.014	0.934
Pair 2 Experimental Group Boys & Control Group Boys	25	-0.231	0.267
Pair 3 Experimental Group Girls & Control Group Girls	11	0.507	0.112
Pair 4 Boys' Scores & Girls' Scores	11	0.833	0.001

Pair 5	Experimental Group & Control Group (Average students)	21	0.078	0.738
Pair 6	Experimental Group & Control Group(Intelligent students)	15	-0.257	0.355
Pair 7	Enhancement of scores of Average &Intelligent Students	15	-0.127	0.653
Pair 8	Experimental Group & Control Group (WBCHSE)	30	0.088	0.642
Pair 9	Enhancement of scores of students of WBCHSE&CBSE	30	-0.036	0.850

Table 3:Paired Samples t-Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Experimental Group – Control Group (CBSE)	30.69444	12.60118	2.10020	26.43082	34.95807	14.615	35	0.000
Pair 2 Experimental Group – Control Group Boys	27.60000	15.48655	3.09731	21.20746	33.99254	8.911	24	0.000
Pair 3 Experimental Group – Control Group Girls	33.63636	9.51076	2.86760	27.24695	40.02578	11.730	10	0.000
Pair 4 Boys' Scores – Girls'Scores	2.72727	6.46670	1.94978	-1.61711	7.07166	1.399	10	0.192
Pair 5 Experimental Group – Control Group (Average Students)	29.5238	9.47428	2.06746	25.21117	33.83645	14.280	20	0.000
Pair 6 Experimental Group– Control Group (Intelligent students)	27.33333	7.03732	1.81703	23.43620	31.23047	15.043	14	0.000
Pair 7 Enhancement of Scores of Average – Intelligent students	0.66667	11.62919	3.00264	-5.77336	7.10670	0.222	14	0.827
Pair 8 Experimental Group – Control Group (WBCHSE)	22.33333	9.71431	1.77358	18.70595	25.96072	12.592	29	0.000
Pair 9 Enhancement of scores of students of WBCHSE–CBSE	7.33333	16.06739	2.93349	1.33367	13.33299	2.500	29	0.018

### Analysis of Null Hypothesis 1 ( $H_01$ )

From the Post-Test Analysis of scores in the achievement of organic chemistry between the students of Control ( $X_1$ ) and the Experimental ( $X_2$ ) Groups in a CBSE school, it is clear that in a two tailed t-test the Null Hypothesis  $H_01$  is rejected as the  $t(35) = 14.615$  is greater than  $t(\text{Critical}) = 2.042$  at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. This analysis clearly revealed that there is a significant difference in the achievement of the students of Control ( $X_1$ ) and the Experimental ( $X_2$ ) Groups i.e. the interactive multimedia courseware has greatly influence the students' achievement in organic chemistry and again the mean of achievement test of the experimental group is very much enhanced than that of the control group. Hence the interactive multimedia courseware has greatly enhanced the performance of students in the organic chemistry as well as comprehension of the abstract chemical concepts.

### Analysis of Null Hypothesis 2(H<sub>0</sub>2)

For the Post-Test Analysis of scores in the achievement of organic chemistry of boys, the Null Hypothesis 02 is rejected in the two tailed t-test as the  $t(24) = 8.911$  is greater than  $t(\text{Critical}) = 2.064$ , at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. This analysis clearly revealed that the interactive multimedia courseware has greatly enhanced the performance of boys in the organic chemistry as well as comprehension of the conceptual chemical knowledge.

### Analysis of Null Hypothesis 3(H<sub>0</sub>3)

Similarly for the Post-Test Analysis of scores in the achievement of organic chemistry of girls, the Null Hypothesis 03 is rejected in the two tailed t-test as the  $t(10) = 11.730$  is greater than  $t(\text{Critical}) = 2.228$ , at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. This analysis is also strengthened the effect of the interactive multimedia courseware on the performance of girl students by assisting abstract visualization of chemical concepts.

### Analysis of Null Hypothesis 4(H<sub>0</sub>4)

In this Post-Test Analysis, comparing the girls' scores and the boys' scores in the achievement of organic chemistry, the Null Hypothesis 04 is accepted in the two tailed t-test as the  $t(10) = 1.399$  is lesser than  $t(\text{Critical}) = 2.228$ , at 0.05 level. So the hypothesis assumed, is true in the 95% confidence level. So the effect of the interactive multimedia courseware on the performance of girls and boys is almost equally effective i.e. the interactive multimedia courseware can enhance the performance students irrespective of any gender effect.

### Analysis of Null Hypothesis 5(H<sub>0</sub>5)

The Cattell's culture fair intelligent test was administered on the students of both the control and experimental groups and those scored IQ above 110 were categorized as intelligent while those scored IQ below 110 were categorized as average students group. Here in the Post-Test Analysis of scores in the achievement of organic chemistry of average students, the Null Hypothesis 05 is rejected in the two tailed t-test as the  $t(20) = 14.280$  is greater than  $t(\text{Critical}) = 2.064$  at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. Thus this analysis clearly revealed that the interactive multimedia courseware has greatly enhanced the performance of average students in the organic chemistry.

### Analysis of Null Hypothesis 6(H<sub>0</sub>6)

Similarly for the Post-Test Analysis of scores in the achievement of organic chemistry of intelligent students, the Null Hypothesis 06 is rejected in the two tailed t-test as the  $t(14) = 15.043$  is greater than  $t(\text{Critical}) = 2.145$ , at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. This analysis is again strengthened the effect of the interactive multimedia courseware on the performance of intelligent students by assisting abstract visualization of chemical concepts.

### Analysis of Null Hypothesis 7(H<sub>0</sub>7)

In this Post-Test Analysis, comparing the enhancement of scores of the intelligent and average students in the achievement of organic chemistry, the Null Hypothesis 07 is accepted in the two tailed t-test as the  $t(14) = 0.222$  is lesser than  $t(\text{Critical}) = 2.145$ , at 0.05 level. So the hypothesis assumed, is true in the 95% confidence level. So the effect of the interactive multimedia courseware on the performance of the intelligent and average students is almost equally effective i.e. the interactive multimedia courseware can enhance the performance students irrespective of their IQ.

### Analysis of Null Hypothesis 8(H<sub>0</sub>8)

The experiment was carried out again in a Bengali medium school under WBCHSE with the Bengali version of the courseware and the result is same. The Post-Test Analysis for scores in the achievement of

organic chemistry between the students of Control ( $X_1$ ) and the Experimental ( $X_2$ ) Groups in this school revealed that the Null Hypothesis 08 is rejected in the two tailed t-test as the  $t(29) = 12.592$  is greater than  $t(\text{Critical}) = 2.064$  at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. Thus the interactive multimedia courseware is also equally effective in Bengali medium school too.

### Analysis of Null Hypothesis 9( $H_09$ )

In this Post-Test Analysis when the test scores of the two schools viz. WBCHSE and CBSE were compared, it was found that the Null Hypothesis 09 is rejected in the two tailed t-test as the  $t(29) = 2.500$  is a little bit higher than  $t(\text{Critical}) = 2.045$ , at 0.05 level. So the hypothesis assumed, is false in the 95% confidence level. So there is significant difference in the performance of the students in the organic chemistry between the two schools and more precisely as the mean of the achievement test of the students of school under CBSE is higher than that of the school under WBCSE, so it can be inferred that the interactive multimedia courseware enhance the performance in organic chemistry of the students of school under CBSE. This fact raises one question that why the performance of the students of school under CBSE is higher than that of the school under WBCSE. The answer is techno-pedagogical competency,- the ability to utilize technology efficiently in the classroom- which must be higher in the teachers of school under CBSE than the latter case.

### CONCLUSION

The results of this experimental research clearly proved that the interactive multimedia courseware is a very good tool to provide a great support to enhance the achievement in organic chemistry of secondary students irrespective of gender, intelligence and board/council. But to convert this tool into an effective techno-pedagogical tool student who are interacting with this tool must have readiness and the associated teachers should have sufficient techno-pedagogical competency to facilitate them in a well equipped technology oriented class. Further to make it popular and more usable some authoring characteristics of the courseware have to be increased as well as new one may be introduced to stimulate multisensory responses by facilitating critical, creative, analytical and innovative thinking through challenging and thrilling experiences in a technological environment. In addition, to be successful in such endeavors, there must be adequate number of computers made accessible to the students and teachers, in order for this type of course to be appropriately carried out. And finally, training in this software should be provided to the teachers to enhance their techno-pedagogical competency so that they can conduct these types of classes smoothly.

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