Research Article

Effectiveness of Instructional Strategy for Teaching Chemistry to VII standard

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Abstract

An experimental study was conducted to study the effectiveness of Instructional Strategy for Teaching Chemistry to VII standard. The instructional strategy consisted of teaching with the Concept Attainment Model (CAM) coupled with multimedia instructions. The objectives of the study were: (i) To study the effectiveness of the instructional strategy in terms of (a) Achievement of students in chemistry, and (b) Reaction of students towards the strategy, (ii) To study the effect of treatment, gender and their interaction on the achievement in chemistry of class VII students, by taking their scores of intelligence as a covariate, (iii) To study the effect of treatment, style of learning and thinking and their interaction on achievement in chemistry of class VII students, by taking their scores of intelligence as a covariate. The sample consisted of 50 students in a school in Bhopal. The random assignment of already formed classes to experimental and control groups was employed to examine the treatment effect. Data was collected by administering the Verbal Intelligence Test, Style of Learning and Thinking inventory and multimedia material of Edurite DigitALly version v.3.6.01 from Pearson Education Services. The Achievement Test in Chemistry and Reaction Scale was developed by the investigator. The findings of the study are: (i) The developed instructional strategy was effective in terms of students' achievement in chemistry,(ii)The developed instructional strategy was effective in terms of students' reactions towards the developed instructional strategy, (iii) The treatment produced a significant differential effect on the achievement of students in chemistry, (iv) Gender did not produce a significant differential effect on the achievement of students in chemistry, (v) The interaction of treatment and gender did not produce a significant differential effect on the achievement of students in chemistry, (vi) There was no significant differential effect of style of learning and thinking on the achievement of students in chemistry, (vii) The interaction of treatment and style of learning and thinking did not produce a significant differential effect on the achievement of students in chemistry.

Keywords: Concept Attainment model, Multimedia instruction, chemistry teaching

Introduction

Chemistry is offered as a school subject across different educational boards in India. The importance of chemistry is evidenced by the many career opportunities it offers in various fields like, medicine, engineering, pharmaceuticals, cosmetics, etc.

Therefore, a sound understanding of the various concepts in the subject is very essential for understanding how things work in our day-to-day life.

This further leads to the important issue of pedagogy of chemistry. Over the years it has been observed globally that students have performed satisfactorily in the examinations, but when interviewed revealed gross misconceptions regarding the chemical phenomena. Hence, there is a need for

a change in instructional strategy to achieve the desired learning outcomes at various school levels.

The instructional strategy consisted of teaching with the Concept Attainment Model (CAM) coupled with multimedia instructions.

Concept Attainment Model (CAM)

This model of teaching was developed by Jerome Bruner and his associates Jacqueline Goodrow and George Austin. Concepts are the building blocks of knowledge. Concept Attainment is "the search for and listing of attributes that can be used to distinguish exemplars from non- exemplars of various categories."(Bruner, Goodrow and Austin, 1967). In this study, the Reception Strategy of the model was used. The students were exposed to positive and negative examples and they identified the common characteristics (attributes) and hypothesized.

Multimedia

Multimedia is a combination of many types of media including audio, video, text, pictures, graphs, animation, etc. Educational multimedia offers many advantages when compared to chalk and board classroom teaching. Since more senses are involved it makes learning long-lasting. It provides an enhanced learning experience with attention to the specific needs of the individual (Almarabeh, Amer and Sulieman, 2015). The use of multimedia helps students with different skills and learning styles (Ilhan and Oruc 2016). Therefore, in this study multimedia instructions were also used with the Concept Attainment Model (CAM).

Review of Literature

Several studies carried out in India and abroad show that the Concept Attainment Model (CAM) and teaching through multimedia effect achievement in chemistry. These are effective for the introduction of concept, creation of interest, and motivation in chemistry.

Kaur (2018) found that students of IX standard when taught chemistry through the concept attainment model possessed higher scores on achievement tests developed by the investigator than students who were taught through traditional methods. Similar results were reported by Mahmood (2017) for IX standard science students. Kalani (2008) in a study found that the achievement of students who were taught by the concept attainment model was better than those who were taught by the control method. Sreelekha and Nayar (2004) found that CAM was effective in improving the overall level of achievement in chemistry. Lukopoteea and Narod (2012) reported that the use of CAM had motivated the students, and increased their level of participation during the lessons. The findings also showed that use of the model had enhanced conceptual understanding and helped to improve students' performance on the topic "Periodic Table". It was also found that students were better able to identify the attributes of the concepts when varied resources and strategies were used to present the exemplars and non-exemplars.

Su (2011) studied the processes of the students' chemistry learning, its effectiveness and their attitudes. The result analyses verified that their ICT integrated environmental learning has a more significant effect on the students" learning performance. The results obtained from this ICT integrated environmental learning when compared with other chemical experimental results showed the same positive and scientific perspective for academic research. Morais and Paiva (2007) studied the application of simulations in the teaching-learning

process in science and found that the aspects considered by pupils to be positive in the study of chemistry using digital resources were: it was less difficult to learn; they understood the content more fully (since the resources can be seen and used again) and the use of images and audio helped them in their understanding and led them to be more attentive.

It is not easy to conclude whether gender influences achievement in chemistry or not. The studies done by Veloo, Hong and Lee (2015), Hatice Belge Can (2012), Busolo (2010), Barmby et al. (2008), Cousins, A. (2007) and Chambers & Andre(1997) found that gender produced a significant differential effect on academic achievement as well as achievement in chemistry.

But the studies of Oluwatosin and Josiah (2017), Azizoglu (2004), Dahindsa and Chung (2003) and Demircloglu and Norman (1999) indicate that academic achievement and achievement in chemistry is independent of gender.
Similarly, mixed results were found in studies related to learning styles on academic achievement and achievement in chemistry. The studies done by Yilmaz-soylu and Akkoyunlu (2002) and Wilson (2011), show that the type of the learning style was not significantly effective on students' achievement. However, the studies of Vaishnav (2013) and Uzuntiryaki (2007) show that there was a statistically significant difference among students with different learning styles concerning academic achievement and achievement in chemistry.

Delimitations of the study

The study was conducted under the following constraints:

- The study is delimited to an English Medium, co-ed school of Bhopal only.
- The study is delimited to the subject of chemistry.
- The study is delimited to students of VII standard studying in ICSE Board.

Objectives of the study

1. To study the effectiveness of the instructional strategy in terms of
   a) Achievement of students in chemistry, and
   b) Reaction of students towards the strategy.
2. To study the effect of treatment, gender and their interaction on the achievement in chemistry of class VII students, by taking their scores of intelligence as a covariate.
3. To study the effect of treatment, style of learning and thinking and their interaction on achievement in chemistry of class VII students, by taking their scores of intelligence as a covariate.

Hypotheses

1. There is no significant effect of treatment on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate.
2. There is no significant effect of gender on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate.
3. There is no significant interaction of treatment and gender on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate
4. There is no significant effect of style of learning and thinking on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate.

5. There is no significant interaction of treatment and style of learning and thinking on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate.

Methodology

The experimental method was employed for this study. The design employed for this research work was Post-test Control Group Quasi-Experimental Design. The size of the sample was 50 students studying in VII standard of an English medium school in Bhopal. The random assignment of already formed classes to experimental and control groups was employed to examine the treatment effect.

Tools

The following tools were used in this study:

- Verbal Intelligence Test developed by Ojha and Ray Choudhary.
- Style of Learning and Thinking (SOLAT) developed by Dr. D. Venkatraman.
- The multimedia material of Edurite DigitALly version v.3.6.01 from Pearson Education Services, Board-ICSE, standard–VII, subject –chemistry, topic- Acids, Bases and Salt was used.
- Achievement Test in Chemistry developed by the investigator.
- The Reaction Scale was developed by the investigator.

Procedure of Data Collection:

Table-1: The Schematic Representation of the Experiment

Activity	***Experimental Group***	***Control Group***	***Time***
Group Formation	Students were randomly divided into two groups and the group were selected randomly		
Activity	***Experimental Group***	***Control Group***	***Time***
Treatment	10 lessons were taught through the newly designed instructional strategy	10 lessons were taught through the Lecture cum Demonstration Method	Each class of 30minutes.
	Administration of Intelligence test		40 minutes
	Administration of Style of Learning and Thinking Tool		30 min.
Post testing of variable	**Administration of Achievement Test in Chemistry**	**Administration of Achievement Test in Chemistry**	30 min.
	Administration of Reaction Scale	----	30 min.

Statistical Techniques Used for the Analysis of Data

1. For studying the effectiveness of the instructional strategy in terms of
   a) Achievement of students in chemistry, and
   b) Reaction of students towards the strategy, descriptive statistics were used.
2. For studying the effect of treatment, gender and their interaction on the achievement in chemistry ANCOVA of unequal cell size was used.
3. For studying the effect of treatment, learning style and their interaction on achievement in chemistry ANCOVA of unequal cell size was used.

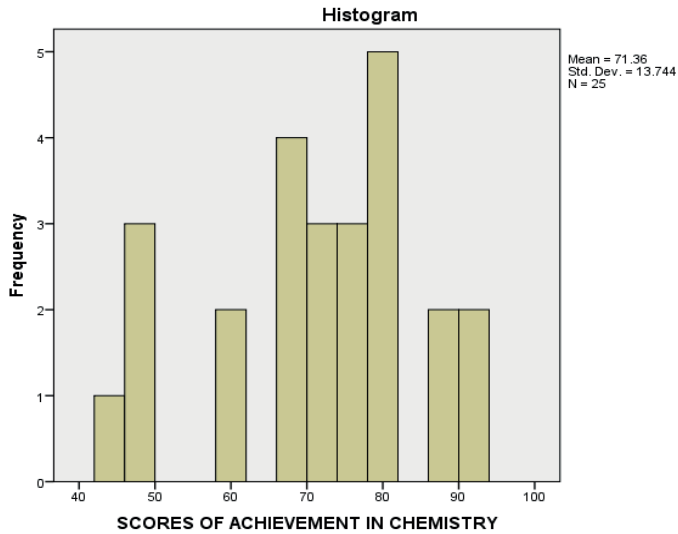
Analysis of Data and Its Interpretations

The data was analysed using SPSS.

Effectiveness of instructional strategy in terms of Achievement of students in chemistry

To study the effectiveness of the instructional strategy in terms of Achievement of students in chemistry, the scores of the experimental group are taken into consideration. The scores were analyzed with the help of Percentiles, Mean, and Standard Deviation. It was found that 10 per cent of students achieved 48 per cent marks. 50 per cent of students achieved 72 per cent marks and 10 per cent of students achieved 89.60 per cent marks. Hence, it can be stated that teaching through this instructional strategy was effective in terms of the achievement of students in chemistry.

Figure-1: Histogram showing Achievement in chemistry



Finding and Discussion

The nature of the approach demands greater involvement of pupils in teaching-learning situations. So, the students were motivated and performed well. Different examples which were presented during teaching might have aroused interest and motivation among the students to study chemistry. Thus, interest and motivation might have contributed to the present result. Due to the MCQ-type test items, pupils' achievement might have been higher.

Thus, teaching through the developed instructional strategy was found to be effective in terms of student's achievement in chemistry.

Table -2: Reactions of students towards instructional strategy for teaching of chemistry in percentages

S. No.	STATEMENT	SA	A	UD	DA	SDA
1	Learning through this multimedia mediated approach is time consuming.	8	32	-	60	-
2	Sometimes it is boring to learn through this approach.	-	-	-	48	52
3	Learning through this approach is an interesting experience.	36	60	-	4	-
4	It is difficult to interact with the teacher while she/ he is teaching through multimedia.	-	-	8	32	60
5	I feel motivated while learning through multimedia approaches.	8	88	4	-	-
6	Studying through this approach develops a competitive attitude.	12	84	-	4	-
7	I feel active and happy in the class when the teacher taught through this approach.	88	8	4	-	-
8	Teaching based on this approach gives a chance to think independently.	-	80	12	4	4
9	I was encouraged to learn when other students attained concepts in the subject.	32	56	12	-	-
10	Studying through this approach motivated the students to explore examples other than those given in textbooks.	68	32	-	-	-
11	Presentation of the contents through this approach helped me to acquire concepts.	28	68	4	-	-
12	Presentation of the examples/ illustrations helped me to understand the concepts well.	4	96	-	-	-
13	Provision for different examples for illustrating a concept helped me to learn with comprehension.	24	76	-	-	-
14	The questions asked in the class helped me to think independently.	16	80	4	-	-
15	I felt motivated in answering questions after watching the videos/animation of the related content.	40	52	8	-	-
16	Linkage of different concepts in the content was well organized.	16	80	-	4	-

The instructional strategy was found to be effective in terms of students' reactions to the strategy. The various aspects of teaching were taken into consideration. The majority of the students expressed favourable reactions towards those above-said aspects. Thus, it can be concluded that the favourable reactions of the majority of students towards the mentioned aspects are of importance and that the students expressed favourable reactions towards the strategy.

Effect of treatment on the achievement in chemistry

Effect and interaction of treatment and gender on the achievement in chemistry

The second objective of the investigation was to study the effect of treatment, gender and their interaction on the achievement in chemistry of class VII students, by taking their scores of intelligence as a covariate. The scores of intelligence were collected by administering the Verbal Intelligence Test on both the groups. The data were analysed with the help of 2 X 2 Factorial design ANCOVA of Unequal Cell Size. The results are presented as under.

Table-3: F-value for Treatment, Gender and their Interaction on the Achievement in Chemistry

Sources of Variance	Df	SS	MSS	F
Group	1	816.667	816.667	5.237*
Gender	1	71.778	71.778	.460
Treatment X Gender	1	88.424	88.424	.567
Error	45	7018.019	155.956	
Total	48			

Significance at 0.05 level

Table-4: Mean and SD for Achievement in Chemistry of Boys and Girls

Treatment	Instructional Strategy			Lecture cum Demonstration Method		
Gender	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Boys	11	66.55	17.369	9	63.11	18.950
Girls	14	75.14	9.037	16	63.25	11.975
Total	25	71.36	13.744	25	63.20	14.468

Table-3 reveals that the F– value of 5.237 for the treatment is significant at 0.05 levels with df equal to1/48. It indicates that the treatment produced a significant differential effect on the achievement in chemistry. In other words, it can be said that the instructional strategy was effective in enhancing the achievement in Chemistry of the students taught through the multi-media model. Therefore, the null hypothesis, namely "There is no significant effect of treatment on the achievement in chemistry of class VII students when their scores of intelligence were taken as a covariate," is rejected. Therefore, it can be said that the achievement in chemistry is dependent upon the method of instruction.

Further table- 4 shows that the mean

achievement scores in chemistry of the students taught through the developed instructional strategy (71.36) are higher than those taught through the Lecture cum Demonstration Method (63.20). It can therefore be said that the developed instructional strategy was found to be more effective in terms of achievement of students in chemistry than the Lecture cum Demonstration Method.

Finding and discussion

There was a significant differential effect of treatment on the achievement of students in chemistry. Therefore, it can be said that the achievement in chemistry is dependent upon the method of instruction. This finding is supported by the findings of Kaur (2018), Mahmood (2017), Kalani (2008), Sreelekha and Nayar (2004), Luckpoteea, and Narod (2012), who found teaching through the concept attainment model to be effective in their studies. It is also supported by the findings of Su (2011) and Morais and Paiva (2007), who found that teaching through multimedia produced positive effects on achievement in chemistry. The reasons could be that the climate of the classroom was open, co-operative and encouraging with the scope for a good deal of students' activity. The instructional strategy thus provided a wide opportunity for students for acquiring concepts, interpreting the data and applying the principles in new and different situations. Multimedia technology offers unique benefits for chemistry courses when students are learning complex and new ideas. This instructional strategy may have stimulated more student-student and teacher-student interactions in different levels of students' competence and performance.

Effect of gender on the achievement in chemistry

Table-3 reveals that the F– value of 0.460 for the gender is not significant at 0.05 level with df equal to1/48. It indicates that gender did not produce a significant differential effect on achievement in chemistry. It shows that students' achievement in chemistry is independent of gender. Therefore, the null hypothesis, namely, "There is no significant effect of gender on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate", is not rejected.

Finding and Discussion

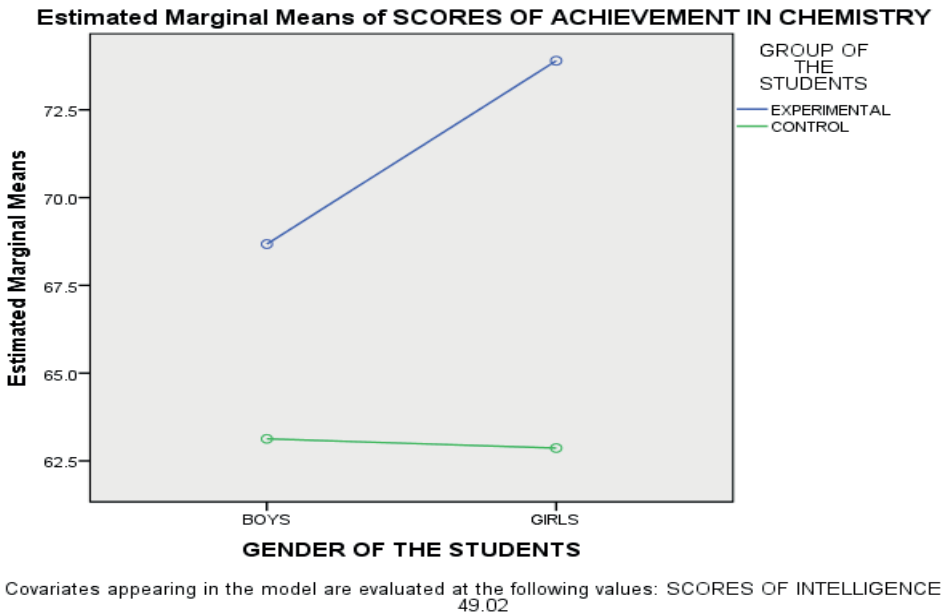
There was no significant differential effect of gender on the achievement of students in chemistry. Therefore, it may be said that there is no significant difference in the performance of boys and girls in terms of achievement in chemistry. This finding is supported by the findings of Demircloglu and Norman (1999), Dahindsa and Chung (2003), Azizgolu (2004) and Oluwatosin and Josiah (2017). In contrast Veloo, Hong and Lee (2015), Hatice Belge Can (2012), Busolo (2010), Barmby et al. (2008), Cousins (2007) and Chambers & Andre (1997) did find significant differences in the performance of boys and girls. However, the results of the present study indicate that the achievement in chemistry is independent of gender and depends on an individual's cognitive development. This change in the attitude of parents and teachers towards education irrespective of gender might be the cause of the present finding.

Interaction of treatment and gender on achievement in chemistry

Table-3 reveals that the F– value of 0.567 for the interaction between treatment and gender is not significant at the 0.05 levels with df equal to 1/48. It indicates that the interaction of treatment and gender did not produce a significant differential effect on the achievement in chemistry. In other

words, there was no interactional effect of treatment and gender of students on achievement in chemistry. Therefore the null hypothesis, namely, "There is no significant interaction of treatment and gender on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate", is not rejected. It indicates that the students of both the groups were equally benefited in the measure of achievement in chemistry.

Figure-2: Achievement in Chemistry of Boys and Girls



Finding and Discussion

The interaction of treatment and gender did not produce a significant differential effect on the achievement of students in chemistry. The results showed that treatment affected the achievement of students in chemistry. The results indicate that the mean achievement of the experimental group was higher than the control group. Further, the mean achievement of girls (75.14 and 63.25) was higher than the boys (66.55 and 63.11) in experimental and control groups respectively. This shows that the effect of treatment on the achievement of students in chemistry is independent of gender. The achievement in chemistry depends on an individual's cognitive development.

Effect of Treatment, Style of Learning and Thinking and Their Interaction on Achievement In Chemistry

The third objective of the investigator was to study the effect of treatment**,** style of learning and thinking and their interaction on the achievement in chemistry of class VII students, by taking their scores of intelligence as a covariate. The data were analysed with the help of 2 X 2 Factorial design ANCOVA of Unequal Cell Size. The results are presented as under:

Table-5: F-value for Treatment, Style of Learning and Thinking and Their Interaction on Achievement in Chemistry

Sources of Variance	Df	SS	MSS	F
Group	1	104.739	104.739	.680
Style of Thinking and Learning	1	84.762	84.762	.550
Treatment X Style of Thinking and Learning	1	190.203	190.203	1.234
Error	45	6933.713	154.083	
Total	48			

Table-6: Mean and SD for Achievement in Chemistry of the Right and Left Hemispheres of Experimental and Control Groups

Treatment	Instructional Strategy			Lecture cum Demonstration Method		
Style of Thinking and Learning	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Right Hemisphere	22	73.09	13.420	21	62.29	15.103
Left Hemisphere	3	58.67	10.066	4	68.00	10.832
Total	25	71.36	13.744	25	63.20	14.468

Effect of Treatment on the Achievement in Chemistry

The findings have been discussed in the previous section.

Effect of Style of Learning and Thinking on Achievement in Chemistry

Table-5 indicates F– value of 0.550 for the style of learning and thinking on achievement in chemistry is not significant at 0.05 level with df equal to1/48. It indicates that the style of learning and thinking did not produce a significant differential effect on the achievement in chemistry. It shows that students' achievement in chemistry is independent of style of learning and thinking. Therefore, the null hypothesis, namely, "There is no significant effect of their style of learning and thinking on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate", is not rejected.

Further, Table-6 also indicates that the mean achievement of students with right hemisphere dominance (73.09) for the experimental group is higher than that of students of the control group (62.29). The mean achievement of students with left hemisphere dominance is 58.67 for the experimental group and the control group is 68.00. But, this difference is not significant.

Finding and Discussion

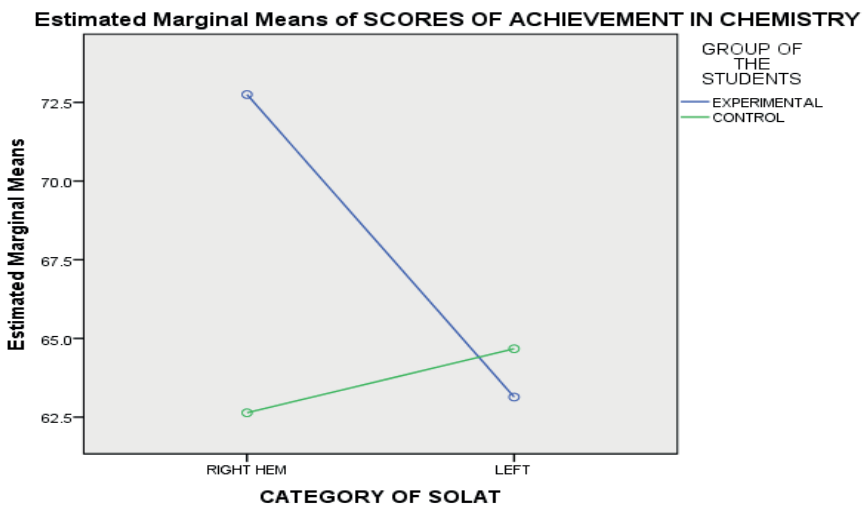
There was no significant differential effect of style of learning and thinking on the achievement of students in

chemistry. Both the groups of learners i.e., students with left hemisphere brain dominance and right hemisphere brain dominance benefitted in the same way. This finding is supported by the findings of Yilmaz-soylu and Akkoyunlu(2002) and Wilson (2011) and is not supported by the findings of Uzuntiryaki (2007) and Vaishnav(2013).

Interaction of Treatment, Style of Learning and Thinking on Achievement in Chemistry

Table-5 reveals that the F– value of 1.234 for the interaction of treatment and style of learning and thinking is not significant at 0.05 levels with df equal to 1/48. It indicates that the interaction of treatment and style of learning and thinking did not produce a significant differential effect on the achievement in chemistry. Therefore, the null hypothesis, namely "There is no significant interaction of treatment and style of learning and thinking on the achievement in chemistry of class VII students when their scores of intelligence were taken as covariate", is not rejected.

Figure-3: Achievement scores of Students having different Styles of Learning and Thinking



Covariates appearing in the model are evaluated at the following values: SCORES OF INTELLIGENCE = 49.02

Finding and Discussion

The interaction of treatment and style of learning and thinking did not produce a significant differential effect on the achievement of students in chemistry. The results showed that treatment affected the achievement of students in chemistry. The results also indicate that style of learning and thinking did not have any significant differential effect on the achievement of students in chemistry. Therefore, there might not be any significant differential effect of the interaction of treatment and style of learning and thinking on the achievement of students in chemistry.

Conclusion

The findings of the study reveal that the instructional strategy was effective in terms of the achievement of students in chemistry and in terms of reactions of students towards the strategy. It produced a significant differential

effect on achievement in chemistry when compared to the Lecture-cum-demonstration method. It was also found that achievement in chemistry is independent of gender and style of learning. Teachers should use more than one teaching style to cater to the individual needs of the students, respecting their style of learning and thinking. The contents of textbooks of chemistry should be presented on CAM approach giving opportunities to the students to explore more examples. These examples should include the ones related to daily life. Teachers should also use such instructional strategies for teaching chemistry which allows students to think independently.

The curriculum developers should make the curriculum gender-friendly at all stages. Parents should give equal importance to their child's educational needs irrespective of their ward's gender. Teachers should also give equality concerning gender in the classroom as well as outside the classroom.

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