

Innovative Teaching Strategies and Chemistry Achievements at Secondary Level

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Abstract

The research study was conducted to investigate the effects of innovative teaching strategies (simulation, brainstorming, peer tutoring, cooperative learning, discovery learning, inquiry learning, and role play) on academic achievements at the secondary level in the subject of Chemistry. The study was experimental research by nature, so pre-test, post-test control group design was adopted and the sample of eighty (80) students of 9th grade from Govt. High School Warburton (City) out of the population of 387 students were divided into control and experimental groups with 40 students (control group) and (experimental group) each. Units (1-4) from the chemistry book 9th grade published by Punjab Text Book Board Punjab were selected as contents of study and two achievements tests (Pre & Post) in chemistry were developed having 20 multiple choice items. The validity of the instruments was assured by the expert opinions of three experts and the reliability of the instruments was assured using test-retest techniques having 0.856 Pearson's product moment. Pre and post tests were administered to the Experimental and Control groups by the researcher along with the two other teachers and data was collected. The data collected were tabulated, mean score and standard deviation statistics were used to explore the answers of the research questions while the t- test statistics were employed to test the hypothesis for the analysis and interpretation of data. It was concluded from the analysis and interpretation of data that innovative teaching strategies affect the academic achievements positively and was recommended that Government may ensure the implementation of the law of teaching the science subjects at the secondary level with innovative teaching strategies to enhance the academic achievements of the students.

Key Words: Innovative teaching strategies, Chemistry, Achievements, Secondary level

Introduction

Education is a light which shows the right direction to mankind to surge. The purpose of education is not just making a student literate but also adds rationale thinking, knowledgeably and self sufficiency (Ruban A, 2014). A teacher tries his best to impart knowledge as the way he understood it. So, any communication methods that serve this purpose without destroying the objective could be considered as innovative methods of teaching. Innovative teaching is a proactive approach to integrate new teaching strategies and methods into a classroom. Innovative teaching also involves creativity on the part of the teacher. Innovative teachers sometimes reorganize the educational process. The use of innovative methods in institutions has the potential not only to improve education but also to empower people, strengthen governance and galvanize the effort to achieve the human development goal for the country (Jayalaxmi, 2016). According to Mary SS (2014), Innovation is the act of constructive thinking, grouping knowledge, skills, and attitude into new, original & rational ideas. There are various Instruction strategies for classroom & clinical are Lecture, discussion, demonstration, simulation, laboratory, seminar, panel, symposium, problem solving, problem based learning (PBL), workshop, project, role- play (socio drama), clinical teaching methods, case based learning, clinical simulation, programmed instruction, self-directed learning(SDL), micro teaching, computer assisted instruction (CAI), computer assisted learning (CAL), blackboard learning (Web based learning), Mind mapping/Concept mapping, Storytelling, Field trips, Games, Use of good Sense of humour etc. But all methods are not emerging & innovative teaching methods. Innovations depend on the teacher that how they utilize the instructional strategies while delivering lectures or teaching in clinical. Innovative applications should be evidence based (Rajesh Kumar Sharma, 2017). According to Gaba (2004), simulation is a "technique", not a technology and focuses on recreating real-life situations to allow students to practice or gain skills in a safe environment. According to Scheckel (2012), simulation is the sums of activities that are learner centered encourage the student to participate in the design of learning tasks while acquiring the knowledge and skills needed to meet the curriculum outcomes. There are

various types of simulators, ranging from low fidelity simulators with body parts, such as an arm, to learn intravenous insertion, to high fidelity human patient simulators with technologically advanced interactive mechanical simulation mannequins (Campbell 2010). Brainstorming means the use of the brain to the active problem solving and the brainstorming session aims to develop creative solutions to problems (Abdullahi Naser, M. A. (2015). Many previous studies (e.g., Drapeau, 2014; Michinov, Jamet, Métayer, & Le Hénaff, 2015; Schlee & Harich, 2014) have claimed that the process involved in the idea generation task may potentially play an exceptional role in stimulating individuals' ability to produce creative solutions that can be further evaluated and, eventually, applied in practice. Very commonly, the individuals' ability during the BS session is measured based on the quantity or uniqueness of the generated ideas (Fu et al., 2015). Peer learning has been proven to be a successful venture when it comes to improving student's academic and social cognitive skills. With peer learning, children get the opportunity to aid in their peers' learning through tutoring and feedback. They also have the opportunity to speak more freely and with less pressure when in group settings and student led discussions. These strategies encourage greater communication among students and lead to increased academic success (Mengping 2014). Results from case studies show that through peer tutoring there are academic improvements in scores and lasting positive effects from experience for both the tutor and tutee (Lingo 2014). The inquiry-based teaching approach is supported on knowledge about the learning process that has emerged from research (Bransford, Brown, & Cocking, 2000). Sandoval & Reiser (2004) pointed out in order to build the inquiry-based classroom environment must construct a community of practice like the scientist's work. Cooperative learning is an educational situation where learning occurs while two or more students are working together to complete a common task (Siegel, 2005).

Huang and Su (2010) concluded: In cooperative learning, because cooperative learning groups have active interdependence, it will cultivate team spirit of students penetrating into the teaching of the class, and team spirit will play an important role in the conversion process of China's software industry from handicraft workshop to industrial production. According to Research Corner: Education Data and Research Analysis from Edvantia (2005), Studies on cooperative learning indicate a strong impact on student achievement as well as increased motivation and improved social interactions with adults and peers. Acar & Tarhan (2007), Nichols, (2002) proved in their various studies that students in a cooperative learning class perform extremely better than those in a non-cooperative learning class with respect to achievement. In a study conducted by Jolliffe (2005), he explored the implementation of cooperative (Student Team Assessment Division Model) in some selected schools in England and found that teachers in those schools were convinced of the effectiveness of cooperative learning regarding its positive effects on academic achievement and development of social skills. Akinbobola (2006) whose study revealed that students taught using the cooperative learning method performed better than those taught using the conventional method. Chemistry is an essential basis for many facets of our everyday lives and has many unforeseen potential benefits for our future. An understanding of chemistry allows us the opportunity to make sense of, and explain the world around us. Understanding and learning core science concepts and principles, including those in chemistry, are difficult; many research studies have revealed major learning difficulties and identified key causes of these difficulties. Indeed it has been suggested that it is useful to distinguish between at least three different types of model that are important for chemistry education: scientific, curriculum and teaching models (Justi & Gilbert, 2000).

Statement of the Problem "Innovative teaching strategies and chemistry achievements at the secondary level: Analysis of effects" was the statement of the problem.

Objectives of the Study

The specific objectives of this research study were:

1. To examine the extent of the difference in the pretest mean achievements scores of experimental and control groups.

2. To ascertain the difference in the post test mean achievements scores of experimental and control groups.
3. To investigate the effects of innovative teaching strategies on the chemistry achievements at the secondary level.

Research Questions

The present research study was guided by the following research questions:

1. What is the difference in the pretest mean achievements scores of experimental and control groups?
2. What is the difference in posttest mean achievements scores of experimental and control groups?
3. How do innovative teaching strategies effect the chemistry achievements at secondary level?

Hypothesis

Following the null hypothesis were formulated to conduct the research study:

1. There is no significant difference in the pretest mean achievements scores experimental and control groups. (H_{01})
2. There is no significant difference in the post test mean achievements scores of experimental and control groups. (H_{02})
3. There is no significant effect of innovative teaching strategies on the chemistry achievements at the secondary level. (H_{03})

Delimitations of the Study

The study was delimited to:

- District Nankana Sahib
- Government Boys High school Warburton (city)
- Only the students of 9th grade

Research Methodology

Research Design

The research study was experimental by nature so pre-test, post-test control group design was adopted to conduct the research study. The study considered a class taught with seven innovative teaching strategies (simulation, brainstorming, peer tutoring, cooperative learning, discovery learning, inquiry learning and role play) as the experimental group while the one taught by a teacher who did not use innovative teaching strategies rather taught with traditional (lecture and discussion) teaching strategies constituted the control group.

Population

All the students (Three hundred and Eighty Seven 387) of 9th class (Science Group) enrolled in the subject of Chemistry as an elective subject from Government High School Warburton (city), District Nankana Sahib (Punjab), Pakistan were the population of this research study. There were nine classes of grade 9 out which two had English as a medium of instruction while seven had Urdu as a medium of instruction.

Sample

The sample of this research study was forty (40) students of one class taught with seven innovative teaching strategies (simulation, brainstorming, peer tutoring, cooperative learning, discovery learning, inquiry learning and role play) (Experimental Group) and Forty (40) students of one other class taught with traditional (lecture and discussion) teaching strategies (Control Group). Purposive and convenient sample techniques were employed to select the two classes having English as a medium of instruction as a sample. A total of eighty (80) students constituted the sample.

Contents of the Study

Units (1-4) named as Fundamentals of Chemistry(unit#1),Structure of Atom(Unit#2),Periodic Table and Periodicity of Properties(Unit#3), Structure of Molecules(Unit#4) from the book of Chemistry grade 9 published by Punjab Text Book Board Punjab were selected as contents of study to conduct this research study.

Instrumentation

The researcher developed two achievements tests (Pre & Post) having two sections. Section I contained students personal information such as class and name of the school while section II had twenty (20) multiple choice items from the units (1-4) of the book of physics 10th grade. Only five (05) items from each unit were included in both tests keeping in view that they covered all the levels (knowledge, understanding, application, analysis, and synthesis). Each item had four options (a, b, c &d) where the respondents were expected to pick the right option.

Validity and Reliability of Instruments

Content and face validity technique was used to assess the validity of the research instruments. In this study, the expert opinions from three experts (Two in chemistry and one in measurement & evaluation) were obtained, and the validity of the instrument was assured that all aspects of the research problem were captured in the achievement tests. A test-retest reliability technique was used to determine the reliability of the research instrument. The achievements tests were first personally administered to ten students of 9th class (science group) from the population for pilot testing, the data was collected, and scores were recorded. After two weeks, the same questionnaires were again administered personally to the same respondents, and the scores were recorded again. Pearson's product moment formula was used to calculate the coefficient of correlation between the first and second scores. The calculated Pearson's product moment was 0.856, and the reliability of the instruments was thus assured. After being assured of the reliability of the instrument, achievements tests were administered.

Data Collection

A structured achievements test in Chemistry (Pre-test) was administered to the students of both the groups (Experimental and Control) at the same time by the researcher along with the two other teachers before the start of the experiment and data was collected. Class environment and arrangements were initially kept the same. The selected units were taught by the same Chemistry teacher in different periods and the time for teaching was forty (40) minutes per day to each group. The described units were taught to both groups for the time of eight weeks. The related teacher was properly informed about the purpose of the research study, and he was properly guided as for how to teach experimental and control groups. The experimental group was taught with seven innovative teaching strategies ((simulation, brainstorming, peer tutoring, cooperative learning, discovery learning, inquiry learning, and role play). The teacher made the use of different innovative teaching strategies in the different intervals of time during the prescribed time of instruction while the control group was taught with traditional (lecture and discussion) teaching strategies. The researcher personally visited both the classes eight times, once in a week, and he is satisfied with the working of the teacher in both the classes. A post test was administered to the students of both the groups (Experimental and Control) at the same time by the researcher

along with the two other teachers and data was collected. Students were guided by the researcher as for how to response the achievements tests while administering the instruments in both pre and post tests.

Analysis and Interpretation of Data

The data collected were tabulated, mean score and standard deviation statistics were used to explore the answers of the research questions while the t- test statistics were employed to test the hypothesis having table value 1.645 at the level of significance 0.05 with a degree of freedom 125 for the analysis and interpretation of data. The values of the t-test, mean and standard deviations were calculated using SPSS (special package for social sciences) software updated version.

Table # 1: Pre Tests Results

Sr.No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Scores	Control Group	64	62	83	72	91	77	71	64	83	65	64	58	78	71
	Experimental Group	59	73	76	89	68	71	61	67	88	93	69	76	69	77
Sr.No.		15	16	17	18	19	20	21	22	23	24	25	26	27	28
Scores	Control Group	92	74	67	83	74	86	90	72	82	78	72	78	64	92
	Experimental Group	60	82	78	74	68	6270	76	84	82	62	78	66	68	74
Sr.No.		29	30	31	32	33	34	35	36	37	38	39	40		
Scores	Control Group	76	72	50	62	74	82	76	88	90	82	78	72		
	Experimental Group	92	60	70	72	62	68	76	84	72	68	74	86		

Table # 2: Analysis of pre-test mean achievements scores

Groups	N	Mean	Std. Dev.	Variance
Control	40	75.22	10.0421	100.8455
Experimental	40	73.55	8.9067	79.3307

Table No.2 reveals that the mean score of the academic achievements in the subject of chemistry at the secondary level of the control group is 75.22 that is higher than the mean score of the academic achievements of the experimental group (73.55). The standard deviation value of the pre-test means achievements scores for the control group is 10.0421 and the standard deviation value of the pre-test mean achievements scores for the experimental is 8.9067 while the variance values of pre test mean achievements score 100.8455 and 79.3307 respectively for the control and experiment groups.

Table # 3: Post Tests Results

Sr.No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Scores	Control Group	62	64	86	70	90	78	72	62	84	64	64	60	78	72
	Experimental Group	84	88	86	94	88	86	76	78	92	96	76	82	80	78
Sr.No.		15	16	17	18	19	20	21	22	23	24	25	26	27	28
Scores	Control Group	92	72	70	86	72	86	90	74	82	80	74	78	64	92
	Experimental Group	86	88	84	94	82	80	90	92	88	82	88	86	78	92
Sr.No.		29	30	31	32	33	34	35	36	37	38	39	40		
Scores	Control Group	74	72	70	762	76	82	76	88	90	82	76	72		
	Experimental Group	98	80	86	90	92	84	70	88	82	88	86	86		

Table # 4: Analysis of post-test mean achievements scores

Groups	N	Mean	Std. Dev.	Variance
Control	40	76.30	9.0304	81.5487
Experimental	40	85.60	5.9948	35.9384

Table No.4 clears that the post- test mean score of the academic achievements in the subject of chemistry at the secondary level of the control group is 76.30 that is lower than the mean score of the academic achievements of the experimental group (85.60). The standard deviation value of the post-test mean achievements scores for the control group is 9.0304, and the standard deviation value of the post -test mean achievements scores for the experimental is 5.9948 while the variance values of posttest mean achievements score are 35.9384 and 79.3307 respectively for the control and experiment groups. The statistics show that innovative teaching strategies affect the chemistry achievements positively which result that students taught with innovative teaching strategies show better achievements than those taught with traditional teaching techniques.

Table # 5: Summary of the t-test statistics for pre-test and post-test to analyze the effects of innovative teaching strategies on chemistry achievements

Groups	Tests	N	Mean	Std. Dev.	Df	t-cal	t-value	α	Decision
Control	Pre test	40	75.22	10.042	78	0.6161	1.960	0.05	H0 Accepted
	Post test	40	76.3	9.0304					
Experimental	Pre test	40	73.55	8.9067	78	9.2298	1.960	0.05	H0 Rejected
	Post test	40	85.6	5.9948					

It is clearly evident from the table #5 that t-calculated value for the control group is 0.6161 having the degree of freedom 78 at the level of significance 0.05 is lower than the table value (1.960) that results that null hypothesis is accepted which means that innovative teaching strategies do not affect the academic achievements. Table #5 represents that t-calculated value for the experimental group is 9.2298, higher than the table value, helps to reject the null hypothesis. The statistics reveal that there is a significant effect of innovative teaching strategies on academic achievements which shows that students taught with innovative teaching strategies show higher academic achievements rather than those taught with traditional teaching techniques.

Conclusions and Discussions

On the basis of analysis and interpretation of data, it was concluded that innovative teaching strategies play their positive role to enhance the academic performance and achievements of the students at secondary level particularly in the subject of chemistry. Students taught with innovative teaching strategies show higher academic achievements rather than those taught with traditional teaching techniques. The result resembles with the point of view of (Jayalaxmi, 2016), according to him, the use of innovative methods in institutions has the potential not only to improve education but also to empower people, strengthen governance and galvanize the effort to achieve the human development goal for the country. Jolliffe (2005) found that teachers were convinced of the effectiveness of cooperative learning regarding its positive effects on academic achievement thus the results of this research study confirm the statement. The present research study also followed the thoughts of Sandoval & Reiser (2004), who pointed out that the inquiry-based classroom environment must construct a community of practice like the scientist's work. Results from case studies show that through peer tutoring there are academic improvements in scores and lasting positive effects from experience for both the tutor and tutee (Lingo 2014). The results of most of the research studies conducted regarding investigate the

effects of innovative teaching strategies on academic achievements are the same concluded from this research study.

Recommendations

On the basis of the analysis and interpretation of data, the researcher recommended the following recommendations:

1. The government may ensure the implementation of the law of teaching the science subjects at the secondary level with innovative teaching strategies to enhance the academic achievements of the students.
2. The government may provide instructional material for the teachers equipped with the effective use of innovative teaching strategies for the effective teaching and learning process.
3. Administrative authorities (CEOs, DEOs), during their visits to schools by directing the teachers, may make it sure teachers use innovative teaching strategies during the teaching to improve the teaching and learning process.
4. Principals / Head Teachers of the schools may take strict actions to force the teachers to teach with innovative teaching strategies for the enhancement of academic performance and achievements.

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