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Comparison between Traditional Text-book Method and Constructivist Approach in Teaching the Concept 'Solution'

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This experimental research study was aimed to compare the traditional text-book method and constructivist approach in teaching the concept 'solution' to 9th grade students. Sixteen constructivist lesson plans of 45 minutes each was particularly developed to change the student's misconceptions about the basic concept 'solution' of chemistry. To achieve this goal 209 subjects were selected randomly and assigned as experimental and control groups from two different girls schools of Lahore. The researcher himself had administered the treatment to the to the experiment groups of 104 subjects for eight weeks. Similarly, 105 students were taught as usual through traditional textbook method. The students' alternative conceptions of experimental and control groups were compared which were explored through interview-about –instances (IAI) instrument of 7 instances or non-instances about this concept. The Cohan Kappa reliability of the instruments was determined. Content validity was established by three experts. After qualitative as well as quantitative analysis, five different categories or forms of misconceptions emerged which may guide the science educators about five alternative kinds or frameworks of students thinking and responding. The findings of this research study indicate that constructivist approach was significantly better than traditional textbook method in changing the pupil's ideas or facilitating to develop the correct scientific conceptions which is a valuable contribution in teaching science.

Keyword: constructivist approach, traditional text-book method, misconceptions, alternative conceptions, solutions, iai (interview-about-instances)

Introduction

Teaching-learning process is highly influenced by the factors such as, the learner's cognitive abilities/ perceptions of learning, and the teacher's own conception about teaching/learning to facilitate conceptual development (Alsop, Bencze & Pedretti, 2005). Learning of isolated science facts, without any sense of how they fit together, is all too common at both the elementary and secondary grade levels. Rote memorization and cramming of such factual information about scientific knowledge has become a routine. In the past, science teachers were used to practice a specified set of teaching methods clearly aligned with any of the existing principles of learning like behaviorism or cognitivism. Traditional lectures were assumed to be simply the transmission of knowledge from teacher to student. But in present day schools, more and more emphasis is laid to develop understanding of scientific concepts in students. Memorization of facts will not suffice in future due to explosion of scientific knowledge at exponential rate (Peter & Gega, 2002), and changes in society, and what we know about how students learn has changed (Feden & Vogel, 2003).

Now the students are not content with just listening to the teacher, doing book reports, taking multiple-choice tests and completing worksheets, or doing their science practical's without relating to any concept in science textbooks. They are doing well on the tests, but unfortunately demonstrate little evidence of remembering the information a week or two later. The students have been facing difficulty in relating the content they learned in class to the world outside. And, there is compelling evidence that students proceed through formal education successfully but without changing their alternative ideas (Feden & Vogel, 2003). If that is true, then students have not learned ideas in a proper way. Sirhan (2007) cited Bruner (1990) that Chemistry is highly conceptual by its very nature while its basic concepts are acquired by rote learning or in other words in a non-meaningful way. Students show some evidence of learning and understanding by obtaining high marks but, researchers consistently find evidence of alternative conceptions and the limitations of rote learning even at degree level where basic ideas of chemistry were not well understood. It is not only imperative to uncover the students' alternative conceptions of chemistry at secondary level but the change of their views, is the main challenge for science educators. In this situation, the constructivist approach of teaching - learning would be the better alternative. This approach has received much attention by the science educators that is why its literature in all popular text-books of science education and educational psychology has been exploded exponentially (Nasir & Iqbal, 2002).This explains the cause of the origins of learners 'alternative conceptions, and to use this information to guide more reflective learning or in other words effective teaching. Constructivism promotes this firm belief that all knowledge is constructed in the minds of the learners, not passed on from the teacher to the students. Thus learning builds on the previously acquired ideas in the learners' mind (Peter & Gega, 2000; Ausubel, 1978). To assist students in constructing their knowledge a constructivist teacher can manipulate any (or combination) of the existing teaching methods. Thus, to know the students understanding about the concept of science, teachers need to understand the philosophical and theoretical rationale of constructivism for becoming constructivist practitioners. (Novak 1993; Zafar Iqbal, 2003). As Sirhan (2007) cited that Johnstone& Driver (1991) indicated, how it make the chemistry problematic to learn when the concepts are represented at macroscopic, to microscopic or representational level. This is merely due to traditional approach of teaching which is sometime contradictory with the nature of science and cause to develop some alternative conceptions in the students.

Osborne, Bell, & Gilbert (1983) noticed that the nature of matter or solution is little understood by school students in their everyday lives. Many countries revised syllabuses in 1960 to 70s in a logical order but now it is felt that this may not be psychologically accessible to the students. These results showed that misconceptions persist for some graduate students even with chemistry as their major. Thus.,Ross,Latkin & McKechnie (2010) concluded that learners have many problems when they are invited to apply or extend their knowledge in their real world. For example, why the odor of a perfume or a bouquet of flower soon seems to fill an entire room? How the nature's strongest driving force for change operates towards mixing things up? Apparently, it seems no problem for a traditional teacher to directly transfer information in the whole class as an isolated fact that this nature's strongest driving force for change is 'a tendency toward an increase in disorderliness or randomness? But for a constructivist teacher, it demands much more. A constructivist teacher will arrange an activity where two gases initially in separate compartments. He will ask a series of questions to his students before mixing both gases spontaneously to each other. Students may guess or predict in different ways and may also reach at the different conclusion. But after thorough discussion with peers, and teachers, they will construct the knowledge in a meaningful way. Many students may have different opinions and creative ideas or imaginations which will be helpful for conceptual understanding not only for them but for others also. Therefore, it may be considered that a definite correct answer of each question is not the target of constructivist teaching but developing intellectual skills and stable emotional consistency are sometimes more important. The above discussion may be explained with another example, that why physical properties of substances are as important as chemical properties. For example, forecast for the farmers is important about the expected precipitation will come in liquid or solid form. As hail (a solid) is universally dreaded because of the damage it can inflict on crops while the rain (a liquid) is usually welcomed. How this simple example elaborates the importance of the physical properties of substances and the transformations among three states of matter influence our lives. Keeping in view the above learning an well as teaching problems in chemistry, many studies also pointed out that students have alternative conceptions and faced difficulties concerning other concepts such as chemical bonding, chemical change and composition of matter because traditionally only definitions with some examples are delivered to the students but not elaborated. (Taber, 1994; Harrison & Treagust,2000) due to their lack of understandings of the abstract and complicated concept- quantum model of atom. Therefore, in this context, this study would compare traditional textbook method and constructivist approach through identifying student's misconceptions in control and experimental groups.

Objectives of Study

1. To compare the traditional textbook method and constructivist approach through identifying student's misconceptions about the concept solution, at high school level.
2. To know which teaching strategy is effective for changing the student's misconceptions about the concept 'solution'.
3. To find the root causes of alternative ways of thinking or responding through categorizing the misconceptions about this concept.
4. To compare the alternative conceptions over scientific responses about the concept solution in experimental and control groups.

The Research Questions of study

1. What misconceptions related to concept solution do learners hold at high school level?
2. Can the misconceptions be further categorized?
3. Is there present a common pattern in student's responses?
4. Can the constructivist approach be efficient/ effective for conceptual change about this concept at high school level?
5. Is traditional textbook method effective for conceptual change about this concept?

Delimitations of the Study

This research study was delimited to:

1. Only female science students studying at secondary schools of Lahore city.
2. Only one concept the solution.

Methodology

The 'post-test only control group design' was chosen for applying the traditional textbook method in control and constructivist approach in experimental groups. Then students' misconceptions were identified by using interview-about-instances (IAI) instrument. The following seven instances and non-instances of this concept were developed to explore the students' misconceptions.

i) White of an egg (non-instance – a colloid)
ii) Oil in water (non-instance – immiscible liquids)
iii) Air (instance – gaseous solution)
iv) Steel Spoon (instance – solid solution)
v) Salt (NaCl) in Water (instance – solid in liquid)
vi) IM Alcohol in Water (instance – liquid in liquid, a standard solution)
vii) Soda Water (instance – gas in liquid)

Three general questions were asked about each instance of this concept as follows:

i) Do you know, what is this (instance name)?
ii) Is it a solution?
iii) How can you justify it?

For further exploration, some other questions were also asked needed.

i) What is its type?
ii) What changes occur by adding it into (relevant thing)?
iii) Do you think liquid is necessary for solution?
iv) Does energy evolve or absorb in the system?
v) What factors affect its properties?

Sampling

To conduct this research study 209 subjects were selected randomly from 9th class of two similar female public high schools which had more than 1200 students. These subjects were randomly assigned as experimental and control groups. In this way many variables such as age, gender, socioeconomic, attitudes etc. were controlled which were likely to be the major threats to the internal validity. Similarly only 2-4 subjects' mortality was found in both control and experimental groups with equal ratio. The experimental group was treated through the teaching strategies based on the constructivist approach and the traditional textbook method was used to teach the control groups. The treatment to all the subjects of both experimental groups was given by the researcher himself in each public high school. To implement the constructivist approach properly the researcher role was assigned as a guide, a facilitator, or more a leader of discussion. The subjects were motivated to ask questions freely to each other and also to the facilitator and encouraged to inquire about the science activities/events. Sixteen lessons were planned according to the Model Lesson Plan Format

(MLPF) which has been designed with the following five parts:

1. Invitation/Starter(the subjects were provided the required materials for performing different activities)
2. Elicitation(The questions to elicit the students understanding were framed)
3. Teacher Intervention(teacher gives some clue to resolve the problem)
4. Restructuring/Formulation of ideas(encouraging students to communicate their understanding in a new situation)
5. Review of Conceptual Change (relating the content to everyday experiences as well as evaluation of new understanding).

Two lessons of the concept solution per week of 45 minutes were taught to both experimental groups for three months. The control groups were also taught through traditional textbook approach during this period. It was observed that during the process of treatment, students participated actively in their learning process through discussion and purposeful dialogue, activities, problem solving, questioning and cooperative learning. The data were collected by the researcher himself in both public schools by asking similar questions and presenting the instances/non-instances of the concept solution with the same sequence irrespective the subjects of control or experimental groups and consciously avoided the data collector bias, and other novelty effects such as location, history, testing effects or implementing threats. Similarly, to control the teacher's effect in both control groups was addressed before the start of research study by considering the equal qualification of science teachers (M.S.Ed degree) and equal experience of teaching/ability etc. The researcher also observes both control groups where traditional text book method was used and same content was taught by both the teachers. Categorical Analysis was made to the content obtained through interviews by the subjects of the study. A summary of the responses' was prepared obtained by the subjects about each instance of this concept and evaluated on the criteria of scientific ideas and assigned into either of the five categories of alternative conceptions or 6th category of scientific response

Reliability of the Instrument

The inter-rater reliability of the IAI instrument was obtained by applying the Cohen Kappa. Its values are given as.

Validity of the Instruments

The research instrument (IAI) which was developed by Osborne & Gilbert (1979), the researcher developed similarly seven instances/non-instances of the selected concept 'solution'. The open-ended questions were asked according to the local curriculum of chemistry. Its content validity was established with the consultation of three experts having Doctoral/M.Phil. degrees in chemistry or master degree in Science Education.

Limitations of the study

- A few students of the experimental groups were hesitant especially for participating in the discussion within the group.

Sometimes student's curiosity/discussion was not up to the mark when handling the equipment's or manipulating the low cost material.

Table: 1: Inter-rater reliability of the instrument

		Value	SE(a)	T(b)	Sig.
Measure of Agreement	Kappa	.823	.019	39.064	.000
N of Valid Cases		520			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

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Identifications of students' misconceptions about 'Solutions'

To identify student's misconceptions of concept solutions 105 female subjects of control group and 104 subjects of experimental groups responded to the seven instances/non-instances of the concept 'solution'. In this process 679 alternative conceptions were identified into their five categories and 56 were the scientific responses.

In contrast, in the experimental group 99 alternative conceptions were belonging to five categories and 625 were the scientific responses. The data description is presented similar to the boys of phase-III in the following way:

1. The subjects of control groups hold 282 frequencies or 38.36% of alternative conceptions in the category-3 of *self-centered/human-centered views*. For example, white of an egg is a diet. It is liquid, insoluble and non-filterable. It's kind of liquid compound and not solution (5). Oil is insoluble in water because it gets freeze on the surface of water (4). Air is a useful mixture of gases for living bodies and not solution because it is necessary for solution to be a liquid (87). Steel spoon is composed of iron and carbon. It is not a solution because it is necessary to be a liquid for solution. It can be separated by bonding forces (72). NaCl in water is a solution. Bonding formation takes place. NaCl ionizes, so it is a physical phenomenon (39). IM alcohol in water is a colloidal solution, not useful for health. Hydrogen bonding takes place. No change appears. It's a good conductor (40). Soda water is cold drink. It is a compound solution. By reacting with salt Co_2 evolves, solubility of Co_2 increases with pressure (35).

In the experimental group an average only 2.33% or 17 frequencies were in *human-centered or self-centered views.* For example, white of an egg is full of vitamins and proteins and in solution form (6) steel spoon is made up of iron. It's not solution, due to its solid nature. Liquid is essential for preparing a solution (1). Soda water (Pepsi) is a solution; Co_2 and H_2O affect its solubility. Co_2 gas evolves by chemical reaction that takes place by adding table salt (1). IM alcohol in water solution is useful for patients and avoiding tiredness (4) etc.

2. The second highest average with 25.42% subjects of the control group hold 184 alternative conceptions in category-1 which were assigned as *incorrect use of scientific term.* For example, white of an egg is Jelly like and liquid – liquid solution. Its chemical composition constitutes calcium, phosphorous and protein (33). Oil in water is a chemical solution. Oil droplets are clear on the surface of water. It's a mixture. There is no role of hydrogen bonding (12). Air is a gas, which is cool and not a solution, as it is in the gaseous form (3). Steel spoon is composed of iron and carbon. It's not a solution. Reversible reaction takes place and it can be separated into its components (17). NaCl in water is a polar solution of two substances. Its solubility increases with rise in temperate. Dissolution and addition reactions take place (41). IM alcohol in water is a mixture of two things but not a solution. Actually alcohol is not soluble in water due to its non-polar nature. It's a colloidal solution (36). Soda water is a soft-drink. It's unsaturated solution. Co_2 gas evolves by chemical reaction with slat on heating. It is a liquid form of solution (42).

In the experimental group, the average only 1.78% subjects replied with 10 frequencies under the category-1 in the following way: White of an egg is not a solution but a suspension – when dissolved in water (7). IM alcohol in water is a solid in liquid solution because solution is homogeneous mixture of different substances (1) etc. Thus, the subjects used frequently scientific terms but without understanding their instances.

3. In the category-5 *(scientific term but incorrect explanation)* there were 21.22% an average of alternative conceptions (156) of seven instances about solution in the control group of girl subjects. Such as, white of an egg is colloidal solution. It is solid into liquid insoluble solution and filterable. It is just like cell – cytoplasm (38). Oil is non-polar so it is insoluble. Hydrogen converts in OH group by reacting with water. Oil does not dissolve in non-aqueous solutions or solute does not dissolve in solvent (61). Air is a mixture of many gases, so it is a solution. Collision of molecules takes place due to increase in temperature. Thus, liquid is essential for making a solution (7). Steel is a compound of iron and copper

components which are joined due to chemical bond and liquid is essential for making solution (2). NaCl in water is solid in liquid, dissolution takes place, ionization and oxidation occurs (18). IM alcohol in water is liquid in liquid solution. Hydrogen bonding appears and a new compound forms and no heat change occurs (14). Soda water is liquid containing gas solution. Its bonds break down and Co_2 evolves (9).

In the experimental group of girls high schools average 3.57% subjects have used scientific term with 34 frequencies but incorrect explanation in such a way: White of an egg is a colloidal solution, so its color is white. It is soluble in water as well as filterable. Its particles are kind of suspension like (7). Oil in water is heterogeneous solution due to its insolubility. Ionic bond plays its role and hydrogen bonding plays no role. No energy evolves or absorbs(7). Air is mixture of many gases. It is necessary for solution to be in liquid state (2). NaCl in water is solid in liquid type solution. H_2o ionizes into H^+ and OH (ions). NaCl into Na^+ and Cl^-. This is called ionization (5). IM alcohol in water is liquid in liquid homogeneous solution. Energy releases and hydrogen bonds break down. Alcohol does not ionize. However it is a good conductor (8). Soda water is a mixture and gas into liquid type of solution. Solubility decreases with increase in pressure (3). Since, the subjects used proper scientific terms such as colloids, non-polar, mixture but explained incorrectly.

4. The subjects of control group with 5.57% hold 41 frequencies of *self-contradictory views* in such a way. The white of an egg is colloidal solution because two things are mixed. It's unsaturated solution, non-filterable due to presence of calcium (14). Oil in water is not solution, as it may catch fire when oil and water would be tried to mix. It is a compound, chemical bonding plays no role, it is oily solution (6). NaCl in water solute – solvent kind of solution. Chemical reaction takes place and converts into ions (3) etc.

Whereas in the experimental group, the 4.39% subjects were of self-contradictory views (32). For example, white of an egg is a colloidal solution and not a homogeneous solution. It is non-filterable and insoluble because suspended particles exist in bottom and pass through holes of filter paper. It is an example of suspension (6). Oil in water is a solution, although, oil not mixed as its lightness hinders to mix, so it is not a solution (1). NaCl in water is homogeneous solution. Energy evolves. Solubility decreases with increase in temperature (4). IM alcohol in water is liquid-liquid solution while mixing water and alcohol, their individual properties are changed, as both are polar states (4). Soda water is liquid in gas heterogeneous solution. Chemical reaction takes place and Co_2 evolves(17).

5. There were only 2.17% girl subjects who replied with 16 frequencies in control group under category-4 *(no scientific term but correct explanation).* Such as air is homogeneous combination of many gases (1). NaCl in water is a true solution in liquid phase (3). Soda water is a solution, bubbles form and Co_2 evolves due to release of pressure. It is physically mixed (4). Air is combination of different gases with different ratio (3). Steel spoon is some type of solution with different proportion(3). Thus, in the above alternative conceptions, the major category is self-centered or human-centered views in boys as well as girls but in qualitative analysis it may be easily concluded that girls were more self-centered and in using the scientific terms incorrectly as compared to boys, they over generalized their statements.

Table: 2: Experimental research data of the concept 'Solutions'

N. Ctl = 50 + 55 = 105

Instances/ Events		White of an Egg		Oil in Water		Air		Steel Spoon	
Categories of Alternative Concept		Ctl	Exp	Ctl	Exp	Ctl	Exp	Ctl	Exp
Incorrect use of scientific term	f %	33 31.42	7 6.73	12 11.42	2 1.92	3 2.85	-	17 16.20	-
Self-contradictory views	f %	14 13.33	6 5.76	6 5.71	1 0.96	2 1.90	-	4 3.80	-
Self-centered or human centered views	f %	5 4.76	6 5.76	4 3.80	-	87 82.85	5 4.80	72 68.57	1 0.96
No scientific term but correct explanation	f %	-	-	1 0.95	-	1 0.95	3 2.88	-	3 2.88
Scientific term but incorrect explanation	f %	38 36.19	7 6.73	61 58.09	7 6.73	7 6.66	2 1.92	9 8.57	2 1.92
Total alternative conceptions	f %	90 85.71	26 25	84 80	10 9.61	100 95.23	10 9.61	102 97.15	6 5.76
Total scientific responses	f %	15 14.29	78 75	21 90.39	94 90.39	5 4.77	94 90.39	3 2.85	98 94.24

N Exp. = 54 + 50 = 104

NaCl in Water		IM Alcohol in Water		Soda Water		Total Frequency & Average %	
Ctl	Exp	Ctl	Exp	Ctl	Exp	Ctl	Exp
41 39.04	-	36 34.29	1 0.96	42 40	-	184 25.03	10 1.78
3 2.85	4 3.84	6 5.71	4 3.84	6 5.71	17 16.34	41 5.57	32 4.39
39 37.14	-	40 38.09	4 3.84	35 33.33	1 0.96	282 38.36	17 2.33
3 2.85	-	7 6.66	-	4 3.80	-	16 2.17	6 0.82
18 17.14	5 4.80	14 13.33	8 7.69	9 8.57	3 2.88	156 21.22	34 3.57
104 99.04	9 8.65	103 98.10	17 16.34	96 91.42	21 20.2	679 92.37	99 12.89
1 0.96	95 91.35	2 1.90	87 83.66	9 8.58	83 78.8	56 7.63	625 86.26

¶ Graph: 1

Bar Graph of the Concept ‘Solutions’

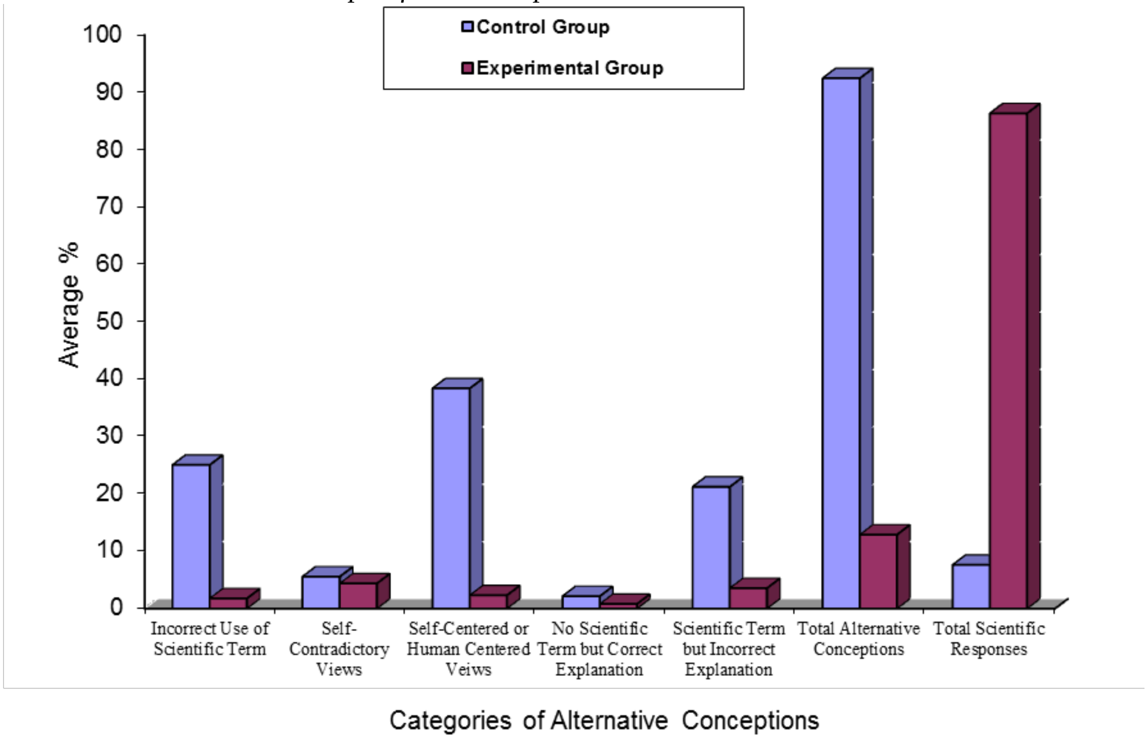

Table: 3: A Comparison of Control and Experimental Groups

Name of Concept	Alternative Conceptions		Scientific Responses		
	Control Group	Experimental Group	Control Group	Experimental Group	X^2
Solutions	679 (92.38%)	99 (13.67%)	56 (7.62%)	625 (86.35%)	907.78***

*** P < .001

Effect size = $\sqrt{.622}$ = .788

Findings

1. The comparison of control and experimental groups indicates that frequencies or percentages of alternative conceptions about concepts of solution in control groups are almost *seven times* more than experimental groups and the frequencies or percentages of scientific responses in experimental groups are almost *11 times* greater than control groups.
2. To find out the *association* between students’ alternative conceptions and scientific responses of the control & experimental groups chi-square test shows that there was *significant association* between alternative conceptions and control groups. Similarly, there was *significant association* between scientific responses & experimental groups with χ^2 (df=1, N=1459)=907.779 p=0.000 for the concept of solution**.** The calculated effect size is .788 which clearly indicates the **large** treatment effectiveness in experimental groups.
3. There were 280 (38.36%) misconceptions in the category of *self-centered or human centered views* of control groups whereas, only 17(2.33%) misconceptions were present in the experimental group
4. The categorical analysis shows that 184 (25.03%) alternative conceptions were identified

in the control group of category *incorrect use of scientific term.* In contrast only 10 (1.78%) of misconceptions were obtained in the experimental groups.

5. Similarly, 156 (21.22%) alternative conceptions were found in control groups in the category of *scientific term but incorrect explanation* as compared to the experimental groups with only 34 (3.57%)
6. However, in the category of *self-contradictory views*, a small number of alternative conceptions i.e. 41 (5.57 %) in the control groups and 32 (4.39%) in the experimental group were found.

7. In the category *no scientific term but correct explanation* the lowest number of alternative conceptions were found with 16(2.17%) in control groups. And just 6(0.82%) misconceptions were found in the experimental groups.

Conclusions

On the basis of findings of the research study it may be concluded that:

1. Majority of the subjects in experimental groups held scientific ideas which shows that constructivist approach was better as compared to control groups in which majority of the subjects held misconceptions where traditional text-book strategy was used.
2. All the results (through frequencies, percentages and $\chi 2$ test) of comparison between alternative conceptions and scientific responses of control and experimental groups measure the conceptual change and definitely shows the worth of teaching methodologies planned under the constructivism for changing misconceptions in experimental groups at secondary school level.
3. Majority of the misconceptions of control groups were found in the category of self-centered or human centered views.
4. Equal numbers of alternative conceptions were found in two categories i.e. 'incorrect use of scientific term' and 'scientific term but incorrect explanation.'
5. However comparatively small number of misconceptions was obtained in two categories such as 'self- contradictory views' and 'no scientific term but correct explanation.'
6. The categorical analysis also helped to find out the five alternative ways of thinking, which guide the teacher to change the student's alternative conceptions through applying the constructivist's methodologies such as questioning, problem solving, inquiry learning, cooperative learning, dialogue and discussion etc. in the perspective of constructivism.

So, all the above mentioned results through frequencies, percentages, chi-square test and comparison between alternative conceptions and scientific responses of control and experimental groups of girls taught through traditional text-book method and constructivist approach respectively measure the conceptual change and clearly determine the effectiveness of constructivist approach in experimental group.

Discussion

Learning in chemistry, students are desired to classify the examples or non-examples of a concept accurately. It requires, learners to come to respond to the relevant features of the concepts and to ignore the irrelevant features in classifying events/instances (Ellis,1978). Thus, this research study was aimed to probe students understanding by using IAI (interview about instances) instrument in which subjects were invited to explain different instances or non-instances about the given concept. This technique was very powerful in investigating student's ideas. This technique provided an opportunity to the respondent to apply his\her knowledge through different instances or non-instances in new situation. In contrast the objective type questioning might not help to find the real knowledge where guessing is prevailed. Even essay type assessment would be inefficient to get full insight about the pupil thinking/feeling. Therefore, probing students' ideas provided base for developing understanding about the natural world but unfortunately traditional textbook method confined the scientific concepts and processes only to the laboratory or classrooms and students could not accomplish the task or classify the examples or non-examples accurately. Whereas in the experimental groups majority of the subject successfully classified the instances and non-instances about the concept solution. It was only due to using the constructivist approach properly. As the previous research studies (such as Chaille, 2007; Fosnot, 2005) suggested that constructivist approach emphasizes the learners' direct experiences and the dialogue of the classroom as instructional tools while deemphasizes lecturing and telling. The present research study also strongly recommends the above mentioned suggestion and further guides the teachers to use questions to elicit the students' level of previous understanding. Nevertheless, the present study indicates the successful application of constructivist approach as an experimental treatment. The chi-square test shows significant association between two groups. The calculated large effect size clearly indicates the effectiveness of constructivist approach towards promoting conceptual change (in the experimental group) about the concept solution in chemistry. Another feature of this approach of teaching was making sense of environment and relevance to everyday lives of the students. As Skamp (2005) edited the views of Wandersee, Mintzes & Novak (1995) and recommended that the alternative conceptions have their origin in a diverse set of personal experiences including direct observation and perception, peer culture and language, as well as teachers' explanations and instructional materials. The present study also confirms that due to above mentioned reasons students become self-centered and preoccupied with their own concerns and frequently ignored some aspects of the concept and assimilate it to fit their current thinking rather than accommodating (in Piagetian term) or changing ideas. It may also be pointed out with respect to this study that students in control groups were mostly confused in using the terms of 'solution'. For example, many students were of the view that "air is not a solution but it is only a form of gas". Similarly some subjects replied that "oil in water is a heterogeneous solution due to ionic bond". The above mentioned both examples demonstrate that subjects have information about the terms of chemistry but either they were using the terms incorrectly or explaining them wrongly. It was due to the misuse of traditional textbook method in which students could not make deeper sense or construct proper meaning of the concept. In contrast, the subjects of experimental groups hold fewer frequencies of alternative conceptions. Thus, all the above mentioned arguments and the findings of the present study clearly support the dominance of constructivist approach over traditional text-book method .Therefore, these results may be generalized to all the secondary school students of public schools of Pakistan for improving their conceptual understanding through applying the constructivist approach.

References

Alsop, S., Bencze, L. & Pedretti, E. (2005). Analyzing exemplary science teaching: theoretical lenses and a spectrum of possibilities for practice. London: Open University Press.

Ausubel, D. (1978). Educational psychology: A cognitive view. New York: Holt, Rinehart and Winston.s.

Bruner, J. S. (1990). *Acts of meaning*. Cambridge: Cambridge University Press.

Chaille, C, (2007). Constructivism across the curriculum in early childhood classrooms. Boston: Allyn & Bacon.

Ellis, H. C. (1978). *Fundamental of human learning, memory and cognition*: Iowa: W. C. Brown company Publishers.

Feden, R. D. & Vogel, R. M. (2003). Methods of teaching: applying cognitive science to promote student learning. Boston: McGraw Hill.

Fosnot, C. (2005). Constructivism: Theory perspectives and practice. New York: Teachers Colleges Press.

Harrison, A.G. & Tragust, D.F. (2002). The particulate nature of matter: Challenges in understanding the submicroscopic world. In J.K. Gilbert, O. de Jong, R. Justi, D. F. Treagust & J.H. Van Driel, Chemical education: Towards research-based practice (pp. 189-212). Dorbdecht: Kluwer Academic Publishers.

Johnston, K. & Driver, R. (1991). *A constructivist teaching scheme in action: Children's learning in science project*, Leeds. Centre for Studies in Science and Mathematics Education. University of Leeds.

Nasir M. & Iqbal, H. M.(2001). Articulating philosophical and theoretical perplexities of constructivism (s) for science teachers: ontological and epistemological perspective. Bulletin of Education and Research, Vol. XXIII, No. 1-2, pp118.

Novak, J. (1993). Proceedings of the third international seminars on misconceptions and educational strategies in science and mathematics (Ithaca, N.Y. Cornell University.)

Osborne, R., Bell, B. F. & Gilbert, J. K. (1983). Science teaching and children's views of the world. European Journal of Science Education, 5, 1-14.

Osborne R. J, & Gilbert , J. K. (1980). *An approach: student's understanding of basic concept in science*. Institute of Educational Technology University of Surrey.

Peter, J. M. & Gega, P. (2002). Science in elementary education. (9 ed.). New Jersey: Merrill Prentice H

Ross, K., Lakin, L. & McKechnie, J. (2010). Teaching secondary science (3rd ed.). New York: Routledge.

Sirhan, G. (2007). Learning difficulties in chemistry: An Overview. Journal of Turkish Science Education. Vol. 4, Issue 2.

Skamp, K. (2005). *Teaching primary science constructively*. London: Routledge Falmer.

Taber, K. S. (1998). An alternative conceptual framework from chemistry education. International Journal of Science Education, 20, 597-608.

Wandersee, J. H. Mintzes, J. & Novak, J. (1995). Research on Alternative Conceptions in Science. In D. Gabel (ed.) *Hand book of research on science teaching and learning*. New York: Macmillan Publishing Company.

Zafar Iqbal, Muhammad (2003) A study of the effect of giving different levels of information to teachers about students misconception. Lahore: Journal of Elementary Education Vol: 13, No.2, IER.