Chapter - 3

Analysis and Interpretation

CHAPTER - 3

ANALYSIS AND INTERPRETATION

3.0 Introduction

ICT Aided Constructivist Learning Approach in Science was Developed and Implemented. The programme developed by employing the various principles of Constructivist Learning Approach, namely, Germination of Novel ideas, Incubation and Exploration through ICT Support, Creation, Construction and Evaluation. Selected Science Lessons were designed, developed and implemented. The Effectiveness of the lessons developed through ICTACLA was studied, both, Quantitatively and Qualitatively.

Objective wise Analysis and Interpretation

3.1 Objective no. 2.1

To study the effectiveness of ICT Aided Constructivist Learning Approach in Science in terms of Reactions of Pre-Service Teachers.

3.1.1 Hypothesis

There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of Reaction Scale for Pre-Service Teachers

3.1.2 Tool

A Reaction scale was constructed by the Researcher to study the Reactions of the Pre-Service Teachers.

3.1.3 Data Collection

Reactions of Experimental group of Pre-Service Teachers towards ICTACLA were collected by the Researcher at the end of the Orientation Programme on ICTACLA.

3.1.4 Data Analysis

To test the formulated null hypothesis -'There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of Reaction Scale for Pre-Service Teachers' against each statement frequencies and χ^2 were calculated as presented through Table 3.

Table 3. Analysis of the Responses of Pre-Service Teachers against various Statements

Sr. No.	Statements	Always	Some times	Never	χ^2	Level of Significance
1	Constructivist principles made me think in constructive ways about Science.	33	2	0	56 90	*
2	I find Science very interesting when teaching-learning is in constructivist ways.	35	0	0	68.04	*
3	I feel happy to search relevant information through Internet.	28	7	0	35.42	*
4	Group work helped me to foster positive attitude towards Science.	30	5	0	42.76	*
5	To find the relevant sites was a very challenging task.	20	14	1	15.28	*
6	I was very active and enthusiastic doing experiments in Science.	34	1	0	62.30	*
7	It helped me to create something new in Science	29	6	0	39.19	*
8	Program helped me to collaborate with experts online.	21	14	0	18.62	*
9	It helped me to learn and integrate web 2.0 Technologies in Science.	21	14	0	18.62	*
10	I learnt respecting each individual idea.	33	2	0	56.90	*
11	It helped me to communicate in real, as well as virtual space	20	15	0	17.59	*
12	It is difficult to apply it in classroom.	1	18	16	13.91	*
13	It is interesting when teaching Science phenomenon.	33	2	0	56.90	*
14	It helped me to become netigen.	27	8	0	31.99	*
15	Relating previous idea to present ideas is good to understand Science.	30	5	0	42.76	*

Sr. No.	Statements	Always	Some times	Never	χ^2	Level of Significance
16	I share my thinking with all my friends in class through e-mail	27	8	0	31.99	*
17	I value each student question and thinking	33	2	0	56.90	*
18	Problem oriented activities made me a critical and creative thinker.	27	8	0	31.99	*
19	I would facilitate the possible opportunities for children to learn themselves.	32	3	0	51.84	*
20	It helped me relate the class ideas to the world outside.	30	5	0	42.76	*
21	I like to assess children throughout the class and through a variety of methods and tools.	31	4	0	47.13	*
22	It is better to give unstructured knowledge and let the children construct it meaningfully.	26	8	1	27.62	*
23	I like reflective activity in Science.	29	6	0	39.19	*
24	Now I feel Science is contextual.	27	7	1	30.88	*
25	I agree that Science is a process than product	31	4	0	47.13	*
26	I can access the Scientific ideas very easily through websites.	30	5	0	42.76	*
27	I can share my ideas on Science with my friends through facebook, e-mail and other social networking sites.	26	9	0	28.91	*
28	I can attend webinars and watch virtual laboratory demonstrations.	20	15	0	17.59	*
29	I can interact with all members of a particular web organization about the Science.	19	15	1	14.42	*
30	I feel motivation is very important for meaningful learning.	33	2	0	56.90	*
31	I feel that the knowledge should be discovered as an integrated whole.	33	2	0	56.90	*
32	I like that the knowledge should be experienced and expressed.	31	4	0	47.13	*
33	I like the various constructivist teaching models because these are very interesting.	34	1	0	62.30	*
34	I find learning and teaching with the help of ICT very interesting.	33	2	0	56.90	*

Sr. No.	Statements	Always	Some times	Never	χ^2	Level of Significance
35	I was curious to watch virtual demonstrations of Science Experiments.	29	6	0	39 19	*
36	It motivates me to prepare animations on Science to make teaching-learning interesting.	28	7	0	35.42	*
37	I feel it is difficult to apply ICTACLA when ICT facilities are not there.	19	11	5	7.91	**
38	I feel it is good for me and for all children because it is multidirectional and social process.	31	4	0	47 13	*
39	Now I can access information web resources though various websites.	30	5	0	42 76	*
40	Now I am info savvy.	30	5	0	42 76	*
41	I can prepare power point presentations on Science and discuss among ourselves.	31	4	0	47.13	*
42	I like freedom of children and support to them for learning meaningfully.	32	3	0	51.84	*

N = 35, Fe = 11.67 df = 2

Table χ^2 Value against 2 df at 0.01 is 9 21, whereas at 0.05 is 5.99

* Significant at 0.01 level

** Significant at 0.05 level

3.1.5 Interpretation

The computed χ^2 value against each one of above mentioned 42 statements has been found to be greater than table χ^2 value at 0.01 level against 2 degrees of freedom except statement no. 37 where it is greater than table value at 0.05 level.

So the null hypothesis 'There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of reaction scale for Pre-Service Teachers' is rejected at 0.01 level against all statements except statement no.37, where it is rejected at 0.05 level.

3.2 Objective no. 2.2

To study the effectiveness of ICT Aided Constructivist Learning Approach in Science in terms of Reactions of School Students.

3.2.1 Hypothesis

There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of Reaction Scale for School Students.

3.2.2 Tool

A Reaction scale was constructed by the Researcher to Study the Reactions of School Students.

3.2.3 Data Collection

Reactions of the students of all the six schools towards ICTACLA were collected by the Researcher at the end of the Practice Teaching by Experimental Group of Pre-Service Teachers.

3.2.4 Data Analysis

To test the formulated null hypothesis 'There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of the Reaction Scale for School Students' against each statement frequencies and χ^2 were calculated, as presented below,

Table 4. Analysis of Responses of School Students against Various Statements

Sr. No.	Statements	Always	Some times	Never	χ^2	Level Of Significance
1	Constructivist principles made me think in constructive ways about Science.	383	52	2	587 63	*
2	I find Science very interesting when teacher teaches in constructivist way.	381	56	0	580.07	*
3	What we study in Science classes is useful to me in daily living.	305	131	1	318.45	*
4	Group work helped me to foster positive attitude towards Science.	280	155	2	265.19	*
5	Use of Videos in the class create interest in Science	322	83	32	329.12	*
6	Doing experiments in Science I was very active and enthusiastic.	335	101	1	402.47	*
7	It helped me to learn Science by use of internet.	266	141	30	191.40	*
8	It helped me to communicate in the real class and virtual space.	223	172	42	119.59	*
9	I feel, by discussing with peer it will create noise in the Science class.	186	156	95	29.53	*
10	Relating previous ideas to present ideas is good to understand the Science.	338	94	5	407.16	*
11	I share my thinking with all my friends in class and through e-mail.	115	240	82	95.37	*
12	Working in groups promotes me to interact with all other members of class.	330	101	6	380.88	*
13	Problem oriented activities made me a critical and creative thinker.	345	88	4	432.41	*
14	It helped me relate the class ideas to world outside the class.	289	142	6	275.05	*
15	It is better to give unstructured knowledge and let me construct it meaningfully.	360	73	4	488.43	*

Sr. No.	Statements	Always	Some times	Never	χ^2	Level Of Significance
16	This way of teaching helps me to get better grade	375	59	3	551.38	*
17	It helped me to access the Science ideas very easily through websites.	122	281	34	215.17	*
18	It helped me to share my ideas about Science with my friends through e-mail.	129	249	59	126.77	*
19	Peer interaction helped me to obtain a deeper understanding of the concepts of Science.	352	82	3	458.83	*
20	I like the constructivist teaching approaches.	373	62	2	543.54	*
21	I feel very interesting to learn with the help of ICT.	338	91	8	404.56	*
22	I am curious to watch virtual demonstrations of Science experiments.	359	70	8	481.83	*
23	It motivated me to do activities in Science	324	111	2	367.28	*
24	I feel it is good for me and for all children because it is multidirectional and social process.	318	106	13	335.50	*
25	I like the freedom and support given by the teacher.	358	75	4	480.59	*
26	Science teacher encouraged me to ask questions.	336	92	9	396.68	*
27	Group discussions in Science class help to enhance my communication skills.	297	126	14	278.88	*

N= 437, Fe=145, df=2

Table χ^2 Value against 2df at 0.01 is 9.21, whereas at 0.05 is 5.99

* Significant at 0.01 level

** Significant at 0.05 level

3.2.5 Interpretation

The computed χ^2 value against each one of above mentioned 27 statements has been found to be greater than table χ^2 value at 0.01 level against 2 degrees of freedom So the null hypothesis 'There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of Reaction Scale for school students' is rejected at 0.01 level against all statements.

Because, the frequency of responses is greater on the higher point of the reaction scale, that is, Always. So, the ICTACLA has been found to be significantly effective as per the reactions of the students.

3.3 Objective no. 2.3

To study the effectiveness of ICT Aided Constructivist Learning Approach in Science in terms of Reactions of Teacher Educators.

3.3.1 Tool

To study this objective a Reaction Scale was constructed by the Researcher to study the Reactions of Teacher Educator.

3.3.2 Data Collection

Reactions of all the Teacher Educators towards ICTACLA were collected by the Researcher at the end of the Orientation Programme for the Pre-Service Teachers.

3.3.3 Data Analysis

The frequencies on each statement against three points were counted and calculated percentage.

Table 5. Frequency and Percentage analysis of Responses of Teacher Educators against various Statements

Sr. No.	Statement	Always	Some times	Never
1	It enables the learners to discover the new information through associating former knowledge.	5 (100%)	0 (0%)	0 (0%)
2	It helps to confirm the learners' opinions on the subject prior to get information about it.	4 (80%)	1 (20%)	0 (0%)
3	It enables learners to use the learning cycle model (discovery, definition and application) which feed the natural curiosity of the learners.	4 (80%)	1 (20%)	0 (0%)
4	It enables the learners to know about current reforms in education through edublogs or other blogs related to Science education.	5 (100%)	0 (0%)	0 (0%)
5	It covers some key terms such as "compare", "define", "classify", "guess", "construct" that guide students' progress in the learning process.	3 (60%)	1 (20%)	1 (20%)
6	It covers problems that enable the students to look from different dimensions.	5 (100%)	0 (0%)	0 (0%)
7	It helps the learners to become info savvy.	5 (100%)	0 (0%)	0 (0%)
8	It supports multiple opinions and encourage students to declare their opinions	4 (80%)	1 (20%)	0 (0%)
9	It provides associations with real life experiences through examples.	5 (100%)	0 (0%)	0 (0%)
10	It provides various ways to make Science interesting among the students by using ICT.	5 (100%)	0 (0%)	0 (0%)
11	It supports learner's autonomy.	5 (100%)	0 (0%)	0 (0%)
12	It supports an interactive relation with other students as well as teacher.	5 (100%)	0 (0%)	0 (0%)
13	It guides the learners for search the sources such as encyclopedias and web pages through open ended and curiosity awakening questions.	3 (60%)	2 (40%)	0 (0%)
14	It covers the answers of questions such as "how to learn" and "what to learn".	5 (100%)	0 (0%)	0 (0%)
15	It directs students to the use of primary sources.	5 (100%)	0 (0%)	0 (0%)
16	It involves learning strategies such as problem based learning, case studies, project based learning and collaborative learning.	5 (100%)	0 (0%)	0 (0%)

Total number of Teacher Educators, N=5

Note: Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies.

3.3.4 Interpretation

Statement wise interpretation of the data as presented in the table 5.

Statement no. 1: It enables the learners to discover the new information through associating former knowledge. 100% of the Teacher Educators responded that ICTACLA always enables the learners to discover the new information through associating previous knowledge.

Statement no. 2: It helps to confirm the learners' opinions on the subject prior to get information about it. 80% of the Teacher Educators responded that ICTACLA always helps to confirm the students' opinions on the subject before going further, while 20% of the Teacher Educator responded that sometimes it helps to confirm the learners' opinions sometimes on the subject prior to get information about it.

Statement no. 3: It enables learners to use the learning cycle model (discovery, definition and application) which feed the natural curiosity of the learners. 80% of the Teacher Educators responded that Always ICTACLA enables to use learning cycle model, which feed the natural curiosity of the learners. Whereas 20% of the Teacher Educators responded that sometimes it enables to use learning cycle model, which feed the natural curiosity of the learners.

Statement no. 4: It enables the learners to know about current reforms in education through edublogs or other blogs related to Science education. 100% of the Teacher Educators responded that ICTACLA Always enables the learners to know about current reforms in education through edublogs in Science education.

Statement no. 5: It covers some key terms such as "compare", "define", "classify", "guess", "construct" that guide students' progress in the learning process. 60% of the Teacher Educators responded that Always within the ICTACLA it covers key terms such as "compare", "define", "classify", "guess", "construct" that guide students' progress in the learning process, 20% of the Teacher educators favoured sometimes, whereas 20% of Teacher Educators favoured Never.

Statement no. 6: It covers problems that enable the students to look from different dimensions. 100% of Teacher Educators favoured positively towards ICTACLA, which includes problems that enable the students to look from different dimensions.

Statement no. 7: It helps the learners to become info savvy. 100% of Teacher Educators revealed that Always ICTACLA helps the learners to become info savvy.

Statement no. 8: It supports multiple opinions and encourages students to declare their opinions. 80% of the Teacher Educators have favoured always ICTACL supports multiple opinions and encourages students to declare their opinions, whereas, 20% of the Teacher Educator favoured sometimes it supports.

Statement no. 9: It provides associations with real life experiences through examples. 100% of the Teacher Educators found Always ICTACLA provides associations with real life experiences through examples.

Statement no.10: It provides various ways to make Science interesting among the students by using ICT. 100% of the Teacher Educators revealed that ICTACLA always provides various ways to make Science interesting among the students by using ICT.

Statement no. 11: It supports learner's autonomy. 100% of the Teacher Educators favoured that ICTACLA always supports learner's autonomy.

Statement no. 12: It supports an interactive relation with other students as well as teacher. 100% of the Teacher Educators responded that ICTACLA always supports an interactive relation with other students as well as teacher.

Statement no. 13: It guides the learners for search the sources such as encyclopedias and web pages through open ended and curiosity awakening questions. 60% of the Teacher Educators responded that ICTACLA always guides the learners for search the sources such as encyclopaedias and web pages through open ended and curiosity awakening questions, whereas, 40% of Teacher Educators favoured some times.

Statement no. 14: It covers the answers of questions such as "how to learn" and "what to learn. 100% of the Teacher Educators favoured always ICTACLA covers the answers of questions such as how to learn and what to learn.

Statement no. 15: It directs students to the use of primary sources. 100% of Teacher Educators felt Always ICTACLA directs students to the use of primary sources.

Statement no. 16: It involves learning strategies such as problem based learning, case studies, project based learning and collaborative learning. 100% of the Teacher Educators revealed that ICTACLA always involves learning strategies such as problem based learning, case studies, project based learning and collaborative learning.

It can be thus said that the majority of the Teacher Educators favoured ICTACLA. Teacher Educators also expressed the desire to use ICTACLA in their classes.

ICTACLA has really made significant change in the Teacher Educator's views regarding teaching-learning. It has helped their Pre-Service Teachers to design lessons by integrating ICTACLA for their practice teaching.

3.3.5 Conclusion

The Pre-Service Teachers and School Students were found to have favourable reactions towards the developed programme based on ICTACLA. A majority of the Teacher Educators were also found to have favourable reactions towards the Programme based on ICTACLA.

3.4 Objective no. 2.4

To study the effectiveness of ICT Aided Constructivist learning Approach in Science in terms of Academic achievement of School Students.

3.4.1 Hypothesis

There will be no significant difference between the post-test mean and pre-test mean scores of single group of the school students.

3.4.2 Tools

The tests constructed by the Pre-Service Teachers to study the Academic Achievement of School Students at both Pre and Post intervention in the practice teaching where in they conducted the classes by employing ICTACLA.

3.4.3 Data Collection

Experimental group of Pre-Service Teachers constructed Achievement tests and administered Pre-Test before conducting the classes and Post-Test after conducting the classes employing ICTACLA. They provided their students Achievement records to the researcher after the Practice Teaching.

3.4.4 Data analysis

The Data collected from Pre-Service Teachers were analysed quantitatively using correlated t-test. First each school students' achievement scores were collected from Pre-Service Teachers. Mean scores of both Pre and Post test score were computed, then Correlation, SD, SEM and correlated t were computed. The data analysis has been presented in Table 6.

Table 6. Pre-Service Teacher wise, School wise Pre-Test mean score (m1), Post-Test mean score (m2), Correlation, Variance, Standard Deviation, Standard Error of Mean, computed t and table t values at 0.01 level.

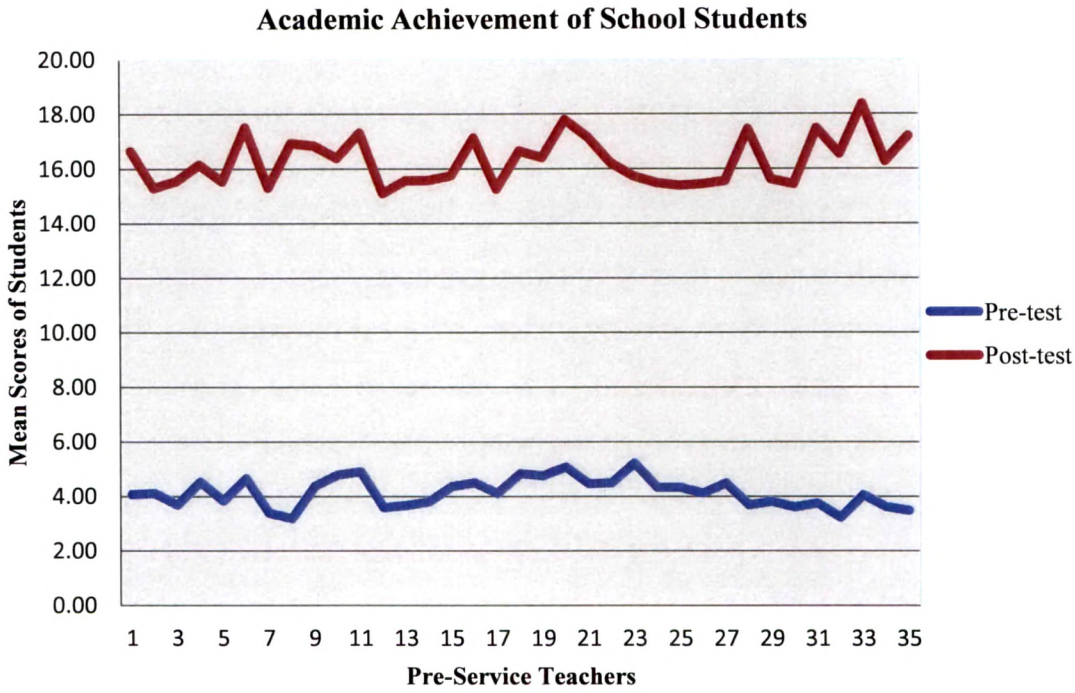
Details of School Students Achievement Test and Analysis															
Pre-Service Teachers	**N**	**m1**	**m2**	**m2 - m1**	**r**	**Var 1**	**Var 2**	**SD 1**	**SD 2**	**SEM 1**	**SEM 2**	**Correlated t**	**t tab**	**df**	**Level of Significance**
1	52	4.08	16.65	12.58	0.75	1.84	7.64	1.36	2.76	0.19	0.38	**46.18**	**2.68**	**51**	*
2	40	4.13	15.30	11.18	0.72	1.34	11.39	1.16	3.38	0.18	0.53	**26.58**	**2.71**	**39**	*
3	27	3.70	15.56	11.85	0 81	2.45	23.64	1.56	4.86	0.30	0.07	**16.56**	**2.78**	**26**	*
4	24	4.54	16.17	11.63	0.26	1.13	6.84	1.06	2.62	0.22	0.53	**22.33**	**2.81**	**23**	*
5	33	3.85	15.55	11 70	0.60	1.45	10.38	1.20	3.22	0.21	0.56	**25.12**	**2.74**	**32**	*
6	29	4.66	17.52	12.86	0.71	1 81	7.33	1.34	2.71	0.25	0.50	**34.72**	**2.76**	**28**	*
7	38	3.39	15.32	11.92	0.38	1.16	7.25	1.08	2.69	0.18	0.44	**29.55**	**2.72**	**37**	*
8	15	3.20	16.93	13.73	0.81	1.46	11.50	1.21	3.39	0.31	0.88	**21.10**	**2.98**	**16**	*
9	26	4.38	16.85	12.46	0.65	1.93	10.30	1.39	3.21	0.27	0.63	**25.08**	**2.79**	**25**	*
10	40	4.80	16.40	11.60	0.54	4.47	6.35	2.11	2.52	0.33	0.40	**32.43**	**2.71**	**39**	*
11	38	4.92	17.32	12.39	0.63	3.59	10.22	1.89	3.20	0.31	0.52	**30.71**	**2.72**	**37**	*

Pre-Service Teachers	N	m1	m2	m2 - m1	r	Var 1	Var 2	SD 1	SD 2	SEM 1	SEM 2	Correlated t	t tab	df	Level of Significance
12	50	3.60	15.10	11 50	0.59	2.65	5.64	1.63	2.38	0.23	0.34	**41.91**	**2.68**	**49**	*
13	47	3.68	15.57	11.89	0.76	2 35	13.68	1.53	3.70	0.22	0.54	**29.88**	**2.69**	**46**	*
14	26	3.81	15.58	11.77	0.46	2 32	10.25	1.52	3.20	0.30	0.63	**21.08**	**2.79**	**25**	*
15	32	4.38	15 75	11.38	0 30	2.24	6.52	1.50	2.55	0.26	0.45	**25.37**	**2.74**	**31**	*
16	24	4.50	17.13	12.63	0.77	3.39	15.16	1.84	3.89	0 38	0.79	**22.64**	**2.81**	**23**	*
17	43	4.12	15.26	11.14	0.77	2.06	9 58	1.43	3.09	0.22	0.47	**33.38**	**2.70**	**42**	*
18	31	4.84	16.65	11.81	0.67	2.34	5.90	1.53	2.43	0.27	0.44	**36.59**	**2.75**	**30**	*
19	42	4.76	16.40	11.64	0.57	1.94	8.69	1.39	2.95	0.22	0.45	**30.95**	**2.70**	**41**	*
20	47	5.09	17.79	12 70	0.74	2.34	12.21	1.53	3.49	0.22	0.51	**33.66**	**2.69**	**46**	*
21	19	4.47	17.16	12.68	0.39	2.04	5.58	1.43	2.36	0.33	0.54	**24.71**	**2.88**	**18**	*
22	40	4.50	16.23	11.73	0.76	2.05	10.08	1.43	3.17	0.23	0.50	**32.43**	**2.71**	**39**	*
23	35	5.23	15.74	10.51	0.48	3.59	7.67	1.90	2.77	0.32	0.47	**24.87**	**2.73**	**34**	*
24	39	4.33	15.49	11.15	0.65	2.65	13.78	1.63	3.71	0.26	0.59	**23.82**	**2.71**	**38**	*
25	36	4.33	15.39	11.06	0.57	2.23	7.39	1.49	2.72	0.25	0.45	**29.59**	**2.72**	**35**	*

Pre-Service Teachers	N	m1	m2	m2 - m1	r	Var 1	Var 2	SD 1	SD 2	SEM 1	SEM 2	Correlated t	t tab	df	Level of Significance
26	42	4.12	15.45	11.33	0 67	1.62	9.77	1.27	3.13	0.20	0.48	**29.90**	**2.70**	**41**	*
27	45	4.49	15.56	11.07	0.53	1.89	6.12	1.38	2.47	0.21	0.37	**35.28**	**2.69**	**44**	*
28	20	3.70	17.45	13.75	0.40	1.59	8.47	1.26	2.91	0.28	0.65	**23.01**	**2.86**	**19**	*
29	40	3.83	15.63	11.80	0.60	1.53	10.04	1.24	3.17	0.20	0.50	**28.55**	**2.71**	**39**	*
30	39	3.62	15.45	11.84	0.76	2.09	10.04	1.44	3.17	0.23	0.51	**32.53**	**2.71**	**38**	*
31	43	3.77	17.49	13.72	0.74	2.23	9.16	1.49	3.03	0.23	0.46	**41.37**	**2.70**	**42**	*
32	45	3.24	16 56	13.31	0.73	1.37	6.25	1.17	2.50	0.17	0.37	**48.75**	**2.69**	**44**	*
33	16	4.06	18.38	14.31	0.74	1.13	9.05	1.06	3.01	0.27	0.75	**24.57**	**2.95**	**15**	*
34	35	3.63	16.29	12.66	0.46	1.83	12.86	1.35	3.59	0.23	0.61	**23.41**	**2.73**	**34**	*
35	30	3.50	17.20	13.70	0.64	1.50	10.37	1.22	3.22	0.22	0.59	**28.70**	**2.76**	**29**	*

* Significant at 0.01 level

Graph 1. Pre-Service Teacher wise School wise Pre-Test and Post-Test mean scores.



3.4.5 Interpretation

35 Pre-Service Teachers have provided their students' scores on pre and post achievement test. The correlated t test was computed between the pre-test scores and post-test scores of the class of each one of the 35 Pre-Service Teachers. The computed t value has been found to be greater than the table t value at 0.01 level of significance against (n-1) degrees of freedom, where n is the number of students in class IX, Pre-Service Teacher wise and School wise.

So the null hypothesis that there will be no significant difference between the Post test mean score and Pre-test mean score is rejected. As the Post-test mean score is greater than the Pre-test mean score. It can also be viewed through Graph 1. So the classes conducted by the Pre-Service Teachers by employing the ICACLA in each of their classes have been found to be effective.

3.4.6 Conclusion

The classes conducted by the Pre-Service Teachers by employing the ICTACLA in each of their classes have been found to be effective.

3.5 Objective no. 2.5

To study the effectiveness of ICT Aided Constructivist learning Approach in Science in terms of Observations by the Researcher, Pre-Service Teachers and Teacher Educators.

3.5.1 Hypotheses

1. There will be no significant difference between the observed frequencies and frequencies expected against equal probability on various elements of Observation Schedule.
2. There will be no significant difference in the observations of practice teaching lessons by the Researchers, Pre-Service Teachers and Teacher Educators.

3.5.2 Tool

An Observation Schedule was constructed by the Researcher to observe the implementation of lessons designed by Pre-Service Teachers through ICTACLA during practice teaching. The observation schedule contains the behaviours to be observed in the practice teaching classes.

3.5.3 Data Collection

Observations of Pre-Service Teachers' classes in their practice teaching schools have been made by the Researcher, Teacher Educators and also by Pre-Service Teachers. During orientating the Pre-Service Teacher on ICTACLA, the Researcher also oriented them on how to observe the lessons of other Pre-Service Teachers who were to conduct classes employing ICTACLA and provided observation schedules to all Pre-Service Teachers. The observation Schedule was also provided to the Teacher Educators. During practice teaching the Researcher visited all the schools and observed the Pre-Service Teachers' classes. Respective Method Masters also observed the classes of their group of Pre-Service Teachers. All the Pre-Service Teachers observed the classes of other Pre-Service Teachers. The Researcher collected the observations at the end of the practice teaching.

3.5.4 Data Analysis

3.5.4.1 Observations made by the Researcher

Table 7. Frequencies and Percentages of elements observed by the Researcher in the classes employing ICTACLA

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
1	Teacher provides situations for the introduction of the lesson.	54 (71.05 %)	19 (25%)	3 (3.94%)	-	-
2	Teacher introduces scientific ideas appropriate to content learning.	21 (27.63%)	47 (61.84%)	8 (10.53%)	-	-
3	Teacher uses the materials according to their interest.	40 (52.63%)	29 (38.16%)	6 (7.89%)	1 (1.32%)	-
4	Teacher interacts with the learner	52 (68.42%)	23 (30.26%)	1 (1.32%)	-	-
5	Teacher carefully listens to students' ideas in order to help them develop their skills.	11 (14.47%)	54 (71.05%)	11 (14.47%)	-	
6	Teacher provides various situations related to subject of the study to get more reflections.	27 (35.53%)	33 (43.42%)	15 (19.73%)	1 (1.32%)	-
7	Teacher suggests new things to look at and try, to encourage further experimentation and thinking.	18 (23.68%)	36 (47.37%)	17 (22.37%)	5 (6.58%)	-
8	Teacher encourages student dialogue related to Science.	32 (42.11%)	31 (40.79%)	10 (13.16%)	3 (3.94%	-
9	Teacher relates classroom discussions to social matters.	47 (61.84%)	24 (31.56%)	5 (6.58%)	-	-
10	Teacher makes connection between content ideas.	49 (64.47%)	23 (30.26%)	3 (3.95%)	1 (1.32%)	-
11	Teacher possesses accurate information about content.	25 (32.89%)	46 (60.53%)	5 (6.58%)	-	-
12	Teacher enquires about student's understandings of the concept before sharing their understandings of those concepts.	8 (10.53%)	34 (44.74%)	31 (40.79%)	3 (3.94%)	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
13	Teacher seeks elaboration of student's initial responses.	22 (28.95%)	47 (61.84%)	7 (9.21%)	-	-
14	Teacher considers students points of view in class they are discussing about the Science concepts.	21 (27.63%)	44 (57.89%)	10 (13.16%)	1 (1.32%)	-
15	Teacher makes cooperative learning groups.	16 (21.05%)	25 (32.89%)	11 (14.47%	19 (25%)	5 (6.58%)
16	Teacher used various websites related to the study for enhancement of knowledge.	4 (5.26%)	10 (13 16%)	36 (47.37%)	22 (28.95%)	4 (5.26%)
17	Teacher demonstrated the experiments on various Science concepts.	25 (32 89%)	37 (48.68%)	12 (15.79%)	1 (1.32%)	1 (1.32%)
18	Teacher demonstrated experiments using virtual laboratories.	1 (1.32%)	1 (1.32%)	24 (31.58%)	25 (32.89%)	25 (32.89%)
19	Teacher uses animations to explain the experiments.	1 (1.32%)	5 (6.58%)	30 (39.47%)	28 (36.84%)	12 (15.79%)
20	Teacher nurtures students' natural curiosity through use of the learning resources from internet.	6 (7.89%)	23 (30 26%)	42 (55.26%)	5 (6.58%)	-
21	Teacher posts the discussions on Science held in the class in the blogs.	-	-	15 (19.74%)	23 (30.26%)	38 (50%)
22	Teacher gives support and freedom to all students.	48 (63.15%)	27 (35.53%)	1 (1.32%)	-	-
23	Teacher interacts with all students in class while discussing concepts of Science.	20 (26.32%)	50 (65.79%)	6 (7.89%)	-	-
24	Teacher makes the learners interact with students through virtual media.	-	4 (5.26%)	12 (15.79%)	37 (48.69%)	23 (30.26%)
25	Teacher provides situations, where in students can construct the knowledge and meaning better in Science.	11 (14.47%)	41 (53.95%)	22 (28.94%)	1 (1.32%)	1 (1 32%)
26	Teacher uses challenging examples to generate the debate in teaching sessions.	23 (30.26%)	48 (63.16%)	5 (6.58%)	-	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
27	Teacher takes feedback from all students about positive points of the teaching.	45 (59.21%)	24 (31.58%)	6 (7.89%)	1 (1.32%)	-
28	Teacher takes feedback from all students about negative points of the teaching.	4 (5.26%)	45 (59.21%)	24 (31.58%)	3 (3.95%)	-
29	Teacher provides learning resources and asks the students to go through for further discussions.	16 (21.05%)	35 (46.05%)	22 (28.95%)	2 (2.63%)	1 (1.32%)
30	Teacher asks the learners to prepare power point presentations on the topic discussed.	1 (1.32%)	9 (11.84%)	24 (31.58%)	25 (32.89%)	17 (22.37%)
31	Teacher gave individual assignments.	57 (75%)	10 (13.16%)	5 (6.58%)	2 (2.63%)	2 (2.63%)
32	Teacher gave group project works.	13 (17.11%)	21 (27.63%)	17 (22.37%)	18 (23.68%)	7 (9.21%)
33	Teacher made all the learners to think critically about any issue of Science.	26 (34.21%)	42 (55.26%)	5 (6.58%)	3 (3.95%)	-
34	Teacher and students together made the class lively and active.	62 (81.58%)	14 (18.42%)	-	-	-
35	Teacher assessed the learners throughout the class.	29 (38.16%)	32 (42.10%)	13 (17.11%)	2 (2.63%)	-
36	Learners demonstrated a willingness to modify ideas.	22 (28.95%)	40 (52.63%)	12 (15.79%)	1 (1.32%)	1 (1.32%)
37	They respect individuals by considering their points of views.	50 (65.79%)	20 (26.31%)	4 (5.26%)	1 (1.32%)	1 (1.32%)
38	Learners are asked to design a fair test as a way to try out their ideas, not expecting to be told what to do.	2 (2.63%)	13 (17.11%)	51 (67.11%)	9 (11 84%)	1 (1.32%)
39	Learners carry out investigations with careful observation.	33 (43.42%)	33 (43.42%)	10 (13.16%)	-	-
40	Learners could infer the results of the experiments done.	28 (36.84%)	37 (48.68%)	10 (13.16%)	1 (1.32%)	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
41	Learners asked to express ideas in a variety of ways like journals, reporting drawing, graphing, charting, etc.	5 (6.58%)	11 (14.47%)	47 (61.84%)	11 (14.47%)	2 (2.63%)
42	Learners interact with their peers about classroom learning.	40 (52.63%)	32 (42.10%)	3 (3.95%)	1 (1.32%)	-
43	Learners exchange ideas among friends through e-mail, social networking sites and other web 2 technologies.	-	5 (6.58%)	10 (13.16%)	32 (42.10%)	29 (38.16%)
44	Learners offer explanations from knowledge gained as a result of ongoing investigation.	26 (34.21%)	40 (52.63%)	9 (11.84%)	-	1 (1.32%)
45	Learners are using multiple strategies to address the problem.	38 (50%)	30 (39.47%)	7 (9.21%)	1 (1.32%)	-
46	Learners use internet to get clarifications and satisfy their own questions.	5 (6.58%)	25 (32.89%)	38 (50%)	6 (7.89%)	2 (2.63%)
47	Learners try to connect previously held ideas.	57 (75%)	16 (21.05%)	3 (3.95%)	-	-
48	Learners look forward to doing Science experiments.	17 (22.37%)	47 (61.84%)	11 (14.47%)	1 (1.32%)	-
49	Learners demonstrate desire to learn more about Internet and its usage.	24 (31.58%)	37 (48 68%)	14 (18.42%)	1 (1.32%)	-
50	Learners exhibit curiosity in observing the activities.	26 (34.21%)	41 (53.94%)	8 (10.53%)	1 (1.32%)	-
Average Frequency and Percentage response against 50 statements of the observation schedule		**24.16**	**27.86**	**14.02**	**5.96**	**3.86**
		31.8%	**36. 66%**	**18.44%**	**7.84%**	**5.07%**

Total 76 classes were observed.

Note: Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies

3.5.4.1.1 Interpretation

It is evident through average frequency and percentage scores obtained against five points of observation schedule-very often, often, sometime, seldom and never (Table 7) that the maximum percentage scores obtained are on the higher side of the scale, that is very often and often (68.46%). It shows that a large majority of the Pre-Service Teachers have often or very often represented ICT Aided Constructivist behaviour in the practice teaching classes.

Table 8. Average Observed frequency response against 50 statements of the Observation Schedule. χ^2 and its Level of Significance

Observed frequency	Very Often	Often	Some times	Seldom	Never	Total	Level of Significance
Fo	24.16 (31.8%)	27.86 (36.66%)	14.02 (18.44%)	5.96 (7.84%)	3.86 (5.07%)	76	
Fe	15.2						
$\chi^2 =$ $(fo-fe)^2/ fe$	5.28	10.54	0.09	5.62	7.73		
$\chi^2 =$ $\sum (fo-fe)^2/ fe$	29.27						*

* Significance at 0.01 level

Note: Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies.

It is evident from the Table 8 that the computed value of χ^2 of 29.27 is greater than the table value of χ^2 of 13.28 against 4 degrees of freedom at 0.01 level. So the null hypothesis that there will be no significant difference between the observed frequencies and frequencies expected against equal probability stands rejected.

A large majority of the Pre-Service Teachers were found to manifest the desirable elements often or very often.

3.5.4.1.2 Conclusion

Pre-Service Teachers manifested ICT Aided Constructivist behaviours in the practice teaching classes. All the Pre-Service Teachers applied ICTACLA in their Science classes during practice teaching as observed by the Researcher.

3.5.4.2 Observations made by Pre-Service Teachers

Table 9. Frequencies and Percentages of elements observed by the Pre-Service Teachers in the classes employing ICTACLA

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
1	Teacher provides situations for the introduction of the lesson.	21 (31.34%)	43 (64.18%)	2 (2.99%)	1 (1.49%)	-
2	Teacher introduces scientific ideas appropriate to content learning.	21 (31.34%)	27 (40.30%)	17 (25.37%)	2 2.99%	-
3	Teacher uses the materials according to their interest.	23 (34.32%)	30 (44.78%)	12 (17.91%)	2 (2.99%)	-
4	Teacher interacts with the learner.	19 (28.36%)	41 (61.19%)	6 (8.96%)	1 (1.49%)	-
5	Teacher carefully listens to students' ideas in order to help them to develop their skills.	11 (16.42%)	38 (56.72%)	14 (20.89%)	4 (5.97%)	-
6	Teacher provides various situations related to subject of the study to get more reflections.	14 (20.90%)	26 (38.81%)	25 (37.31%)	2 (2.98%)	-
7	Teacher suggests new things to look at and try, to encourage further experimentation and thinking.	16 (23.88%)	21 (31.34%)	20 (29.85%)	10 (14.93%)	-
8	Teacher encourages student dialogue with related to Science.	10 (14.95%)	27 (40.30%)	28 (41.79%)	2 (2.98%)	-
9	Teacher relates classroom discussions to social matters.	11 (16.42%)	30 (44.78%)	17 (25.37%)	9 (13.43%)	-
10	Teacher makes connection between content ideas.	17 (25.37%)	21 (31.34%)	26 (38.81%)	2 (2.99%)	1 (1.49%)
11	Teacher possesses accurate information about content.	15 (22.39%)	37 (55.22%)	14 (20.90%)	1 (1.49%)	-
12	Teacher enquires about student's understandings of the concept before sharing their understandings of those concepts.	12 (17.91%)	33 (49.25%)	21 (31.34%)	1 (1.49%)	-
13	Teacher seeks elaboration of student's initial responses.	16 (23.88%)	33 (49.25%)	15 (22.39%)	2 (2.99%)	1 (1.49%)

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
14	Teacher considers students points of view in class they are discussing about the Science concepts.	19 (28.36%)	30 (44.78%)	14 (20.89%)	3 (4.48%)	1 (1.49%)
15	Teacher makes cooperative learning groups.	12 (17.91%)	22 (32.63%)	30 (44.78%)	3 (4.48%)	-
16	Teacher used various websites related to the study for enhancement of knowledge	5 (7.46%)	14 (20.90%)	25 (37.31%)	18 (26.86%)	5 (7.46%)
17	Teacher demonstrated the experiments on various Science concepts.	19 (16.42%)	15 (22.39%)	25 (49.25%)	7 (10.45%)	1 (1.49%)
18	Teacher demonstrated experiments using virtual laboratories.	7 (10.45%)	6 (8.96%)	33 (49.25%)	15 (22.39%)	6 (8.96%)
19	Teacher uses animations to explain the experiments.	5 (7.46%)	6 (8.96%)	18 (26.86%)	23 (34.39%)	15 (22.39%)
20	Teacher nurtures students' natural curiosity through use of the learning resources from internet.	3 (4.48%)	12 (17.91%)	22 (32.86%)	27 (40.30%)	3 (4.48%)
21	Teacher posts the discussions on Science held in the class in the blogs.	1 (1.49%)	8 (11.94%)	12 (17.91%)	33 (49.25%)	13 (19.40%)
22	Teacher gives support and freedom to all students.	16 (23.88%)	29 (43.28%)	19 (28.36%)	3 (4.48%)	-
23	Teacher interacts with all students in class while discussing concepts of Science.	12 (17.91%)	28 (41.79%)	23 (34.33%)	3 (4.48%)	1 (1.49%)
24	Teacher makes the learners to interact with students through virtual media.	5 (7.46%)	8 (11.94%)	20 (29.85%)	26 (38.81%)	8 (11.94%)
25	Teacher provides situations, where in students can construct the knowledge and meaning better in Science.	5 (7.46%)	21 (31.34%)	35 (52.24%)	5 (7.46%)	1 (1.49%)
26	In teaching sessions teacher uses challenging examples to generate the debate.	8 (11.94%)	20 (29.85%)	23 (34.33%)	15 (22.39%)	1 (1.49%)
27	Teacher takes feedback from all students about positive points of the teaching.	9 (13.43%)	18 (26.87%)	23 (34.33%)	14 (20.90%)	3 (4.47%)

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
28	Teacher takes feedback from all students about negative points of the teaching.	23 (34.33%)	13 (19.40%)	11 (16.42%)	16 (23.88%)	4 (5.97%)
29	Teacher provides learning resources and asks the students to go through it for further discussions.	12 (17.91%)	27 (40.30%)	12 (17.91%)	13 (19.40%)	3 (4.48%)
30	Teacher asks the learners to prepare power point presentations on the topic discussed.	2 (2.99%)	12 (17.91%)	16 (23.88%)	25 (37.31%)	12 (17.91%)
31	Teacher gave individual assignments.	2 (2.99%)	27 (40.30%)	16 (23.88%)	14 (20.89%)	8 (11.94%)
32	Teacher gave group project works.	5 (7.46%)	23 (34.33%)	25 (37.31%)	13 (19.40%)	1 (1.49%)
33	Teacher made all the learners to think critically about any issue of Science.	6 (8.96%)	27 (40.30%)	30 (44.77%)	4 (5.97%)	-
34	Teacher and students together made the class lively and active.	18 (26.87%)	31 (46.27%)	16 (23.88%)	1 (1.49%)	1 (1.49%)
35	Teacher assessed the learners throughout the class.	12 (17.91%)	35 (52.24%)	15 (22.39%)	5 (7.46%)	-
36	Learners demonstrate a willingness to modify ideas.	20 (29.85%)	18 (26.87%)	20 (29.85%)	9 (13.43%)	-
37	They respect individuals by considering their points of views.	18 (26.87%)	22 (32.84%)	23 (34.39%)	4 (5.97%)	-
38	Learners are asked to design a fair test as a way to try out their ideas, not expecting to be told what to do.	12 (17.91%)	19 (28.36%)	23 (34.33%)	12 (17.91%)	1 (1.49%)
39	Learners carry out investigations with careful observation	6 (8.96%)	25 (37.31%)	21 (31.34%)	14 (20.90%)	1 (1.49%)
40	Learners could infer the results of the experiments done.	14 (20.90%)	22 (32.84%)	25 (37 31%)	5 (7 46%)	1 (1.49%)
41	Learners asked to express ideas in a variety of ways like journals, reporting drawing, graphing, charting, etc.	8 (11.94%)	28 (41.79%)	11 (16.41%)	16 (23.88%)	4 (5.97%)
42	Learners interact with their peers about classroom learning.	15 (22.39%)	20 (29.85%)	25 (37.31%)	7 (10.45%)	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
43	Learners exchange ideas among friends through e-mail, social networking sites and other web 2 technologies.	3 (4 48%)	11 (16.42%)	16 (23.88%)	26 (38.81%)	11 (16.41%)
44	Learners offer explanations from knowledge gained as a result of ongoing investigation.	9 (13.43%)	18 (26.87%)	25 (37.31%)	10 (14.93%)	5 (7.46%)
45	Learners are using multiple strategies to address the problem.	20 (29.85%)	19 (28.36%)	16 (23.88%)	9 (13.43%)	3 (4.48%)
46	Learners use internet to get clarifications and satisfy their own questions	5 (7.46%)	10 (14.93%)	33 (49.25%)	14 (20.90%)	5 (7.46%)
47	Learners try to connect previously held ideas.	15 (22.39%)	25 (37.31%)	23 (34.33%)	4 (5.97%)	-
48	Learners look forward to doing Science experiments.	18 (26.87%)	32 (47.76%)	12 (17.91%)	4 (5.97%)	1 (1.49%)
49	Learners demonstrate a desire to learn more about internet and its usage to them	18 (26.87%)	20 (29.85%)	17 (25.37%)	9 (13.43%)	3 (4.48%)
50	Learners exhibit curiosity in observing the activities	13 (19.40%)	32 (47.76%)	15 (22.39%)	6 (8.96%)	1 (1.49%)
Average Frequency and Percentage response against 50 statements of the observation schedule		**12.12**	**23.2**	**19.68**	**9.48**	**2.5**
		18.09%	**34.63%**	**29.40%**	**14.15%**	**3.73%**

Total 67 classes were observed.

Note: Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies.

3.5.4.2.1 Interpretation

It is evident through average frequency and percentage scores obtained against five points of observation schedule-very often, often, sometime, seldom and never (Table 9) that the maximum percentage scores (52.6%) obtained are on the higher side of the scale, that is often, and very often. It shows that a majority of the Pre-Service Teachers have often represented ICT Aided Constructivist behaviour in the practice teaching classes.

Table 10. Average Observed frequency response against 50 statements of the Observation Schedule. χ^2 and its Level of Significance

Observed frequency	Very Often	Often	Some times	Seldom	Never	Total	Level of Significance
Fo	12.12 (18 09%)	23.2 (34.63%)	19.68 (29.40%)	9.48 (14.15%)	2.5 (3.73%)	67	
Fe	13.40						
χ^2= $(fo-fe)^2/fe$	0.12	7.17	2.94	1.15	8.07		
χ^2= $\sum (fo-fe)^2/fe$	19.45						*

* Significant at 0.01 level

Note: Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies.

It is evident from the Table 10 that the computed value of χ^2 of 19.45 is greater than the table value of χ^2 of 13.28 against 4 degrees of freedom at 0.01 level. So the null hypothesis that there will be no significant difference between the observed frequencies and frequencies expected against equal probability stands rejected.

A large majority of the Pre-Service Teachers were found to manifest the desirable elements often or very often.

3.5.4.2.2 Conclusion

Pre-Service Teachers manifested ICT Aided Constructivist behaviours in the practice teaching classes. All Pre-Service Teachers applied ICTACLA in their Science classes during practice teaching as observed by Pre-Service Teachers.

3.5.4.3 Observations made by Teacher Educators

Table 11. Frequencies and Percentages of elements observed by the Teacher Educators in the classes employing ICTACLA

Sr. No.	Elements observed	Very often	often	Some times	Seldom	Never
1	Teacher provides situations for the introduction of the lesson.	20 (57.14%)	14 (40%)	1 (2.86%)	-	-
2	Teacher introduces scientific ideas appropriate to content learning.	14 (40%)	19 (54.29%)	2 (5.71%)	-	-
3	Teacher uses the materials according to their interest.	7 (20%)	25 (71.43%)	3 (8.57%)	-	-
4	Teacher interacts with the learner.	14 (40%)	14 (40%)	7 (20%)	-	-
5	Teacher carefully listens to students' ideas in order to help them to develop their skills.	14 (40%)	12 (34.29%)	9 (25.71%)	-	-
6	Teacher provides various situations related to subject of the study to get more reflections	11 (31 43%)	15 (42.86%)	9 (25.71%)	-	-
7	Teacher suggests new things to look at and try, to encourage further experimentation and thinking.	12 (34 29%)	14 (40%)	9 (25.71%)	-	-
8	Teacher encourages student dialogue with related to Science.	14 (40%)	17 (48.57%)	4 (11.43%)	-	-
9	Teacher relates classroom discussions to social matters.	10 (28.57%)	21 (60%)	4 (11.43%)	-	-
10	Teacher makes connection between content ideas	21 (60%)	12 (34.29%)	2 (5.71%)	-	-
11	Teacher possesses accurate information about content.	18 (51.43%)	15 (42.86%)	2 (5.71%)	-	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
12	Teacher enquires about student's understandings of the concept before sharing their understandings of those concepts.	6 (17.14%)	14 (40%)	14 (40%)	1 (2.86%)	-
13	Teacher seeks elaboration of student's initial responses.	15 (42.86%)	17 (48.57%)	3 (8.57%)	-	-
14	Teacher considers students points of view in class they are discussing about the Science concepts.	4 (11.43%)	23 (65.71%)	8 (22.86%)	-	-
15	Teacher makes cooperative learning groups.	6 (17.14%)	18 (51.43%)	11 (31.43%)	-	-
16	Teacher used various websites related to the study for enhancement of knowledge.	-	6 (17.14%)	16 (45.71%)	13 (37.14%)	-
17	Teacher demonstrated the experiments on various Science concepts.	10 (28.57%)	18 (51.43%)	7 (20%)	-	-
18	Teacher demonstrated experiments using virtual laboratories.	1 (2.86%)	5 (14.29%)	18 (51.43%)	11 (31.43%)	-
19	Teacher uses animations to explain the experiments.	-	4 (11.43%)	17 (48.57%)	14 (40%)	-
20	Teacher nurtures students' natural curiosity through use of the learning resources from internet.	1 (2.86%)	9 (25.71%)	22 (62.86%)	3 (8.57%)	-
21	Teacher posts the discussions on Science held in the class in the blogs.	-	2 (5.71%)	3 (8.57%)	11 (31.43%)	19 (54.29%)
22	Teacher gives support and freedom to all students.	18 (51.43%)	16 (45.71%)	1 (2.86%)	-	-
23	Teacher interacts with all students in class while discussing concepts of Science.	13 (37.14%)	20 (57.14%)	2 (5.71%)	-	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
24	Teacher makes the learners to interact with students through virtual media.	3 (8.57%)	11 (31.43%)	12 (34.29%)	9 (25.71%)	-
25	Teacher provides situations, where in students can construct the knowledge and meaning better in Science.	8 (22.86%)	13 (37.14%)	13 (37.14%)	1 (2.86%)	-
26	In teaching sessions teacher uses challenging examples to generate the debate.	10 (28.57%)	22 (62.86%)	3 (8.57%)	-	-
27	Teacher takes feedback from all students about positive points of the teaching.	5 (14.29%)	27 (77.14%)	2 (5.71%)	1 (2.86%)	-
28	Teacher takes feedback from all students about negative points of the teaching.	7 (20%)	12 (34.29%)	15 (42.86%)	1 (2.86%)	-
29	Teacher provides learning resources and asks the students to go through it for further discussions.	6 (17.14%)	13 (37.14%)	15 (42.86%)	1 (2.86%)	-
30	Teacher asks the learners to prepare power point presentations on the topic discussed.	4 (11.43%)	9 (25.71%)	9 (25.71%)	13 (37.14%)	-
31	Teacher gave individual assignments	16 (45.71%)	19 (54.29%)	-	-	-
32	Teacher gave group project works.	7 (20%)	14 (40%)	13 (37.14%)	1 (2.86%)	-
33	Teacher made all the learners to think critically about any issue of Science.	5 (14.29%)	20 (57.14%)	10 (28.57%)	-	-
34	Teacher and students together made the class lively and active.	14 (40%)	18 (51.43%)	3 (8.57%)	-	-
35	Teacher assessed the learners throughout the class.	10 (28.57%)	20 (57.14%)	4 (11.43%)	1 (2.86%)	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
36	Learners demonstrate a willingness to modify ideas.	9 (25.71%)	19 (54.29%)	7 (20%)	-	-
37	They respect individuals by considering their points of views.	12 (34.29%)	18 (51.43%)	5 (14.29%)	-	-
38	Learners are asked to design a fair test as a way to try out their ideas, not expecting to be told what to do.	6 (17.14%)	11 (31.43%)	16 (45.71%)	2 (5.71%)	-
39	Learners carry out investigations with careful observation	8 (22.86%)	20 (57.14%)	5 (14.29%)	2 (5.71%)	-
40	Learners could infer the results of the experiments done.	9 (25.71%)	18 (51.43%)	5 (14.29%)	3 (8.57%)	-
41	Learners asked to express ideas in a variety of ways like journals, reporting drawing, graphing, charting, etc.	2 (5.71%)	13 (37.14%)	11 (31.43%)	9 (25.71%)	-
42	Learners interact with their peers about classroom learning.	7 (20%)	25 (71.43%)	3 (8.57%)	-	-
43	Learners exchange ideas among friends through e-mail, social networking sites and other web 2 technologies.	-	4 (11.43%)	7 (20%)	22 (62.86%)	2 (5.71%)
44	Learners offer explanations from knowledge gained as a result of ongoing investigation.	3 (8.57%)	21 (60%)	8 (22.86%)	3 (8.57%)	-
45	Learners are using multiple strategies to address the problem.	3 (8 57%)	26 (74.29%)	5 (14.28%)	1 (2.86%)	-
46	Learners use internet to get clarifications and satisfy their own questions.	3 (8.57%)	14 (40%)	17 (48.57%)	1 (2.86%)	-

Sr. No.	Elements observed	Very often	Often	Some times	Seldom	Never
47	Learners try to connect previously held ideas.	9 (25.71%)	20 (57.14%)	6 (17.14%)	-	-
48	Learners look forward to doing Science experiments.	14 (40%)	18 (51.43%)	1 (2.86%)	2 (5.71%)	-
49	Learners demonstrate a desire to learn more about internet and its usage to them	12 (34.29%)	20 (57.14%)	1 (2.86%)	2 (5.71%)	-
50	Learners exhibit curiosity in observing the activities.	15 (42.86%)	18 (51.43%)	2 (5.71%)	-	-
Average Frequency and Percentage response against 50 statements of the observation schedule		**8.72**	**15.86**	**7.44**	**2.56**	**0.42**
		24.91%	**45.31%**	**21.26%**	**7.31%**	**1.2%**

Total 35 classes were observed.

Note. Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies.

3.5.4.3.1 Interpretation

It is evident through the Table 10 that the Average frequency and percentage scores obtained against five points of observation schedule-very often, often, sometime, seldom and never, that the maximum percentage scores (70.22%) obtained are on the higher side of the scale that is often and very often. It shows that a large majority of the Pre-Service Teachers have often or very often manifested ICT Aided Constructivist behaviour in the practice teaching classes.

Table 12. Average Observed frequency response against 50 statements of the Observation Schedule.

Observed frequency	Very Often	Often	Some times	Seldom	Never	Total	Level of Significance
Fo	8.72 (24.91%)	15.86 (45.31%)	7.44 (21.26%)	2.56 (7.31 %)	0 42 (1.2%)	35	
Fe	7						
$\chi^2 =$ $(fo-fe)^2/ fe$	0.42	11.21	0.03	2.22	5.28		
$\chi^2 =$ $\sum (fo-fe)^2/ fe$	19.16						*

* Significant at 0.01 level of significance

Note: Number outside the parenthesis indicates the frequencies and the number inside the parenthesis indicates the percentage of the frequencies.

It is evident from Table 12 that the computed value of χ^2 of 19.16 is greater than the table value of χ^2 of 13.28 against 4 degrees of freedom at 0.01 level. So the null hypothesis that there will be no significant difference between the observed frequencies and frequencies expected against equal probability stands rejected.

A large majority of the Pre-Service Teachers were found to manifest the desirable elements often or very often.

3.5.4.3.2 Conclusion

Pre-Service Teachers manifested ICT Aided Constructivist behaviours in the practice teaching classes. All Pre-Service Teachers applied ICTACLA in their Science classes during practice teaching as observed by Teacher Educators.

3.5.5 Data Triangulation of all the Observations made by the Researcher, Pre-Service Teachers and Teacher Educators.

Table 13. Average Observation Frequencies of Observations made by the Researcher, Pre-Service Teachers and Teacher Educators

Observers		Very often	Often	Sometimes	Seldom	Never	N
Researcher	O	24.16	27.86	14.02	5.96	3.86	76
	E	19.21	28.57	17.57	7.69	2.89	
Pre-Service Teachers	O	12.12	23.2	19.68	9 48	2.5	67
	E	16.94	25.19	15.49	6.78	2.55	
Teacher Educators	O	8.72	15.86	7.44	2.56	0.42	35
	E	8.85	13.16	8.09	3.54	1.33	
Total		45	66.92	41.14	18	6.78	178

Calculated $\chi^2 = 7.09$

Table value = **20.09** at 0 01 level against 8 degrees of freedom
=**15.51** at 0.05 level against 8 degrees of freedom

3.5.5.1 Interpretation

The calculated Value of χ^2 of 7.09 is lesser than the table value of χ^2 of 20.09 and 15.51 at 0.01 level and 0.05 level respectively against 8 degrees of freedom. So the null hypothesis that there will be no significant difference in the observations of practice teaching lessons by the Researchers, Pre-Service Teachers and Teacher Educators is not rejected at both the levels. So, there has been found to be no significant difference in the observations of Researchers, Pre-Service Teachers and Teacher Educators. Hence the observations made by all the three are in tune. Thus it establishes the reliability of the observations.

3.6 Objective no. 2.6

To study the effectiveness of ICT Aided Constructivist learning Approach in Science in terms of Reflections of Pre-Service Teachers.

3.6.1 Tools

Semi-Structured Interview Schedule and Focused Group Discussion (FGD)

Semi-Structured Interview Schedule was developed by the Researcher to interview the Pre-Service Teachers on ICTACLA. And The Researchers conducted Focused Group Discussion with all the Pre-Service Teachers on their Reflections on ICTACLA.

3.6.2 Data Collection

At the end of the orientation the Semi-Structured Interview was conducted with all the Pre-Service Teachers. Also, the Researcher Conducted Focussed Group Discussion with all the Pre-Service Teachers. They were asked to discuss their reflections regarding ICTACLA. These were video recorded.

3.6.3 Data Analysis

The data collected were analysed qualitatively. The completed Semi-Structured Interview Schedule was collected and content analysed. Also the video records of the Focus Group Discussion were content analysed.

3.6.3.1 Content Analysis of the Written Semi-structured Interviews

The Pre-Service Teachers of the University College of Education, Dharwad, Karnataka, have reflected on the orientation programme on ICT Aided Constructivist Learning Approach (ICTACLA) in Science after undergoing the orientation programme. In the written interview schedule there were 10 aspects expected to be explored by the Pre-Service Teachers. These are as follows:

1. Opinion of the Pre-Service Teachers regarding ICT Aided Constructivist Learning Approach
2. Utility of ICTACLA in Science
3. Feeling during the preparation of the lessons employing of ICTACLA for Practice Teaching.
4. Experiences during practice teaching using ICTACLA in the schools
5. Role of Pre-Service Teachers in the ICTACLA in future teaching Profession

6. Organization of Instructional Environment employing Constructivist Learning Approach
7. Problems faced during lesson preparation employing ICTACLA
8. Problems faced during practice teaching employing ICTACLA
9. Opinion regarding the effectiveness of ICTACLA
10. Suggestions on the orientation programme employing ICTACLA in Science.

On these aspects all the Pre-Service Teachers have reflected in their own ways as follows:

1. Opinion of the Pre-Service Teachers Regarding ICTACLA

- ICTACLA really helps in Science. All the students come to class with constructivist ideas.
- It helps the students to think of a concept in as many ways as possible.
- Small ideas help in building broader concepts; the prior knowledge helps to build further knowledge and facilitates meaningful learning.
- This approach brings teachers and students closer and makes the environment learning friendly.
- Teachers and students feel free to learn and teach through various strategies at their own pace.
- Students are able to understand the concepts clearly through ICTACLA.
- It tries to bind the students according to their interests in the subjects.
- It helps to make abstract ideas of Science into concrete.
- Students validate their own learning by making sure of certain concepts through experiential learning.
- It needs a lot of practice.
- It involves students into the subject. The students are active learners.
- This approach motivates the teachers for teaching and students for learning.
- It creates Interest and sustains curiosity on the subject matter.
- It helps the teacher to understand the Psychology of learners and helps to prepare various Instructional designs suitable to them.
- It makes the teachers as well as students creative and critical thinkers.
- It increases the self-confidence in teachers as they practice more and more before the class.

- Here students create their own ideas of a concept. So, they are the owners of their knowledge.
- Lot of freedom makes the learners think in different ways to create a rich environment and increases the divergent thinking.
- It helps the learners to hypothesize and test the hypothesis.
- Every student is valued for their profile of learning.
- In this approach, the teacher gathers more information. So, the teacher can teach, more than what the syllabus demands.
- Teacher is a guide, friend and philosopher.
- Knowledge gained through this approach is retained for longer time.
- It is very useful for both teachers and learners, because, it is based on "Learning by doing".
- It makes all go by trial and error and finally learn meaningfully.
- It is productive learning. It makes the teachers and learners adjust with modern changes.
- Teaching of difficult subjects can be done effectively.

2. Utility of ICTACLA in Science

- It is useful approach because the striving students can access and produce delicious food in the form of ICTACLA. Ideas, views and imagination of the students are brought in front of their own eyes in the form of Power Point Presentations, Specimen, virtual classes, field trips which can make students understand subjects like Science very well.
- It actively engages the students in learning and doing experiments. Thus the abstract concepts of Science are easily intelligible, like, structure of atom, chemical bonds, cell division process, the Configuration of Electrons, Protons and Neutrons and Solar System and many more can be can be made much clear through this approach.
- Most of the concepts of Science cannot be taught in the classroom as a formal lesson, but, with the help of ICT we can create concept compatible environment, making teaching-learning effective.
- Science is such a subject which needs practice and experiments. So, this approach helps Science a great deal.
- Learners can have conceptual clarity through videos and animations.
- It makes the students self-reliant and resourceful.

- It creates interest and sustains curiosity and motivates to learn Science more and more.
- Science is a subject of experiments. It cannot be made clear through only drawing picture on blackboard. Through this approach experiments are conducted to realize meaningful learning.
- It always moves from known to unknown. So, linking every new bit with previous learning broadens the previous knowledge base. Learners enjoy the success of each step.
- This approach gives a concrete picture to our imagination of the concepts of Science.
- Science can be learnt better through experience and experimentation.
- It helps to communicate Science universally.
- While introducing structure of an atom to class, presenting colorful picture from Internet really facilitates thinking and expression.
- The evolution of life and theories on evolution could be well presented generating interest.
- We can attend the virtual laboratories, when such experiments are not possible in the laboratories because of non-availability of resources.
- Through this approach by hyper linking one gets more and more information on Science discoveries, inventions and biography of the Scientists.
- It increases the students' experimental skills and ICT skills.
- ICTACLA increases the interaction of teachers, learners and subject matter and inter-communication.
- It helps in developing the practical knowledge; it makes the learners into scientists or discoverers and has great impact on learning.
- Through lecture method Science can only be instructed, but not constructed. One size does not fit all. ICTACLA is a blend of various approaches, so helps learners of various profiles.
- By aid of ICT in constructivist classes in Science facilitates preparation of various teaching aids.

3. **Feeling during the preparation of the lessons using ICT Aided constructivist Learning Approach for Practice Teaching.**

- Even the smallest work needs practice. It was difficult at initial stage, but easy after practicing. During Integration students also liked this approach. It made them self-reliant to learn on their own. Pupils really enjoyed learning. It was like play-way learning.
- We need to relate the previous knowledge from earlier events may be from society, laboratory and library and construct our lesson plan in a better way. It helped to learn the abstracts concepts.
- It helps us to write a good and effective lesson and teach in multiple ways. It is an innovative approach in preparing lesson plans using ICT. It is activity based and student centered.
- Prior to orientation on this approach we were not aware of the application of ICT in Education. During Integration of this approach in Practice Teaching, initially it was difficult to manage the class as there was a lot of noise due to co-operative groups, so, controlling was difficult.
- Preparation of lesson plans and teaching in schools was challenging and difficult, but we could do it very interestingly.
- During preparation of lesson plans, we learnt what are different strategies through which we can plan, how we can prepare lessons and implement accordingly. We got healthy feedback from students in school. We felt very difficult at the initial stage, but, after practicing and implementing in school, felt happy by the healthy feedback and interaction with the students.
- During preparation of lessons, we were in confusion that how to integrate ICT in constructivist classes. Selecting and preparing Teaching Aids according to content and availability of resources was little tricky and difficult. We experienced various lesson plans prepared by the researcher. After practicing model lessons, confidence developed and we tried further.
- Preparation and practice made us perfect in the content knowledge because during preparation, resource collection, managing resources was done, and practiced many times.
- In lesson plan writing, the black board writing work has been drastically reduced. We felt at ease and good compared to formal lesson plan and realize learning meaningfully.

- If we don't use this method, we remain primitive. This approach is needed in present classes which are complex.
- During preparation of lessons by this approach we feel motivated. Interestingly the curiosity of its application in the school was more. A kind of confusion was there that whether we can do it, perform it successfully in school and whether school would provide facilities or not. Such kinds of doubts came. Later after implementing in school we got the confidence and decided to use this approach in future classes also.
- By looking at the prepared lesson plans, one can understand easily about the concept of Science and feel its innovativeness.
- During preparation we got more information from Internet on application of ICT in Science classes and became resourceful.
- During preparation we worked in groups, co-operated with each other in knowing the resources from Internet, group wise we learnt computer skills and basic requirements in computer and we shared the Information, feedback and suggestions regarding their practice presentations in the college through e-mail, which made us communicate better.
- During preparation of lesson plans, 'I have integrated web link which shows the process of circulation of blood from the heart and during practice in college, I felt so interested and curious that I decided using ICT Aided Constructivist Learning Approach in Science.
- Preparation of lessons for practice teaching really brought satisfaction in us. Earlier only fillings the pages of given lesson plans was boredom. Now I find it interesting to write through ICTACLA. It is flexible, easy and innovative compared to traditional lessons. The group interactions really made us enjoy, because preparation was also based on learning by doing.
- Preparation needs hard work; helps us to construct our own ideas and images of topics to integrate with the contents of Science. We are creator of our own methods. As it needed more work, so we became progressively perfect and constructed effective lesson plans.
- It is one of the creative and easy strategies for writing lesson plans provided a lot of practice has been done. We feel it helps to provide quality Education.
- It makes us think in divergent ways and we experienced this in preparation of lessons.

- Preparing lesson plans is no burden because in each lesson we integrate different activities. So, each lesson looks different.
- It increases the work of teacher as it needs a lot of preparation and searching of resources, integrating wherever need is felt. But once the teacher is ready with the task, it makes better learning for the self and students also.
- As students are more creative, teachers' needs to be more and more creative.
- We are very happy to learn about the ICTACLA, practicing to prepare lessons based on this approach made us more confident and there in college of Education itself like microteaching we made groups and practiced and got feedback for improvement. It developed teaching confidence in us.
- We watched some of the movie clips, animations and pictures related to Science topics. We really enjoyed. It motivated us to use such videos in our lessons.
- Preparation was rigorous. So, we could do it effectively in school. We have interacted well.
- It was really a good experience of preparation of lessons. It made all of us very creative and developed interest. Some contents were such that we could not integrate it very easily. We tried to create a constructivist learning environment in our group and prepared for practice teaching.

4. Experiences During Practice Teaching Using ICTACLA in the Schools

- By adopting such strategy in the schools, students were made very active and teachers could make the concept very clear. Through this approach the teaching-learning was very interactive, students learnt with a lot of interest, curiosity and enthusiasm. Because of doing experiments in the classroom and showing experiments virtually through animations and videos, students could engage themselves by watching there and then they discussed.
- It is really a good experience to learn with learners and materials.
- Pre-Service Teachers administered Achievement test to students, where in students have done well.
- The use of ICT could show even biographies of Scientists through Internet, could teach more than required syllabus.

- Initially it was a challenging task but as we practiced well in the college theoretically we were confident, but due to non availability of facilities in some places could not use ICT, but experienced the constructivist approach very well. In teaching some concepts of Science which were very abstract in nature could be made very simple.
- New ideas have been created by the students; it developed the analytical thinking of the concept.

5. **Role of the Pre-Service Teachers in the ICTACLA in future Teaching Profession**

- Pre-service Teachers opined that from the day they know it, they value it. To make the education of good quality one should adopt various teaching-learning approaches. All schools should be well-equipped with ICT facilities. If this approach becomes compulsory in the School Education and College of Education then all the students will use it regularly and compulsorily. Constructivist learning environment makes the teachers efficient by practicing it. They are guiding the learners along with self-guiding. The Pre-Service Teachers opined that in future, their all the Science classes would be conducted through this approach. They will also learn along with the learners. They would definitely adopt all the criteria of ICTACLA.

6. **Organization of Instructional Environment employing Constructivist Learning Approach**

- As per the reflections of the Pre-service Teachers, regarding the organization of Instructional Environment employing Constructivist approach could be done in various ways. Arrangement of different experiments, demonstrations, providing the freedom to the learners in creating and constructing the ideas and experiencing them, so that students could internalize them, could adopt learning by doing method, and guiding the learners instead of instructing and providing the information, based on the learners' previous knowledge. All students' ideas and expressions are accepted and valued. It Provides the learners opportunities for learning, so that, they could think divergently. Making co-operative learning groups among students and discussing the Science concepts makes the learner very enthusiastic and motivated. By providing the different learning situations and asking the learners and engaging them in different activities in that situation, ultimately resulted into brings meaningful learning; moving from simple to complex.

7. Problems faced during Lesson Preparation Employing ICTACLA

- Initially it was difficult to follow the steps and the Pre-Service Teachers got confused regarding what to do. And faced difficulty in preparing the lesson plans and getting time to review the sources of Science concepts but after practice they were well acquainted with the ICTACLA.
- We don't have computer laboratory visiting habits and also because of lot of assignments, we don't get time to go and access and access information. In such a state working with ICTACLA was very difficult. I don't have time and patience for writing University lesson plans which are simpler and mechanical compared to ICTACLA. Here lies the problem of following ICTACLA. It was difficult to integrate it with the lessons. A lot of thinking was needed for writing even a single lesson plan, designing all the lessons employing ICTACLA was difficult to begin with. But later once we identified with it, we could get along.
- There were less ideas and knowledge about ICT before this orientation. So we felt handicapped some times during Integration.
- The computer laboratory was not fully equipped. Only 3 to 4 computers were having Internet facility. Whenever we went to computer laboratory some other Pre-Service Teachers were found using, waiting for our turn was again difficult. So we felt insufficient facilities.
- Only after orientation we came to know of ICTACLA, We practiced University lesson plans in our first semester. So getting tuned to different approach in second semester introduced by the researcher was difficult. We really struggled going with ICTACLA.
- Everyone thinks that, the unknown thing and unknown knowledge is unbreakable stone, but once they come to know, it will be a monkey's play. This proverb flows with employing ICTACLA.
- Once we start using any new thing and new concept certainly there would be difficulties similarly, we also faced the difficulties, namely, lack of prior practice and knowledge regarding ICT, Lack of proper technologies. But, in the conditions of such difficulties we proved that things are possible in such difficult conditions also.

- Felt difficulty in preparing lesson plans using ICTACLA, because, already we have had a lesson plan format, fitting new format in the old was little difficult.
- Sometimes for some Science concepts, we felt difficulty in Integration process, including the activities, inquiry and constructivism in lesson plan was difficult rather than actually practicing it in the classroom.

8. Problems faced during Practice Teaching employing ICTACLA

- Because of large number of students in each classroom, it became difficult to manage. Even though I made groups among them, timings of the period were not sufficient, required much more time to deal with even a single subunit.
- All schools don't possess the well equipped computer laboratory, Science laboratory and Internet facilities. So it was difficult to implement at the school level.
- Even though some schools have all the facilities, but still they did not allow Pre-Service Teachers to make use of these facilities. Even the permission to enter computer laboratories was not given.
- During the classroom activities Science experiments were conducted and group wise demonstration, group discussions were made. It created noise and disturbed other class. So other class teachers came out and suggested us to be very strict and not to allow students to talk.
- Creating constructivist environment in the school is very difficult, because as we are Pre-Service Teachers we go for practice teaching. Some topics we get for teaching might have already been completed. So, students don't attend to us, in other classes, most of the Units have not completed by teachers. So the teachers ask us to give notes rather than doing activities and discussions. So we were in dilemma that to follow our new method or what school teachers and principals are suggesting.
- During preparation of lesson plans, we have written clearly, but when practicing them in the schools facilities were not available, we felt handicapped.
- Though we Pre-Service Teachers were skilled with the approach, but there were no facilities in schools.
- Considering each and every student's point of view was difficult and going with different strategies for various learners was a challenging tasks.

- Even in such situations or in difficulties also, we have used ICTACLA wherever possible we have our own personal laptops and before coming to class we brought the materials which we wanted to show through hyper linking with the internet and we got printed materials. It has added to the work and responsibility. But otherwise very interestingly and enthusiastically we followed the approach wherever there are ICT facilities; we demonstrated in class, took students to Campus Garden, made co-operative learning groups and conducted discussions and followed 5E method in maximum lessons.

9. Opinion regarding the Effectiveness of ICTACLA

- During B. Ed. only we came to know of ICTACLA, It is our fortune. During this training we learnt about ICTACLA. Its effectiveness was fully established.
- Science is subject of experiencing and experimenting using ICTACLA in Science. The concepts become quite easy and clear.
- This approach motivates Pre-Service Teachers, and also School Students and creates interest. Because of use of ICT students were curious about the information and to compare that with what teacher provides in the classroom.
- Science follows the principle of learning by doing. So through this method all of us learnt by actively participation and also discussed actively with school students.
- The teaching-learning can be made more effective through ICTACLA.
- Through this approach we could engage learners in the class. We were able to connect previous knowledge with present one.
- We use teaching aids, models, demonstrations and virtual experiments. It provides firsthand experience to learners. So, naturally there is more interest.
- By teaching-learning through co-operative groups, students come with different ideas, develop confidence and create new ideas related to Science concepts.
- In a short time, we adopted this approach and we discussed in our classes in groups. It has developed confidence in us and also in all groups of the class.
- By giving opportunities to students to share their ideas, considering their views, valuing them, makes learners very excited and interested in learning. They could learn better and could construct new knowledge.
- With the help of ICT and through Internet we can show students recent researches, changes and challenges and can bring the whole Science world into the classroom.

- Sharing the information through Social Networking can be used for sharing Science discussions and posting Science experiments.
- Virtual fieldtrips, virtual laboratories help learners experience the concepts very easily without going too far off places.
- This approach encompasses varied learners with different pace of learning.

10. Suggestions on the Orientation Programme employing ICTACLA in Science

- In this modern world, all teachers should adopt ICTACLA to prepare their students for the future.
- B.Ed. syllabus should include teaching of Science through ICTACLA. University should make efforts to integrate ICTACLA in the curriculum of Teacher Education.
- ICTACLA should also be integrated with the other subjects.
- ICTACLA based approach should be guided prior to Practice teaching from the First semester and it should be a part of method of teaching and added as a compulsory unit.
- Colleges of Teacher Education and Schools should possess well equipped computer laboratories, Science laboratories, so that, the experiments could be conducted.
- Separate guidance classes for lesson planning based on ICTACLA in Science should be there, rather than guiding the group of learners of different subjects.
- College of Teacher Education should organize seminars, discussions on ICTACLA by Experts in the field.
- We expect our Teacher Educators also follow ICTACLA in teaching of B.Ed. So that, it could be easy for Pre-Service Teachers.
- More and more research and development should be done in this area, so as to take this to policy level.
- Such kinds of orientations should be given to In-Service Science Teachers also.

3.6.3.2 Content Analysis of the Focused Group Discussion.

Focused Group Discussions were conducted to collect Pre-Service Teachers' Reflections on ICTACLA in Science. The initial reflections of the Pre-Service Teachers on ICTACLA have probed them to discuss various aspects further namely, feel of ICTACLA, ICTACLA facilitating Science, lesson designing employing ICTACLA, experiences during practice teaching while employing ICTACLA, exploring the Possible Role of Pre-Service Teachers in the context of ICTACLA in their Profession, Designing Constructivist Learning Approach Environment, problems faced during Practice Teaching with ICTACLA, Effectiveness of ICTACLA in Science, Suggestions of the Pre-Service Teachers on ICTACLA in Science. The discussions have been content analysed as follows,

1. Feel of ICTACLA

Pre-Service Teachers opined that this approach has really helped in Science. It trains all students in such a way that they come to class with constructive ideas. It helps the students to think about a concept in different ways. Small ideas help to build bigger concepts easily. Prior knowledge helps to build further knowledge meaningfully. It makes the learning environment more learners friendly. As it is based on the principle of learning by doing, it makes the learners very active. Teachers prepare various interesting strategies as per the interest of the students. The assessment is an opportunity to the students. As teachers need to practice more, it brings confidence among both teachers and learners.

2. ICTACLA facilitating Science

Pre-Service Teachers felt that ICTACLA helps in Science. They can explore their own ideas and views and also imagination of the students is brought in front of their eyes in the form of power point presentations, specimens, and virtual classes, field trips which can erase the wrong imagination or idea and make students understand subjects like Science much better. In Science there are lots of experiments to do, the environment could be provided by ICT facilities and engages the learners in the discussion. The abstract concepts, like, structure of atoms, chemical bonds, animal and plant physiology and many more concepts could be made clearer through animations. This approach gives a concrete picture for our imagination of the concepts of Science. It helps to develop Science process skills. Through lecture method Science can only be instructed but the scientific ideas cannot be constructed. This approach is a composite approach; a mix of various approaches.

3. Lesson Designing employing ICTACLA for Practice Teaching

It made the Pre-Service Teachers work a lot before going to the actual field. ICTACLA motivated the Pre-Service Teachers to formulate exploration based lesson designs. Learning by doing principle always kept them active. Innovative Lesson Designing by use of ICTACLA was really joyful and creative. In designing the lesson plans, there was a lot of freedom to use various strategies for teaching-learning. Designing Lesson Plans was difficult but at the same time creative and joyful. Feedback by the investigator on the Lesson Plans designed by the Pre-Service Teachers employing constructivist approach really made them excel in innovative lesson designing for Science Teaching.

4. Experiences during Practice Teaching employing ICTACLA in the Schools

Pre-Service Teachers opined that by adopting such strategy in the classroom, students were made very active and teachers could make the concept very clear. Through this approach the teaching-learning was very interactive, students learnt with a lot of interest and curiosity. Because of doing experiments in the classroom and demonstrations through virtual media via animations and videos students could be fully immersed. Activity based Evaluation by the Pre-Service Teachers was really exhilarating. Through Internet the biographies of the Scientists could be accessed. The Pre-Service Teachers could teach even more than the syllabus demanded. Initially it was a challenging task but as Pre-Service Teachers had practiced well in the College of Education, theoretically, they were confident, but, due to non availability of facilities in some places could not use ICT. Even then they experienced the constructivist approach very well. While teaching some concepts of Science which were very abstract in nature could be introduced relatively easily. Students also learnt with a lot of interest and enthusiasm. New ideas were generated by the students. It developed their enquiring skills & analytical thinking.

5. Exploring the Possible Role of Pre-Service Teachers in the context of ICTACLA in their Profession

Pre-Service Teachers opined that from the day they know ICTACLA, they value it. To bring the quality in education one should adopt various teaching-learning strategies. All the schools should be well equipped with ICT facilities. If the ICTACLA is integrated

in Education & Teacher Education then all the students & Teachers will be benefitted. Creating the constructivist learning environment really makes the teaching-learning efficient & effective. Pre-Service Teachers opined that in future their all Science classes would go through this approach. They will also learn along with the learners and would definitely adopt all facets of the ICTACLA.

6. Designing Constructivist Learning Approach Environment

The Pre-Service Teachers have reflected that Constructivist Learning Approach Environment can be realized through, arrangement of different experiments, demonstrations, providing freedom to the learners in creating and constructing the ideas and experiencing them. Instead of instruction, the students can adopt learning by doing method. All the students' ideas and expressions be accepted and valued and if possible implemented in the class. The learners could be provided the opportunities for learning, to think divergently. Making co-operative learning groups among students and discussing the Science concepts makes the learner very enthusiastic. Motivating the learners by providing various learning situations and engaging them in different activities ultimately brings meaningful learning. Going from simpler ideas to complex ones really helps in learning of difficult and complex concepts. Learners need to be provided the learner friendly environment.

7. Problems faced during Practice Teaching with ICTACLA

Pre-Service Teachers reflected that initially they did not know the approach, but after knowing it was helpful. In the rigid schedule of the course the orientation program was additional to the course, so initially it was difficult to adjust. Less knowledge regarding the computers was another impeding factor. During the preparation of the lesson plans the Pre-Service Teachers got confused in selecting the teaching aid, hyper linking the materials, arrangement of the activities and other teaching-learning tasks according to the 5E and 7E. How to adopt various evaluative procedures was a challenging task. In the practice teaching the facilities of ICTACLA were not adequately available. It was difficult to adjust initially. Large number of students in the classes made it difficult. Time management was a big challenge. Concentrating on each and every student was difficult. In spite of Smart classes in the schools the administration did not provide the facilities. Lack of motivation of the school teachers was another limitation.

8. Effectiveness of ICTACLA in Science

ICTACLA in Science really works well. Science is a subject of objectivity & exactness. So, through this approach the teacher can work perfectly. Science process skills could be developed very well. Science concepts & higher order thinking could be developed. By use of different strategies in the classroom, like, cooperative learning, teacher can develop co-operative learning skills, expression skills, life skills and values. Demonstrations in the classroom really help to make the abstract concepts very simple and concrete. Providing life like situations helps the learners think and discuss among themselves. It is based on the principle of learning by doing, so, it makes the learners and teachers active and interactive throughout the day. In the post-test students scored very well compared to pre test. The engagement of the students in the activities and their involvement in the classroom was also assessed through observation. Due to use of ICTACLA Pre-Service Teachers' knowledge, skills and creativity regarding Science and integration of ICT in Science through Constructivist Approach have been developed. ICTACLA was found to be a Powerful Method of Teaching Learning Science for wholistic development of Teachers & Learners.

9. Suggestions of the Pre-Service Teachers on ICTACLA in Science

Pre-Service Teachers suggested that it is a powerful approach which can be well integrated in the teacher education and school education. Schools and colleges of teacher education must have all the ICT facilities in their institutions. Teachers and Teacher Educators could be oriented on this approach. This orientation program was in second semester of the year, it could be started in the first semester itself, for better integration. Project works could be included for both Pre-Service Teachers and School Students. This type of orientation courses could be conducted for all subjects. Action research on such a kind of orientation courses could be done in schools and teacher education colleges.

3.6.3.3 Conclusion

The orientation program based the ICT aided Constructivist Learning Approach in Science and its implementation on the Pre-Service Teachers has had substantive returns. It is evident that use of ICTACLA has made the Pre-Service Teachers confident in using this innovative approach in teaching Science. The development of the Lesson plans using 5E and 7E has made the Pre-Service Teachers engage

themselves completely. Integration of ICT applications into the lessons, engaging in virtual world of Science, hyper linking the information with artifacts, discussing through social networking systems, evaluating throughout the classroom, emphasizing on self evaluation has demonstrated how the Pre-Service Teachers could be transformed into Teaching Scientists.

3.7 Objective no. 2.7

To study the effectiveness of ICT Aided Constructivist learning Approach in Science in terms of the emerging status of the ICTACLA.

3.7.1 Tools

1. Pre-Service Teacher's Diary.
2. Researcher's Diary for Field Note

3.7.2 Data Collection

The Researcher has provided each Pre-Service Teacher a note-book to mention the daily activities on ICACLA throughout the programme, their views on the orientation programme and suggestions for further improvement. These diaries were collected by the researcher at the end of the program.

The Researcher has maintained the Diary from the first day to the last day of data collection, wherein notes were taken, during orientation in the college of education, during practice teaching and after practice teaching.

3.7.3 Data Analysis

3.7.3.1 Content Analysis of Pre-Service Teacher's Diary

The views of Pre-Service Teachers have been read and coded into some categories. Accordingly all Pre-Service Teachers' views have been gathered, decoded and analyzed qualitatively. These are presented as follows:

Table 14. Categories of Pre-Service Teachers' views on ICTACLA

Sr. No.	Aspects / Characteristics
1	Concept and Characteristics of Constructivism
2	Concept of ICT
3	ICT Aided Constructivist Learning Approach
4	Prior knowledge of ICT Aided Constructivist Learning Approach
5	Problems in Lesson Designing Employing ICTACLA
6	Problems in Lesson Implementation Employing ICTACLA at school
7	ICTACLA Integration at the College of Teacher Education.
8	ICTACLA Integration at the School
9	ICTACLA Advantages for Pre-Service Teachers and School Students
10	Pre-Service Teachers views on Researchers Approach
11	Suggestions by Pre-Service Teachers
12	Findings according to Pre-service teachers

Accordingly their views have been studied and the essence of each category has been written as follows:

Concept and Characteristics of Constructivism

Constructivism is a philosophy of learning. The concept of constructivism is to create a constructive environment wherein teacher helps to construct the ideas and students construct and create the meaning of the ideas. It is completely based on the principle of learning by doing. Students can experience what they are doing and relate to other activities. As the teacher is like a guide, friend and philosopher, students discuss freely & independently by connecting previous knowledge to present.

Constructivism demands that the classroom environment is created in such a way that the students think and discuss with each other & construct an idea & attach meaning to it. It is basically a problem solving strategy. It includes engaging the students, exploring the knowledge, explaining the concepts, elaborating and evaluating and extending the knowledge to the society. The constructivist classes are based on the principle of 'learning by doing', known to unknown, concrete to abstract, student centered, principle of ease, principle of prior knowledge, principle of negotiation. Constructivist Teachers consider Students as discoverer of knowledge and Scientists and provide equal opportunities to all students by considering their prior knowledge, originality and their pace of learning, capability of using different strategies, transition from one method of teaching to other and capability of connecting classroom to the

society. Students are very active learners. They participate in all the activities. They are independent in thinking & constructing ideas thereby making sense of what they are learning. Here assessment is an opportunity for learning. It is continuous & hence experiential.

Concept of ICT

- ICT that is Information and Communication Technology Includes Computers, Internet, and other Electronic Gadgets used for communication. The frequently available are Power point presentations and over head projectors could be used in daily teaching.
- Use of ICT in Science teaching is an innovative method which makes abstract concepts concrete. By using ICT, the students will be more curious to know the things and develop interest.
- Internet helps in collecting materials from different resources.
- Through Internet they could experience the virtual world of Science.
- ICT helps for the better communication by creating the spaces in e-mail, social networking and wiki space and exchanging the information.
- ICT came to help during the preparation of teaching aid, searching of information about teaching innovatively, recent updates and development of Science and preparation of lesson plans and unit plans.
- ICT helps to connect the world and makes it a global village.
- ICT learning and Integrating and teaching with the help of ICT needs skills and practice.

ICT Aided Constructivist Learning Approach

- It is Using ICT along with constructivist approach.
- Engaging students and then exploring, explaining the concepts can be done very well through some videos.
- Preparing lesson plans based on principle of constructivism with the help of ICT was a challenging task.
- We prepared unit plans based on ICTACLA.
- Teaching Science through ICTACLA is interesting and it requires practice and lot of preparation and facilities.
- The principle of ICTACLA, that is, step by step towards abstract to concrete process helps to build motivation, and solve the problems.

- Helps in viewing the laboratory and virtual classes interestingly with other students and teachers.
- Using ICT in Constructivist Science classes facilitates the learning of concepts.
- In Science, the concepts such as, working of petrol engine could be shown through animations and discussed to come to the conclusion that how it works. This creates interest and curiosity.
- The best teacher is one who integrates innovations in the classrooms and helps to enhance the learning.
- Classroom discussions on Science concepts and their history, discovery could be hyperlinked.
- In the world of ICT students need to be active and Interactive. So, ICTACLA equips the students.
- Classroom ideas could be discussed though e-mail.
- Use of ICT in the classes employing Constructive method facilitates teaching, learning, evaluation and feedback.

Prior knowledge of ICT Aided Constructivist Learning Approach

- Earlier they were unaware of constructivism, ICT and integration of ICTACLA in the lessons and classroom activities.
- Before undergoing orientation programme on ICTACLA, they did not know how to write effective lesson plans other than the Model Lesson Plan given by the College.
- Knowledge regarding constructivism was not there, but somewhere they have practiced in school days.
- We had knowledge of subject matter to be taught, but teaching according to their needs, their psychology of learning, ways of understanding were not known. ICTACLA is enough for teaching the whole class.
- In the first semester practice teaching we have used the model lesson plans taught in the very formal way, because we did not know these innovative methods.
- We were unaware of importance of ICT and constructivism in the classroom.
- During practice teaching we experienced the implementation of ICTACLA based lessons, and same teaching has been used in Innovative practice teaching.
- We got to know many things which we did not know earlier about Science teaching through ICTACLA.

Problems in Lesson Designing Employing ICTACLA

- Faced number of problems, like, which topic should we teach, which teaching aids to prepare and how to proceed ahead.
- Because of lot of assignment work we all were in tight schedule, preparation of lesson plans based on ICTACLA is difficult at initial stage to manage all the things.
- All Science students were with different method masters. Sometimes coming all together for orientation was difficult.
- Communicating Pre-Service Teachers of other batch was difficult because of multitasks.

Problems in Lesson Implementation Employing ICTACLA at School

- I could not completely implement the ICTACLA based lessons in schools because of less facilities of ICT, but certainly used the constructivist approach in Science classes.
- Because of some administrative problems, school did not provide the facilities, but within our resource limits we completed the lessons through this approach.
- Because we are Pre-Service Teachers school authorities did not allow us to use the smart classes.
- When we are teaching through this approach, students were excited and managing them was really difficult because of big classes.
- Other class teachers started complaining to authorities to maintain silence in the classroom.

ICTACLA Integration at the College of Teacher Education.

- We started writing lesson plans based on the principles of ICTACLA step by step with Researcher's guidance, we have used 5E model in the lessons.
- During lesson preparation we used Internet regularly to find related animations and video clips which suited the concepts selected.
- Based on ICTACLA we have prepared Resource plan on Science.
- We have watched various movie clips, animations regarding teaching of Science in the classroom.
- In the Biological method classes we have learnt the units through ICTACLA.
- In the classes we have followed problem solving method, experiential learning and co-operative learning methods. We ourselves learnt the application of these methods.

- As per the Researchers guidance, we integrated the lessons, hyperlinked the materials as per the concepts in Science. The Researcher helped us during preparation of lesson plans whenever needed.
- We have included lot of activities in the lesson plans.
- We have practiced the lessons which are based on ICTACLA in the college before going to the practice teaching.
- We prepared Innovative lessons based on ICTACLA for the Innovative teaching classes in the college, also.
- We prepared power point presentations on Science concepts in the innovative classes.
- As there were facilities in the college, we could practice well.
- Initially we learnt basics of computer, which helped us later to use it during integration and practice; we actively worked by helping each other.
- Created our own e-mails, WebPages in social networking sites and started sharing information and communication. We became Netizens.
- We developed our skills and knowledge regarding ICTACLA.
- Writing lesson plans in different ways gives the pre service teachers experience of using different activities. It is flexible.
- In the computer lab we all used to learn and share the knowledge whatever we have studied regarding ICT and Constructivism and its development.
- We were very active and enjoyed the process of Integration of ICTACLA in Science.
- Researcher corrected the lesson plans prepared by us based on ICTACLA and continuously guided and motivated to experience a new way teaching-learning.
- All the classes were more interactive and lively. We were made to participate in the class instead of sitting idle and listening to the teacher.
- We have had a field trip to University of Agricultural Sciences, Dharwad. A beautiful and very famous Agri University in India. Wherein we perceived various plant breeding varieties, Horticulture Department, Plant Microbiology, Green Houses, Hybrid Plants, Vegetables, Poultry, Dairy, Home Science Department, and got the information through discussing with the experts related to the departments.

ICTACLA Integration at the School

- Lesson Plans were prepared based on ICTACLA, and we were eager to see its effects after implementing at school.
- First we started the class by providing various examples, pictures and engaged them in the class and elaborated the knowledge of their responses and explained and extended the topic to other places as applications and evaluated throughout the class. In the class we made cooperative learning groups and organized group discussions.
- During observation of the Pre-Service Teachers' class, we observed how the class environment and teaching were, wherein we have observed that the Pre-Service Teachers were following the steps of 5E's. Classrooms were well managed; Lot of noise was there as there were group discussions.
- We got good effect of the approach, because such an environment was created which facilitated self thinking, experimentation, students involvement and freedom, We felt we have provided that kind of environment.
- When there was ICT Aided constructivist learning class, students were very curious, interested and enjoyed the class.
- In some schools we have used Projectors and our own laptops, because of not having facilities.
- Through the guidance of the Researcher, we were able to make our students more active and interactive and enhance learning.
- Students were given freedom, so as to come up with their own ideas and they found it as a good approach.
- As group discussions were held, they come across many problems, doubts and could find enough time to find the solutions.
- Students designed their own activities. We made the platform for them to think on their own divergently.
- We oriented the students towards respecting and considering individual difference among them.
- We believed in, I listen I forget, I see I remember, and I do and understand. So there was focus on practical learning.
- In the class of Science, I was teaching 'Magnetism and Electricity', I provided magnets and Iron powder, students only performed the experiments according to suggestions and they said we all did this at home when we were playing with magnets, so it became real learning.

- The classes were not for the merely completion of syllabus but for clear understanding.
- School students co-operated in organizing the classroom. Whenever the researcher was there in our school she also helped in organizing the classes.
- During observations, one of the Pre-Service Teachers taught periodic table with the help of pictures of periodic table which were downloaded through internet. She hyperlinked the resources in the class.
- In some schools they provided computer lab, wherein, group wise we conducted some classes.
- In one class, I took students out of the class for showing and discussing on Algae in the artificial ponds in the campus.
- Organized exams, throughout the class we have evaluated them through observations, discussions, questioning in between, conducting achievement test, playing games by giving some names like vitamins and Plant families.
- Could maintain and retain the same interest and curiosity among students throughout the class.
- We conducted classes by keeping the students as centre of learning; asking their prior knowledge of the concepts to be taught.
- The topics such as Cell Division, Mitosis and Meiosis are so complex and abstract, which could not be understood through drawing diagram on black board, but by using the animations for the whole process could be so concrete and clear to students.
- Home assignments were given to students based on activities.
- Used different teaching method according to different concepts, content and learners.
- In the class of Micro-organisms engaged the learners through the video and asked them to discuss and come up with ideas, Students so actively participated and made such reflections that they could further explain them.

ICTACLA Advantages for Pre-Service Teachers and School Students

- ICTACLA in Science is very applicable and useful.
- ICTACLA helps in creating Interest in the subject and develops creativity and critical thinking.
- It is very essential to the present context for effective teaching learning.

- Constructivism helps to build the conceptual relationship and clear understanding of the concept.
- Step by step learning makes the learners very enthusiastic.
- Through this approach one can easily teach about abstract concepts of Science.
- It increases the learners' activities and facilitates the interactions.
- It motivates the learners as well as teachers towards innovative approaches of teaching.
- In constructivist classes use of ICT helps to communication of the ideas to others.
- It helps to know the learners' learning problems and provides the opportunities to solve them through various strategies.
- Designing lesson plan through this approach is really innovative, flexible and effective.
- Teachers are also learners of ICTACLA.
- Teacher uses media according to the need. It makes the learners curious about concepts and increases interest, and makes the concept and process clear, for example, Breaking of Chemical bonds, Life cycle of a Butterfly.
- There is scope for improvement in teaching as well as learning because of the principle of learning by doing. Students learn better through experiential learning.

Pre-Service Teachers views on Researchers Approach

- The Researcher helped us to improve our computer knowledge, knowledge of technology based Science teaching, how to handle the resources, how to use internet for surfing and accessing the information, which related materials can be used for which concepts of Science, how to hyperlink and how to write lesson plans in Science using ICTACLA, the process of implementation and evaluation. We were oriented to the whole process.
- We wish to thank the Researcher for choosing our University College of Education as experimental group. We got to know all the elements of the ICTACLA, and how to redefine our teaching & learning.
- As per the Researchers guidance the lesson plans were prepared. She has used ICTACLA in all our classes in orientation and Biology method classes.
- Researcher has provided the knowledge of e-gadgets and their use in the Science classes.

- Researcher has given a lot of freedom to prepare the lesson plans, teaching aids, suggested for innovative strategies, and solved our problems regarding selection of content and matching teaching aids and other teaching resources. We were also oriented to evaluation procedure in constructivist classes.
- Initially the Researcher taught some of the topics of school Science textbooks through ICTACLA. We appreciate the innovative strategy which made the learning really meaningful.
- In school also whenever there was a problem in teaching arrangement, the Researcher has helped us and made us confident in teaching.
- Researcher has initiated the field trip to University of Agricultural Sciences, Dharwad. Wherein she guided us to collect some plants for preparing Herbarium, understanding of Taxonomy of plants, Global Warming, Green Houses, Dairy, Poultry, Horticulture, Home Science and concepts regarding Food and Nutrition.
- During Innovative teaching in the department, she suggested on ICTACLA based lessons. Accordingly we designed the lessons and presented well.
- Throughout her data collection process, she has used questionnaires, group discussions, video recordings, taking photos, observations by her and by all Pre-Service Teachers and Teacher Educators. Discussions with school students and Teacher Educators about ICTACLA. Altogether we enjoyed the work with ICTACLA during second semester.

Suggestions of Pre-Service Teachers

- All Pre-Service Teachers should try this ICACLA irrespective of the subject.
- We wish to attend such orientation programmes in future also
- It could have been started in the first semester itself, so that, we could have lot of time and practiced more and become regular constructivist teacher.
- ICTACLA could be applied in other subjects also like languages, history and geography.
- It should be implemented for In-Service Teachers also, so that, they would also get benefit of it.
- I suggest all my friends to follow this approach in future.
- I suggest everyone to create such an environment, wherein all students gets opportunity to learn and learn themselves based on their activities.

- As it is very effective approach. I suggest this should be integrated in Teacher Education Colleges and it should be a complete package of ICTACLA.
- This orientation on ICTACLA could be certified for us. We could have got a certificate of participation.
- It could be for the whole year and made compulsory.
- We request the Researcher to provide further development of this programme through mail or social network. We will be eager to know more regarding this approach.
- According to the needs of the present society, and in this technology era, schools and Teacher Education colleges should equip with the facilities needed to implement the ICTACLA.
- A successful person is one who can lay a firm foundation with the bricks others have thrown at him. So practicing ICTACLA might be criticized and problems may come but we should not stop the exercise of trying it. So I request and suggest everybody to adopt such strategies in class and try to overcome the difficulties during the process.

Findings by the Pre-Service Teachers

- ICTACLA has been found to be lively and effective.
- We experienced new way of teaching learning and benefitted.
- Our College Method Masters appreciated the Researcher's approach that is ICTACLA.
- The orientation program on ICTACLA made us knowledgeable.
- After implementation of this ICTACLA in teaching-learning, the class was more interesting. It made the peer group grasp the content matter easily.
- Using ICT as a tool really makes the class innovative and adds to the effectiveness of teaching-learning.
- The principle of 'learning by doing' of constructivism was found to be a very effective way of learning.
- I do I understand really suits the constructivist classes.
- In future whenever and wherever we will join as teacher, we are going to adopt this ICTACLA in our daily teaching-learning and suggest others also.
- The subject like Science really needs innovative strategies, like ICTACLA.

- ICTACLA develops critical and creative thinking.
- ICTACLA is effective way of designing and presenting the lessons.
- ICTACLA helps to bring the abstract concepts of Science to concrete one.
- During the classroom teaching through ICTACLA, the learners are found very active, enthusiastic and curious throughout class.
- We found that it is better to teach through ICTACLA.
- When we conduct experiments in Science, teaching-learning becomes effective through experiential learning.
- School students favored the Pre-Service Teachers classes employing ICTACLA.
- The evaluation pattern really is an opportunity for learners and teachers to improve.
- Compared to traditional classes, we find it as an effective teaching strategy.
- All school students participated with Interest.
- Present students are in need of such approaches to equip with the changes.
- The students' performance is good through ICTACLA. It is evident through achievement test and overall evaluation.
- Implementation of such approach in all classes is difficult, because of lack of facilities and more number of students in each class.

3.7.3.2 Content Analysis of Researchers' Diary for Field Notes

During data collection process The researcher has observed as a participant observer and noted all the activities during the data collection process at the University College of Education, Dharwad, and at all schools where the Practice Teaching was been conducted.

During administration of the pre-test all the Pre-Service Teachers were very curious. Some of them had few doubts regarding the questions and they asked the meaning of few words. Some of the Pre-Service Teachers of other methods wished to attend the test and orientation program. They were permitted to attend only orientation. Two of them helped in administering the questionnaire. The Principal of the University College of Education was very supportive and asked all the students to come to the college one hour that is at 10.00 a.m. for the orientation class, i.e., from 10.00 a.m. to 11.00 a.m. and assured that everyday two classes will be provided for the orientation program.

All the Pre-Service Teachers were very curious regarding constructivist principles; the researcher interacted with learners about ICT Aided Constructivist Learning Approach. All the Pre-Service Teachers exchanged their ideas and experiences related to ICT in

Education and their utility in the routine work of teaching learning and also in other activities. As they are only aware about educational programs in Television and Radio, accordingly they were discussing.

The researcher explained the theories behind Constructivism and Technology Aided Constructivism. It was really difficult to get the coordination from the teaching staff. They did not agree to send their Science students for the orientation. But on repeated request they agreed.

During the orientation classes the researcher made groups, and asked them to engage in the activity. All the groups were asked to write their ideas on ICT and Its educational implication. A few students hesitated to talk about on behalf of group, but the researcher motivated the students to talk and share their ideas. There were inter-group and intra-group discussions, where all the groups interacted in the classroom and shared their ideas with others. During the orientation classes there were presentations regarding the Constructivist classes and constructivist lessons. There was discussion on how to plan lessons based on ICTACLA.

A few students were in tension because they wanted to finish it their College work of practice teaching. The researcher convinced them that orientation programme would help them to develop the lesson plans and prepare the required teaching aids and makes them ready for the practice teaching.

The orientation was initiated by discussing about demonstrating the lessons based ICTACLA. The demonstration lessons were on the topic Magnetism which was designed based on the ICTACLA. All the students were actively engaged in the class, wherein they discussed how to motivate the students for the present concept. Use of ICT for teaching magnetism, for engaging, explaining, exploring and evaluating was discussed. The steps for developing the lesson plan employing ICTACLA were introduced.

All students were very happy about the development of the lesson but at the same time they were having various doubts that whether schools have the facility of Internet and ICT facilities for the integration and implementation.

To the same question one of the pre-service teacher said that if Internet is not available in the school, before going for the school we will download the required pictures and information of the concept and then that could be discussed. The researcher also agreed. The researcher asked all the per-service teachers to talk on their topics given by school for the practice teaching. Each of them gave their list of topics namely;

1. Cell Biology
2. Microorganisms
3. Force and Motion
4. Non-Metals
5. Electricity and Magnetism

The researcher made the groups and asked each group to prepare lesson plans on their topics.

All Pre-Service Teachers were engaged in the process. One of the group members of each group was asked explain how to motivate the students to use ICT, in their topic and how to follow the constructivist ways of integrating ICT.

As all Pre-Service Teachers were not from English medium, so they felt difficult in understanding the integration process especially during hyper-linking information. Students asked how to know about the different websites providing information regarding particular concepts in Science.

One of the students asked that in Science topics like Evolution, how ICT could be used to teach and discuss the concepts. Then the researcher said that it is possible that to prepare the animations and presentations on the Evolution. For example one can show the Giraffe in the earlier days with the small neck transformed to Giraffe with the long neck, which took longer period, the environmental changes which made these transformations could be shown, and this can be made interesting to the students.

All Pre-Service Teachers prepared some lesson plans based on ICTACLA. A few of them wrote the lesson plans by following the principles of ICTACLA; some of them felt the difficulty. There was enough discussion on different evaluation methods using activities with the help of ICT. Most of them liked and used 5 E model rather than 7E which looked similar to that of 5E. Pre-Service Teachers were going for audiovisual room (technology room) for preparation of the lessons and for try out.

The Researcher demonstrated various lessons in the Technology room. Also researcher used Edurite Karnataka State Board Educational Software package, which has syllabus wise, unit wise explanation, animations, evaluation activities, examples to the application level. Researcher involved Pre-Service Teachers in evaluation activities. Some of the Pre-Service Teachers wanted to see all units in that. So it would be easy for them to go for such activities. Based on that Pre-Service Teachers continued the lesson preparation and try out. Pre-Service Teachers were engaged in the evaluation activities on the unit chemical equations, balancing the chemical equations, filling of evaluation sheets.

Researcher has shown some video clips on Cell division, water pollution and asked the Pre-Service Teachers to reflect on those. She asked them to find, to create, to download such video clips for providing situations to engage the learners in the classroom during their practice teaching. Pre-Service Teachers prepared teaching aids on different topics and discussed with the researcher about more teaching aids for their topics, Some Pre-Service Teachers were again demanding some lessons should be shown on LCD. Some examples were demonstrated again. After discussion all of them visited and utilized the computer laboratory every day. After developing the lesson plans, Pre-Service Teachers used to get them corrected by the researcher, after receiving suggestions they used to update them.

Along with the orientation on ICTACLA, researcher also oriented the Pre-Service Teachers to observe the classes of their classmates during the practice teaching, what components to be observed were discussed through the Observation Schedule prepared by the researcher. The researcher distributed the observation schedules to all the Pre-Service Teachers.

Before going for the practice teaching there was a group discussion, where in the researcher asked all of them discuss among themselves about their topic and how would they practice in the class, how they will engage the learners, how they would provide the constructivist learning environment to the learners in the classroom, how they would integrate the ICT with constructivist classes, All these processes were discussed and presented. This discussion synthesized the whole orientation programme.

Field notes taken in the Schools during Practice teaching

The researcher visited all the six schools in Dharwad where the University College of Education' Pre-Service Teachers go for practice teaching programme, namely

1. University Public School, Dharwad
2. Vidhyaranya High School, Dharwad
3. Karnataka Education Board' s (K.E. Board) School, Dharwad
4. Raja Lakamangouda Sardesai (RLS) High School,Dharwad
5. Karnataka High School, Dharwad
6. Basel Mission School, Dharwad

All the Science Pre-Service Teachers were distributed to all the schools by the University College of Education. All of them were given 8th and 9th Standard classes. As the researcher has delimited the study to 9th Std. only, the researcher observed and noted the details regarding 9th classes only, Participant observations were done by the researcher, where she become one of the students of the school. During observation of the classes the researcher has taken some photos and some part of process was video recorded.

Here are some reflections by the researcher in each school.

1. University Public School

In the University Public School when the researcher visited, Five Science Pre-Service Teachers were supposed to conduct the classes for 9th class on different topics, namely, Metals, Non metals and Carbon, Motion, Magnet and Electricity and on The Living World. Researcher attended each one's period once and two period sometimes whenever it was possible, in the classes Pre-Service Teachers provided learning situations by engaging the learners into small inquiries, activities and even by use of computer they have shown the pictures and AV's to the learners. As the school was Educomp smart class future ready school, but the principal disagreed to provide the laboratory to them but Pre-Service Teachers with their own arrangements they tried to utilize and integrate the technology in their classes, provided learning materials, and showed the models related to the topic, made groups of students of 4-5, for activities telling them to perform and explain the process. Students were actively engaged in the class, and provided individual and group assignments.

2. Vidhyaranya High School

Here in this school six Science Pre-Service Teachers were conducting the classes on different topics. The classes were very lively; Pre-Service Teachers used the computer laboratory for the students for some topics like Microorganisms and Magnetism and Electricity. They used laptops in the class to show the picture of microorganisms, and showed animations on magnetism, as the class size was big, students could not see properly then made use of computer laboratory. In the classroom Pre-Service Teachers created constructivist environment, where in they engaged the learners by asking their

previous knowledge regarding the concepts. Freedom has been given to the learners to think and put forth their ideas; initially concepts were explored by the learners, examples which the learners have seen in day to day life have been emphasized, lot of motivation has been given to the learners and explained by Pre-Service Teachers later and given various web sources to the learners to look into at the leisure time. Experiments were carried out to show the principles of magnet, involved learner's participation in the demonstration, and allowed them to show other principles and asked the learners to observe carefully and infer the outcome. The assignments were both individual and group wise, and both formative and summative evaluation has been done.

3. Karnataka Education Board' s (K.E. Board) School

In the KEB school six Pre-Service Teachers were teaching different topics, they were discussing on Nature of Matter, Motion and sub topics in these, The researcher found that all pre-teachers were very active and the learners in the classroom were also found very active throughout the class, they used the constructivist principles in their classes, used internet and shown different animations, online demonstration of experiments and made the concepts very interesting. Considered learners point of view during the discussion, few of them involved inquiry based teaching, use of 5E was common. In-between they used available materials as resources and used as them. Pre-Service Teachers gave assignments in the class and asked them to do in the class and then to discuss group wise, provided home assignments individually and group wise, throughout the class observation has been done, taken the feedback from the students.

4. Raja Lakamangouda Sardesai (RLS) High School

In the RLS school the Five Science Pre-Service Teachers were teaching different topics, when the researcher visited the school, one of them was checking their previous class home assignments, lot of encouragement for the learners was there from the Pre-Service Teacher. All Pre-Service Teachers engaged learners by providing learning situations, all of them followed 5E model in their teaching. Used different strategies for assessment of their learners, provided group assignments, and also individual assignments.

5. Karnataka High School

When the researcher visited the school one of the Pre-Service Teacher was teaching The study of Cell, where she was talking about Mitosis, she was showing the animation of Cell Division with help of Computer for engaging the learners in the classroom, learners found very interesting, and prior to teacher questions learners were started telling what is going on in that AV. In other classes also Pre-Service Teachers were found interesting and actively involved in the class with peers. Classes were interactive, there was use of Internet in laboratories for further information of the units, and some assignments were also like to download the pictures of scientists and their contributions. Students were active and looked much disciplined, recapitulation has been done by Pre-Service Teachers, as there was freedom to express the ideas of learners, there was much noise in the classes. During presentation of the experiments, Pre-Service Teachers allowed the learners to draw the figures on the black board, and also to write the answers on back board to the questions asked by them.

6. Basel Mission School

Here in this school the Science Pre-Service Teachers were discussing on topics like, The study of the Cells, Dynamics, Nature of Matter and subunits of these topics. Pre-Service Teachers have prepare lesson plans based on ICTACLA, they were very active, when the researcher attended the school they had become acquainted with the approach, and shared with the researcher that they really like the approach, initially felt very difficult, as they get experience it become easy and comfortable. Involved all students by making group among the learners for discussion to engage them and asked them to express their ideas without hesitation. The researcher found the learners were enthusiastic. Group wise work has been given for some assignments like balancing the chemical equation, drawing the figures of mitosis and meiosis. Home assignments have been checked and provided positive feedback to the learners, motivated those who have not involved in the group discussion. Learners also felt that group discussion, cooperative learning really made them to learn actively, helps to express the ideas in front of all, work load would be divided and even group assignment was also made them to work easily in the group.

Orientation after Practice Teaching

As the University College of Education syllabus has prescribed that there would be orientation on Innovative teaching practices, so it helped the researcher to provide them more guidance on ICTACLA.

In the audio visual room there was discussion about ICT and web 2.0 applications, already it had been discussed earlier but again as there was opportunity to learn for the Pre-Service Teachers, they felt it should be continued. In the discussion all students exchanged their e-mail and shared the discussion, here Pre-Service Teachers who have already acquainted with this have guided others.

There was class on Approaches of Science teaching; the researcher conducted this class through constructivist perspective using ICT. Where in they were actively participated, generated examples on different methods, each of them with the small concept developed lessons and presented. With the help of power point presentation some of them presented the concepts.

Pre-Service Teachers developed innovative lesson plans based on ICTACLA, for their teaching in their College of Education, it was like Microteaching wherein a small concept has been taken, other Pre-Service Teachers act as their peers and the lesson should be given within stipulated time. Here they need do one lesson on Technology based lesson another would be on Concept attainment model, for both of the Pre-Service Teachers utilized the researcher's introduced ICTACLA and presented the lessons very well. Because then they had a good experience with the model. Here they have made use of OHP, Power point presentations, used animations, used tape recorder for role playing.

3.7.3.2.1 Reflections of Researcher during Observation:

- Managing the learners in the classroom was difficult in the constructivist classes.
- When some Pre-Service Teachers made groups and discussed about some activities, school teachers asked to dictate notes or write on the board so that it helps them for examination.
- While doing group discussion other classes got disturbed.
- When Pre-Service Teachers started the class by engaging the learners with any activity, it made the learners very attentive; they become curious regarding the topic to be discussed.
- It was very difficult for the researcher to take photo snaps without the knowledge of the learners.
- After the orientation programme, Pre-Service Teachers frequently visited the computer laboratory whereas earlier they rarely visited the laboratory.
- By the use of ICTCLA in Science teaching, Pre-Service Teachers and school students felt better as compared to previous classes.

3.8 Objective no. 3

To study the level of professional development of Pre-Service Teachers through ICT Aided Constructivist Learning Approach.

3.8.1 Hypotheses

1. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers As Learners.
2. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers As Teachers.
3. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers both As Learners and As Teachers.
4. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers As Learners.
5. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers As Teachers.
6. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers both As Learners and As Teachers.
7. There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Learners.
8. There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Teachers.
9. There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers both As Learners and Teachers.

10. There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Learners.
11. There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Teachers.
12. There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers both As Learners and Teachers.

3.8.2 Tool

Questionnaire in two forms namely As Learner Perceived form and As Teacher form, where in all Science Pre-Service Teachers were to complete the questionnaire by perceiving themselves as Teachers and as Learners.

3.8.3 Data Collection

Researcher administered the questionnaire to both the Experimental and Control group of Pre-Service Teachers as Pre-Test and Post-Test.

3.8.4 Data Analysis and Interpretation

The collected data were analysed by employing Chi-Square contingency. The total scores of each pre-service teacher of both the groups have been obtained by following the scoring procedure given below.

Table 15. Scoring Procedure for Questionnaire

Response Category	Score for Positive Statements	Scores for Negative Statements
Very Often	5	1
Often	4	2
Sometimes	3	3
Seldom	2	4
Never	1	5

Total score for each of the Pre-Service Teacher was obtained by summing up scores on each item in both the forms of questionnaire.

Table 16. Five Interval Scores of Pre-test and Post-test of the Pre-Service Teachers of the Experimental Group.

Intervals	Test	As Teacher	As Learner	Total (Teacher + Learner)
Very Good	Pre	0	0	0
	Post	17	17	8
Good	Pre	4	2	2
	Post	16	18	25
Average	Pre	14	16	16
	Post	2	0	2
Poor	Pre	14	14	15
	Post	0	0	0
Very Poor	Pre	3	3	2
	Post	0	0	0

Table 17. Five Interval Scores of Pre-test and Post-test of the Pre-Service Teachers of the Control Group.

Intervals	Test	As Teacher	As Learner	Total (Teacher + Learner)
Very Good	Pre	0	0	0
	Post	0	0	0
Good	Pre	2	3	1
	Post	6	6	7
Average	Pre	8	7	9
	Post	12	11	10
Poor	Pre	15	15	17
	Post	12	13	13
Very Poor	Pre	5	5	3
	Post	0	0	0

Data have been analyzed in following ways:

I. As Teacher (Pre-test) to As Teacher (Post-test) of Experimental Group.

Table 18. 2 x 5 Contingency table for Experimental Group of Pre-Service Teachers As Teachers

		VG	G	A	P	VP	N (Total)
Pre	O	0	4	14	14	3	35
	E	8.5	10	8	7	1.5	
Post	O	17	16	2	0	0	35
	E	8.5	10	8	7	1.5	
		17	20	16	14	3	70

$\chi^2 = \sum (fo-fe)^2 / fe =$ **44.76**

Table value =**13.28** at 0.01 level against 4 degrees of freedom

The computed χ^2 value of 44.76 is greater than the table χ^2 value of 13.28 at 0.01 level of significance against 4 degrees of freedom. Therefore the Null Hypotheses that there will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers As Teachers is rejected.

II. As Learner (Pre-test) to As Learner (Post-test) of Experimental Group.

Table 19. 2 x 5 Contingency table for Experimental Group of Pre-Service Teachers As Learner

		VG	G	A	P	VP	N (Total)
Pre	O	0	2	16	14	3	35
	E	8.5	10	8	7	1.5	
Post	O	17	18	0	0	0	35
	E	8.5	10	8	7	1.5	
		17	20	16	14	3	70

$\chi^2 = \sum (fo-fe)^2 / fe =$ **57.42**

Table value = **13.28** at 0.01 level against 4 degrees of freedom

The computed χ^2 value of 57.42 is greater than the table χ^2 value of 13.28 at 0.01 level of significance against 4 degrees of freedom. Therefore the Null Hypotheses that there will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers As Learners is rejected.

III. Both As Learner & As Teacher (Pre-test) to Both As Learner & As Teacher (Post-test) of Experimental group.

Table 20. 2 x 5 Contingency table for Experimental Group of Pre-Service Teachers As both Learner & Teacher

		VG	G	A	P	VP	N (Total)
Pre	O	0	2	16	15	2	35
	E	4	13.5	9	7.5	1	
Post	O	8	25	2	0	0	35
	E	4	13.5	9	7.5	1	
		8	27	18	15	2	70

$\chi^2 = \sum (fo-fe)^2 / fe$ = **50.47**

Table value =**13.28** at 0.01 level against 4 degrees of freedom

The computed χ^2 value of 50.47 is greater than the table χ^2 value of 13.28 at 0.01 level of significance against 4 degrees of freedom. Therefore the Null Hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers both As Teachers and As Learners is rejected.

IV. As Teacher (Pre-test) to As Teacher (Post-test) of Control group

Table 21. 2 x 5 Contingency table for Control Group of Pre-Service Teachers As Teacher

		VG	G	A	P	VP	N (Total)
Pre	O	0	2	8	15	5	30
	E	0	4	10	13.5	2.5	
Post	O	0	6	12	12	0	30
	E	0	4	10	13.5	2.5	
		0	8	20	27	5	60

$\chi^2 = \sum (fo-fe)^2 / fe$ = **5.89**

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

7.81 at 0.05 level of significance against 3 degrees of freedom.

The computed χ^2 value of 5.89 is lesser than the table χ^2 value of 11.34 and 7.81 at 0.01 & 0.05 levels of significance respectively against 3 degrees of freedom. So, the null hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers As Teachers is not rejected.

V. As Learner (Pre-test) to As Learner (Post-test) of Control group

Table 22. 2 x 5 Contingency table for Control Group of Pre-Service Teachers As Learner

		VG	G	A	P	VP	N (Total)
Pre	O	0	3	7	15	5	30
	E	0	4.5	9	14	2.5	
Post	O	0	6	11	13	0	30
	E	0	4.5	9	14	2.5	
		0	9	18	28	5	60

$\chi^2 = \sum (fo-fe)^2 / fe = \mathbf{4.94}$

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

7.81 at 0.05 level of significance against 3 degrees of freedom

The computed χ^2 value of 4.94 is lesser than the Table χ^2 value of 11.34 and 7.81 at 0.01 & 0.05 levels of significance respectively against 3 degrees of freedom. So, the null hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers As Learners is not rejected.

VI. Both As Learner & As Teacher (Pre-test) to Both As Learner & As Teacher (Post-test) of Control group.

Table 23. 2 x 5 Contingency table for Control Group of Pre-Service Teachers As both Learner & Teacher

		VG	G	A	P	VP	N (Total)
Pre	O	0	1	9	17	3	30
	E	0	4	9.5	15	1.5	
Post	O	0	7	10	13	0	30
	E	0	4	9.5	15	1.5	
		0	8	19	30	3	60

$\chi^2 = \sum (fo-fe)^2 / fe = \mathbf{5.71}$

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

7.81 at 0.05level of significance against 3 degrees of freedom

The computed χ^2 value of 5.71 is lesser than the Table χ^2 value of 11.34 and 7.81 at 0.01 & 0.05 levels of significance respectively against 3 degrees of freedom. So, the null hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers both As Learners and Teachers is not rejected.

Comparison between the Experimental and Control groups

I. Experimental group Pre-test As Teachers to Control group Pre-test As Teachers

Table 24. 2 x 5 Contingency table for Pre-test of Experimental & Control Group of Pre-Service Teachers As Teacher

		VG	G	A	P	VP	N (Total)
Exptl Pre	O	0	4	14	14	3	35
	E	0	3.23	11.85	15.62	4.31	
Control Pre	O	0	2	8	15	5	30
	E	0	2.77	10.15	13.38	3.69	
		0	6	22	29	8	65

$\chi^2 = \sum (fo-fe)^2 / fe = \mathbf{1.34}$

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

7.81 at 0.05level of significance against 3 degrees of freedom

The computed χ^2 value of 1.34 is lesser than the table χ^2 value of 11.34 and 7.81 at 0.01 & 0.05 levels of significance respectively against 3 degrees of freedom. So, the null hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Teachers is not rejected.

II. Experimental group Pre-Test As Learners to Control group Pre-Test As Learners

Table 25. 2 x 5 Contingency table for Pre-test of Experimental & Control Group of Pre-Service Teachers As Learner

		VG	G	A	P	VP	N (Total)
Experimental Pre-test	O	0	2	16	14	3	35
	E	0	2.69	12.38	15.62	4.31	
Control Pre-test	O	0	3	7	15	5	30
	E	0	2.31	10.62	13.38	3.69	
		0	5	23	29	8	65

$\chi^2 = \sum (fo-fe)^2 / fe$ = **3.03**

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

7.81 at 0.05 level of significance against 3 degrees of freedom

The computed χ^2 value of 3.03 is lesser than the table χ^2 value of 11.34 and 7.81 at 0.01 & 0.05 levels of significance respectively against 3 degrees of freedom. So, the null hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Learners is not rejected.

III. Experimental group Pre-Test both As Teachers and As Learners to Control group Pre-Test both As Teachers and As Learners

Table 26. 2 x 5 Contingency table for Pre-test of Experimental & Control Group of Pre-Service Teachers As both Learner & Teacher

		VG	G	A	P	VP	N (Total)
Experimental Pre-test	O	0	2	16	15	2	35
	E	0	1.62	13.46	17.23	2.69	
Control Pre-test	O	0	1	9	17	3	30
	E	0	1.38	11.54	14.77	2.31	
		0	3	25	32	5	65

$\chi^2 = \sum (fo-fe)^2 / fe =$ **1.68**

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

7.81 at 0.05 level of significance against 3 degrees of freedom

The computed χ^2 value of 1.68 is lesser than the table χ^2 value of 11.34 and 7.81 at 0.01 & 0.05 levels of significance respectively against 3 degrees of freedom. So, the null hypotheses that There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers both As Teachers and As Learners is not rejected.

IV. Experimental group Post-Test As Teachers to Control group Post-Test As Teachers

Table 27. 2 x 5 Contingency table for Post-test of Experimental & Control Group of Pre-Service Teachers As Teacher

		VG	G	A	P	VP	N (Total)
Experimental Post-test	O	17	16	2	0	0	35
	E	9.15	11.85	7.54	6.46	0	
Control Post-test	O	0	6	12	12	0	30
	E	7.85	10.15	6.46	5.54	0	
		17	22	14	12	0	65

$\chi^2 = \sum (fo-fe)^2 / fe =$ **37.91**

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

The computed χ^2 value of 37.91 is greater than the table χ^2 value of 11.34 at 0.01 level of significance against 3 degrees of freedom. So, There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Teachers is rejected.

V. Experimental group Post-Test As Learner to Control group Post-Test As Learners

Table 28. 2 x 5 Contingency table for Post-test of Experimental & Control Group of Pre-Service Teachers As Learner

		VG	G	A	P	VP	N (Total)
Experimental Post-test	O	17	18	0	0	0	35
	E	9.15	12.92	5.92	7	0	
Control Post-test	O	0	6	11	13	0	30
	E	7.85	11.08	5.08	6	0	
		17	24	11	13	0	65

$\chi^2 = \sum (fo-fe)^2 / fe =$ **44.00**

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

The computed χ^2 value of 44.00 is greater than the table χ^2 value of 11.34 at 0.01 level of significance against 3 degrees of freedom. So, There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Learners is rejected.

VI. Experimental group Post-Test both As Teachers and As Learner to Control group Post-Test both As Teachers and As Learners

Table 29. 2 x 5 Contingency table for Post-test of Experimental & Control Group of Pre-Service Teachers As both Learner & Teacher

		VG	G	A	P	VP	N (Total)
Experimental Post-test	O	8	25	2	0	0	35
	E	4.31	17.23	6.46	7	0	
Control Post-test	O	0	7	10	13	0	30
	E	3.69	14.77	5.54	6	0	
		8	32	12	13	0	65

$\chi^2 = \sum (fo-fe)^2 / fe = \mathbf{33.74}$

Table value = **11.34** at 0.01 level of significance against 3 degrees of freedom

The computed χ^2 value of 33.74 is greater than the Table χ^2 value of 11.34 at 0.01 level of significance against 3 degrees of freedom. So, There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers both As Teachers and As Learners is rejected.

3.8.5 Conclusion

The frequencies at the post- intervention level of the Experimental Group are on the higher points of the scale, namely, Very Good and Good. These have been found to be greater than those at the pre- intervention level of Experimental Group. So, the Intervention has been found to be effective. Also, there has been found no significant difference between the observed frequencies on perceptions of Control Group of Pre-Service Teachers as Learners, As Teachers, and also as Learners and Teachers Pre-Intervention and Post-Intervention. This implies that the Control Group of Pre-Service Teachers was not significantly differed on their perceptions on ICTACLA. Also, there has been found no significant difference between the observed frequencies on perceptions of Experimental Group and Control Group of Pre-Service Teachers as Learner, as Teacher, and as both Learner and Teacher Pre- Intervention. It could be inferred that both the groups were at the same entry level. There has been found a significant difference between the observed frequencies on perceptions of Experimental

Group and Control Group of Pre-Service Teachers as Learners, as Teachers and as both Learners and Teachers Post- Intervention. It could be inferred that, both the groups at Post-Intervention level differed significantly. The difference is attributed to the programme on ICTACLA.

3.9 Content Analysis of Lesson Plans developed by the Pre-Service Teachers employing ICTACLA.

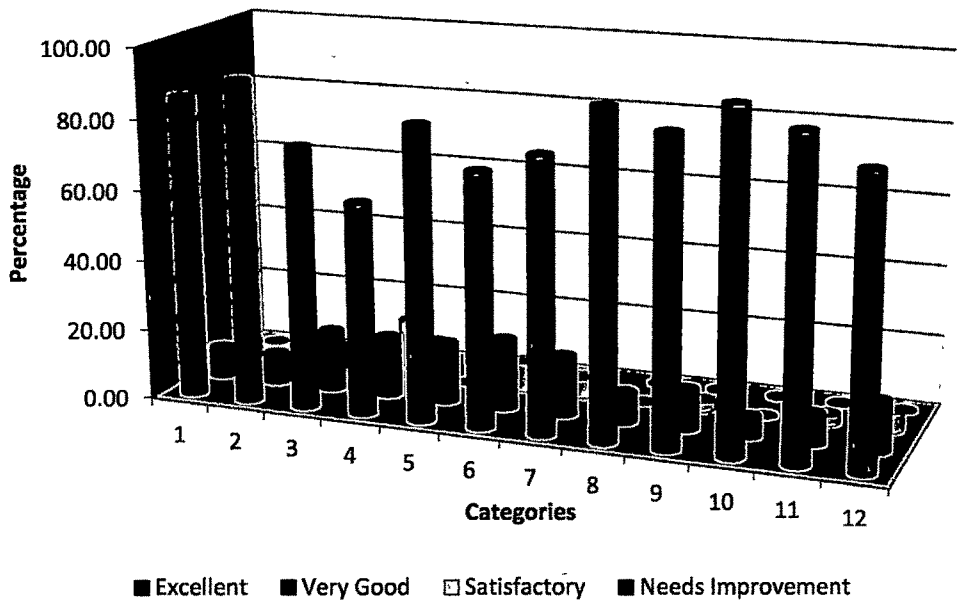
The Pre-Service Teachers constructed the lesson plans based on ICTACLA. And conducted the classes in schools employing ICTACLA in practice teaching. And at the end of the orientation researcher collected lesson plans from the Pre-Service Teachers and content analysed. And also the lesson plans developed by Pre-Service Teachers employing ICTACLA were analysed by constructing rubrics. Rubrics have been used by the Researcher to assess the lesson plans of Pre-Service Teachers which are designed based on the ICTACLA. The constructed Rubric contains 12 Categories, those all 12 categories are assessed on 4 point scale namely, Excellent, Very Good, Satisfactory and Needs Improvement, and they involves certain criteria for assessing which are given in the Rubric.

The Analysis of Lesson Plans is as follows:

Table 30. Frequency, Percentage of Pre-Service Teachers' Lesson Plans Categories

Categories	Excellent		Very Good		Satisfactory		Needs Improvement	
	F	%	F	%	F	%	F	%
1	26	85.71	3	8.57	2	5.71	0	0.00
2	32	91.43	3	8.57	0	0.00	0	0.00
3	26	74.29	6	17 14	3	8.57	0	0.00
4	21	60.00	6	17.14	6	17.14	2	5 71
5	29	82.86	6	17.14	0	0.00	0	0.00
6	25	71.43	7	20.00	3	8.57	0	0.00
7	27	77.14	6	17.14	2	5.71	0	0.00
8	32	91.43	3	8.57	0	0.00	0	0.00
9	30	85 71	4	11.43	1	2.86	0	0.00
10	33	94.29	2	5.71	0	0.00	0	0.00
11	31	88.57	3	8.57	1	2.86	0	0.00
12	28	80.00	5	14.29	2	5.71	0	0.00

Graph 2. Frequency, Percentage of Pre-Service Teachers' Lesson Plans Categories



3.9.1 Interpretation

As per the Content Analysis, All the 35 Lesson Designs have been mostly (60%-94.29%) rated Excellent on all the categories of lesson designs, namely, Learning Objectives, Required Elements, Cooperation, Use of ICT, Use of Students Prior Knowledge, Use of Students' Interest, Use of student-centered activities, Engagement, Exploration, Explanation, Elaboration and Evaluation. Next, the Concentration of the ratings is on very good, ranging from 5.71% to 20.00%. From the Graph 2 it can be found that there have been found rare ratings on Satisfactory and Needs Improvement. So Most of the lessons designs have been found to be Excellent on all the specified categories of lessons designs.

3.9.2 Conclusion

The lessons designed by the Pre-Service Teachers employing ICTACLA were found to be excellent. They have followed 5E method and inquiry approach in most of the lessons. Pre-Service Teachers have well attempted in the process of designing the ICTACLA lessons and initiated into the process of transformation towards Constructivism.