

## *Chapter - 4*

### *Findings and Discussion*

## **CHAPTER - 4**

### **FINDINGS AND DISCUSSION**

#### **4.0 Introduction**

This chapter presents the findings of the study followed by discussion. The discussion goes as reflections on present findings and that of prior research on ICT Aided Constructivist Learning Approach and tries to find the reality through emerging trends.

Objective wise findings have been presented and followed by discussion.

#### **4.1 Findings of Objective no.1**

To develop ICT Aided Constructivist Learning Approach in Science for the Pre-Service Teachers.

- ☐ The programme on ICT Aided Constructivist Learning Approach was well developed by the Researcher in the form of Introductory Manual and Lesson Designs.

#### **4.2 Findings of Objective no. 2.1, 2.2 & 2.3**

To study the effectiveness of ICT Aided Constructivist learning Approach in Science in terms of Reactions of Pre-Service Teachers, School Students and Teacher Educators.

- ☐ The Pre-Service Teachers were found to have favourable reactions towards the developed programme based on ICTACLA.
- ☐ The School Students were found to have favourable reactions towards the developed programme based on ICTACLA.
- ☐ The Teacher Educators were found to have favourable reactions towards the developed programme based on ICTACLA.

##### **4.2.1 Discussion**

There is a significant difference between observed frequencies and expected frequencies against equal probability hypothesis on various statements of Reaction scales. Pre-Service Teachers, School Students and Teacher Educators have been found to have favourable reactions towards ICTACLA. The Present findings further support the findings of 59 studies of the past. In the present study Pre-Service Teachers opined that, Constructivist principles made them to think in constructivist ways about Science,

through group work one can develop leadership, communication, creative and critical thinking, problem solving skills. It developed Interest and sustained the curiosity in Science and helped them to become netizens and Info-savvy and Techno-savvy. The school students opined that they enjoyed the classes of Pre-Service Teachers by ICTACLA. They have shown interest in learning. They liked the freedom given in the class and also it helped them to get better grade. Problem oriented activities made them critical and creative thinkers, whereas, group learning helped to develop positive attitude towards Science. Majority of the Teacher Educators found to have favourable reactions towards ICTACLA. The Teacher Educators are of the opinion that the ICTACLA enables the learners to think and create new knowledge based on prior experiences, helps them as well as all kinds of learners to get updated with current reforms in general Science in particular through Internet. It helps to become info-savvy. It provides associations with real life experiences, which encourages the meaningful learning. It develops communication skills and provides wide opportunity for assessment as it encompasses various evaluation techniques to answer both how to learn and what to learn. This is in congruence with findings of Jett and Pamela (2009).

### **4.3 Findings of Objective no. 2.4**

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

- There has been found significant difference between the Post-Test mean and Pre-Test mean scores of single group Pre-Test and Post-test of the School Students. So the classes conducted through ICTACLA in schools by Pre-Service Teachers have been found to be effective. So the Intervention provided to the Pre-Service Teachers has been found to be effective.

#### **4.3.1 Discussion**

All the Science Pre-Service Teachers were oriented on ICTACLA in Science. During practice teaching they employed ICTACLA in Science classes and found that there was a significant difference between post-test mean scores and pre-test mean scores. The post-test mean scores were greater than the pre-test mean scores. So, the classes conducted by Pre-Service Teachers by employing ICTACLA were found to be effective. Student achievement in Science subject is one of the key factors of professionally developed teachers. In connection to this finding, O'connell & Francis

(2009) found that mature professional learning activities connected by constructivist strategies and technology lead to increased student achievement. Out of 15 reviews on achievement and ICTACLA, 13 studies found that the constructivist strategies and aid of technology in constructivist classes were effective as compared to traditional classes. Two studies by Dethlefs (2002) and Duffy (1995) found that no specific dimensions of constructivist learning environment were related to student achievement and traditional class students achieved more than constructivist class. There was difficulty in connecting what they learn in computer and in class. The present study emphasized the integration of ICT in constructivist classroom, so that, there would be no isolation of ICT and Constructivism since both are embedded with each other. Hence the difficulty of connecting between the two is not there.

#### **4.4 Findings of 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.

- ☐ A large majority of the Pre-Service Teachers have very often and often manifested ICT Aided Constructivist behaviours in the Practice Teaching classes, as observed by the Researcher, The Science Pre-Service Teachers and Teacher Educators.
- ☐ There has been found to be no significant difference in the observations of practice teaching lessons by the Researchers, Pre-Service Teachers and Teacher Educators. Hence the observations made by all the three are in tune with each other.

##### **4.4.1 Discussion**

The observations made by the Researcher, Pre-Service Teachers and Teacher Educators were analysed, and it has been found that a large majority of the Pre-Service Teachers have very often and often manifested ICT Aided Constructivist behaviours in Practice Teaching classes as observed by the Researchers, Pre-Service Teachers and Teacher Educators.

Also, there has been found to be no significant difference amongst the observations of practice teaching lessons by the Researcher, Pre-Service Teachers and Teacher Educators. Hence the observations made by all the three are in tune with each other. It is since Pre-Service Teachers have designed the lessons by employing ICTACLA and practiced number of times in the guidance classes and during practice teaching they implemented the designed lessons. Even when the ICT facilities were not available, Pre-Service Teachers could manage the materials required for their classes and followed the principles of constructivist learning approach in their classes. This was observed by Researcher as a participant observer, Peer-Pre-Service Teachers and Their respective Teacher Educators. The Pre-Service Teachers attempted to connect the theory and practice. Pre-Service Teachers practiced the ICTACLA in Science during practice teaching on which they were oriented during guidance classes in college of Teacher Education. The present findings support the findings of Kroll (2004), who found that, It has helped Pre-Service Teachers to investigate their own ideas of learning and teaching with constructivist theory in order to think critically about their own practices. The findings are in congruence with other reviewed studies namely, Forbes (2009), Lourdasamy et.al., (2001), Bimbola (2010), Boone & Kent (2009), Galting & Pfitzner (2010). Yilmaz et al., (2011), wherein they found that through this approach PST could translate their espoused inquiry into practice and provided novel insights. Forbes (2009) and Bimbola et al., (2010) strongly recommends that Science teachers should incorporate this approach. Galting & Pfitzner (2010) found constructivist methods have stronger impact on improving Pre-Service Teachers beliefs & skills to design inquiry based instruction for diverse learners & Yilmaz (2011) found Pre-Service Teachers preferred Constructivist teaching views than traditional teaching views. Out of 25 studies reviewed on effectiveness ICTACLA on Pre-Service Teachers practices, 23 were found to be in congruence with present finding. And a study by Sounders & Soundra (2009) found there was no significant difference between teachers who implement constructivist practices and those who do not. Chai et al., (2009) Pre-Service Teachers found to have less constructivism in beliefs and teaching. The observations by all the three viz, Researcher, Pre-Service Teachers and Teacher Educators found that the learners get benefitted from implementation of ICTACLA, wherein the learners demonstrated a willingness to

modify their earlier ideas, respected each and every other student ideas, carried out experiments, could classify, observe and infer the results of the experiments, could interact with peer and teachers, helped by scaffolding techniques of the approach. Demonstrated a desire to use internet for learning scientific concepts. All these sub findings support various studies namely Sridevi (2008), Williamson & William (2000), Gopal & Tamilselvi (2009), Akar (2003), Loyens et al.,(2009), Yager et al., (2010), Cubuku & Zuhail (2008), Tsai & Lee (2005), Oslen (2000). Also the findings are in congruence with the findings of Ramkumar (2003) that the students' autonomy to learn has been increased and they showed a willingness to change the ideas in light of evidence in the classes conducted through instructional strategy based on constructivism.

#### **4.5 Findings of Objective no. 2.6**

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

##### **4.5.1 Semi-Structured Interview**

- ☐ ICTACLA in Science has been found to be innovative through which the teaching-learning in Science has become meaningful and ICTACLA has been found to be very effective in Science Teaching & Learning, as evident through the Interview by the Researcher with the Pre-Service Teachers.
- ☐ ICTACLA increases the divergent thinking of students.
- ☐ ICTACLA was found to be valuable in connecting prior knowledge with the present one.
- ☐ ICTACLA was found to develop individual accountability along with group consideration.
- ☐ ICTACLA was found to create, develop and sustain the curiosity and interest in Science.
- ☐ The role of teacher in ICTACLA was found to be complex and equally important as that of learners.
- ☐ At the end of the orientation, Pre-Service Teachers were found to be confident, self-reliant and resourceful.
- ☐ ICTACLA was found to increase communication skills of students.

- ☐ Practicing ICTACLA made all Pre-Service Teachers perfect in designing lesson plans.
- ☐ Management of the classroom and time management were found to be challenging.
- ☐ School students were found to be interested in classes employing ICTACLA
- ☐ ICTACLA was found to offer congenial environment, wherein students came out with constructive ideas.
- ☐ ICTACLA was found to increase the Techno-Savvy and Info-Savvy Skills of Pre-Service Teachers.
- ☐ ICTACLA was found to flow with learning by doing.
- ☐ ICTACLA was found to be good strategy to write effective lesson plans in Science.
- ☐ ICTACLA was found to be flexible and innovative approach.
- ☐ ICTACLA increased the achievement of School Students in Science.
- ☐ Apart from non-availability of ICT in some school, Pre-Service Teachers made all attempts and their own arrangements to teach in the classroom with ICTACLA.
- ☐ Pre-Service Teachers were found to be confused initially to find their niche between University Prescribed lesson designing, and the Researcher introduced approach that is ICTACLA.
- ☐ Time factor was one of the limitations for Pre-Service Teachers.
- ☐ In school, after group discussions, and activities, other class teachers found to suggest to conduct class silently and to provide the notes. Sometimes it created hindrances.
- ☐ Pre-Service Teachers felt that they became netizens and future ready teachers.
- ☐ Pre-Service Teachers suggested that Universities should make efforts to integrate ICTACLA in Teacher Education Curriculum.
- ☐ Pre-Service Teachers opined that Teacher Education Colleges and all Schools should possess well- equipped Computers and Science laboratories.
- ☐ Teacher Education Colleges should also make efforts to invite expertise in innovative approach in teaching-learning, like, ICTACLA.
- ☐ Research and Development should be done on ICTACLA in all the subjects.
- ☐ Orientation on ICTACLA could also be given to the In-Service Science Teachers at school level.

#### **4.5.1.1 Discussion**

ICTACLA in Science has been found to be innovative through which Science teaching-learning has become meaningful and ICTACLA has been found to be very effective in Science. It also takes care of individual accountability along with the group consideration. ICTACLA has been found to develop and sustain the curiosity and interest in the Science Classes. This finding supports the findings of Kroll (2011), Forbes (2009) that it provided novel insights into the teaching-learning of Science. KyogNa (2009), Active learning strategies was found to have a positive effect on the student learning of Science. It enhanced students' critical thinking. Pre-Service Teachers stated that learning by doing flows with ICTACLA. It provides a lot of freedom and flexibility in designing the lessons. Even though in practice teaching schools, the facility of ICT was not there, but Pre-Service Teachers attempted to make their own arrangements. Use of ICTACLA lead to increased achievement of school students, which further establishes the earlier findings. Pre-Service Teachers opined that Teacher Education Colleges and all Schools should be well-equipped with computer and Science laboratories and universities should make efforts to integrate ICTACLA in Teacher Education Colleges. It needs a lot of Research & Development. Marjorie & Terpstra (2009), suggest that Teacher Educators need to call explicit attention to educational technology modelling. Howard & Sester (2004) & Kimetlal (2011), also opined that definition of practice of implementation of constructive roles needs further research at all schools across the country and research is needed to refine the understanding of meaningful technology integration.

#### **4.5.2 Focused Group Discussion**

- ☐ ICTACLA was found to be very effective approach in Science as evident through Focussed Group Discussion.
- ☐ ICTACLA was found to be learner friendly.
- ☐ The abstract concepts of Science could be made concrete through ICTACLA.
- ☐ ICTACLA was found to be a blend of various approaches.
- ☐ ICTACLA was found to be motivating Pre-Service Teachers towards teaching Profession.
- ☐ Meaningful Learning has been found through ICTACLA.
- ☐ ICTACLA was found to be challenging for the Pre-Service Teachers and School Students.



- ❑ The orientation programme on ICTACLA in Science and its implementation on the Pre-Service Teachers has had substantive returns.
- ❑ It is evident that the use of ICTACLA has made the Pre-Service Teachers confident in using this innovative approach in teaching Science.
- ❑ The development of the lessons using ICTACLA has made the Pre-Service Teachers engage themselves completely and enjoyed the process.
- ❑ Integration of ICT applications into the lessons, engaging in virtual world of Science, hyper linking the information with artifacts, discussion 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.
- ❑ Pre-Service Teachers suggested that, ICTACLA is a powerful approach, which can be well integrated in Teacher Education and School Education.
- ❑ Action Research can be done at different levels to study the impact of ICTACLA.
- ❑ ICTACLA develops co-operative and collaborative learning environments.
- ❑ ICTACLA was found to be an effective approach for teaching-learning Science for Wholistic development of learners and teachers.

#### **4.5.2.1 Discussion**

The Focussed Group Discussion with the Science Pre-Service Teachers has generated insight into the ICTACLA. ICT Aided Constructivism facilitates meaningful learning. Meaning making is central to the transformative learning (Freed & Maxine, 2009). It is a novel approach which fits for most of the Science concepts. ICTACLA is a blend of different approaches. ICTACLA is learner friendly and allows the learner to think divergently & independently. The integration of ICTACLA has substantive returns. Pre-Service Teachers are engaged completely and enjoy the whole process. It develops different skills, such as Communication, Creative thinking, Critical thinking and problem solving, and helps in wholistic development of the learners. All these present findings support the researches, namely, Lord (1997), KyongNA (2009), Galting & Pfitzner (2010), Williamsom & William (2010). Learning if joyful during integration of ICTACLA, has stronger impact on Pre-Service Teachers, & facilitates knowledge construction, co-operative & collaborative learning, authentic learning, self-regulation and develops Science process skills, creative thinking, critical thinking and problem solving skills among learners. Pre-Service Teachers Opined that, Integration of ICTACLA was highly challenging initially, but, due to continuous efforts, interest and

curiosity regarding this new approach made them get adjusted to the ICTACLA. The facilities of ICT in the College of Education are usually less as compared to other professional training centres. Teacher Education Colleges are practicing traditional approaches mainly. There is less use of innovative approaches. Motivation to use such innovative approaches is not there. After putting efforts to integrate ICTACLA in College of Education the positive results have been found regarding integration. Everybody could come to know it is possible if they could struggle even in the presence of various constraints.

#### **4.6 Findings of 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.

##### **4.6.1 Pre-Service Teachers Dairy**

- ☐ Constructivism has been found to demand challenging environment.
- ☐ Teachers as well as learners were found to be the discovers of knowledge.
- ☐ Pre-Service Teachers were found to experience Actual as well as Virtual world of Science through ICTACLA.
- ☐ Engaging the learners has been found to increase the learners' interest and curiosity.
- ☐ ICTACLA facilitates meaningful learning.
- ☐ Designing Science lessons employing ICTACLA has been found to be relatively meaningful. It involved higher order thinking to imagine the Science Concepts in multiple Perspectives.
- ☐ When there was no facility of ICT in school, a few Pre-Service Teachers followed only 5 E without the help of ICT, but they designed lessons on ICTACLA.
- ☐ Despite administrative refusal not to use smart class, Pre-Service Teachers made all efforts to use their own resources.
- ☐ Pre-Service Teachers found that the investigators' approach to them was basically constructive.
- ☐ Pre-Service Teachers found that motivation provided by the Investigator played a very important role to use ICTACLA.
- ☐ Field visits were certainly found to increase the knowledge and understanding of Science Concepts, Developed Leadership and Communication skills.

- ☐ Teaching in co-operative learning groups leads to better learning, but school climate doesn't allow to discuss in groups.
- ☐ ICTACLA was found to increase Meta-Cognition of Pre-Service Teachers.
- ☐ Problem-Solving Environment in ICTACLA developed the learners into creative and critical thinkers.
- ☐ The prescribed syllabus could not be completed within stipulated time.
- ☐ Pre-Service Teachers found the school students excited in class using ICTACLA.
- ☐ The Pre-Service Teachers experienced a new and efficient way of teaching-learning as evident through Pre-Service Teachers' Diaries.
- ☐ It has been found that the Pre-Service Teachers were interested to undergo orientation on ICTACLA in future also.
- ☐ Pre-Service Teachers felt that the orientation of ICTACLA could be started from I semester and continued in II semester.
- ☐ It has been found that ICTACLA has developed the confidence among Pre-Service Teachers.
- ☐ It has been found that 'I do I understand' really suits the constructivist classes.
- ☐ It has been found that the subject like Science really needs innovative strategies like, ICTACLA.
- ☐ It has been found that designing the lesson plans by employing ICTACLA provides ample opportunities for Pre-Service Teachers to design the lesson in an effective way.
- ☐ It has been found that by employing ICTACLA, the teachers can know each student's profile and helps in selecting and implementing different strategies.
- ☐ It has been found that in classroom teaching through ICTACLA, the learners are found to be very active, enthusiastic throughout the class.
- ☐ It has been found that ICTACLA creates and sustains the curiosity of the learners.
- ☐ It has been found that the evaluation is an opportunity for learners and teachers.
- ☐ It has been found that implementation of ICTACLA in Science in all classes is difficult, due to lack of facilities and student-teacher ratio.
- ☐ Professional Development programmes on ICTACLA should be provided for In-Service Teachers also.

#### **4.6.1.1 Discussion**

The emerging status of ICTACLA in Pre-Service Teacher Education for Professional Development of Pre-Service Teachers has also been drawn from the daily diaries of Pre-Service Teachers, from which the researcher found that the Constructivist learning aided with ICT facilitates meaningful learning. It needs the challenging environment of learning, wherein the learners would be the creators, discoverers and constructors of their own knowledge. Through this approach Pre-Service Teachers experienced the actual as well as virtual world of Science. They usually followed 5E approach rather than 7E, which is similar to 5E. Despite lack of ICT facilities Pre-Service Teachers made efforts to integrate ICTACLA wherever possible. Field visit enlightened them about the Science concepts, wherein it was realized that children should be exposed to as many as direct experiences as possible. School must provide numerous opportunities for children to explore, inquire and manipulate. First hand experiences are vital. Piaget & Barbel (1958) have gone even further with the relationship of direct sensory experiences to learning. They state that the children's ability to deal with the broad concepts of space, time, matter and causality depends upon a type of thinking that slowly develops from the direct sensory experience. The present finding also supports the Galting & Pfitzner (2010) that the field based methods have a stronger impact on improving Pre-Service Teachers' beliefs and skills in regard to designing inquiry based instruction for diverse learners. Integration of ICTACLA has lead to development of higher order thinking. Beatrice & Hall (2010) also found that it gives students more opportunities to practice desired constructivist learning skills and higher order skills. Pre-Service Teachers suggested that such orientations should also be provided to In-Service Science teachers. Writing the daily diary for all the pre-service teachers helped to express their ideas openly and constructively, increased the writing skills, and encouraged them to record the daily activities. Beatrice & Hall (2010) also stresses importance of informal diary writing on the part of students. Pre-Service Teacher's diaries provided the insight to the researcher towards Pre-Service Teachers ideas regarding ICTACLA.

#### **4.6.2 Researchers Diary for Field Notes**

- ☐ Through Researchers' Field Notes it has been found that the Pre-Service Teachers' got acquainted with the ICTACLA progressively, and found it to be an effective approach.
- ☐ Constructivism has been found to be Philosophy of meaningful learning.
- ☐ It has been found that children should be exposed to first-hand experiences, which helps them explore new knowledge.
- ☐ It has been found that the University based lesson plan emphasises on black board writing. It was found to be stereotypic in nature.
- ☐ It has been found that the lesson plans employing ICTACLA were found to be innovative and involving.
- ☐ It has been found that the Science teaching in the College of Education is being done mainly through lecture method.
- ☐ It has been found that time is not sufficient for Pre-Service Teachers to complete the tasks.
- ☐ It has been found that Pre-Service Teachers have shown more Interest in group activities.
- ☐ It has been found that apart from development of Science knowledge and understanding of Pre-Service Teachers, students as well developed in different skills, namely, communication skills, inter-personal and intra-personal skills, leadership skill and problem solving skills.
- ☐ It has been found that peer-peer discussion leads to more learning in the class and outside the class.
- ☐ All the Pre-Service Teachers have used 5E approach and Inquiry models in designing the lessons.
- ☐ It has been found that by giving home assignments, which are at the application level and relate to the society really helps the learner to enrich the constructed knowledge.
- ☐ It has been found that the Pre-Service Teachers communicated virtually after the orientation.
- ☐ It has been found that the teachers' role is highly valued because he/she needs to be always guiding students at their level and facilitating the learning.
- ☐ It has been found that ICTACLA helped Pre-Service Teachers for their Innovative lesson presentations.
- ☐ Managing the Pre-Service Teachers during orientation was challenging for the Researcher.
- ☐ Programs of Teacher Education should be lengthened and strengthened.

#### **4.6.2.1 Discussion**

The researcher throughout the data collection process maintained a diary & noted important points from administering the Pre-Test, through orientation on ICTACLA, Practice of ICTACLA and implementation at school during practice teaching, field visit, innovative lesson practicing up to administering Post-Test on Pre-Service Teachers. Researcher as orientor/mentor/guide and also as participant observer observed the whole process and made reflections in the diary. The researcher defines the constructivism as a philosophy of meaningful learning. It has been found that the Pre-Service Teachers got acquainted with ICTACLA progressively and found it to be an effective approach. Children should be given opportunities to explore the knowledge, provided direct experiences through activities, experiments, games, field visits virtual, as well as, actual. ICTACLA has been found to be innovative and involves process of thinking. Pre-Service Teachers have shown more interest in it, felt a lot of difficulty at the initial stage, but due to continuous practice, they could design lessons employing ICTACLA and prepare accordingly. In ICTACLA role of teacher is also equally important as that of learners. ICTACLA also helped Pre-Service Teachers in developing innovative lessons. During the process of integration of ICTACLA, Pre-Service Teachers developed different skills as the orientation was done by making groups, group discussions and presentations and demonstrations. Pre-Service Teachers developed communication skills, creative thinking, critical thinking, problem solving skills as evident through their discussions. Providing assignments to learners at application level & connecting the classroom knowledge to society facilitates meaningful learning. Pre-Service Teachers used 5E approach and inquiry based models in their lessons, communicated in virtual space. Pre-Service Teachers were able to prepare power point presentations and use other e-gadgets for teaching-learning purpose. Also school students liked this approach and enjoyed during classes and scored higher on their achievement tests. ICTACLA provided insights into the Constructivism aided by ICT. These findings are in congruence with findings of Forbes (2009), Gopal & Tamilselvi (2009), Galting & Pfitner (2010), Williamson & William (2010), Brooks & John (2010), Dogru & Kalender (2007), Sridevi (2008), McDavitt & David (1995), Smeets & Mooji (2001), Ann & Koch (2009). ICTACLA helps in meaning making process to facilitate better understanding of the process. Freed & Maxine (2009) called it a transformative meaning making. Scaffolding was found to be very important technique to engage the learners in the classroom.

Scaffolding prior concepts regarding the concepts to learn today really works well. Learners feel interesting and attentive. Brush & Saye (2001)'s & Gaensler & Edwina (2004) finding also flows with the present finding. But the facilities required for the successful integration were not adequate. Their existence was to exhibit, not to use. In Teacher Education College the traditional method of guidance does not need all these facilities. University prescribed lesson plan writing was stereotyped wherein the importance was on black board writing. In schools also the teaching process is stereotypic in nature. Apart from the schools are smart class future ready, not ready to provide the facilities to use. The technology resources should be more accessible and teacher teaching in technology should be more timely and appropriate (Jolonski, 2009), Cubuku & Zuhail (2008) throughout the world, because the internet infrastructure has developed quite rapidly. It has been offered as an alternative way for a rich learning and teaching environment. More challenging again is time. During one year B.Ed. programme to complete all the tasks and provide time for researcher for orientation was highly challenging. Researcher motivation to Pre-Service Teachers worked out. When Pre-Service Teachers find the importance and innovativeness of ICTACLA, they themselves come up with interest for participation. And other limitation is that, the orientation programme could have been started from the first semester because the acquaintance with ICTACLA would be more if they get orientation during the whole year. In the first semester they practiced conventional lesson plans and in second semester Researchers' ICTACLA. So, time was not sufficient for Pre-Service Teachers. Also, the Pre-Service Teachers got confused to find their niche between university based traditional lesson designing and ICTACLA based lesson designing and it supports the ideas of Kelly, (2000) & Sullivan et al., (2000).

In schools during practice teaching Pre-Service Teacher conducted classes employing ICTACLA. Pre-Service Teachers allowed students to express more of their ideas, engaged them in learning, a lot of freedom provided to them, evaluated the students throughout the class. So the school students also enjoyed the classes with Pre-Service Teachers. Group discussions were there in most of the classes but other class teachers suggested that not to make noise and to take classes silently, to give notes rather than to discuss. This kinds of opinions hindered Pre-Service Teachers. Completing the unit provided by the school would be difficult as ICTACLA integrated classes would consume more time.

After orientation Pre-Service Teachers frequently visited the computer laboratory, whereas earlier they visited rarely. It could be inferred that Pre-Service Teachers were motivated through ICTACLA. Kimetal (2011) says research is needed to refine the understanding of ICTACLA. Howard & Sester (2004) also opined that further research is needed at school level. The researcher also is of the same view that rigorous research is needed at both the teacher education and school levels. Efforts are needed to bridge theory and practice. The present research tries to bridge Teacher Education and School Education.

#### **4.7 Findings of Objective no. 3**

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

- ☐ There has been found a significant difference between the observed frequencies on perceptions of Experimental group of Pre-Service Teachers as Learners Pre-Intervention and Post-Intervention.
- ☐ There has been found a significant difference between the observed frequencies on perceptions of Experimental group of Pre-Service Teachers as Teachers Pre-Intervention and Post-Intervention.
- ☐ There has been found a significant difference between the observed frequencies on perceptions of Experimental group of Pre-Service Teachers both As Learners and As Teachers Pre - Intervention and Post - Intervention.
- ☐ 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.
- ☐ There has been found no significant difference between the observed frequencies on perceptions of Control group of Pre-Service Teachers As Learners Pre-Intervention and Post Intervention.
- ☐ There has been found no significant difference between the observed frequencies on perceptions of Control group of Pre-Service Teachers As Teachers Pre-Intervention and Post Intervention.
- ☐ There has been found no significant difference between the observed frequencies on perceptions of Control group of Pre-Service Teachers both As Learners and As Teachers Pre-Intervention and Post Intervention.



- ☐ There has been found no significant difference between the observed frequencies on perceptions of Experimental group and Control group of Pre-Service Teachers As Learners Pre-Intervention.
- ☐ There has been found no significant difference between the observed frequencies on perceptions of Experimental group and Control group of Pre-Service Teachers As Teachers Pre-Intervention.
- ☐ There has been found no significant difference between the observed frequencies on perceptions of Experimental group and Control group of Pre-Service Teachers both As Learners and As Teachers Pre-Intervention.
- ☐ 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 Post-Intervention.
- ☐ There has been found a significant difference between the observed frequencies on perceptions of Experimental group and Control group of Pre-Service Teachers As Teachers Post-Intervention.
- ☐ There has been found a significant difference between the observed frequencies on perceptions of Experimental group and Control group of Pre-Service Teachers both As Learners and As Teachers Post-Intervention.

#### **4.7.1 Discussion**

The Researcher administered Pre-Test on the Pre-Service Teachers to study their entry professional level on ICTACLA. The Researcher considered the Pre-Service Teachers As both Learners and Teachers. The Researcher administered a questionnaire on Constructivist Practices aided by ICT and asked the Pre-Service Teachers to respond perceiving themselves As both learners and teachers. After orientation of the Pre-Service Teachers on ICTACLA, the Pre-Service Teachers designed the lessons employing ICTACLA and practiced during practice teaching. At the end pre-service teachers were administered the same questionnaire to know the post-status.

There has been found a significant difference between the observed frequencies on perceptions of Experimental group of Pre-Service Teachers as Learners, as Teachers and also as both Learners and As Teachers Pre-Intervention and Post- Intervention.

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 both 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, which establishes the effectiveness of the ICTACLA for Pre- Service Teachers. The orientation of the Pre-Service Teachers on ICTACLA to develop them professionally was found to be effective. It is also evident through prior findings of the same study, namely, through Academic achievement of school students, favourable reactions of Pre-Service Teachers, School Students and Teacher Educators, Observations by Researcher, Pre-Service Teachers and Teacher Educators, through Focused Group Discussion with Pre-Service Teachers, Semi-structured Interview, through Pre-Service Teachers Diary and Researcher Diary for field note. It reveals that the developed programme on ICTACLA was effective. The present finding that the ICTACLA intervention was found to be effective is in congruence with 48 different studies at different levels that the constructivist learning environment and Integration of ICT in Constructivist learning environment were found to be effective. Lourdasamy et al., (2001) strongly felt that the ICT Aided Constructivist Learning Environment could be successfully used in Teacher Education by creating interesting learning activities and motivating Pre-

Service Teachers. 100% of the sample of Pre-Service Teachers found the course on ICTACLA effective, which helped them to grow and develop professionally (Martha, 2006). Boone & Kent (2009) were of the view that impact of professional development programme for teachers could be seen through students' achievement level after practicing at school level. They suggested that such researches are important for social change in education as these try to close the gap between the theory and practice in the classroom. It corroborates the present study and findings. Marjorie & Terpstra (2009) revealed that after practicing technology integration classes, the Pre-Service Teachers exhibited more technology knowledge and application skills.

In the College of Education as well as in the sample schools the facilities for integration of ICT were very less. This has been a major drawback of schools where in there are less avenues for implementation of new approaches. Lutonsky & Rose (2009), also highlighted on how technology access is more important for integration. They also specified that professional development in terms of training of both the in-service and pre-service teachers is needed.

During orientation of the Pre-Service Teachers on ICTACLA initially it was difficult to seek the attention of all Science Pre-Service Teachers as they were too busy in their guidance for practice teaching and there was time constraint. But once the Pre-Service Teachers were tuned to the practice of lesson designing it became easier. Researcher finds that the time management on the part of the researcher for Pre-Service Teachers was challenging. In this context Lourdusamy et al., (2001) suggest that time management is a factor that needs to help students to cope up with. The Researcher felt that it is desirable to introduce such orientation from beginning in the first semester, because then the Pre-Service Teachers could practice earlier. In the second semester due to sudden introduction of ICTACLA, they were in a confusion that which method to follow - University prescribed or ICTACLA? This supports the idea of Sullivan et al. (2000). Through this approach Pre-Service Teachers developed in different areas apart from Science that is they could think critically before selecting any area to teach, think creatively for developing teaching aids and select evaluation tools and design their lessons. Due to group discussions the Pre-Service Teachers developed leadership skills, problem-solving skills and divergent thinking. It has helped the Pre-Service Teachers to incorporate their own ideas of learning and teaching with ICTACLA to

critically think on their practice. During accessing the Internet and working with computer they developed their info-savvy skills and techno-savvy skills. When the Pre-Service Teachers demonstrated the classes in groups, sharing and learning of new ideas took place which helped them to understand Science. The Pre-Service Teachers realised their capabilities and also with the help of researcher they could design various lessons based on inquiry and 5E methods and prepare different teaching aids. It flows with the ideas of Vygotsky's Zone of Proximal Development (ZPD), wherein it is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. All the Pre-Service Teachers fully utilized the freedom given by the researcher in designing the lessons and they liked it. During practice teaching also they practiced whatever they learnt in the College. The school students also enjoyed the process of learning with the Pre-Service Teachers. They scored well in their achievement, in turn the discussions, animations, presentations and demonstrations also increased interest of students and sustained the curiosity. All these findings support the findings of studies conducted by Sridevi (2008), Kroll (2004), McDavitt & David S.(1995), Gibson (2000), Willimason & William (2010), Forbes (2009), Akar (2003), Bimbola et al. (2010), Yager et al., (2010), Cubuku & Zuhail (2008), Yilmaz et al., (2011), Petras & Carol-Lynn (2010), Tsai & Lee (2005), Smeets & Mooji (2001), O'Connell & Francil (2009). On the other hand the present findings stand deviant from the findings of Duffy et. al., (1995), Chai et. al., (2009), Sounders and Soundra (2009). They found that each strategy is important as other, didn't find much difference between constructivist classes and traditional classes. According to them the Pre-Service Teachers indicated more relativist epistemological outlooks and less constructivist beliefs in their training programme. There was no significant difference found between teachers who implement constructivist practices and those who did not.

The findings of Galting & Pfitzner (2010) revealed that both constructivist and traditional instructions have strengths and weakness, but constructivist methods have strong impact on improving the beliefs and skills of the Pre-Service Teachers with regard to designing inquiry based instruction for diverse learners. The traditional course also promoted confidence in Pre-Service Teachers to teach different Science contents.

A paradigm shift is needed to absorb new ideas and abandon traditional view of teaching-learning. Those who are not familiar with the constructivist approach using ICT as tools may first require a change in the educational philosophy (Healy, 1998). Accordingly, in the present study the Pre-Service Teacher's transformed their view of teaching-learning towards ICTACLA, which is the dire need of the changing society.

#### **4.8 Findings and Discussion of Rubric for Lesson Plans**

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%. There have been found ratings on Satisfactory and Needs Improvement. Most of the lessons designs have been found to be Excellent on all the specified categories of lesson designs. This shows that most of the Pre-Service Teachers integrated ICTACLA in their lesson designs. This finding is in congruence with the research process of Boon & Kent (2009) that who participate in professional development programme will change their classroom practices and considered the lesson planning also. This highlights the importance of lesson designs.

## 4.9 Conclusion

Science as a discipline, as way of inquiry keeps on gifting the mankind with various innovations for livelihood. The heart of the Science lies not in the conclusions reached, but in the method of observation, experimentation and mathematical reasoning by which conclusions are established (Dewey 1993). As a discipline Science needs the learners to be the discoverers to bring the innovations, NCF (2000) viewed the child as a discoverer or scientist wherein he takes up the role of scientist and develops skills and attitudes and construct his own knowledge. Hence it is desirable that the School Education should promote the students to be the constructors and discoverers of knowledge and the teachers as facilitators, guides and mentors. NCF (2005) Teacher is required to be a facilitator of children's learning in a manner that the child is helped to construct her knowledge. The Constructivist Learning Environment provides the opportunities for the teachers to transform into facilitators. ICT provides a variety of learning experiences required for the constructivist classrooms. If school teachers are expected to bring about a revolution in their approach to teaching in the school, the same revolution must precede and find a place in the Colleges of Education. There is a need to equip teachers with competencies to use ICT for their own professional development (NCF, 2009). Technology alone never invokes learning. It needs to be embedded with constructivist learning theory for the meaningful learning with varieties of learning tools. So in the present study the importance of teacher's preparation and support for the successful implementation of constructivist approach using ICT as tools for the teaching Science is emphasized. The Researcher developed programme on ICTACLA for orienting the Pre-Service Teachers. The effectiveness of the programme has been studied at both the Teacher Education and School Level. Such attempts do bridge the gap between Teacher Education and School Education. It corroborates with the suggestion of Boone & Kent (2009) that there is need to conduct research at the Teacher Education Level and finds it's utility at the school level so as to bridge the gap between Theory and Practice. The present findings reveal that ICTACLA has been found to be effective.