AN ANALYSIS OF THE USE OF EDUCATIONAL

TECHNOLOGY FOR SCIENCE TEACHING IN

PAKISTAN

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By

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A thesis submitted in partial fulfilment of the requirement for the degree
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بسم الله الرحمن الرحيم

SUPERVISOR'S CERTIFICATE

The thesis titled "An Analysis of the Use of Educational Technology for Science Teaching in Pakistan" submitted by Mr. Mohammad Abid Khan, Reg.No.121 FSS/PHD/EDU/F16 is partial fulfilment of PhD degree in Education, has been completed under my guidance and supervision. I am satisfied with the quality of student's research work and allow him to submit this for further process as per IIUI rules and regulation.

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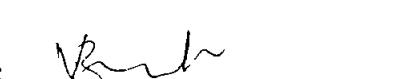
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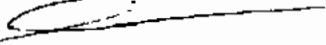
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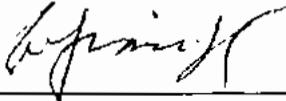
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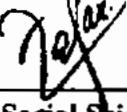
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AUTHOR'S DECLARATION

I, Mohammad Abid Khan, Reg. No. 121-FSS/PHDEDU/F16 as a student of PhD in Education at International Islamic University, Islamabad do hereby declare that the thesis entitled, "An Analysis of the Use of Educational Technology for Science Teaching in Pakistan", submitted for the partial fulfilment of PhD in Education is my original work, except where otherwise acknowledged in the text and has not been submitted or published earlier and shall not in future, be submitted by researchers for obtaining and degree from this or any other university or institutions.
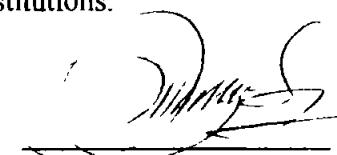
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DEDICATION

TO MY DECEASED MOTHER

Whose love and virtuous support always inspired me to rise and to remain hopeful from the eternal kindness of Almighty ALLAH (SWT). May Allah shower His mercy on the departed soul forever. (Ameen)

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First of all, I offer my modest and earnest appreciation to the Almighty ALLAH who granted me the aspirations and strength to complete this PhD thesis. All the complements for the last Holy Prophet HAZRAT MUHAMMAD (Sallah-o-ale wasalm) who guided the humanity to its extreme to know the very purpose of mankind creation in the light of revelations of Almighty ALLAH.

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Mohammad Abid Khan

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LIST OF ABBREVIATIONS AND ACRONYMS

BECTA	British Educational & Communication Technology
CBL	Computer Based Learning
CPD	Continuous Professional Development
HEC	Higher Education Commission
ICT	Information and Communication Technology
IMCB	Islamabad Model College for Boys
IMCG	Islamabad Model College for Girls
ITU	International Telecommunication Union
LFT	Laptop for Teachers
MoFEPT	Ministry of Federal Education and Professional Training
NPST	National Professional Standard for Teachers
NSES	National Science Education Standards
PERN	Pakistan Educational Research Network
PiL	Partners in Learning
PBL	Problem Based Learning
STEP	Strengthening Teacher Education in Pakistan
UNDP	United Nation Development Program
STEM	Science, Technology, Engineering and Mathematics

ABSTRACT

The teachers of today's technology enriched environment are encouraged to use ICT tools by the government, school management and parents in teaching learning process for better understanding and concept building of the science students. The aim of this study was "To analyze the use of Educational Technology for Science Teaching in Pakistan" in the light of National Professional Standard on ICT: "Effective Communication and Proficient use of Information Communication Technologies" (National Professional Standards for Teachers in Pakistan, 2017). The objectives of the study were: To evaluate the Knowledge and Understanding of Science Teachers regarding the use of Educational Technology in teaching learning process at secondary level in Islamabad Model Colleges Islamabad, To examine the Skill level of Science Teachers in using Educational Technology with reference to 4Cs (Communication, Collaboration, Critical thinking and Creativity) as 21st century learning skills for teaching learning process , To evaluate the Disposition of Science Teachers regarding the use of Educational Technology in teaching learning process, To analyze the current trends of using Educational Technology in teaching learning process. It was a mixed method approach and study has Sequential explanatory design following Quan-Qual Model. All the Heads of institutions, Science Students and Science Teachers of Secondary level (Grade-X) in Islamabad Model Colleges were the population of this study. Random sampling technique was used to select the sample from the head of different institutions, Science teachers and Science students. The sample of this population included 09 Head of Institutions, 95 Science Teachers and 300 Science Students (150 Male and 150 Female). Research tools of the study were Questionnaire, classroom observation and interview. The analysis of Quantitative data was done with the help of SPSS in the form of % Age, Mean, Frequency, Standard Deviation (SD) and Chi Square while for qualitative data. The findings of this study revealed some of the major hurdles in making the use educational technology for the science teaching learning process more effective which include: methodology, lack of mandatory practice of using ICT tools, Lack of motivation of the science teachers to use the ICT tools, lack of easy access to ICT tools, excessive failure of electricity. On the basis of findings, following conclusions were drawn: 1)Teachers, students and Head of institutions strongly agree/agree to use of ICT tools in teaching science to increase motivation, confidence and conceptual clarity in understanding scientific phenomenon. 2) Most of the Islamabad model colleges lack ICT tools and infrastructure to facilitate science teaching learning process. 3)The science teachers of Islamabad Model Colleges also need proper training for the effective use ICT tools inteaching learning process.4) Science teacher's disposition with respect to the use of ICT tools in science teaching is positive for all aspects except for MS Excel use to solve Complex Mathematical Calculation of Science. 5) The skill level of science teachers observed during this study was also unappreciable. The knowledge of all the 4 Cs: Communication, Collaboration, Critical thinking and Creativity were reflective findings of this study which are in fact barriers to make the science teaching process more operational.6) Lack of interest of head of institution was also observed during this study as one of the barriers in the use of ICT tools in teaching of science. Therefore, on the basis of said conclusions, following recommendations were made maximum provision of ICT tools, mandatory practice of using ICT tools, Professional development of science teachers through training programs, availability of subsidized ICT tools for the science students and teachers, effective role of NGOs, patronage of heads of institutions and policy makers.

CHAPTER 1

INTRODUCTION

The universalization of contemporary age of 21st century has revolutionized all walks of life including the field of Education. In Education, the utilization of Educational Technology in the form of Information and Communication Technology has played leading role in growth and development to enhance the quality education worldwide. Educational Technology is the set of tools that are developed by the human beings to monitor and improve the knowledge and changes in material environment. The educational technology methodologies have been changed from the initial use of merely instructional tools to the advanced devices of the modern world which includes: digital technologies, simulations, problem-based learning, use of face book, twitter and Instagram as a social network, cloud computing, flipped classroom, animations. The use of these technologies has revolutionized the whole culture of the world especially the field of education (Tezci, 2018).

The understanding and mastering of basic skills of ICTs are regarded as the part of core education in addition to writing reading and numeracy. The Educational Technology helps to eradicate the cultural, social, economic and technical hurdles confronting the field of Education, by developing new models, ways and technologies so that the performance of teaching learning process can be improved (Gilakjani, 2019). According to Roblyer (2017), the term educational technology is a theoretical as well as quantifiable instrument which is employed by the educators to boost the standard of quality education.in present day teaching and learning process, the technology tools are employed for the development, designing and assessment of mechanical and human resources of educational theories, models and tools from various knowledge area. The

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ultimate objective of this all is to facilitate the teaching learning process to create potential change in the society needed for the preparation of the generation for the 21st century workplace. It is due to this reason that the educational tools have gained mandatory pivotal role in the teaching learning process. Today, the use of technology has become unavoidable in teaching learning process for the enhancement of excellence of education and to prepare the generation of 21st century to play commendable role at his work place (Timur, 2019). With the advent of educational technology, its use started in the field of education to create positive attitude among the teachers and students, the two basic pillars of teaching learning process. Now the technology is being used by the students by their active participation in teaching learning process through exciting, collaborating technological practices.

The positive attitude helps the science students in effective gaining of knowledge, skill enhancement activities and inspiration. According to Beak, Jung & Kim (2019), If students have positive attitude towards science, they will not fall behind the times by using technology directly on education process, they might be more interested in this field and prefer professions related with science in the future A. George. Cross-Domain Analysis of Change in Students' Attitude.

Realizing the today's technological innovations and industrialized standing of education, the studies conducted by Marks, & Eilks (2017), reveals that it has now become quite indispensable to use educational technology to remove educational complications in this way by encouraging outcomes from the students having different ways of learning can be achieved through technological enriched teaching learning process successfully. For this purpose, inclusion of technologically by competent teachers in teaching learning process is obligatory so that technological pedagogical

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content knowledge can be incorporated to solve difficulties of the students by creating new knowledge with the help of technology (Education Reform, 2019).

The use of technology for science education helps the students to construct their knowledge with technology supported activities which creates active learning, improved student involvement and value added social interaction of the students (Geer, & Sweeney, 2018).The use of technology in science teaching actually provides number of opportunities for the students like animation, visualization and vocalization which help in structuring of students' knowledge, creating stimulating interest and increasing motivational level. According to Ardac & Unal, (2019), science concepts in the form of abstract notions can be effectively explained ensuring permanent learning by using educational technology in the form of audio-video presentation. The literature on the contribution of technology supported environment supporting science learning reveals that the technology supported teaching learning process helps in the development of positive attitude among the students in science learning process, effective participation of the students, materializing theoretical abstract knowledge supporting constructive learning and ultimately creating meaningful and lifelong learning.

According to literature, there are certain limitation while using educational technology in teaching learning process which includes: availability of well-trained science teacher skillful for preparing and using educational technology, Class room having modernized educational technology, trouble free access to internet and target-oriented curriculum assisting in the achievement of student objectives. It is very important to use of Educational Technology for solving varied problems of education successfully especially in developing countries like Pakistan, it has to be acquired and manipulated by the teachers to synchronize their teaching methodology with the

innovative methods of teaching being used in developed countries so they can prepare their students for the 21st century workplace. Rapid technological development has revolutionized all walks of life including Science Education. These technological developments have effectively solved the problems and issues of Science Education. The use ICT tools in teaching Science has significantly enhanced the understanding and motivation of students. These tools are now also being employed by the science teachers to boost the communication skill, encourage inquiry learning, and create teaching material and to assist student self-expression (Beak et al., 2019). ICT tools play a potential role in science teaching learning process to expedite work production, support exploration and experimentation, to visualize Scientific processes in their real forms, support in collaborative knowledge building and to shift from teacher centered learning to student centered learning activities Computer and computer related technologies can be effectively used in teaching Science like display of Human anatomy, action of bacteria and viruses on human beings, watching of reactions as in real life, Animations and videos of complex molecular structures, explanation of mechanism of electric generator etc. Using ICT tools, information on picture, text, Models, tables and graphs are presented to the students so that students are able to manipulate for making necessary changes and hence to evaluate real theme of the scientific concept by an easy way (Henessy, 2016).

The role of teacher has become very significant in this regard. Now the power of ICTs in Science teaching is valued by the role of science teacher. Whether the Science teacher understands the power of educational technology in the form of ICT tool in science instruction? Does he value it in science teaching? It is revealed by the research reports that the prospective science teachers have more confident to use and

incorporate ICT tools for the effective science teaching than the perspective science teachers (Galanouli & McNair, 2018; Sime & Priestley, 2015; Andersson, 2017).

Despite the widely accepted important role of ICTs in teaching learning process, there are number of obstacles which create problem for the Science teachers and students in using ICT tools in teaching learning process like insufficient availability of educational technologies in the institution, lack of sufficient knowledge and skills of the Science teacher for using ICT tools, lack of institutional training programs as a regular practice for the Science teachers (Beak et al., 2019).The teaching learning process can be made effective by the significant role of a science teacher. Since this is the basic unit of pedagogical process who can understand and utilize educational technologies in the form of theories, models, procedures and devices to make the teaching learning process easy and interesting for the science students (Saettler, 2020).

The potential and experience of science teacher to integrate educational technology is considered as pre requisite for effective use of these resources. The experienced teacher can very easily save his time during integration of educational technology (Pringle, 2018). All the stake holders related to the field of education have strongly emphasized on the importance and need to bring a change in the students' attitudes, to shift the student from rote memorization to true understanding of concepts by using educational technology. This allows the students to use technology in innovative ways to learn more about educational technology (Chandrasekhar, 2018)

The benefits of Technology in teaching learning process mainly depends upon the teacher's attitude of Teacher. The potential and experience of teacher to integrate educational technology particularly for science teaching is considered as pre requisite for effective use of these resources. The experienced teacher can very easily save his

time during integration of Educational Technology to create productive teaching learning process (Pringle, Dawson & Ritzhaupt, 2018). According to the Science Education Reforms of The American Association for the Advancement of Science, It is mandatory for the Science Teacher to have sufficient knowledge to integrate technology and inquiry based teaching learning process in to their instruction so that science students can be prepared for the 21st century demands. The National Science Education Standards (NSES) demand that teachers should apply "a variety of technologies, to support student inquiry-based learning. This brings a change in the students' attitudes, to shift them from rote memorization to true understanding of concepts by using Educational Technology (Oguzor, 2020). Gilakjani (2019), points out that in constructivist classroom, knowledge is built on the basis of prior knowledge and experience of the learner. Therefore, the first step in this situation is to activate prior knowledge of the learner. In a technologically enriched learning atmosphere, this work is done by watching images, videos or listening voice recorded lecture at the beginning of the class. Here the teacher as a facilitator helps the learner to correct the prior knowledge of the learner, if there is any misconception. The teacher also helps the student in giving prior knowledge by giving additional activities, in case the learner has no prior knowledge. In this way, the knowledge of the learner is increased.

Constructivist theories are of great value to teachers in their efforts to help students' comprehension, the fundamental constituent of the subjects they are teaching. Constructivist learning environment develops knowledge, collaborative learning, and replication which, together assist the learner to provoke their own learning requirements. Educational technologists need to certify that these expressive and related practices are manageable and used to enhance learning about knowledge and identity

of the learner which are quite necessary promote, restructure, and deepen the educational experience. It is very necessary to understand the relationship between constructivist learning theory and the use of educational technology in teaching learning process. The constructivist learning theory states that "the learner builds new knowledge from his prior information and experience while the teacher, schools, families and other learners are the main benefactors in the construction of new knowledge. Here question arises whether the educational technology fits in well with the constructivism or not? The main focus of constructivist approach is to promote student centered learning atmosphere which is facilitated by engaging the learner to build his knowledge personally using the educational technology in teaching learning process whereas the role of teacher, family, school and community is to is to support and encourage the learner in active construction of his knowledge (Kumar, 2018). There is very close association of constructivism and educational technology. The constructivist classroom is student centered where student has wide opportunity to receive information through meaningful activities like browsing of internet, problem-based learning, power point presentation. In this modern classroom, the software and hardware has become tools for the student to create knowledge. Now the teacher acts as a facilitator in the classroom and is encouraged to use educational technology to improve the teaching learning process by engaging his students by interacting them with interesting learning material and digital technologies in the form of laptop, mobile phone, collaborative software, television, internet.

It is the quite important to note that learner understanding is between 30-50 % enhanced in technology enriched Classroom as compared to the traditional classroom. This is due to the fact that modern class room is a constructivist classroom where the

learner has opportunity for questioning, decision making, to interact, collaborate and communicate with the teacher as a facilitator and learning sources in the form of family, classmates, community and e-resources. Thus, the constructivist learning environments are designed to offer multiple tracks to get information to enhance his knowledge with thehelp of different learning resources (Gilakjani et al., 2019).

According to priorities of Pakistan National Education Policy frame work (2018, 2019), The Ministry of Federal Education and Professional Training (M.FE&PT) will maximize the use of computers supported by internet technologies in teaching learning process to achieve better learning outcomes in a short period of time. The use of ICT tools by the teachers is not only effective source for enhancing content knowledge of the teacher but also a powerful source to prepare new generation for the work place. The Mo. FE&PT has reiterated his determination in thisframe work to exploit the power of ICT tools in the form of computers, mobile applications and internet for quick gains in access and quality. In this regard, Ministry of Federal Education and Professional training has launched blended-e-learning program in the public sector educational institutions of Islamabad. For this purpose, an agreement has been signed between the Federal Directorate of Education, Tele- Taleem, Knowledge platform and Robotics to implement the blended learning to keeppace with the ever-changing modern world. This new approach blended-e-learning provides interaction between the on-line education materials with the traditional classroom methods. A teacher as a mentor can use different ICT tools at different levels to make the science teaching learning process more effective so that students learning can be boosted to its maximum (Web Desk-On Apr 13, 2021-Last updated Apr 13, 2021). However, a teacher can face number of problems including availability of proper laboratory

equipment for experimentation, difficulties in concept building inaddition to methods and practices for the enhancement of knowledge and skills to achieve the desired learning objectives (Lopez, 2018.b).

It is therefore, mandatory togive special emphasis on improvement of different pedagogical approaches to make the science teaching learning process more potent by improving learners' interests and motivation for the enhancement of quality education (Clark, 2016). The shift of traditional knowledge transmission is observed to the coherent transmission of knowledge and capabilities with objective based method the development of skills by practical training. During last two decades, a new pedagogical approach, "historical investigation" has developed for the physical sciences after the "problem-based learning" and "problem solving approach". This new approach "historical investigation "is quite helpful to identify problems, articulate hypotheses, active participation of the students in the experiment, analysis of results, to discuss the results with their peers and ultimately to become the real scientists. Actually, the decline in learning science by the youth can traced and rectified by searching suitable pedagogical approaches and educational technologies to make the physical sciences more friendly (Halai, & Durrani, 2018).

Realizing the significance of this global concern of 21st century in the field of education, this study was designed to analyze the current status of the use of educational technology for secondary level science teaching in the light of National professional standard on Information and communication technology (ICT). The substantial aim of this study was to assess the knowledge & understanding, Disposition and skill level of science teacher, as three important components of national professional standard ICT in addition to their knowledge of instructional and emerging technologies being

employed in teaching learning process in Pakistan.

1.1 Rationale of the Study

According to Alazam, Bakar, Hamah and Asmiran (2019), the practice of using educational technology in science class room is considered as vibrant process not only for the students which encourages the them to enhance their motivation level for thoughtful consideration of challenging concepts in a stress-free way but also facilitates the science teachers to give solid empirical evidence to prove the originality of the abstract scientific phenomenon. But this is more important to keep in mind the factors which greatly affect the whole teaching learning process. These includes: the availability & accessibility of technological tools, knowledge of the science teacher, disposition of the science teacher to teach in a technological enriched environment, Skill level of the science teacher, availability of hardware and software infrastructure, patronage of the school administration, continuous professional development programs for the science teachers, experience of the science teacher to teach in the technology supported classroom, provision of funds, self- confidence of the science teacher. These factors directly or indirectly responsible to influence to formulate an effective ICT supported strategy necessary for the digitalization of teaching learning process. Oguzor (2020) is of the view that the everlasting role of science teacher in the classroom cannot be disregarded in any ways even in the presence of educational technology tools as an effective way of teaching. However, the competency level of the science teachers in terms of his knowledge, experience, disposition and pedagogical skills are mandatory to customize the software according to the proposed curriculum in order to create consistent teaching learning process in the school.

Professional standards are the gadgets used by the experts to analyze and evaluate the performance of the teacher in terms of his knowledge, disposition and skill

level quantitatively to know about overall objective of his activity i.e. Quality of education (Coghill, 2019). ICT tools in the form of Multimedia, Interactive white boards, internet, google classroom, Science Models, MS-Word, Power Point, Excel, Flash Player, spread sheets, Data logging etc. enhance the understanding and motivation of science students (Gray, 2018).The technology equip the students with the skills of self-centered learning, due to its flexibility and diversity of its usage, collaborative, problem-based learning, creative learning and critical thinking etc. (Kang, 2018). (Oguzor, 2020) is of the view that the everlasting role of science teacher in the classroom cannot be disregarded in any ways even in the presence of educational technology tools as an effective way of teaching. However, the competency level of the science teachers in terms of his knowledge, experience, disposition and pedagogical skills are mandatory to customize the software according to the proposed curriculum in order to create consistent teaching learning process in the school.

According to the Science Education Reforms of The American Association for the Advancement of Science, It is mandatory for the Science Teacher to have sufficient knowledge to integrate technology and inquiry based teaching learning process in to their instruction so that science students can be prepared for the 21st century demands. The National Science Education Standards (NSES) demand that teachers should apply "a variety of technologies, to support student inquiry-based learning. This brings a change in the students' attitudes, to shift them from rote memorization to true understanding of concepts by using Educational Technology (Oguzor, 2020). Papert's technology constructionism theory. As foundation for today's extensive use of the computer in the constructivist learning environment. Papert, constructionism children will do best by finding ("fishing") for themselves the specific

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knowledge they need". Technology connects students with information and for collaboration (Gilakjani, 2019).

The Ministry of Federal education and professional training has reiterated his determination to exploit the power of ICT tools in the form of computers, mobile applications and internet for quick gains in access and quality as indicated in the objectives of different national educational policies of the country. In this regard, Ministry has launched blended-e-learning program in the public sector educational institutions of Islamabad. For this purpose, an agreement has been signed between the Federal Directorate of Education, Tele- Taleem, Knowledge platform and Robotics to implement the blended learning to keeppace with the ever-changing modern world. This new approach blended-e-learning provides interaction between the on-line education materials with the traditional classroom methods. A teacher as a mentor can use different ICT tools at different levels to make the science teaching learning process more effective so that students learning can be boosted to its maximum (Web Desk-On Apr 13, 2021-Last updated Apr 13, 2021).

Realizing the significance of this global concern of 21st century in the field of education, this study was designed to analyze the current status of the use of educational technology for secondary level science teaching in the light of National professional standard on Information and communication technology (ICT). The substantial aim of this study was to assess the knowledge & understanding, Disposition and skill level of science teacher, as three important components of national professional standard ICT, in addition to their knowledge of instructional and emerging technologies being employed in teaching learning process in Pakistan.

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1.2 Statement of the Problem

The power of using Educational Technology is an innovative and quick way to achieve better learning outcomes. One of the basic reasons for using ICT tools in teaching learning process is to prepare the generation of 21st century for their work place. The Ministry of Federal Education and Professional Training intends to exploit the power of ICT tools for quick gains in access and quality in the field of Education in Pakistan. In fact, this is not only the priority of the present Government but it also remained the preference of previous regimes during about last forty years. The formulation of National ICT strategy, the objectives of National Educational polices of 1998, 2009, 2017, 2018, 2020 Dakar declaration-2017, HEC-Vision 2025 about integration & effective use of ICT in teaching learning process at Alimentary level, Secondary level and in Teacher Education, are no doubt the continuity of this effort. What is the level of achievement of this objective in Pakistan after formulation of policies and taking necessary steps at National level to materialize this concept is yet to be answered, particularly the "Analysis of using Educational Technology for effective science teaching at secondary level in the light of National Professional Standard on ICT at secondary level in Pakistan, is yet to be investigated? The National Professional Standards are the gadgets for the assessment of quality of education having three basic components: Knowledge & understanding, Disposition and skill level of science teacher (21st century 4Cs skills: (Collaboration, Communication, Critical thinking and Creativity). This study was designed to investigate the effectiveness, issues and barriers of using educational technology for science teaching in the light of national professional standard on ICT in public sector secondary level educational institutions of Islamabad working under the ambit of Federal Directorate of Education Islamabad. The analysis of this study has provided a thorough feedback showing the

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weak areas, the significance of the leading role of head of institution, the hurdles in the utilization of educational technology for effective science teaching learning process. This study has provided the foundation to take further initiatives by the Government for the implementation and effective use of Educational Technologies for Science teaching in Pakistan to prepare the present-day learner for the 21st century work place and to keep up with the ever- changing modern world of today.

1.3. Objectives

The objectives of the present study were:

1. To evaluate the Knowledge and Understanding of Science Teachers regarding the use of Educational Technology in teaching learning process at secondary level

2. To evaluate the Disposition of Science teachers regarding the use of educational technology in teaching learning process

3. To examine the Skill level of Science Teachers in using educational technology with reference to 4Cs (Communication, Collaboration, Critical thinking and Creativity) as 21st Century learning Skills for teaching learning process

4. To analyze the current trends of using Educational Technology in teaching learning process at secondary level

1.4. Research Questions

This encounter the four objectives of this study, following seven research questions were formulated:

1. How the Educational Technology is effective for science teaching in the light of National Professional Standard on ICT for teachers at secondary level?

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2. In what way, the Knowledge and Understanding of Science Teachers can be evaluated regarding the potential use of Educational Technology in teaching learning process?

3. What is the Disposition of Science Teachers regarding the use of Educational Technology in teaching learning process?

4. What is Skill level of Science Teachers in using educational technology with reference to 4 Cs (Communication, Collaboration, Critical thinking and Creativity) as 21st century learning skills for teaching learning process at secondary level?

5. What are the current trends of using educational technology in science teaching learning process?

6. What is the attitude of Secondary level Science Students regarding the use of Educational Technology for teaching learning process?

7. Whether the Science Teachers possess the knowledge of National Professional Standard on ICT necessary for quality education?

1.5. Significance of the Study

Science teachers are thrilled to use educational technologies in teaching and learning process for the deepened engagement of their students to develop better understanding of scientific conceptions but the set-up of the classroom has changed. There is a gap between our society and our teaching learning process. Comparing the society with the education system, we realize that the technology has modernized our society on one hand but the teaching learning process has remained far behind so far from the technologies of 21st century. We are still using the old teacher centered instructional methods for science teaching or teaching without any proper knowledge, understanding and skills of using educational technologies. The use of educational

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technologies in the form of multiple sources of learning is more beneficial for the students. For this reason, the use of ICT tools and multimedia is too much essential for effective teaching and learning process. As a result, the chosen educational technology adversely affects instead of giving benefits to the teaching learning process in terms of time, motivation, money and discouraging bad experience of the science teacher.

The present study has pointed out the weak areas and the hurdles influencing the technology supported teaching learning process which can be adopted to speed up the glorifying effects of educational technology on teaching learning process for effective teaching of science in Pakistan. The findings of this study obtained in the light of national professional standard on ICT: knowledge, disposition and skill level of the teachers for the science teaching, The anticipated learning outcomes of this study will be no doubt advantageous for the perspective as well as prospective science teachers to understand the current trends and issues regarding the use of educational technologies for science teaching at secondary level. By knowing the existing proficiency of the science teachers in using educational technologies for the science teaching assessed in the light of national professional standard on ICT as findings of this study will be beneficial for the Heads of institutions and policy makers to know about the barriers and issues/barriers prevailing in the system so that potent remedial strategy can be formulated to boost the concept and practice of using educational technology for the science teaching in Pakistan. Finally, the prospective researchers will be also able to extrapolate the findings of this study as guidelines and foundation for science teaching at higher secondary and college level in Pakistan.

1.6. Delimitations of the Study

This study was delimited to:

i. The analysis of Educational Technology for Science teaching at secondary level in the light of National Professional Standard on ICT (National Professional Standard #7). Islamabad Model Colleges for Boys and Girls working under Federal Directorate of Education Islamabad including five male colleges: IMCB F-10/3, IMCB F8/4, IMCB G10/4, ICB G-6/3, IMCB I-8/3 and five female Colleges: IMCG F-6/2(street-25), ICG F /2, IMCG F7/4, IMCG F-10/2 and IMCG G-10/2etc.

ii. Secondary level Science Students enrolled during session 2020-21.

iii. The Science Teachers of Secondary level teaching in Islamabad Model colleges for boys and girls Islamabad.

iv. Science teaching includes the teaching of Biology, Chemistry and Physics

1.7. Limitations of the Study

The limitations of a study are its flaws or shortcomings which include: a limited sample size or lack of reliable data such as self-reported data, missing data, and deficiencies in data measurements. In the present study, the science student questionnaire consisted of ten mixed statements. It was not classified as the questionnaire of science teachers including three components of national professional standard on ICT, knowledge& understanding, disposition and skill level of the science teacher. Thus, the questionnaire items asked created some difficulty in compilation of quantitative data that could have been used to address a specific issue more effectively.

1.8 Theoretical Framework of the Study

This study is based on the main theories of constructivism including Dewey, Piaget, Bandura and Papert's technology constructionism theory. Constructivism is a learning approach which helps to develop the instruction technique grounded on the construction of knowledge of the learner based on his prior knowledge and experience. According to Kadijevich (2017), the constructivism is an educational theory that focuses on the knowledge acquisition of the leaner by his interaction with his own family, class mates, teachers for getting the knowledge and how people learn. Activity based teaching and learning helps the learner in the construction of his own knowledge, the main focus of this approach is to develop cognitive skills in the learner. Constructivist approach based on the prior knowledge. Gilakjani (2019), point out that in constructivist classroom, knowledge is built on the basis of prior knowledge and experience of the learner. Therefore, the first step in this situation is to activate prior knowledge of the learner. In an educationally enriched learning atmosphere, this work is done by watching images, videos or listening voice recorded lecture in the form of educational technology at the beginning of the class. Here the teacher as a facilitator helps the learner to correct the prior knowledge of the learner, if there is any misconception. The teacher also helps the student in giving prior knowledge by giving additional activities, in case the learner has no prior knowledge. In this way, the knowledge of the learner is increased.

According to Bandura's theory of modeling, children learn through observing, imitating, and demonstrating. In teaching learning process, the teacher as a facilitator represents the best practice in the classroom. For this purpose, the teacher give ideas, examples to their students on technology incorporation technique and tools to

understand their concepts more effectively. Piaget's self-learning theory illustrates that educators learn through constructing logical steps one after another based on what they already know and have recently learned. According to Dewey's belief, learning was grounded in life experiences, technology blends with the constructivist's theory of learning by doing. According to Papert,s constructionism was "built on the assumption that children will do best by finding ("fishing") for themselves the specific knowledge they need". Papert's ground breaking work was the foundation for today's extensive use of the computer in the constructivist learning environment. Building further on the constructivist's theory that students construct knowledge through accommodation and assimilation, technology connects students with information and each other for collaboration. In fact, the constructivists' use of technology in education is to give out information to students for the purpose of learning, not reproduce their learning experience. Through the use of technology as a tool, constructivist educators have been able to positively affect the cognitive development of students (Gu et al., 2017; Mims-word, 2016).

Constructivist theories are of great value to teachers in their efforts to help students' comprehension, the fundamental constituent of the subjects they are teaching. Constructivist learning environment develops knowledge, collaborative learning, and replication which, together assist the learner to provoke their own learning requirements. Educational technologists need to certify that these expressive and related practices are manageable and used to enhance learning about knowledge and identity of the learner which are quite necessary promote, restructure, and deepen the educational experience. It is very necessary to understand the relationship between constructivist learning theory and the use of educational technology in teaching learning

process (Kadijevich, & Nova, 2017). There is very close association of constructivism and educational technology. The constructivist classroom is student centered where student has wide opportunity to receive information through meaningful activities like browsing of internet, problem- based learning, power point presentation. In this modern classroom, the software and hardware has become tools for the student to create knowledge. Now the teacher acts as a facilitator in the classroom and is encouraged to use educational technology to improve the teaching learning process by engaging his students by interacting them with interesting learning material and digital technologies in the form of laptop, mobile phone, collaborative software, television, internet. It is the quite important to note that learner understanding is between 30-50 % enhanced in technology enriched classroom as compared to the traditional classroom. This is due to the fact that modern class room is a constructivist classroom where the learner has opportunity for questioning, decision making, to interact, collaborate and communicate with the teacher as a facilitator and learning sources in the form of family, classmates, community and e-resources. Thus, the constructivist learning environments are designed to offer multiple tracks to get information to enhance his knowledge with the help of different learning resources (Gilakjani et al., 2019).

1.9 Science Teaching and Learning Process Using Educational Technology: Issues and Challenges

According to Alazam, Bakar, Hamah and Asmiran (2019), the practice of using educational technology in science class room is considered as vibrant process which encourages the students to enhance their motivation level for thoughtful consideration of challenging concepts in a stress-free way. But this is more important to keep in mind the factors which greatly affect the whole teaching learning process. These includes: the accessibility of technological tools, knowledge of the science teacher, disposition

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of science teacher to incorporate educational technology in teaching learning process, Skill level of the science teacher, availability of hardware and software infrastructure, patronage of the school administration, continuous professional development programs for the teachers, experience of the science teacher to teach in the technology supported classroom, provision of funds, self- confidence of the science teacher. These factors directly or indirectly responsible to influence to formulate an effective ICT supported strategy necessary for the digitalization of teaching learning process (Oguzor, 2020) is of the view that the everlasting role of science teacher in the classroom cannot be disregarded in any ways even in the presence of educational technology tools as an effective way of teaching. However, the competency level of the science teachers in terms of his knowledge, experience, disposition and pedagogical skills are mandatory to customize the software according to the proposed curriculum in order to create consistent teaching learning process in the school. One of the reasons pointed out by Bauer and Kenton (2017), for not using educational technology in the class room on regular basis, is scarcity of time because science teacher needs extra time for its class preparation. Other reasons for not using ICT tools in the class room are non-availability of suitable software and hardware and availability of technical assistance. The attitude, knowledge and the level of experience of a Science teacher for ICT tools play a significant role in ICT supported class room.

According to Chandra and Lloyed (2016), the use if ICT tools for teaching Science has positive impact on students' performance and academic achievements. Almekhlafi and Almeqdadi (2019), are of the view that major hindrances in integration and effective use of ICT tools in teaching learning process are: non-availability of computers inside the class room, on-cooperation of administration and lack of technical

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assistance. Conclusively it can be added here that the knowledge of challenges and issues related with the use of ICT tools for teaching learning process helps the teachers to devise a strategy to overcome the obstacles to become a successful educational technology user.

1.10 Operational Definitions

1.10.1. Educational Technology

The concept of educational technology is a modern technique and easy approach to boost the teaching learning process by assisting the five senses, perception and memory with the help of models, skills and techniques so that the learning outcomes can be improved to their maximum. This will no doubt fetch encouraging change in the human behaviors which is the eventual objective of the whole education process (Halai, & Durrani, 2018).

1.10.2 Professional Standards

Professional Standard is a tool for the educators to measure their individual expertise and skills so that they are able to boost the excellence of teaching learning process with the help of continuous professional development program (CPD). In 2017, Government of Pakistan with the support of USAID and UNESCO, developed ten national professional standards to be employed as a criterion to judge the quality of education in the country (Ministry of Education, 2017).

1.10.3. The four Cs as 21st century learning skills

The four Cs: Communication, Critical thinking, Collaboration and Creativity are the modern learning skills which are considered as mandatory for our school system and professional development programs. These skills are identified by the United States of America as 21st century skills (Pi 21) to prepare the young generation for work place of the modern age (Wallace, 2017).

CHAPTER 2

LITERATURE REVIEW

This chapter is associated with the review of literature relating to the present study The review of previous studies in the form of research articles, surveys, books relevant to the area of research provides the researcher critical evaluation, summary and description in relation to the research problem being explored which acts as a mentor for researcher to guide him in a right direction (Fink & Arlene, 2017).

According to Bryman (2017), the main objective of literature review is to establish the domain of research performed in the area of his interest so that the researcher is able to justify his frame of study for investigation. Therefore, it is mandatory for any research to review the literature to get operational step of any successful research.

2.1. Educational Technology

Educational technology denotes the zone of technology quantified for the boosting of quality of education with the help of ICT tools in the form of software, hardware and pedagogical methods and practices. In other words, educational technology is a problem-solving technique which provides the mechanism for the enhancement of level and extent of learning outcomes by the employment of appropriate educational theories, ICT tools and techniques to facilitate the application of our five senses retention and perception of the learner and facilitator. Educational technology is a broader term and covers four areas:

    i. Educational Technology as a mass media

    ii. Educational technology as instructional design

    iii. Educational Technology as an exercise/practice.

iv. Educational Technology as a discipline (Clark, 2016).

The first area of Educational Technology provides foundational step and includes different ICT tools like audio and video aids, interactive whiteboards (IWB), computers, tablets and social networks, virtual classroom, mobile devices, learning management system (LMS). All of these in the form of multimedia are effective sources of engaging the students in teaching learning process by creating interesting and motivating teaching learning process. Now ICT tools have become integral part of teaching learning process like the substitution of chalk board with the interactive white board, use of smart phone during classroom. This all is in fact useful for the preparation of young generation for the work place of 21st century (Doering, 2018).

There are variety of Information and communication technologies in the form of ICT tools employed for the information and communication purpose. When these ICT tools are used for the facilitation of teaching learning process so that standard of education can be boosted by creating interactive, collaborative, problem based interesting and potent learning environment for the learner, then it is called educational technology. This term encompasses material tools as well as theoretical foundation in the form of pedagogical principles to support and improve the quality of education (Robleyer, 2017).

The significance of educational technology in teaching learning process is evident from the diversity of its employment in different stages including development, designing and evaluation of human and mechanical resources in the light of pedagogical theories, ICT tools and practices from multiple knowledge domains to facilitate the whole teaching and learning process. This improvement in the teaching learning process with the help of educational technologies ultimately will bring the influential

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change in the society in creation of technology enriched classrooms for the preparation of 21st century learners to prepare them for their workplace (Daniels, 2016).

In education sector, now a days, the use of ICT tools are considered as building block for the teaching learning process. The teacher should not be the only expert in reading, writing and mathematical knowledge but he must be the master of using basic skills of ICT tools. In the present age, the common people consider ICT tools as computer and computer related activities only. This is a fact that computer and computer appliances have fundamental role in the contemporary information management system but the range of ICT tools cannot be completed without the inclusion of other technologies and systems. According to Pelgrum and Law (2018), the term Computer was substituted by the word IT during late 80, the replacement was actually the shift of application from the computing technologies to the information storage and reprocessing capability. By the incorporation of E-mail in to the daily use of general public in 1992, the term IT was then transformed to ICT (Information and Communication Technology).

According to UNESCO (2017) information and communication technology (ICT) is the amalgam of information and communication technologies since everybody has access to both information as well as communication technology like information technology (IT) but here in ICT, the main focus is on communication technologies including internet, wireless network, cell phones and other communication media. With the passage of time digital technologies took new direction during the last few decades, and a new concept educational instruction, instructional design and instructional technology emerged. This new concept was just like information technology (IT) and information and communication technologies (ICT) and factually these are different

labels which are interchangeably used for educational technology. It is important to note that education for technology and education in technology are two different categories regarding the use of educational technology in education. The ICTs for education are actually the development of ICTs for teaching learning process and second category refers to the usage of ICTs to facilitate the teaching learning process (Wilson. et al, 2016).

The Educational Technology helps to eradicate the cultural, social, economic and technical hurdles confronting the field of Education, by developing new models, ways and technologies so that the performance of teaching learning process can be improved (Nguyen, Williams, & Nguyen, 2017).

2.2.Nature of Educational Technology

Different people take the terminology of educational technology in different connotations. Some of the people define educational technology as the set of electronic tools employed for the facilitation of teaching learning process. These include: computers, tape recorders, and television and film projectors. Other group of people considers this term for non-instructional material like models, charts, books and photographs. There is still another category of people which take this term as the electronic equipment needed by the administration for the maintenance of record of students on microfilms, the employment of computers for the preparation of examination papers and the source of communication between school administration and the parents via radio. These are different inferences about the e- contents employed in teaching learning process. In fact, there is no unanimously established definition of educational technology so far. However, there is comprehensive definition suggested by Association of Educational Communication Technology which states that the

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collection of people, plan of action, tools and philosophies and an organization meant for the inquiry of problems, formulation, searching solutions of issues after the assessment involved in the whole teaching learning process (Agarwal 2019).

Kadijevich, & Nova (2017), are of the view that the concept of educational technology in the traditional classroom needs the revolutionary changes in the role of science teacher. The teacher as a facilitator is the one who has to modify himself with the innovative instructional techniques and equipment. The teacher has to sacrifice in terms of his time, energy, skills and the mastery of using educational technology. The unskilled and untrained teacher may commit blunders and may face embarrassing situation in the modern classroom due to having little knowledge and skill of using modern technologically supported methods of teaching after leaving his role of classroom chief. He may feel incompetency to control the teaching situation due to having fear of going wrong. This may lead to depression and ultimately can affect the readiness of the science teacher to accept the challenge of teaching in the modern classroom. It is really very disappointing that our teacher has not yet transformed himself with the evolution of modern technology which has unlocked the new traditions in every walk of life specially the field of education. Actually, the bionomics of traditional formal teaching learning system are the main barriers in understating and comprehending the concept of educational technology in education system of Pakistan. The basic theme of utilizing educational technology in teaching learning process is based on the following realities:

i. The operational use of diverse educational tools

ii. Focus of teacher on self-learning

iii. Stress on system based-methodology

2.3. General Characteristics of Educational Technology

According to Mishra & Sharma (2018), the main features of educational technology are as following:

i.   Educational technology is based on the scientific principles to solve educational concern.

ii. Educational technology is focused on the development of innovative methods, practices and actions to make effective teaching learning process.

iii. It is also concerned with the formulation of assessment tools to be employed for measurement the learning outcomes.

iv. The effectiveness and facilitation of the whole teaching learning process can be improved with the help of using media, procedures and methods in the classroom

v.   Educational technology involves three features of education: input, teaching learning process and output.

vi. Educational technology involves the use of electronic media and system approach in the whole education system.

vii. It plays pivotal role in the boosting of 4Cs skills Communication, Collaboration, Creativity and Critical thinking.

2.4 Objectives of Using Educational Technology in Teaching Learning Process

The vital role of educational technology in facilitating teaching learning process cannot be challenged in any way. There are number of aims due to which the incorporation of these tools has become mandatory in the present-day classroom. Some of the substantial objectives are as following:

i.   The utilization of educational technology is a best source of improving

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instructional process to make it dynamic for the learners.

ii. The use of ICT tools and other instructional material in teaching learning process has helped to uphold the deteriorating standard of education by replacing mass education imparted in the traditional classroom.

iii. The use of television, tape recorder, radio and other planned teaching programs has supported greatly to improve distance education throughout the country.

iv. The professional development of the teacher in technology enriched classroomcan produce effective mentors.

v. The solution of administrative issues can be solved scientifically and soundly via system analysis with the help of technology tools.

vi. Theoretical research vs experimental research: The researchers of modern age is well versed with the knowledge and skill of using educational technology and is more successful than the traditional researcher due to difference in the natureof their research. Modern researcher uses ICT tools for the solution of educational problems practically and experimentally unlike traditional researchbased on theoretical grounds.

vii. Educational technology effectively supports to understand the structure and nature of teaching learning process. Using educational tools and pedagogical philosophies, new teaching models can be formulated.

viii. Individual differences of the learners faced during teaching learning process can be easily handled with the help of innovative practices and modalities of modern age.

ix. The concept of educational technology facilitates to construct new pedagogical concepts and theories to teaching learning process easy and understandable. This provides the scientific foundation to the education and hence enhances the quality of education (Mishra & Sharma, 2018).

2.5 Functions of Educational Technology

According to Mishra and Sharma, (2018), Educational Technology is abroader term with respect to its nature, functions and importance in the teaching learning process. Some of the prominent functions are as following:

i. It supports to identify educational aims and objectives specified for the particular community.

ii. Specific educational goals can be attained by manipulative suitable and definedcurriculum

iii. Educational technology is functional for the assessment and evaluation of the whole teaching learning process with help of innovative tools and models of education.

iv. It develops and improves proper instructional materials for the creation of effective teaching learning process

v. Educational technology aides in deciding the suitable instructional approachfor the attainment of productive results.

vi. Its function for facilitating the use of hardware and hardware in teachinglearning process is momentous

vii. The evaluation through educational technology can be obtained by the feedback.

viii. It prepares the teacher to equip with the technologically enriched

classroom

ix. According to Agarwal (2019), educational technology has supplemented inmaking teaching learning process easy and interesting.

2.6 Educational Technology & Constructivism as a Learning Theory

Constructivism is a learning approach which helps to develop the instruction technique grounded on the construction of knowledge of the learner based on his prior knowledge and experience. According to Kadijevich and Nova (2017), the constructivism is an educational theory that focuses on the knowledge acquisition of the leaner by his interaction with his own family, class mate, teachers for getting the knowledge and how people learn. Activity based teaching and learning helps the learner in the construction of his own knowledge, the main focus of this approach is to develop cognitive skills in the learner. Constructivist approach based on the prior knowledge. Gilakjani, (2019), point out that in constructivist classroom, knowledge is built on the basis of prior knowledge and experience of the learner. Therefore, the first step in this situation is to activate prior knowledge of the learner. In an educationally enriched learning atmosphere, this work is done by watching images, videos or listening voice recorded lecture at the beginning of the class. Here the teacher as a facilitator helps the learner to correct the prior knowledge of the learner, if there is any misconception. The teacher also helps the student in giving prior knowledge by giving additional activities, in case the learner has no prior knowledge. In this way, the knowledge of the learner is increased.

Constructivist theories are of great value to teachers in their efforts to help students' comprehension, the fundamental constituent of the subjects they are teaching. Constructivist learning environment develops knowledge, collaborative learning, and

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replication which, together assist the learner to provoke their own learning requirements. Educational technologists need to certify that these expressive and related practices are manageable and used to enhance learning about knowledge and identity of the learner which are quite necessary promote, restructure, and deepen the educational experience. It is very necessary to understand the relationship between constructivist learning theory and the use of educational technology in teaching learning process (Gilakjani, 2019).

The constructivist learning theory states that "the learner builds new knowledge from his prior information and experience while the teacher, schools, families and other learners are the main benefactors in the construction of new knowledge. Here question arises whether the educational technology fits in well with the constructivism or not? The main focus of constructivist approach is to promote student centered learning atmosphere which is facilitated by engaging the learner to build his knowledge personally using the educational technology in teaching learning process whereas the role of teacher, family, school and community is to is to support and encourage the learner in active construction of his knowledge (Kadijevich, & Nova, 2017). There is very close association of constructivism and educational technology. The constructivist classroom is student centered where student has wide opportunity to receive information through meaningful activities like browsing of internet, problem- based learning, power point presentation. In this modern classroom, the software and hardware has become tools for the student to create knowledge. Now the teacher acts as a facilitator in the classroom and is encouraged to use educational technology to improve the teaching learning process by engaging his students by interacting them with interesting learning material and digital technologies in the form of laptop, mobile

phone, collaborative software, television, internet. It is the quite important to note that learner understanding is between 30-50 % enhanced in technology enriched classroom as compared to the traditional classroom. This is due to the fact that modern class room is a constructivist classroom where the learner has opportunity for questioning, decision making, to interact, collaborate and communicate with the teacher as a facilitator and learning sources in the form of family, classmates, community and e-resources. Thus, the constructivist learning environments are designed to offer multiple tracks to get information to enhance his knowledge with the help of different learning resources (Gilakjani et al., 2019).

The potent use of educational technology in teaching learning process is based on the thought, planning and objectives necessary for the teacher for his instructional presentation. The haphazard and disorganized use of educational technology and absence of learning theory may create gap between the content and the learning goals. The effective role of the teacher as a facilitator is helpful in creating powerful and technology supplemented atmosphere for the learners. The emphasis on student centered learning environment is productive for the students so that the content is more effectively transferred to the student and can be retained for a longer period of time. Now, it is quite understandable that the effective usage of educational technologies in teaching learning process improves the knowledge of the student. Concentrating on the student and using constructivist learning theory enhanced by the usage if educational technologies will become an effective way to engage students so that these learners of 21st century are able to retain their own experience in addition to new knowledge for their brighter future for the longer time (Oguzor, 2020).

It is very important to know by the teacher the individual differences among the

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students of his class. Some students are slow learners and requires more exercises as compared to other classmates. This will be a barrier for those students to understand the subject. For this purpose, computer can be effectively used for repeated practices by the slow learners. These students can get immediate feedback to know about their mistakes and to access correct concepts of the subject matter. This all is possible to be materialized by the technology supported constructivist approach. In this regard, the educational Technology facilitates to interpret information's of the subject, to activate the prior knowledge in remembering, to get new and additional information's. In this way, constructivist approach is developed with the help of technology enriched environment (Kadijevich, & Nova, 2017).

The other positive use of technology in teaching learning process is to enhance the collaboration among the teachers and student. The students can benefit more from the guidance of teacher using educational technology. Social learning is another element of constructivist approach. The learner can interact with the environment using educational technology ensuring communication throughout the world. The use of internet is a powerful source of communication for the learner with his teachers, classmates and experts of the subjects anywhere in the world (Gilakjani et al. 2019).

One of important benefits of using educational technology in teaching learning process is the development of skills rather than changes in behavior of the learner. The students can be engaged in different activities using computer like problem-based learning skills and decision-making skills like programming, drawing of graphs. The finding of the study of Bani Hani (2018), on 5E model reflects that the experimental group had higher retention test scores than the control group. The experimental group had facility to develop laboratory activities for the subject of science. This all shows

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that educational technology support constructivist approach in many ways. The teacher as a facilitator plays most productive role with the help of limited resources so that their students are able to organize their learning environment, to provide guidance and to evaluate their learning outcomes. The use of educational technology has made teaching learning process easier for the teacher. It is therefore, necessary to improve teachers' knowledge and skills for using educational technology through trainings, availability of technology supported classrooms and to encourage all the science teachers for using educational technology to make teaching learning process effective.

2.7 Pedagogical Approaches for Technology Integrated Science Teaching

Educational experts are exploiting the use of commonly available modern technologies so that the science classroom can provide a source of friendly environment for devising new pedagogical strategies to make teaching learning process more vibrant for the students. These adjustments provide focused attention on the fundamental scientific concepts and their correlation during interpretation of new scientific concepts. No doubt, it is quite difficult to get idealized results in the presence of technology enriched environment due to number no of constraints during manipulation of scientific phenomenon by the students. This actually provides an adaptive solution for the difficult and time-consuming process during collective student-centered classroom which can be observed by the feeling of the students by their involvement in conceptual learning in a technology enriched classroom. Similarly, the specific role of teacher as a facilitator to bridge the scientific concepts by pointing out the differences and similarities, has become more vibrant by the use of modern educational technologies in teaching learning process (Kareem, & D'Souza, 2017). Around the world, the interest

of the youth in the science is declining due to its abstract nature and the process of learning and teaching of science is weakening day by day (Crook, Fisher, Harrop & Stokes, 2017). The number of problems associated with this issue includes: Trouble in achieving the objectives of experiments in the laboratory, trouble in concept building in addition to knowledge and teaching practices (Osamah, Fong, & Ziad, 2017). For this reason, present day researches are giving special emphasis on the development of pedagogical approaches to make active science teaching learning process and to enhance the learners' interests and motivation (Crook, Fisher, Harrop, & Stokes, 2017)

The shift of traditional knowledge transmission is observed to the coherent transmission of knowledge and capabilities with objective based method the development of skills by practical training. During last two decades, a new pedagogical approach, "historical investigation" has developed for the physical sciences after the "problem-based learning" and "problem solving approach". This new approach "historical investigation "is quite helpful to identify problems, articulate hypotheses, active participation of the students in the experiment, analysis of results, to discuss the results with their peers and ultimately to become the real scientists. Actually, the decline in learning science by the youth can traced and rectified by searching suitable pedagogical approaches and educational technologies to make the physical sciences more friendly (Hadad & Draxler, 2018).

The study of literature reveals that following pedagogical approaches are being applied now a days to make the science teaching learning process effective and to provoke the interest of modern youth in the understanding of abstract concepts of physical sciences.

    i.   Objective based approach

ii. Competency approach

iii. Skills based approach

iv. Project based approach

v. Problem solving based approach

vi. Historical investigative approaches

vii. Multimedia simulation

viii. Data logging

ix. Interactive white board

Multimedia simulation provides a vibrant and perfect visual demonstration of scientific concepts and experiments which would be otherwise very costly and difficult to perform in such an effective way. In fact, use of multimedia withdraws the stress of students from the hard and lengthy procedures rather its use expedites the theoretical and practical work of all the stake holders including students as well as teachers. In this way the learner and facilitator is more focused on the main issues of their learning objectives. In science teaching learning process, the use of Multimedia simulation encourages the students to investigate and explore their queries in a reliable way making them more confident and reliable. For example, the students usually listen about electron as a fundamental particle of an atom in a traditional classroom but the same can be observed actually revolving around the nucleus with the help of simulation. Data logging computerizes the collected data from the experiments using sensitive detecting devices and then immediately generates feedback, thus facilitating hectic data compilation and its analysis. The vibrant graphical display obtained through data logging supports the activities to be watched and adjusted comfortably. However, its elaboration is done in a usual manner (Peterson, 2019).

Interactive white boards are universal tools which provides an easy and quick access to a web-based multimedia resources for the whole class. The use of interactive white board facilitates the learners to show abstract knowledge in visualized form. It is student cantered modern approach and is a potential source of generating collective knowledge building environment in a shorter and quicker way (Coghill, 2019).

2.8 Educational Technology: A Pragmatic Approach for Science Teaching and Learning Process

Tezci (2018), considers ICT tools a best alternative of a teacher cantered class room not only for the students by providing a new style of learning but also for the teachers to change their teaching methodology. He suggests that effective utilization of ICT tools in the class room for the teaching of science subjects can enrich the lecture of a science teacher so that students' participation is increased in an interactive environment and the focus of classroom activity is shifted from teacher to students. Thus, the effective use of Educational Technology makes value in the teaching learning process but the role of a teacher remains as a key factor in this whole process. Similarly, Smeets, Gennip and Rens (2018), indicated in their study that with the advent of tools of educational technology, the focus has been now shifted from transfer of knowledge to construction of knowledge.

The use ICTs in teaching science has significantly enhanced the understanding and motivation of students. Now the technology is being used as a source to encourage inquiry based learning, to enhance communication, construct teaching materials and to assist students' self-expression (Beak et al., 2019). ICT plays a potential role in science teaching learning process to expedite and enhance work production, support exploration and experimentation, to visualize scientific processes more clearly, support in

collaborative knowledge building and to shift from teacher centered learning to student centered learning activities (Henessy, 2016).

According to Kareem and D'Souza (2017), the true potentials of ICT tools are: the deep knowledge of science teacher for Educational Technologies, proper usage of educational technology, in- Service training programs, role of School leadership for the provision of infra-structure for better utilization of educational technologies for effective Science teaching etc. In fact, these potentials are not being exploited in teaching learning process to their appropriate extent.

2.9 Implications of ICT in Science Education: Issues and Problems in Science Education

Information and communication technology is a category of educational technology. It has playing vital role to boost the overall standard of life specially the field of education. In this regard the field of science has got special emphasis because it is responsible for the uplift of socio-economic development of the society. The science is an abstract knowledge which is relatively difficult to understand. Hence the ICT tools have made it interesting and understandable. There is world over a consensus that development is meaningful if it is driven by science and technology. The role of ICT tools has greatly influenced the teaching of science. With the actualization of awareness and visions, the following are the prerequisites for the making of science teaching process effective in a technology environment classroom (Rehmani, 2019):

    i.   Finance: The science teaching with the help of ICT tools is directly linked with the availability of suitable funds. Availability of proper funding for the science equipment and ICT tools is prerequisite for the success of ICT integrated science teaching learning process.

ii. Instructional material: The availability of the material, facility and equipment which is needed by the science teacher to facilitate the teaching learning process is instructional material. Proper provision of instructional material guaranties the maximum learning outcomes.

iii. Professional development: The success of science teaching is based on the pivotal role of a teacher. It is mandatory to give up-dated knowledge and technology to the science teacher through professional; development program. Pre-service training for the prospective teachers is also a prerequisite for the success of whole teaching learning program because teacher is the principal stake holder and major architect for the making of science education effective. Therefore, professionally strong science teacher can handle the increased number of students in the class and intelligent enough teacher are needed ready for the proper implementation of ICT program for the science teaching.

iv. Remuneration: The remuneration is the effective source to improve the efficiency of a science teacher. The status and image of a science teacher is required to be rehabilitated by the government. This can be done by enhancing salary package, house facility and increase in utility allowances. There should be a special package for the teacher serving in the rural areas. This all will help to improve the efficiency of the science teacher and ultimately the boosting of teaching learning process.

v. Monitoring and evaluation: It is one of basic requirement for the whole system to be monitored and evaluated for the updating of teaching learning process. It is the responsibility of all the ranks of government and

educational administration to take care of the whole system.

vi. Pedagogical methods: Teaching methods are the means of lesson presentation by the teachers in the light of his knowledge, experience and skills. Mirskaya (2017), is of the view that teaching methodology plays significant role and makes the teacher professional. The scientific methods can support the up gradation of science concepts

2.10 Educational Technology in Science Teaching Learning Process

The objectives of using educational technology in teaching learning process demands whether the technology in the classroom enhances student learning and is this gain in learning justify the money invested on educational technology? Technology is not only a device rather it is theory, imagination and creativity to implement the device in a classroom to facilitate teaching learning process. It is matter of fact that Technology can facilitate in instructional designing but this design of learning activities to incorporate technology for teaching learning process makes the difference in student engagement and learning (Erdoğdu, 2018). The work of Ramboll (2016), on integration of educational technology shows that it is more important to have knowledge of technology integration than merely knowing about ICT. Therefore, teachers can benefit from educational technology only by knowing altered teaching approaches. For this reason, the potential and experience of science teacher to integrate educational technology is considered as pre requisite for effective use of these resources. The experienced teacher can very easily save his time during integration of educational technology (Roblyer, 2017)

According to the science education reforms of the American Association for the Advancement of Science, It is mandatory for the science teacher to have sufficient

knowledge to integrate technology and inquiry based teaching learning process in to their instruction so that science students can be prepared for the 21st century demands. The National Science Education Standards (NSES) demand that teachers should apply "a variety of technologies, to support student inquiry-based learning (Krajcik & Nova 2017).

All the stake holders related to the field of education have strongly emphasized on the importance and need to bring a change in the students' attitudes, to shift the student from rote memorization to true understanding of concepts by using educational technology. This allows the students to use technology in innovative ways to learn more about educational technology (Chandrasekhar, 2018). The findings of British Educational and Communication Technology Agency BECTA, (2016), revealed that by the active involvement of science teachers practically in the projects, workshops etc. the attitude of the science teachers can be made positive towards technology use during teaching learning process. The scheme launched In UK as an initiative of Laptops for Teachers (LFT) so that teachers' and head teachers' access to computers can be enhanced.

The evaluation of this study confirmed the above statement about teachers' positive attitudes and confidence by having their own laptop computers to be used during teaching learning process (BECTA, 2016). The use of educational technology needs support and professional development for teaching science in developing countries. This professional development provides collaboration of teachers in the form of teaching communities to improve and support the teaching learning process. During collaboration, teachers share their knowledge, experiences and practices, mutually discuss the issues related to student learning. Thus support each other's knowledge and

pedagogical skills during their learning about new technologies (Miller, 2019).

2.11 Educational Technology in Science classroom

Rapid Technological development has affected all walks of life including science education. These Technological developments have effectively solved the problems and issues of science education. The use ICTs in teaching science has significantly enhanced the understanding and motivation of students. Now the technology is being used as a source to encourage inquiry-based learning, to enhance communication, construct teaching materials and to assist students' self-expression ICT plays a potential role in science teaching learning process to expedite and enhance work production, support exploration and experimentation, to visualize scientific processes more clearly, support in collaborative knowledge building and to shift from teacher centered learning to student centered learning activities(Beak et al., 2019).

Computer and computer related technologies can be effectively used in teaching science like display of Human anatomy, action of bacteria and viruses on human beings, watching of reactions as in real life, Animations and videos of complex molecular structures, explanation of mechanism of electric generator etc. using ICT tools, information on picture, text, tables and graphs are presented to the students so that students are able to manipulate for making necessary changes and hence to evaluate it. Information on text, picture, tables and graph are presented to students using ICT specially to visualize a complex process in physics teaching (Henessy, 2016).

When this information is presented, students can manipulate it to make changes and at the same time evaluate the changes made. In this regard, the role of teacher becomes very important. Hence the power of ICT in science teaching is valued by the role of science teacher. Whether the science teacher understands the power of ICT in

science instruction? Does he value it in science teaching? Research reports reveal that traditional experienced science teachers are reluctant to incorporate ICTs in teaching learning process while the present day students and newly qualified teachers are more confident users of the ICTs (Galanouli & McNair, 2018). Despite the widely accepted important role of ICTs in teaching learning process, there are number of obstacles like insufficient availability of computers in the institution and lack of sufficient knowledge and skills for using ICT tools. Are problematic for the teachers and students in using ICTs in teaching learning process (Beak et al., 2019). The concept of educational technology has played a pivotal role in the boosting of teaching learning process because it provides the foundation, ideas, instrumentation and pedagogical theories which are the basics of enhancement of quality of education (Saettler, 2020).

The teaching in the technology enriched class room provides unexpected access to valuable information, effective ways to communicate with the students and ability to demonstrate with the help of innovative ways of teaching. Technology supported teaching learning process is basically constructivist approach which guides their learners to collaborate and construct meaning, demonstrate understanding to integrate technology in most purposeful ways (Saettler, 2020). It is therefore obligatory for the science teacher to acquire basic skills and knowledge of using ICT tools for the teaching learning process. For example, the knowledge of using MS Word for the preparation of assignments, notes, tests. Similarly, MS excel for preparation of results and class records, knowledge of data bases, efficient use of internet for searching information are quite compulsory are quite necessary for every science teacher (UNESCO, 2019).

The reality of scientific knowledge requires the empirical evidence of the fact which can be argued to understand the originality of real fact. The foundation of science

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requires a grounded knowledge. In this regard, the usability of ICT tools plays crucial role to facilitate teaching learning process. Today, the basic reason for employing educational technology is to boost and improve the standard of science education. In this regard, the professionally strong science teacher can play significant role to prepare the leaners of 21st century for their workplace by helping them to acquire knowledge of 4Cs (Collaboration, Communication, Critical thinking and Creativity). Educational technology plays a potential role for the understanding of science subjects. Thus, the learning outcomes can be successful if the ICT tools are utilized to understand scientific phenomenon (Nazir, Rizvi, & Pujeri, 2018)

Science is a systematic commencement that builds and organizes knowledge in the form of testable explanations of the observed facts and the predictions about the universe (Ellison, Steinfield, & Lampe, 2017). The developmental level of scientific literacy in any society reflects its economic growth and its social stability at political and social levels. Today the use of technology has transformed all aspects of society: its institutions including industry, commerce, social life and education. In particular, scientific knowledge can be made more accessible and understandable with the help of educational technology because educational technology creates inquiry- based learning environment for the students. The students can understand the scientific phenomenon more easily by using computer, internet, CBL's telescopes, microscopes, pH meters, projection panels, Geiger counters, lasers, spectrophotometer, glassware, VCR's, graphing calculators, electronic balances etc. to observe, classify, infer and experiment in the science class It is therefore, well said that a science class without the apparatus and tools of science do not provide environment practice science properly (Davis, & Tearle, 2019).

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The Technology has changed the way to scientific inquiry. Now almost every aspect of scientific exploration has been touched in some way or the other by technology. It is also a fact that today's science work is not possible without technology. With the integration of technology, Students are, creating and sharing media such as original artwork, blogs, web pages, digital photographs and videos (Joshua, 2011). The effectiveness of educational technology in the science teaching learning process can be assessed with help of some common questions: How does the educational technology lead to improved student achievements in science? Is this technology helpful to improve student learning? Is it to increase the proficiency level of the science teachers regarding its use? Researches in this field strongly support that educational technology is an effective means for addressing educational needs. There are number of intermediate goals like: improved student behavior towards learning, their engagement and attendance, improved opportunities for professional development of science teachers, improved efficiency of classroom, better communication between teachers, students, parents and administration etc. Which show a strong link between technology and intermediate goals that lead to high achievement (Haddad & Draxler, 2018).

Computers and other ICTs are now frequently being used in science teaching learning process for developing different scientific skills and to relieve the introduction of diverse educational information. MS-Word, Power Point, Excel, Flash Player etc. provide wide spectrum of working with educational technologies in teaching learning process (Treacy, 2020). The use of spread sheets is supportive for entry and analysis of big data in a shorter span of time. The simulated scientific experiments are not only safer to present but also save sufficient time for laboratory preparation (Abdelwahed, 2018). Similarly, the use of multimedia is a means of instructional delivery in the form

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of sound, words and diagrams through a single system to create interactive and meaningful teaching learning environment for the students. Multimedia is not only helpful for the teacher to control the contents and flow of information but also supportive for the students to increase their interest and understanding level necessary for the enhancement of their memorizing power. The reason for using these technologies in education is to prepare the youth of this modern age to become successful in the society lead by information and communication technologies (Gilakjani, 2019).

The technology lead teaching learning process equip the students with the skills of self-centered learning, collaborative, problem-based learning, creative learning and critical thinking etc. These skills ultimately help the individuals to create sense and feeling to adjust themselves in this modern world shaped with the culture of using technologies for all disciplines of life particularly the field of science (Kang, 2018).This foundational base for materializing this objective is to create the environment of positive behavior and practice towards the use and of educational technology in teaching –learning process which ultimately relies mainly upon the crucial role of Science teacher. Because the technology and pedagogy are equal partner in this modern world. The future success of educational technologies in science teaching depends upon the quality of thought given by the teacher with defined focus on learning objectives (Mirskaya, 2017). The effective use of educational technologies in teaching learning process encourages creativity and innovation that builds the skill of inquiry and investigation among the students which creates positive attitude among the students towards scientific literacy (Marks & Eilks, 2017).

Regarding pedagogical area of teaching learning process, the ICTs have

significant role in applying theories of learning. The students equip them with strong motivation to learn, investigate and eventually to expand their interests in scientific knowledge. The use of educational technologies in teaching learning process actually provides high flexibility and diversity of its usage which allows the instructor to produce knowledge based interactive environment for the students to learn and share with their peer members in a well-organized method (Anderson, 2019).

This is the most important question to be answered by the technology users. CT is simply a tool; it does not ensure learning in any way. However, the application skills help to improve students' understanding in this situation, teacher plays mediation role between the students and educational technologies. In science, the interactive communication plays significant role to explore ideas together, designing own hypothesis, consolidating scientific and informal ideas. Hence the teacher can guide his students using right idea by the right person on right time in the light of desired objectives with the help of educational technologies. But how much active the students are involved in learning? The answer is how much the teacher is skillful in using and blending of pedagogy and technology (Morris, 2019).

2.12 Educational Technology and Professional Development for ScienceTeaching

The concept of professional development is a type of continuing education for the teachers for the improvement of their teaching skills and to boost students' outcomes. The professional development in education meant to improve the quality of teaching learning process and its efficacy with the help of educational technology and training sessions to meet the necessities of their students. The teacher as a facilitator gets more opportunities to enhance their knowledge in their respective subjects and new

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teaching strategies including analytical, technical and quantifiable skills to make teaching learning process a vibrant in a technology enriched environment. Most commonly used professional development approaches includes tutoring, mentoring, reviewing case studies, discussions, collaboration, evaluation and technical support (Hadad, & Draxler, 2018).

It is dire need of the day the teacher should improve teaching practice as well as student learning outcomes. In this regard, the teachers practically gained ability value beliefs are specially emphasized during professional development design. The use of educational technology in teaching learning process has become mandatory for the present-day teacher to prepare the learner for 21st century work place (Miller, 2012). The learner of information and communication technology are expected to be able to reflect as a critical thinker, problem solving to collaborate with his classmates, communicate with the teachers and fellows, to have knowledge of using educational technology, creative and brings varied perceptions in teaching learning process." Educational technology can facilitate the Learner to create all these capabilities in advanced way of learning. The modern technology enriched environment is a student totally centered. In this environment, the student acts as an independent and active learner whereas the technology enhances the learner's autonomy in learning so that they can assimilate new knowledge in constructive and self-directed and active way (Angadi, 2018).

According to Halai, and Durrani (2018), that the educators have now switched over to the innovative technology enriched classrooms and accordingly their methodology has also changed due to incorporation of modern technology in teaching learning process. However, the successful integration of technology is possible only if

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the teacher has sufficient tools for the effective instruction and teaching learning process. It shows that the vibrant role of technology is possible if the teacher changes his instructional practice in the light of 21st century knowledge, understanding and skill level of using technology (Morrison & Lowther, 2016). For this very purpose, the interest and motivation of the teachers plays a potent role (Afshari et.al, 2017). Here the professional development program can play a pivotal role in training the teachers to familiarize them with the knowledge and skills to integrate the educational technology in his teaching learning process because studies show that the teachers are somewhat reluctant and feel uneasy in a technology enriched environment due to low knowledge and experience. It is also observed that due to low level of knowledge, teacher use inappropriate teaching tools for teaching learning process due to which learning outcomes are not attained to its excellence. In spite of realizing the significance of the use of education technology, the role of the teacher remains insignificant. This issue is actually due to lack of proper training. Teacher as a facilitator in the modern classroom should be trained not only to make them well aware of the use of educational technology but also, they should learn to incorporate in their instructions. Also, the level and the number of training sessions also matter in updating the knowledge and skill level of the science teachers so that they are well prepared to prepare the 21st century generation for their work place The professional development programs are required to prepare pre-service teachers to get knowledge, understanding and skills for the use of educational tools (Cavas et al., 2018).

The success of training programs is totally based upon the development of comprehensive and integrated professional development program keeping in mind the clear targets to be achieved during the training sessions. It is expected that in addition

to the provision of educational tools, the instructional design must include the science content along with the tools because the success of achieving learning out comes is possible when the curricula goals are closely associated with the vibrant instructional methods (Camera, 2016).

The creation of blogs can be helpful for the science teachers to make their teaching learning process more effective. Using blogs, the teacher can discuss the issues with their colleagues in using the educational technologies. Similarly on-line tutorials should be the part of professional development programs in order to provide guidance to the science teachers in their lesson planning and other related activities to make the scientific topics understandable and interesting with the help of educational technologies. Researches in the field of education show that professional development programs are no more effective to produce expected results because prospective teachers are not life-long learners for updating knowledge and skills of ICT tools. Hence there is a dire need to provide continuous professional development training sessions and support to the science teachers to materialize the learning comes of the desired objectives (Halai, & Durrani, 2018).

According to Rizvi and Khamis (2019), professional development is actually authorization process which enhances the expertise of the teachers by encouraging them to create positive attitude towards their students. Modern world of 21st century demands from the educational experts to nurture interrelationship among the teachers by providing them the technical assistance to increase their efficiency in the classroom because teachers are in a position to inculcate the modern culture of using technologies in teaching learning process to achieve the desired learning outcomes.

Training of the instructor is a kind of practical activity which creates self-drive

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among the teachers for inspiring their students to create technological self-reliance among the students. The professional development is in fact provides continuity for knowledge acquisition within a particular profession (Adebayo, 2017).

At school level, the participation of a teacher in training session of technology education provides him not only the knowledge of emerging technologies but also is a better source to acquire necessary skills for the respective technological tools. The domain of professional development includes mentorship and advancement of 21st century skills without which we cannot prepares our adults for the present-day workplace. Mentor ship helps the teacher to develop practical approach dealing with the procedural deficiency in the class. Mentorship is a source of personal development of the teacher so that the teacher does not involve his students in bad behavior. It is one of the important features of professional development that the quantitative skills acquire during training enhance the interaction among the students and teachers in a technology enriched classroom, in addition to team work and analytical skills. Regardless of the high cost of professional development program, the resultant advantages characterize the significance of educational technologies to be employed for teaching learning process (Peterson, 2014).

The lowermost advantage of professional development is that it raises the motivation of teachers for adaptation of modern technologies and creates advanced administrative power in the teaching learning process. The inclusion of modelling and sharing integration skills also requires additional development. The incorporation of recommendations for the professional development includes: nurture culture that can assimilate the instructional design effective for teaching 21st century students, create the culture to which can develop collaboration and communication, involve the teacher

as a facilitator in planning process so that he is able to identify and acquire the fundamental technological resources mandatory for the promotion of 21st century learning skills and commitment of teachers for professional development programs (Lopez, 2018).

2.13 Educational Technology in Pakistan – Situational Analysis

Pakistan is a developing country and like other countries is trying to keep pace the ever-changing modern world. The initiatives to utilize ICT tools in teaching learning process started since early eighties. Realizing the pivotal role of educational technology, this concept has been incorporated in national educational policies and computer literacy programs since very long, to make it core part of the national curriculum. It is really very unfortunate that in spite of having passed a period of about forty years, this concept could not flourish to its expected level. The unstable political scenario of the country may be one of the major hurdles in this regard. The short term and discontinuity in the implementation of ICT policies have reduced the anticipated development of this concept in spite of the government will to boost its level to its maximum. The two initial steps taken in this field were Pakistan Education Research Network (PERN) and National Digital Library (NDL). The span of forty years comprises struggle of different governments which is part of the history. This includes: National ICT strategy, the objectives of different national educational policies of 1998, 2009, 2017, 2018 are some of the evidences in favor of different regimes of Pakistan which have tried their best to materialize this concept at Alimentary level, Secondary level and in teacher education to continue and flourish its use in teaching learning process. No doubt, the efforts done by different regimes of the country are appreciable but it remains unsatisfactory without knowing the level of achievement of using

educational technology in science teaching learning process specially in the light if national professional standard on ICT. Despite all these efforts made by the government, the application of ICT has not been reached to its gross root level due to one or the other reason. According to UNESCO report, (2017) on "Education in Pakistan "the major educational challenges faced by Pakistan are: poor quality of education, poor teaching skills, depressing school environment, and acute shortage of well-trained teachers, non-availability of text books, load shedding etc.

Besides all these, there is also budgetary constraint as overall expenditure on education in Pakistan about 2.5 % of its GDP. The choice of technology is associated with the expenses involved. Hence the availability of ICTs facilities and its use can be easily assessed on the basis of available resource in Pakistan. Higher education of Pakistan (HEC) has played significant role by providing ICT resources to all universities and degree awarding educational institutions of the whole country to maximize the use and implementation the ICT policies in education system. The purpose behind the effort was to expand the level and skill level of utilizing ICT tools to keep pace with this modern age of 21st century. HEC through its ICT expansion program has made it compulsory for all B.Ed. teachers' programs to take 1-3 months training course which consists of Pedagogical skills, information and communication technology skills. This short ICT course includes: MS word, MS excel, power point presentation, knowledge of using A-V aids, Internet browsing-mailing. But unfortunately, this practice could not be extended as a mandatory exercise for the prospective and perspective science teachers/lectures at secondary and higher secondary level in Pakistan. Majority of the science teachers have knowledge and understanding if using educational technologies and they have gained this knowledge

from their own resources but there is no integrated coherent activity organized by the government institutions for the professional development of their science teachers. It is also a fact that most of the teachers do not know about the knowledge and significance of national professional standard on ICT, a necessary gadget for the determination of quality of education in Pakistan. It is therefore, necessary to analyze the knowledge, attitude and skill level of the science teacher regarding the utilization of educational technology for effective science teaching learning process. What are the current trends and issues of using educational technology in teaching learning process, is quite necessary to know so that the science teacher is motivated to boost his knowledge and skill of using educational technology through continuous professional development program (CPD) (HEC, 2018).

The foremost purpose of this study was to assess the Technology supported Science Teaching learning practices being used in public sector secondary level classes in Pakistan, in the light of National Professional Standard (NPST's) on ICT. The assessment in the light of national professional standard on ICT provided opportunity to assess three important features of a science teacher regarding the use of educational technology i.e., knowledge, disposition and skill level of the science teacher by using 21st century 4Cs skills (Collaboration, Communication, Critical thinking and Creativity). Today the technology has considerably transformed our schools and classroom structure and substituted the text books. Now we can search everything that we want any time anywhere in the world regardless of time and place. The topics that were uninteresting at one time for the students, are now have been converted in to thought-provoking texts with the help of technology in the form of audio video tools, practical lessons, interactive smart boards and multimedia approaches. The purpose of

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using technology is to provide a comprehensive base and actual concept to the students. If a teacher gets ahead in doing this, then in future the student will be able to comprehend difficult concepts very easily. This entire thought principally depends upon the efficacy of teaching learning process. The educational technology has played substantial role in this regard because Educational Technologies are those ideas, actions, strategies or technologies which help to make teaching learning process more fruitful and operative at any place in the world Factually, this study will provide inclusive feedback of all the struggles and steps taken so far by the Government of Pakistan during the last forty years (since last eighties) to happen this concept in its true sense in Public Sector Educational institutions for Science Teaching learning process. This study will also provide a wide-ranging foundation to take judicious curative steps after detecting the short comings and obstructions in using ICT in teaching learning process, to fix the right direction and to keep pace with the present day technologically based evolving world to prepare his young generation for the 21st century work place (Saettler, 2020).

2.14 Educational Technology in Teaching Learning Process

The objectives of using Educational Technology in teaching learning process demands whether the technology in the classroom enhances student learning and is this gain in learning justify the money invested on educational technology? Technology is not only a device rather it is theory, imagination and creativity to implement the device in a classroom to facilitate teaching learning process. It is matter of fact that Technology can facilitate in instructional designing but this design of learning activities to incorporate technology for teaching learning process makes the difference in student engagement and learning (Kadijevich, & Nova, 2017)

The work of Roblyer (2017), on integration of educational technology shows that it is more important to have knowledge of technology integration than merely knowing about ICT. Therefore, teachers can benefit from educational technology only by knowing altered teaching approaches. For this reason, the potential and experience of science teacher to integrate educational technology is considered as pre requisite for effective use of these resources. The experienced teacher can very easily save his time during integration of educational technology (Roblyer, 2017).

According to the Science Education reforms of the American Association for the Advancement of Science, it is mandatory for the science teacher to have sufficient knowledge to integrate technology and inquiry-based teaching learning process in to their instruction so that science students can be prepared for the 21st century demands. The National Science Education Standards (NSES) demand that teachers should apply a variety of technologies, to support student inquiry-based learning (Nguyen, Williams, & Nguyen, 2017).

All the stake holders related to the field of education have strongly emphasized on the importance and need to bring a change in the students' attitudes, to shift the student from rote memorization to true understanding of concepts by using educational technology. This allows the students to use technology in innovative ways to learn more about educational technology (Chandrasekhar, 2018). The findings of British Educational and Communication Technology Agency (BECTA, 2017) revealed that by the active involvement of science teachers practically in the projects, workshops etc. the attitude of the science teachers can be made positive towards technology use during teaching learning process. The scheme launched In UK as an initiative of Laptops for Teachers (LFT) so that teachers' and head teachers' access to computers can be

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The evaluation of this study confirmed the above statement about teachers' positive attitudes and confidence by having their own laptop computers to be used during teaching learning process (BECTA, 2017). The use of Educational Technology need support and professional development for teaching science in developing countries. This professional development provides collaboration of teachers in the form of teaching communities to improve and support the teaching learning process. During collaboration, teachers share their knowledge, experiences and practices, mutually discuss the issues related to student learning. Thus support each other's knowledge and pedagogical skills during their learning about new technologies (Norris & Soloway, 2019).

2.15 Educational Technology and Science teaching

Rapid Technological development has affected all walks of life including science education. These Technological developments have effectively solved the problems and issues of science education. The use ICTs in teaching science has significantly enhanced the understanding and motivation of students. Now the technology is being used as a source to encourage inquiry-based learning, to enhance communication, construct teaching materials and to assist students' self-expression ICT plays a potential role in science teaching learning process to expedite and enhance work production, support exploration and experimentation, to visualize scientific processes more clearly, support in collaborative knowledge building and to shift from teacher centered learning to student cantered learning activities (Henessy, 2016). Computer and computer related technologies can be effectively used in teaching science like display of Human anatomy, action of bacteria and viruses on human beings, watching of

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reactions as in real life, Animations and videos of complex molecular structures, explanation of mechanism of electric generator etc. using ICT tools, information on picture, text, tables and graphs are presented to the students so that students are able to manipulate for making necessary changes and hence to evaluate it. Information on text, picture, tables and graph are presented to students using ICT specially to visualize a complex process in physics teaching. When this information is presented, students can manipulate it to make changes and at the same time evaluate the changes made. In this regard, the role of teacher becomes very important. Hence the power of ICT in science teaching is valued by the role of science teacher. Whether the science teacher understands the power of ICT in science instruction? Does he value it in science teaching? Research reports reveal that traditional experienced science teachers are reluctant to incorporate ICTs in teaching learning process while the present-day students and newly qualified teachers are more confident users of the ICTs (Galanouli, 2018). Despite the widely accepted important role of ICTs in teaching learning process, there are number of obstacles like insufficient availability of computers in the institution and lack of sufficient knowledge and skills for using ICTs tools are problematic for the teachers and students in using ICTs in teaching learning process (Beak et al., 2019).

This reflects that the whole story moves around the effectiveness of teaching learning process which can be made interesting and motivating with the support of educational technology because the concept of educational technology is a comprehensive domain. It is not only concerned with the procedures, and ideas but it also includes the devices and machines which produce successful learning outcomes and always remain effective everywhere provided its prerequisites are materialized to

its maximum (Saettler, 2020).

The usability of educational technology in teaching learning process provides immense access to information to the learners as well as the facilitator. It guides how to communicate with the others and gives opportunity to demonstrate their learning with the help of innovative way of teaching. Technology supported teaching learning process is a type of constructivist style which provides guideline to the learner for better communication and collaboration to construct new meanings and show more understanding to integrate the ICT tools in more effective way to make teaching learning process a successful activity (Saettler, 2020). It is therefore obligatory for the science teacher to attain basic knowledge and skills of using ICT tools during teaching. It will not only fulfil his requirement for professional development but also for their routine use for the facilitation of the leaners. The basic skills of ICT tools include: preparation of notes, question papers by MS word, class lists, results, work sheets by MS excel, searching of useful information, literature review by internet are quite necessary for every teacher to know for his students of technology enriched classroom (UNESCO, 2019).

The teaching in a science classroom is somewhat different from the teaching of non-science subjects. The science knowledge comprises experimental proof to verify the authenticity of any datum. It is not a simple assemblage of particular ideas but somewhat constructed on rational contacts between proof, explanation and confirmation of practical or anticipated facts by organized scientific process. The very purpose of using educational technology in today's classroom is to improve and to develop the excellence of the Science teaching learning process so as to prepare a professionally strong science teacher because this educator has to prepare his students

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for the 21st century work place by learning skills (collaboration, communication, critical thinking and creativity). It is the requirement of the 21st century skills that the teacher must have understood to use educational technology and inquiry-based instruction in their classrooms. The knowledge and understanding of basic science subjects like mathematics, physics, chemistry and the teaching of social sciences, can be excellently boosted by 21st century 4 Cs skills (Critical thinking, Communication, Collaboration, and Creativity).To materialize these aims, we need to support science teachers in refining his knowledge and understanding of using ICT tools and the authorities of education system to device policies to implement innovative strategies in the science class rooms with the help of educational technology(Craft, 2017).

Science is a systematic commencement that builds and organizes knowledge in the form of testable explanations of the observed facts and the predictions about the universe (Abbitt, 2017). The developmental level of scientific literacy in any society reflects its economic growth and its social stability at political and social levels (Aina & Adedo, 2016). Today the use of technology has transformed all aspects of society: its institutions including industry, commerce, social life and education. In particular, scientific knowledge can be made more accessible and understandable with the help of educational technology because educational technology creates inquiry- based learning environment for the students. The students can understand the scientific phenomenon more easily by using computer, internet, CBL's telescopes, microscopes, pH meters, projection panels, Geiger counters, lasers, spectrophotometer, glassware, VCR's, graphing calculators, electronic balances etc. to observe, classify, infer and experiment in the science class. It is therefore, well said that a science class without the apparatus and tools of science do not provide environment to practice properly (Rizvi, 2019).

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Technology has changed the way to scientific inquiry. Now almost every aspect of scientific exploration has been touched in some way or the other by technology. It is also a fact that today's science work is not possible without technology. With the integration of technology, Students are, creating and sharing media such as original artwork, blogs, web pages, digital photographs and videos (Sime, & Priestley, 2018). The effectiveness of educational technology in the science teaching learning process can be assessed with help of some common questions: How does the educational technology lead to improved student achievements in science? Is this technology helpful to improve student learning? Is it to increase the proficiency level of the science teachers regarding its use? Researches in this field strongly support that educational technology is an effective means for addressing educational needs. There are number of intermediate goals like: improved student behavior towards learning, their engagement and attendance, improved opportunities for professional development of science teachers, improved efficiency of classroom, better communication between teachers, students, parents and administration etc. Which show a strong link between technology and intermediate goals that lead to high achievement (Solomon, & Schrum, 2017).

Computers and other ICTs are now frequently being used in science teaching learning process for developing different scientific skills and to relieve the introduction of diverse educational information. MS-Word, Power Point, Excel, Flash Player etc. provide wide spectrum of working with educational technologies in teaching learning process. (Treacy, 2020). The use of spread sheets are supportive for entry and analysis of big data in a shorter span of time. The simulated scientific experiments are not only safer to present but also save sufficient time for laboratory preparation (Abdel waheed

2018). Similarly, the use of multimedia is a means of instructional delivery in the form of sound, words and diagrams through a single system to create interactive and meaningful teaching learning environment for the students (Rolfe & Gray, 2018). Multimedia is not only helpful for the teacher to control the contents and flow of information but also supportive for the students to increase their interest and understanding level necessary for the enhancement of their memorizing power. The reason for using these technologies in education is to prepare the youth of this modern age to become successful in the society lead by information and communication technologies (Gilakjani, 2019).

The technology lead teaching learning process equip the students with the skills of self-centered learning, collaborative, problem-based learning, creative learning and critical thinking etc. These skills ultimately help the individuals to create sense and feeling to adjust themselves in this modern world shaped with the culture of using technologies for all disciplines of life particularly the field of science (Kang, 2016). This foundational base for materializing this objective is to create the environment of positive behavior and practice towards the use and of educational technology in teaching learning process which ultimately relies mainly upon the crucial role of Science teacher because the technology and pedagogy are equal partner in this modern world. The future success of educational technologies in science teaching depends upon the quality of thought given by the teacher with defined focus on learning objectives (Mirskaya, 2017).

The effective use of educational technologies in teaching learning process encourages creativity and innovation that builds the skill of inquiry and investigation among the students. Which creates positive attitude among the students towards

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scientific literacy (Smeets, Gennip, & Rens, 2018). Regarding pedagogical area of teaching learning process, the ICTs have significant role in applying theories of learning. The students equip them with strong motivation to learn, investigate and eventually to expand their interests in scientific knowledge. The use of educational technologies in teaching learning process actually provides high flexibility and diversity of its usage which allows the instructor to produce knowledge based interactive environment for the students to learn and share with their peer members in a well-organized method (Anderson, 2017).

2.16 Educational Technologies and understanding of Science Students

This is the most important question to be answered by the technology users. CT is simply a tool; it does not ensure learning in any way. However, the application skills help to improve students' understanding (Harrison et al, 2002).in this situation, teacher plays mediation role between the students and Educational Technologies. In Science, the interactive communication plays significant role to explore ideas together, designing own hypothesis, consolidating scientific and informal ideas.

Hence the teacher can guide his students using right idea by the right person on right time in the light of desired objectives with the help of educational technologies. But how much active the students are involved in learning? The answer is how much the teacher is skillful in using and blending of pedagogy and technology (Zhao, Hueyshan, & Mishra, 2017).

2.17 Issues and Problems of Science Education in Pakistan

Science education is a specialized field of education which occupies fundamental role in the success as well as survival of the whole nation in this technology enriched modern world. The vital role of science teacher as a facilitator

mostly depends upon the academic knowledge, understanding and skills of scientific concepts as well as the knowledge of integration of educational technology in teaching learning process (Al Rajhi, 2018). However, the researches show that the present level of science teacher in Pakistan is very pitiable due to improper implementation of educational policies and frameworks since number of years in Pakistan (Halai & Durrani, 2016; Hina, 2018).

2.17.1. Historical Background

The previous education system of British focused on merely writing, reading and arithmetic was replaced by the recommendations of education conference to signify the importance of scientific research and technical education (Government of Pakistan, 1975). Later, the policies and efforts of the government concentrated on the improvement of science education by including the science as a compulsory subject at secondary level as well as the training of science teachers by establishing teacher education institutes in the country because government realized that satisfactory delivery of basic science education functions as a foundation for the success and advancement of the nation in 21st century innovative world of technology. In this regard, the significant role of UNESCO is of high value for uplifting quality of education particularly the science education in Pakistan (UNESCO, 2006a). USAID introduced the concept of Pre-STEP model of teacher professional development program in Pakistan to facilitate by removing barriers in the education system of Pakistan (Zhao, & Cziko, 2019). Since independence, Government of Pakistan has introduced number of reforms, policies. However, poor implementation and monitoring in addition to following factors have stuck the whole education system of Pakistan (Rizvi & Khamis, 2019).

2.17.2. Ways to improve Science education

According to Rizvi and Khamis (2019), the present-day competitive world needs to utilize its natural resources in justifiable way for the survival of the country economically. This enables the country to create knowledge-based economy by procuring scientific and technical capability of the individuals. In fact, the inclusion of science education in priorities is one of the vital narratives in this regard. Pakistan as a developing country can show better performance in the international economy by enhancing standard of science education at elementary and secondary level. We need to nurture the culture of science education in our youth by taking following revolutionary steps of the Federal and Provincial governments so that the future of coming generation can be secured.

i. Beginning of STEM Education program: It is the mixture of Science, Technology, Engineering and Mathematics program used to boost up the passions of students so that they are able to chase the career in these fields. This program offers thorough coaching and laborious training program for the students on the basis of their mental capability. This program is required to be started at district level to nurture the culture of competition to improve the approachability and to enhance the standard of science education in the country

ii. Boosting the moral of students to follow constructivist approach: The standard of science education can be improved by apprising the instructional design so that the learner is motivated to opt learning by doing and self-discovery approach, problem-based learning, inquiry-based learning, project based learning and self-exploration approach

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iii. Boosting the use of Educational Technology: The effective use of educational technology in teaching learning process in the form of multimedia, information and communication technology will provide a solid step for the improvement of standard of science education.in the country.

iv. Nurturing the culture of competition among the students: The culture of competition in teaching learning process will help to understand the level of scientific of science teaching. The competition in science education may include; Knowledge of scientific facts, degree and understanding, problem solving technique, projects. It is the duty of the government to create technology enriched educational institution for the young generation.

v. Refining the working condition for the teaching faculty: As the work of a science teacher is technical, time taking and hard, it should be accommodated by granting them special allowance so that young teachers are encouraged to opt teaching profession.

vi. CPD is a continuous professional development program. Special training programs must be launched for the in service and prospective science teachers for the enhancement of their professional skills.

Educational technology as an Information Communication Technology imports a leading role in human actions in daily life in order to manage and adopt suitable plan to accomplish the demand of the present day of modern age. If the idea of science education is to bring socio-economic progress of the country, then the character of ICT in science education cannot be ignored in any way. It is generally granted throughout the world that progress could only be significant if and when it is science and

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technology driven. By admitting the reality of this fact, the vision and prospects of using educational technology in teaching learning process, the following recommendation are obligatory to be continued for the enhancement of quality of science education:–

i.   Satisfactory finance: The provision of ICT tools for the teaching of science basically depends on funding. This success of enrichment of the science classroom can be accomplished only if the allocated fund is appropriately consumed for the improvement of science classroom with the support of ICT tools meant for the teaching of science.

ii. Instructional Resources: Facility of Instructional Materials is one the basic requirement needed by the teacher to demonstrate, clarify and highlight the viewpoint for better comprehension by the science students.

iii. Professional development of the science teacher: The role of a science teachers is to accomplish the principles of teaching science program

iv. For the boosting of student motivation and involvement in the teaching learning process. The updated knowledge and understanding of teaching science in an technology enriched classroom is possible only if the science teacher is professionally strong. This can be made possible by continuous professional development program during the service and mandatory training sessions for the pre-service science teachers.

v.   Salary packages: Remuneration and financial benefits of the teacher can progress work condition of science educators. The motivation and spirit of the science teacher directly backs to the good quality of science education (Lewin, C., & McNicol, S, 2017). The image and status of the teacher can be uplifted by the government by improving teacher's salary packages,

housing facility and utility grants. The teachers working in rural areas to perform their duties should be given special allowances to inspire teacher's retention for the science education program.

vi. Monitoring and appraisal: The duty of all the government agencies is to detect science education potential limitation so that suitable step can be taken to overcome them.

vii. Teaching Methodology: Techniques of teaching are actually the methods that a teacher uses to deliver lesson thereby making learning experience concrete to learners. The success of teaching science is totally based on the methodology and knowledge and understanding of using educational technology opted by the science teacher in his classroom. The innovative technology supported methods can guarantee the success and boosting of science teaching learning process.

2.18 Education Technology and National Professional Standard

The notion of education technology in teaching learning process is excellently used to boost the overall excellence of education. Educators and trainers use professional standards as a framework to analyze and evaluate their performance of teaching quantitatively so that they can to improve their pedagogical skills through continuous professional development (CPD) programs. In 2009, the Government of Pakistan with the support of UNESCO and USAID framed ten National Professional Standards (NPSTs) for teachers through its teacher strengthening education program in Pakistan (STEP). These ten National Professional Standards overall define the quality of education in Pakistan.

These ten national professional standards also include one standard which is

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concerned with the concept of educational technology. The 7th national professional standard is "Effective communication and proficient use of ICT. This standard is very necessary for every Science teacher to improve his teaching style and approach using educational technology to encounter the present-day challenges of 21st century. This standard will eventually help to standardize and improve the quality of technology supported science teaching learning process throughout the country. The professional standard 7 postulates that it is obligatory for all the prospective and perspective science teachers to integrate ICT tools in teaching learning process to boost the standard of education and to keep pace with the modern world. The knowledge and understanding of using ICT tools in teaching learning process is also the essential component of B.Ed. degree program in Pakistan (NPSTs, 2017).

Education has pivotal role in the national development. It is a continuous and secure process to fulfil the aims and objectives of national interests. The educated persons have knowledge and wisdom to work collectively for the betterment of the country. The quality of education is considered as the elixir for all social disorders which can be overcome only by a professionally strong and competent teacher which is possible only when the teacher is well equipped with the latest instructional strategies to meet the international agenda of quality education (Rehmani, 2019). To fulfil the increasing demand of teaching profession, the concept of professional development of the teachers has been initiated worldwide. For this purpose, some standards for quality education are necessary as a gadget for every teacher to analyze and improve his teaching style and strategy for a quality education. The concept of National Professional Standards for calibration of quality education is a mile stone in educational development of Pakistan. These Standards provide a framework for trainers and teachers to critically

analyze their own practice and to improve their pedagogical skills through Continuing Professional Development (CPD). The Government of Pakistan with financial support of USAID and technical support of UNESCO through its project, strengthening teacher education in Pakistan (STEP) formulated ten National Professional Standards for Teachers (NPSTs) to improve the quality of education in the country. Each of these ten standards consists of three components:

i. Knowledge and understanding

ii. Disposition (attitudes, behavior and values) and

iii. Skills and performance

These three parts of each standard are in fact basic parameters to evaluate the proficiency level of knowledge, attitude and skills of the teachers etc. These standards ultimately help to know the quality of education in the country. Although these professional standards were initially formulated for primary level. However, these standards can also be applied for secondary level teachers and teacher educators (Ministry of Education, 2017). Teacher is the nerve center of whole education system and the most significant agency to rehabilitate and standardize the whole teaching learning process. It is therefore, necessary for the teacher to know about variety of educational and pedagogical skills to transform his knowledge to the students at secondary level. According to National education policy (2009), Teacher can provide quality education on the basis of quality of instructions. It is therefore, necessary to equip the teacher with the modern technological based instructional strategies through professional development programs to fulfil the international agenda of standard based improvement of teacher for quality education. In this situation, the national professional standards for teacher education provide the basis for the homogeneity and consistency

what comprise value teaching to assist knowledge expression, understandings, values and skills necessary foe effective teaching. Thus becomes a strong means for rising status and position of teacher in the society.

2.18.1 Educational Technology for Knowledge and Understanding

In teaching learning process, a powerful knowledge base of a teacher plays pivotal role in creating interactive learning environment and for adequate provision of instructional material for the learners. In this regard, the use of educational technology in the form of information and communication technologies plays catalytic role not only in creating interactive environment for the teacher and student but also to improve quality of education. However, the use of technology requires the maturity and competency of the user i.e., teacher. Information and communication technologies provide knowledge, skill and understanding for exchange of information using electronic machines in the form of computer, cell phone, video, E-mail, radio, television, soft wares, hardware video Conferencing etc. It is therefore, quite necessary for the present-day teacher to have appropriate knowledge and understanding of the using modern technologies in teaching learning process otherwise the role of a teacher will become outdated in the coming future and ultimately the quality of education will deteriorate. It is therefore quite necessary for a teacher to be trained to acquire appropriate knowledge and good understating to use technology effectively in teaching learning process to meet the demands and challenges of 21st century (Geer & Sweeney, 2018).

The objectives of using educational technology in teaching learning process demands whether the technology in the classroom enhances student learning and is this gain in learning justify the money invested on educational technology? Technology is

not only a device rather it is theory, imagination and creativity to implement the device in a classroom to facilitate teaching learning process. It is matter of fact that Technology can facilitate in instructional designing but this design of learning activities to incorporate technology for teaching learning process makes the difference in student engagement and learning (John, 2019).

The work of Ramboll (2016) on integration of educational technology shows that it is more important to have knowledge of technology integration than merely knowing about ICT. Therefore, teachers can benefit from educational technology only by knowing altered teaching approaches. For this reason, the potential and experience of science teacher to integrate educational technology is considered as pre requisite for effective use of these resources. The experienced teacher can very easily save his time during integration of educational technology (Roblyer, 2017)

According to the science education reforms of The American Association for the Advancement of Science, it is mandatory for the science teacher to have sufficient knowledge to integrate technology and inquiry-based teaching learning process in to their instruction so that science students can be prepared for the 21st century demands. The National Science Education Standards (NSES) demand that teachers should apply "a variety of technologies, to support student inquiry-based learning (Neo, 2016).

All the stake holders related to the field of education have strongly emphasized on the importance and need to bring a change in the students' attitudes, to shift the student from rote memorization to true understanding of concepts by using educational technology. This allows the students to use technology in innovative ways to learn more about educational technology (Chandrasekhar, 2018).

The findings of British Educational and Communication Technology Agency

(BECTA) revealed that by the active involvement of science teachers practically in the projects, workshops etc. the attitude of the science teachers can be made positive towards technology use during teaching learning process. The scheme launched In UK as an initiative of Laptops for Teachers (LFT) so that teachers' and head teachers' access to computers can be enhanced. The evaluation of this study confirmed the above statement about teachers' positive attitudes and confidence by having their own laptop computers to be used during teaching learning process (BECTA, 2017).

The use of educational technology needs support and professional development for teaching science in developing countries. This professional development provides collaboration of teachers in the form of teaching communities to improve and support the teaching learning process. During collaboration, teachers share their knowledge, experiences and practices, mutually discuss the issues related to student learning. Thus support each other's knowledge and pedagogical skills during their learning about new technologies (Zyad, 2016).

2.18.2 Educational Technology and Disposition

Disposition is a characteristic attitude as a result of which a person shows his prevailing mental and emotional outlook. In schools, the technology despite its ability to enhance 21st century skills largely remain underused and overused. Among other things, the teachers are unable to utilize technology in teaching learning process due to insufficient training and attitudinal barriers. In this situation, technology disposition gives us better understanding to know the beliefs and attitudes about technology influence on teachers practice, teachers proficiency level in using and incorporating educational technology into classroom teaching.in this regard, professional development program enables to get deeper understanding of teachers disposition and

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extent to which it impacts their pedagogical practice. Hence the remedial steps to cope with the deficiencies of a teacher regarding effective use of educational technology can teaching learning process can be taken (Yusuf, 2018).

The 21st century skills partnership demands to prepare the students as a problem solver, critical thinker, ICT literate, flexible, creator, and collaborator, communicator competent and financially literate, requiring their teachers to adopt their curriculum and digital technology practices to meet 21st century demands. Disposition is in fact teachers' beliefs and impact of these beliefs in technology use in teaching learning process. These teachers are essential component to digital technology integration and success of in teaching learning process. If a teacher is not willing to use educational technology in teaching learning process to improve student learning outcomes or to prepare students for high level competency tests, then teacher will not keep himself bound to use educational technology or using a device in to classroom instructional practices. Hence it is important to understand the teachers 'perspective and experiences to improve the effectiveness and success of technology supported teaching learning process for science (Erdoğdu & Erdoğdu, 2018).

The field of education is greatly influenced by the rapid developments in information and communication technologies. It has not only changed the role of teacher as a facilitator but also the students' achievements especially due to ICTs access to the students (Erdoğdu & Erdoğdu, 2018). It is therefore, necessary for a science teacher to have positive attitude towards the use of educational technology during teaching learning process. Researches shows that majority of the teachers have limited use of educational technology in the form of word processing, E-mail, power point presentation during their teaching practices. This may be due to infrastructural,

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curricular or logistical reasons or personal attitude toward educational technology (Zyad, 2016).

According to Gartner (2019), it is not necessary for the novel teachers to have positive attitude for using educational technology for teaching purpose on the basis of their prior ICTs skills gained from their social and private lives. No doubt the integration of ICTs tools in teaching learning process as a coherent activity in much important by the teachers to prepare them for communication, collaboration, creation and critical thinking using computer and other educational technologies to materialize their learning objectives. But it is also a fact this new emphasis on the use of educational technologies do not directly change the teacher's approach. Hence it has become more important to change the teachers' disposition rather than merely the introduction of new technologies for teaching learning purpose (Wallace, 2017).

According to Morris, (2019), the major predictor for effectiveness to use computer and other ICTs tools in teaching learning process is actually the attitude teacher towards educational technology. A positive attitude towards educational technologies develops aspiration and assurance of the teacher to use educational technology in his class room. The study of Pamuk, (2019), reveals that if the science teacher believes in the usefulness of educational technologies in teaching learning process, then it will be not only easier for teacher to integrate educational technologies in his class room but also motivational to acquire technology related necessary skills. The only way in achieving educational standards is through institutional support of the teacher so that the teacher can be made professionally strong by developing interests and positive attitude towards the use of educational technologies during teaching learning process (Kadijevich & Haapasalo, 2017).

The research of educational technology indicates that one of the major barriers that creates hindrance for the teacher to use ICTs in teaching learning process is his "confidence level". According to BECTA (2017), lack of confidence is the major barrier for the teacher to integrate ICTs in the classroom. The reason behind the lack of confidence is "fear of failure". The teachers having little knowledge and poor skills in using ICTs make the teacher concerned in front of the students who perhaps have more knowledge than he knows (Beggs, 2017).

2.18.3 Educational Technology for Skill Development

Skills are the competencies of an individual which create confidence in doing a particular job. These skills enhance working, creates more proficiency, work place productivity and ultimately profitability of the organization. In modern learning environment, computer and other ICT tools are becoming essential for teaching learning process (Mishra & Sharma, 2013). The use of multimedia is an effective tool for the teacher to motivate his students by presenting information in an innovative way (Osamah, Fong, & Ziad, 2019), Multiple media in the form of text, audio, image, video, audio and animations inspire students to become quick learner, critical thinker, problem solver and more suitable to seek specific information (Neo &. Neo, 2016). In this way, productivity of learning is improved by bridging the gap between knowledge acquisition and knowledge application after the elimination of time and place factor (Abbitt, 2017). The learning material of multimedia should be understandable, clearly oriented and well- structured. The incorporation of dynamic elements in the form of animations, attractive banners and multiple sensory modalities provide an interactive, creative and environment of better retention for the learners (Nguyen, Williams, & Nguyen, 2017).

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It is therefore, quite necessary for the teachers to take digital courses like mobile learning, e-learning, and blended learning specifically target the area of skills through professional development programs. E- Learning courses are usually hosted on learning management system (LMS) using personal computers. Hence the user can take the any course of his interest on time. If someone is slow learner, he can proceed the course at his own pace. E- Learning courses deliver knowledge effectively because these courses virtually use appealing elements such as videos, animations, and info graphics with proven instructional design principles (Lewin, & McNicol, 2017).

2.19 Educational Technology and 21st century 4Cs Learning Skills

The modern technology has restructured the teaching learning process, the style of conducting business, and even observing the world. Now live information from the whole world thousand miles away can be benefited in a few seconds so that the methods for acquiring and collecting data seems endless and easily accessible Hennessy, (2016). In the 21st century, it has become necessary for all the citizen to be well aware of information as well as technological literacy. The P-21 i.e., Partnership for 21st Century Skills provides the Framework for 21st Century Learning, known as the "Four Cs" (Critical thinking, Communication, Collaboration, and Creativity).it is quite necessary for the Professional development program of a science teacher to include the ways to teach 4 Cs skills i.e. critical thinking, Collaboration, Communication, and Creativity. In this regard, the role of professional learning communities can be more beneficial because in this type of environment, colleagues work collaboratively to improve classroom practices of the "Four Cs." Learning skills of 21st century. No doubt, the use if ICTs are effective for the development of 4Cs but it is will be more effective if these 21st century skills are developed by cross curricular changes which also demands

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changes in pedagogical practice (Hennessy, 2016).

2.20 Ways to Integrate Educational Technology in Teaching Learning Process for each of the four Cs

2.20.1 Educational Technology for Communication: Communication means the ability to exchange thoughts, to criticize and to present information with the intension of conveying message to others. Communication skills involves reading, writing, speaking and listening. Educational technologies have significant role in all walks of life specially education. ICT tools not only makes easier and understandable to reach the audience at par but also faster way of communication. Today a best teacher is the one who can effectively communicate information to his students and ensures feedback and debate mechanism between the teacher and students by exchange of ideas and information using technology tools (Lewin, & McNicol, 2017). Most commonly ICTs in the form of communication tools used in teaching learning process are: internet, video tapes, mobile phone, communication labs, twitter, blogging, and educational satellite, drop box, web, video conferencing etc. these communication tools effectively cover all the four domains of communication i.e., reading, writing, speaking and listening (Vrasidas, & Glass, 2019)

2.20.2 Educational Technology for Collaboration: This is an important learning skill because collaboration creates most suitable and interactive environment for the students to learn. The use of educational technology in the form of ICT eliminates barriers of distance, time and resources and allows its learners to share their knowledge, skills and experiences any time, any place in the world through a collective venture. Collaboration is not the replacement of face to face, rather it supplements the face-to-face component of teaching learning process by facilitating the team members of diverse locations working together on the same task through digital tools (Bessagnet, Schlenker, & Aiken, 2015). ICT is a collaborative technology that not only provides environment for coordination of group work but also tools for recording progress of the students,

feedback and as a reference center for Meta information (Author, date and sequence of contributions). In the light of report issued by Australian government regarding the significance of collaboration in teaching learning process, various ICT tools used in all sectors of education include: a) Social networking (face book) for sharing messages, photos, videos and any other information. b) Wikies (Wikipedia) for collaborative content creation. c) Microblogs (tweeter) for brief updates of an individual on any topic for the users, d) Video conferencing for effective interaction of two or more people at different locations using appropriate software and hardware (Farren & Tweedy, 2019). e) The internet and on-line tutorials for flexible, accessible and as collaborative learning sources etc. In brief, some of other benefits ICT tools for collaborative learning given by BECTA, (2016) include: increased participation and engagement of quieter students without anxiety of raising questions in front of class, discussion among students through social networking outside class and thorough investigation of any study with the help of Tolls (Anderson, 2017).

2.20.3 Educational Technology for Critical Thinking: It is the high order cognitive activity which involves process of analyzing, synthesizing, developing and evaluating the huge range of information collected from different sources to make sensible decisions (Crook et al., 2017, cited in Lewin & McNicol, 2017). Critical thinking is commonly called problem solving skill because recognition of a solution depends upon initial thinking of the individual, finding of information about the problem, planning for achieving target, searching alternative ways of solution on the basis of the anticipated results, testing and evaluating results for the continuous betterment of solution. This sequence of events ultimately provides basis for Critical thinking (Vrasidas, & Glass, 2019).

The commonly used ICT tools for critical thinking are: Blogs, Wikies, social networking. These webs 2.0 ICT tools allow its users to create links directly or indirectly from other users through their web Page. These web 2.0 are regarded as a second generation of the World Wide Web (www) and are effectively activates the potential of the people to collaborate, share and discuss using blogs, Wikies and social networks. The action and response in a repetitive way ultimately becomes source of critical thinking (Solomon & Schrum, 2017).

2.20.4 Educational Technology for Creativity: According to Aldous, (2018) "creativity is the thinking process which enables learner to utilize his imagination to generate ideas, hypotheses ultimately leading to the production of unique, novel and usable product. Creativity is considered as one of the most important skills to address the anticipated challenges of 21st century. In this regard, ICT tools can play pivotal role to support learners' creativity by developing new ideas, providing interactive environment through on line connectivity and creating more recent digital outputs (Loveless, 2009). Creativity or Innovation can be created by Multimedia presentations, Voice threads to create stories, Window movies makers, by using blogs, Wikies etc. (Treacy, 2020).

2.21 Emerging Trends in Educational Technology

The Technological advancement is the commanding factor behind the present-day knowledge driven economies of the modern world. Both advanced and developing countries are giving prime importance to equip and utilize the Educational Technologies in the form of information and communication technologies according to their resources to fulfil the educational demands of 21st century. The use of Educational Technology helps the students of today's information age to learn and apply 21st

century skills. The digital revolution has reshaped the role of society in the presence of new tools ranging from social media to digital transaction management. (Hennessy, 2016).

The present era has not only changed the ways the people interact and do business but also has notably influenced the learning styles. Now the class room has become one of the most flourishing markets for new technology. The emerging technologies have created positive impact on the ways students of different levels Consume their course material. For this reason, the educational institutions are forced to stay competitive by providing technology enriched learning environment to the students. There are two major emerging trends in educational technology:

i.   Technology for mass instruction and

ii.   Technology for individual instruction.

The first type included lectures, instructional broad casting, CCTV, filmed lectures, television and motion pictures. All these techniques of mass communications are equally applicable for a small number of students as well as for large audiences.

The second type included: computer assisted instructions, language laboratories, learning modules, auto tutorial systems and teaching machines (Vrasidas, & Glass, 2019).

According to Gartner's hype cycle Gartner (2019), there are twelve emerging Educational Technologies which can be grouped into four sets representing the current trends in Education Technology development which are:

i.   Multimode or multichannel technologies for learning. This type includes: Emerging and Mass Notification System (EMNS), with student retention CRM, unified communication and collaboration.

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ii. Social learning technologies: In this type, Open-source repositories, social learning platforms (Social learning technologies) are included.

iii. Cloud based learning technologies: cloud office emails for staff and faculty and cloud high performance computing.

iv. ICT interoperability. This includes hosted virtual desktops and open-source mid ware suites.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter covers the methodology of the research which includes research design, population, sampling and sample technique, development of research tools, data collection, and selection of statistical techniques for analysis of data etc. To meet the objectives of this research, the data were collected by using four different tools including questionnaire for the Science Teachers, questionnaire for the Science Students, Classroom Observation Tool, and Interview tool for the Head of Institutions. Data collected through these tools was analyzed through appropriate statistical techniques and tests. Findings were extended to draw conclusions from the analyzed data. Finally, recommendations were proposed on the basis of findings and conclusions of this study.

3.1 Research Design

In the present study, Descriptive mixed method approach was adopted which included the collection of quantitative as well as qualitative data. The research design of the present study was Sequential explanatory design, following Quan-Qual Model. The mixed method is an approach to investigation that combines both quantitative as well as qualitative data to minimize the chances of biasness in the data, to give satisfactory answers of the research questions and to enhance the chances of generalization of results Creswell (2016). The quantitative data were collected from the science teachers and science students of secondary level with the help of two separate questionnaires while qualitative data were collected by conducting interviews of Heads of institutions and classroom observation in selected Islamabad Model Colleges for Boys and Girls. This strategy helped the researcher to validate the responses from

teachers and students. The data collected through teacher and student questionnaire was authenticated through head of institutions interview and classroom observation.

3.2 Descriptive Method Approach

Descriptive method approach is employed for the collection of explicit and defined evidence about the existing position of a certain occurrence. This helps to extrapolate and simplify the elucidations from which effective generalizations can be organized positively. The present study has Sequential Explanatory Design which can be particularized with the help of following "Quan - Qual model" (Creswell, 2016). In this Quan- Qual sequential explanatory design, first of all, quantitative data were collected from the Science teachers and Science students of Secondary level with the help of two separate questionnaires. This was followed by collection of qualitative data by conducting interviews of heads of institutions and classroom observation in selected Islamabad Model Colleges for Boys and Girls. Then analyzed data of all tools was combined for interpretation, finding, conclusions and ultimately generalization to the whole population for recommendations.

3.3 Population

There are twenty "Islamabad Model Colleges for Boys and Girls, located in different sectors of Islamabad working under the Federal Directorate of Education, Ministry of Federal Education and Professional Training. Out of these twenty colleges, ten are for boys while rest of the ten colleges are for girls All the science teachers, science students, and heads of these twenty Islamabad Model Colleges were the population of this study. Each of these public sector Islamabad model colleges comprises three sections, junior section from grade 1 to 5 supervised by the head mistress, school section from grade 6 to 10 and college section from grade 11 to 12.

The principal is the overall head of the institution. In this setup, a teacher having at least master's degree in a particular subject teaches as a subject specialist from grade VI to grade XII classes. The present study was only for the science teachers and students of secondary level i.e., grade IX & X (session: 2020-2021). Islamabad Model Colleges are considered as best public sector educational institutions of the federal capital in terms of their infrastructure, facilities and profound supervision by the administration to provide quality education. It is obvious to expect that the use of educational technology is supposed to be well established in these institutions for science teaching and learning and its teachers to be well trained in using educational technologies for the effective teaching of science.

The necessary knowledge and skills of using educational technology to make teaching learning process effective includes the use of personal computer, laptop for preparing notes and assignments, presentations and AV aids, science models, multimedia, Internet browsing, WhatsApp for sharing text and videos, word- processing (MS word) for writing, MS Excel for preparing class lists, results & mark sheets, science laboratory apparatus etc. The purpose of this study was to analyze the effective use of these educational technologies of modern age for the teaching of science in well-established public sector educational institutions of Islamabad so that the level of achievement to prepare the 21st century generation can be determined precisely for its refinement. The summary of population is as under:

Table 3.1: *Population of the Study*

S #	Category	Actual Population
1.	Head of Institutions	20
2.	Science Teachers	150
3.	Science Students	3600

3.4 Sampling and Sample

For the selection of sample from the heads of institutions, science teachers and science students, simple random sampling technique was used because this basic technique of sampling provides equal opportunity to each member of the population being selected as a subject. The whole sampling process was performed in a single step with each science subject (physics, chemistry, biology) independently of the other members of the population. There were ten colleges selected as a population of this study. Following is the detail of five boys' colleges of the population:

    i.   Islamabad Model College for Boys F-10/3

    ii. Islamabad Model College for Boys F-8/4

    iii. Islamabad College for Boys G-6/3

    iv. Islamabad Model College for Boys G-10/4

    v. Islamabad Model College for Boys I-8/3

While the five female collages included in the sample were:

    i.   Islamabad Model College for Girls Street-25, F-6/2

    ii. Islamabad College for Girls F-6/2

    iii. Islamabad Model College for Girls F-7/4

    iv. Islamabad Model College for Girls F-10/2 and

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v. Islamabad Model College for Girls G-10/2.

According to procedure for the sample selection, the sample size for the population of 500 to 1000 should be around 200 (Smith, 2014). Following table shows the detail of sample size taken for the study of this research:

Table 3.2: *Sample of the Study*

S #	Category	Sample Size
1.	Head of Institutions	09
2.	Science Teachers	95
3.	Science Students	300 (150 Male and 150 Female)

3.5 Research Instruments

Due to the descriptive nature of this study, methodological pluralism concept was employed in the form of multiple research tools to minimize the biasness of data, to maximize validity and reliability of the collected information. Realizing the fundamental role of a science teacher in teaching learning process, the substantive objective of this study was to assess Knowledge & Understanding, Disposition and Performance /Skills (4C'S) as a 21st century learning skills model, which are the three components of the national professional standard on ICT and are used as a gadget to assess quality of education with regard to the use of educational technology by the science teacher for teaching learning process (Trilling, Bernie, & Charles Fadel, 2019).Thus the main source of quantitative data collection was the questionnaire for the science teacher while rest of the three tools were employed to validate the knowledge, disposition and skill level of the science teacher. So, the questionnaire for the science teacher was especially designed to cover the whole domain of national professional

standard on ICT while rest of the three research tools (i) Questionnaire for the science students, (ii) interview from the head of institution and (iii) classroom observation, were focused to validate the contents of science teacher questionnaire. Qualitative data were collected by two research tools, Classroom observations and interviews from the head of institutions while for the quantitative data, questionnaire for the science teachers and the questionnaire for the science students were developed. Overall, the following four research tools were developed to collect the quantitative and qualitative data of this study.

Instrument 1 - Questionnaire for the science teachers

Instrument 2 - Questionnaire for the science students

Instrument 3 - Interviews from the Heads of institutions

Instrument 4 - Class room observations

All the four instruments were employed to explore answers for seven (7) research questions.

3.5.1 Instrument – 1: Questionnaire for the Science Teacher

The purpose of this questionnaire was to collect the data from the science teachers of ten Islamabad model colleges for boys and girls, five from boys and five from girls' colleges, selected through random sampling technique. As the substantial objective of this study was to assess the three components of the National Professional Standard: Knowledge & Understanding, Disposition and Performance /Skills (4C'S) with regard to the use of educational technology by the science teacher for teaching learning process, so the questionnaire for the science teacher was especially focused to cover the whole domain of national professional standard on ICT In addition, the knowledge of instructional technologies employed by the science teacher during

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teaching learning process was also judged as one part of this questionnaire (Please refer to appendix A). Following is section wise detail of questionnaire for the science teacher.

Section 1: Respondent's personal information

Section 2: Knowledge and understanding of Science Teacher for:

    i. The use of ICT tools

    ii. National Professional Standard on ICT (NPS#7)

Section 3: Disposition of science teachers towards usage of ICT tools for

        Teaching learning process

Section 4: Skill level of science teachers towards ICT tools with regard to

        4 C's. (Communication, Collaboration, Critical thinking and Creativity)

Section 5: Instructional technology for the science teaching learning Process.

3.5.2 Instrument 2: Questionnaire for the science Students

This questionnaire was constructed to collect the quantitative data from the secondary level science students of ten Islamabad Model Colleges for Boys and Girls enrolled during session 2020-2021.The purpose of this questionnaire was to get feedback from the science students to validate the knowledge & understanding, disposition and skill level of the science teacher during teaching learning process. The questionnaire consisted of ten items with three options, disagree, neutral and agree. (Please refer to appendix B)

3.5.3 Instrument 3: Interview from the Head of Institution

The purpose of in-depth interview from the head of institution was to collect qualitative data by face-to-face interaction of the participant and the researcher. This direct interfacial approach is a more reliable way of getting information from the participant. Semi structured interview was conducted by the researcher with open ended

questions. This tool was composed of nine questions in all. The interview session helped the researcher to get comprehensive information about the facilities provided by the institution and the government for the implementation of ICT policy, the opinion of the head about the knowledge & disposition of science teachers regarding the use of ICT tools, institutional training programs and major challenges faced as a head in the provision and implementation of ICT tools for science teaching in the institution. (Please refer to appendix C)

3.5.4 Instrument 4: Classroom Observation

This tool was constructed in order to get information to calibrate three components of national professional standard on ICT in the natural settings i.e., availability and knowledge of ICT tools in the Classroom, Disposition of science teacher towards ICTs during teaching learning process, Skill level (4Cs) of science teacher and instructional technology. Thirteen classroom observation sessions were conducted in different Islamabad model colleges for boys and girls with prior permission from the head of institutions. It was proposed by the supervisor to perform two observation sessions during the science teaching classes, in each of the sample college. However, due to corona pandemic, instead of overall twenty proposed observation sessions to be performed in each college of the sample, only thirteen sessions could be performed in six different boys and girls model colleges and ultimately data of these six colleges were used to verify the results of the study. These observation sessions provided comprehensive evidence the ground realities about the availability ICT tools, their usability in instructional technologies for getting evidence of knowledge, disposition and skill level of the science teacher (Please refer to appendix D).

3.6 Pilot Testing of the Questionnaires

Pilot testing was done as a provisional trial with the help of limited number of science teachers, science students, and head of institutions to examine the clear understanding of the terminology and understanding of the items used in the questionnaires. Pilot testing was done in one of the boys' model colleges with 20 science students, 5 science teachers and head of the institution. The results of the pilot testing revealed that all the participants clearly understand the terminology of their respective questionnaires and they can easily grasp the depth of items of the research to reply. However, some of the science students of secondary class pointed out the difficulty in understanding the concept of "hands on activities" "posters for understanding of scientific concepts". These are the rare terms with respect to the secondary level students. Similarly, in section 5 of the questionnaire for the science teacher, containing items about emerging trends in educational technology, the teachers were not well versed with the terminology of modern technology like cloud-based learning technologies, zoom app, google class room and emerging and mass notification system (EMNS). These were explained by the researcher. The inference of pilot testing was that all the clarified features of questionnaire were understandable and can accomplish all the objectives of research to its maximum. After making some necessary changes, all the questionnaires were finalized in the light of instructions given by the co- supervisor and supervisor. The participants of the pilot testing were not included in the actual sample.

3.7 Validity and Reliability of the Instruments

Validity means exactness of measurement Clark, (2014). The validity of this study was checked with the help of experts in the field including Prof. Dr Azhar Mahmood Chairman Department of Education IIUI, Prof. Dr M. Munir Kayani IIUI, Dr Zafar Iqbal IIUI and Prof. Dr Fazal Ur Rehman, Chairman Early Childhood Education (ECE) AIOU Islamabad. In the light of their valuable suggestions and recommendations, necessary changes were made in all the four questionnaires. Lastly, with the approval of Prof. Dr Nabi Bux Jumani Supervisor, the questionnaires were finalized before pilot testing in the selected college.

Reliability refers to the homogeneity of the measurement. Reliability shows how trustworthy is the score of the test. If the collected data shows the same results after being tried repeatedly using various methods and sample groups, the material is reliable. The reliability of this study was determined by applying Cronbach Alpha to calculate internal consistency based on the inter-relationship between different elements and rate of co-relation.

Table 3.3 *Cronbach Alpha Values for each Tools*

S #	Tool	Cronbach Alpha Value
1.	Questionnaire for Science Teachers	0.84
2.	Questionnaire for Science Students	0.80
3.	Interviews from Heads of institutions	0.87
4.	Class room observations	0.91

Table 3.3 shows the Cronbach Alpha values for each tool. This varies from 0.80 to 0.9. The result showed maximum internal consistency because the found value is

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close to 1. It reflects that reliability is acceptable. Further, the correlation value shows

good estimate of internal consistency, since it falls in the range of 0.8 to 1. It is

important to note that pilot testing was conducted to discover the proof about the correct

distribution of questionnaires and satisfaction of the users.

3.8 Data Collection

Due to descriptive nature of this study, methodological pluralism concept was

employed in the form of multiple research tools to minimize the biasness of data and to

enhance validity and reliability of the research. All the ten Islamabad Model Colleges

of the sample were visited personally by the researcher. However, frequent school

closure due to COVID-19 pandemic, the data collection process suffered but the

cooperation of the heads and science teachers made it possible to achieve the target up

to 90%.

Table 3.4 *Data Collected for Each Category*

S #	Category	Questionnaire Delivered	Questionnaire Received	%Age
1	Head of Institutions	10	9	79%
2.	Science Teachers	120	95	83%
3.	Science Students	360	300	90%

The Class room observation was conducted by the researcher himself and 13

sessions were completed in different Islamabad model colleges for boys and girls

during period of two months.

3.9 Data Analysis

The present study was a mixed method approach has sequential explanatory

design. Hence the collection of both quantitative and qualitative data was necessary for

and interpretation of the results. Quantitative data was analyzed and interpreted with the help of % age, Mean, Standard Deviation (SD) and Chi-Square(x^2). The use of % age in analysis is useful for comparing values, with different totals. By converting data to percentages, the comparison between the values become easy. Similarly mean helps to reduce a large complex set of data to one number that represents the entire set and shows the tendency of the entire data set (Stoltman, 2021). On the other hand, the standard deviation is used to determine the spread of the data. Low standard deviation shows that the data is very reliable in contrasts to a data set with high standard deviation. (Bluman, 2016). Whereas Chi square statistical analysis was used to explore the significance of difference between dependent variables and independent variables. This helped the researcher to accept or reject the null hypotheses.

The qualitative data was analyzed by thematic analysis. Thematic analysis is the process of identifying patterns or themes within qualitative data. After thorough review of the data, all the statements were coded to get a summarized overview of the main points and common meanings that reappear all over the data. These codes later enabled the researcher to categorize the data into 3-4 understandable themes. In the interview tool for the head of institution, there were 10 questions. Out of 10, two questions were open ended. The data collected through open-ended questions was grouped into 3-4 understandable themes. Whereas the data for other 8 questions was tabulated and frequencies were calculated to apply percentages. Percentages helped the researcher to draw inferences accordingly.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

This chapter covers both quantitative and qualitative analysis of data and description concluded from the 4 instruments of this research study including Questionnaire for Science Teachers, Classroom Observation tool, Student Questionnaire and Interview tool from the head of institution. The quantitate data of this study was collected using two separate questionnaires: questionnaires for the secondary level science teachers and the science students of Islamabad Model Colleges for boys and girls session 2020-2021 while qualitative data was collected with the help of Classroom Observation tool and Interview tool from the head of institution.

Table 4.1 provides the overall detail about number of respondents in each category. Data collected through the questionnaires and other tools were analyzed using appropriate soft wares and statistical tests to draw authentic and solid conclusions.

Table 4.1. *Number of Respondents/ Observations for each tool*

Instrument	Female	Male	Total
Questionnaire for Science Teachers	44	51	95
Classroom Observation Tool	06	07	13
Student Questionnaire	135	165	300
Interview Tool for Head of institution	04	03	07

4.1. Analysis of Quantitative Data

4.1.1. Questionnaire for Science Teachers

Science Teachers Questionnaire essentially focused on three components of national professional standard i.e., "Knowledge and Understanding" of Science

Teacher regarding the use of Educational Technology in teaching learning process, "Disposition" of Science Teacher regarding the use of Educational Technologies in Teaching Learning process, "Skill level" of science teachers in using Educational Technologies with reference to 4Cs i.e., Communication, Collaboration, Critical thinking and Creativity, and Current trends of using Educational Technologies in Science Teaching Learning process.

4.1.1.1 Knowledge and Understanding of Science Teacher regarding the use of Educational Technology in teaching learning Process

Table 4.2. *Knowledge and Understanding of Science Teacher*

Statements	Cumulative Percentage Scores					Mean
	A	U	O	R	N	Scores
S1. Lecture cum discussion method is made interesting using Multimedia	42%	23%	22%	9%	5%	3.87
S2. Science teachers make group discussion for difficult concepts and problems using WhatsApp	13%	19%	31%	23%	14%	2.95
S3. Video conferencing is used for a debate during the teaching of science (debating).	11%	11%	19%	31%	28%	2.45
S4. ICT tools are utilized for brainstorming of Science Students	22%	25%	19%	24%	11%	3.23
S5. Project based learning in small groups is made effective for science students using ICT tools	23%	32%	24%	13%	9%	3.47
S6. Science Teachers give	57%	24%	11%	6%	2%	4.27

Statements	Cumulative Percentage Scores					Mean
	A	U	O	R	N	Scores
demonstrations about scientific phenomena with the help of models in the laboratory						
S7. Science Teachers use direct method by writing notes on blackboard or transparency to explain Science concepts	44%	34%	13%	5%	3%	4.11
S8. Students' ideas are taken in to consideration by the Science Teacher through observation using electronic devices.	15%	25%	26%	25%	10%	3.11
S9. Teacher facilitates discussion about difficult concepts using videos	25%	25%	24%	18%	9%	3.39
S10. Hands on activities is effective than lectures to teach scientific concepts.	34%	31%	20%	6%	8%	3.78
S11. Science teachers can share notes of science subjects with their students through google drive	24%	22%	27%	20%	8%	3.33
S12. MS Word is helpful for framing of lecture/quizzes	41%	25%	15%	18%	1%	3.86
S13. Utilization of YouTube is best for visual presentations of difficult	40%	46%	8%		3%	4.16

Statements	Cumulative Percentage Scores					Mean
	A	U	O	R	N	Scores
topics of science						

Table 4.2 shows the thirteen (13) statements that science teachers were supposed to respond under the category, "Knowledge and Understanding of Science Teacher regarding the Use of Educational Technology in teaching learning process" on a five item Likert scale including Always (A), Usually (U), Occasionally (O), Rarely ® and Never (N).

Figure 4.1. *Percentage Teachers' responses for Knowledge and Understanding.*
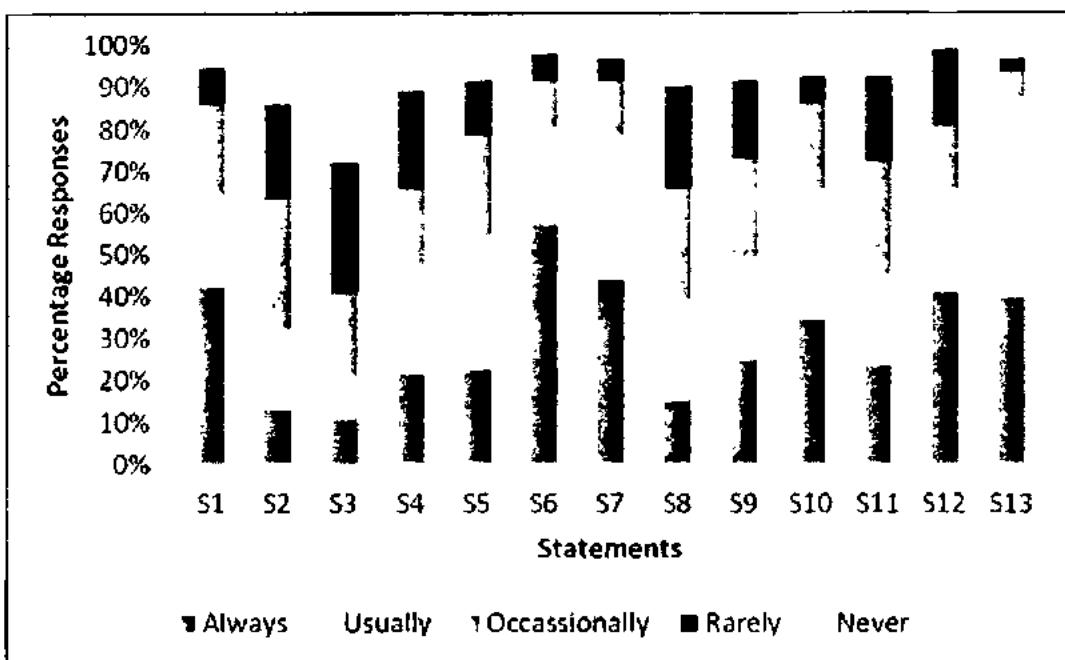
Figure 4.1 shows the cumulative percentage responses of teachers for each statement. This shows that in 8 out of 13 statements, 50% or more teachers claim to use either always or usually. Whereas for statements S2 (Science teachers make group discussion for difficult concepts and problems using WhatsApp), S3 (Video conferencing is used for a debate during the teaching of Science (debating).), S4 (ICT tools are utilized for brainstorming of Science Students), S8 (Students' ideas are taken in to consideration by the Science Teacher through observation using electronic devices) and S11 (science teachers can share notes of science subjects with their students through google drive) this percentage is less than 50%.

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Figure 4.2. *Cumulative Teachers responses for Knowledge and Understanding.*
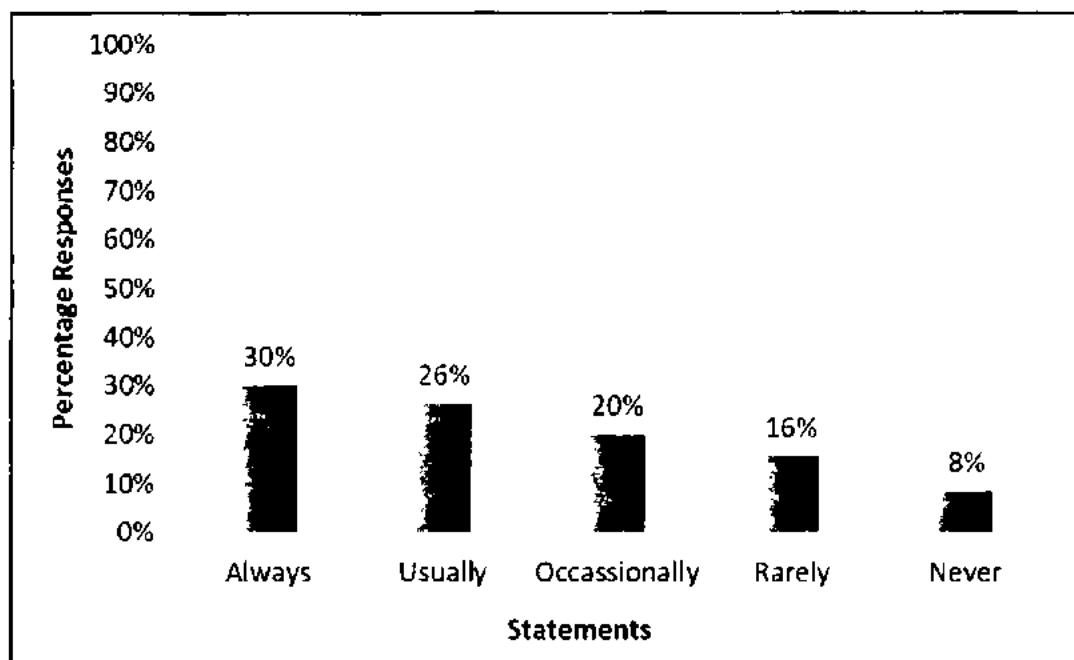
Figure 4.2 shows the cumulative percentage average of teachers' responses for all the thirteen (13) statements. This shows 30% teachers claims to have sufficient "Knowledge and Understanding regarding the Use of Educational Technology in teaching learning process", 26% teachers use usually, 20% uses occasionally, 16% rarely and 8% never use.

Figure 4.3. *Percentage Teachers' Responses for Knowledge and Understanding.*
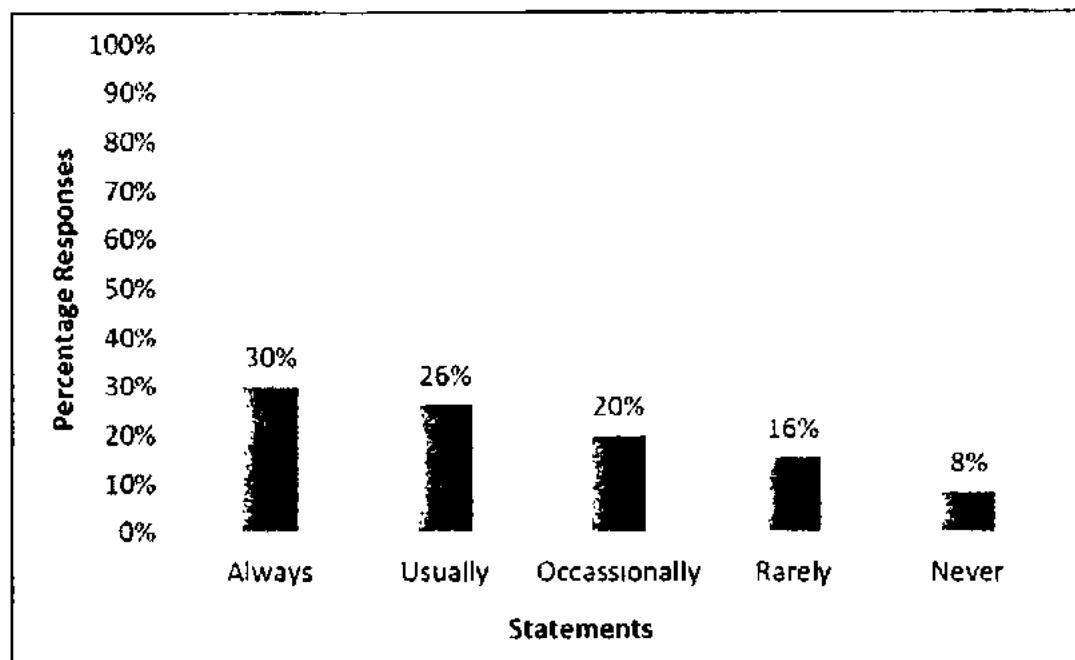
Figure 4.3 **Shows** Percentage Teachers' Responses for Knowledge and Understanding of Science Teacher regarding the Use of Educational Technology in Teaching Learning Process. The cumulative percentage average of teachers' responses for all the thirteen (13) statements shows 30% teachers claims to have sufficient "Knowledge and Understanding regarding the Use of Educational Technology in teaching learning process", 26% teachers use usually, 20% uses occasionally, 16% rarely and 8% never use.

Figure 4.4. *Comparison of Mean Scores for Knowledge and Understanding.*
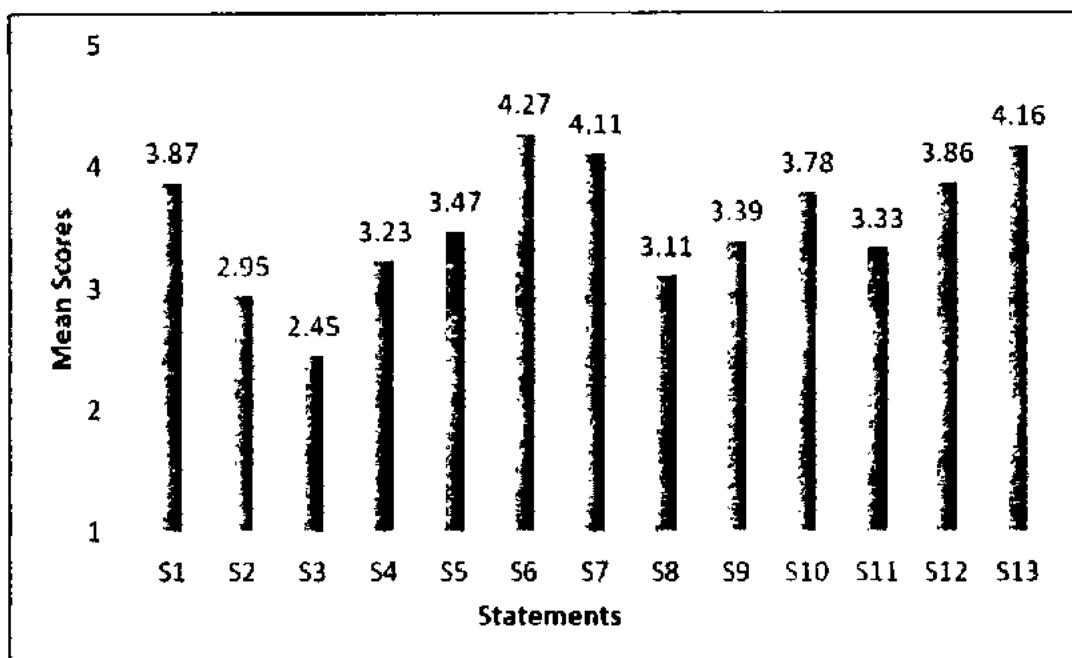
Figure 4.4 shows the comparison of all thirteen (13) statement i.e. The Comparison of Mean Scores for Knowledge and Understanding of Science Teacher regarding the use of Educational Technology in Teaching Learning process. This shows that teachers, "Knowledge and Understanding regarding the use of Educational Technology in teaching learning process" for 3 out of 13 (S6, S7 and S13) lies between Always and Usually, for 8 out of 13 (S1, S4, S5, S8, S9, S10, S11 and S12) lies between Usually and Occasionally, whereas for 2 out of 13 (S2 - Science teachers make group discussion for difficult concepts and problems using WhatsApp and S3 - Video conferencing is used for a debate during the teaching of Science (debating)) it lies between Occasionally and Rarely.

Figure 4.5. *Chi Square values for Knowledge and Understanding*
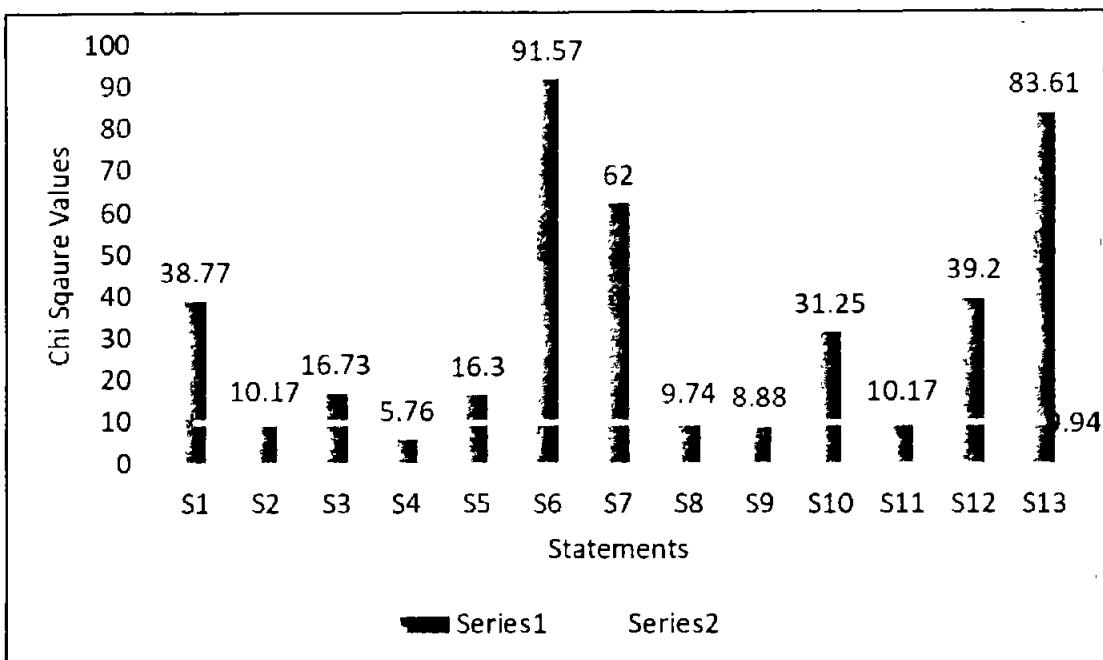
The Chi square values as given in Figure 4.5 shows that science teacher's knowledge and understanding regarding the use of educational technology in teaching learning process is positive for 11 out of 13 statements against critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 11 statements are accepted. On the other hand, statement S4 (The two areas ICT tools are utilized for brainstorming of Science Students) and S9 (Teacher facilitates discussion about difficult concepts using videos) have low chi square values as compared to critical value of 9.94. This shows that teachers don't have positive attitude towards these two statements. Therefore, both are rejected.

4.1.1.2 Disposition of Science Teacher regarding the use of Educational Technologies in Teaching Learning Process

Table 4.3 shows the ten (10) statements that science teachers were supposed to respond under the category, "Disposition of Science Teacher regarding the use of Educational Technologies in Teaching Learning process" on a Likert scale of five (5) items including Strongly Agree (SA), Agree (A), Undecisive (UD), Disagree (DA) and Strongly Disagree (SDA).

Table 4.3. *Disposition of Science Teacher.*

Statements	Cumulative Percentage Scores					Mean
	SA	A	UD	DA	SDA	Scores
D1. ICT tools have changed the methodology of science teacher as a facilitator in modern classroom	31%	54%	9%	5%	1%	4.09
D2. ICT tools have made lectures more interesting, easier and time saving for teaching Science.	47%	42%	6%	3%	1%	4.31
D3. MS Power Point is an effective presentation tool for science teachers to give the students a clear concept of science topics	29%	52%	12%	6%	1%	4.01
D4. Overhead projector creates conducive learning environment allowing the view of small document to be shared with a large group of science students.	31%	54%	8%	8%	0%	4.09

Statements	Cumulative Percentage Scores					Mean Scores
	SA	A	UD	DA	SDA	
D5. Multimedia as a combination of texts, audios, videos, graphics and animation is a powerful source of brain Storming	42%	46%	3%	6%	2%	4.19
D6. I feel easy by using videos in laboratory for demonstration of different Experiments	30%	48%	12%	9%	1%	3.98
D7. Being a Science teacher, I take interactive white board as a valuable instructional tool for clear understanding of scientific phenomena.	41%	44%	11%	3%	1%	4.20
D8. Zoom App is an effective interaction source to improve students' motivation for learning Science topics.	24%	47%	11%	15%	3%	3.73
D9. Google Classroom is essential to prepare Science students to live and work in 21st century	28%	46%	18%	6%	1%	3.94
D10. ICT tools have improved learners' autonomy in learning Science	28%	55%	13%	3%	1%	4.05

Figure 4.6. *Cumulative Percentage Responses about Disposition.*
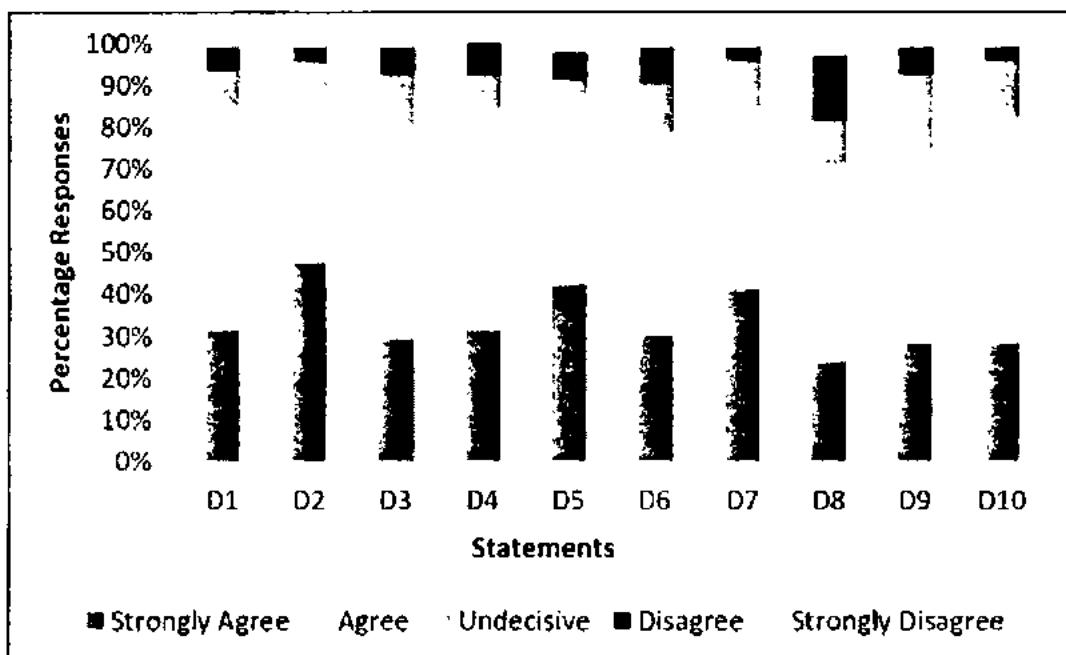
Figure 4.6 shows the cumulative percentage responses of teachers for each statement i.e. Cumulative Percentage Responses about Disposition of Science Teacher regarding the use of Educational Technologies in Teaching Learning process

This shows that in 8 out of 10 statements, 80% or more teachers either strongly agree or agree. Whereas for two statements i.e., D8 (D8. Zoom App is an effective interaction source to improve students' motivation for learning Science topics) and D9 (D9. Google Classroom is essential to prepare Science students to live and work in 21st century) this percentage is slightly less than 80% for SA and A.

Figure 4.7. *Cumulative Percentage Average Responses about Disposition.*
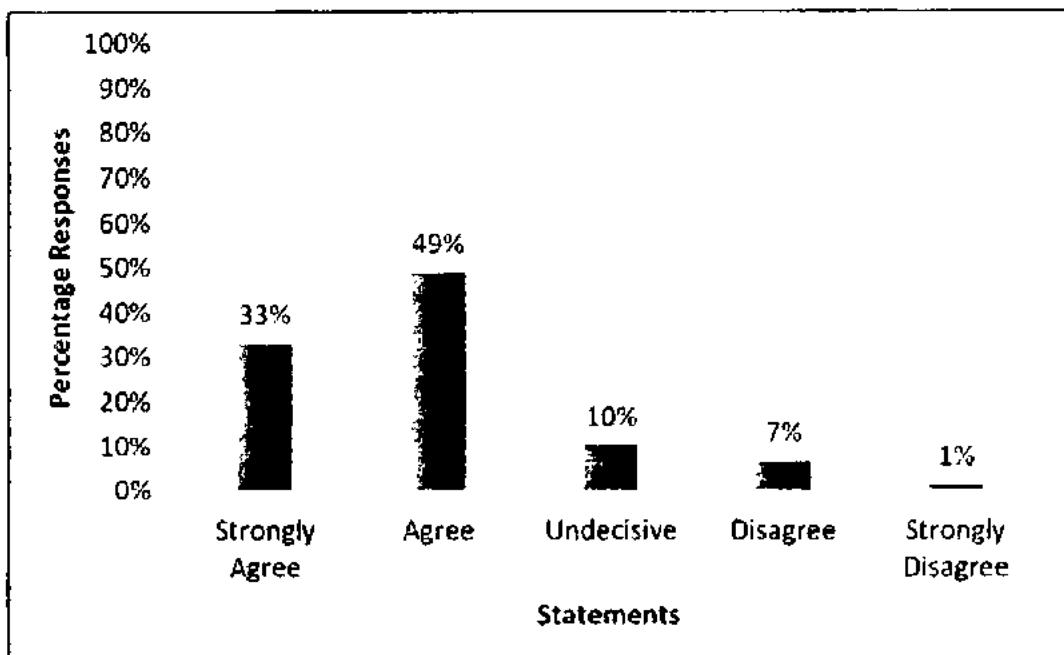
Figure 4.7 shows the cumulative percentage average of teachers' responses for all the ten (10) statement i.e. Cumulative Percentage Average Responses about Disposition of Science Teacher regarding the use of Educational Technologies in Teaching Learning process. This shows that 33% teachers strongly agree with their "Disposition about the Use of Educational Technology in teaching learning process", 49% teachers agree, 10% are undecisive, 7% disagree and only 1% strongly disagree.

Figure 4.8. *Comparison of Mean Scores about Disposition of Science Teacher.*
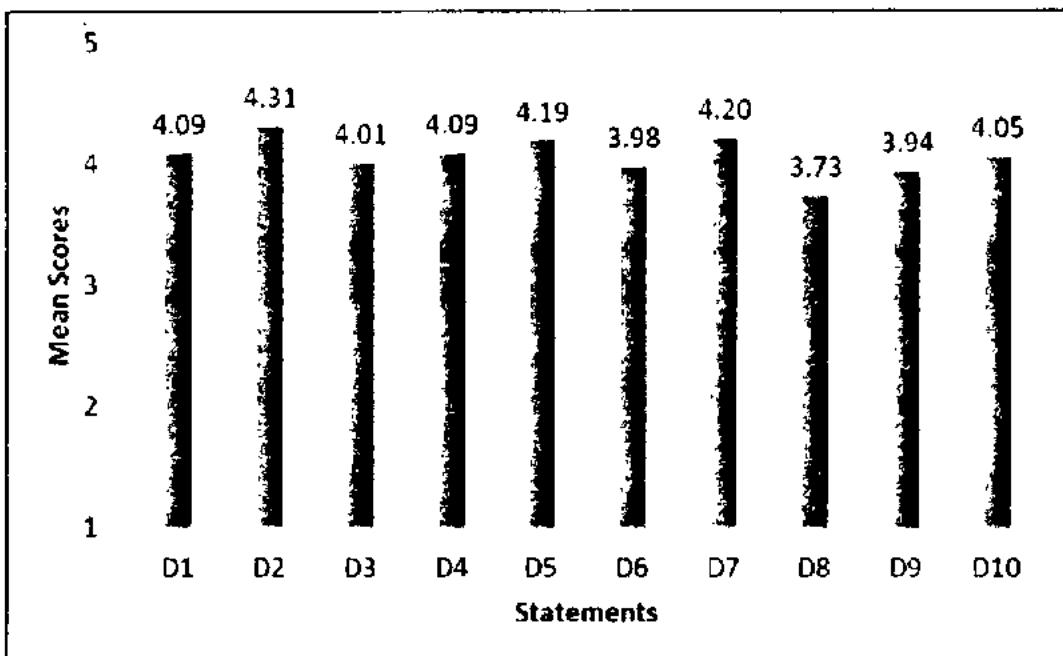
Figure 4.8 shows the comparison of means for all thirteen (10) statement.i.e Comparison of Mean Scores about Disposition of Science Teacher regarding the use of Educational Technologies in Teaching Learning Process. This shows that teachers, "Disposition regarding the use of Educational Technology in teaching learning process" for 9 out of 10 lies between Strongly Agree and Agree. This lies between Agree and Undecisive for D8 (Zoom App is an effective interaction source to improve students' motivation for learning Science topics) only.

Figure 4.9. *Chi Square values About Disposition of Science Teacher.*
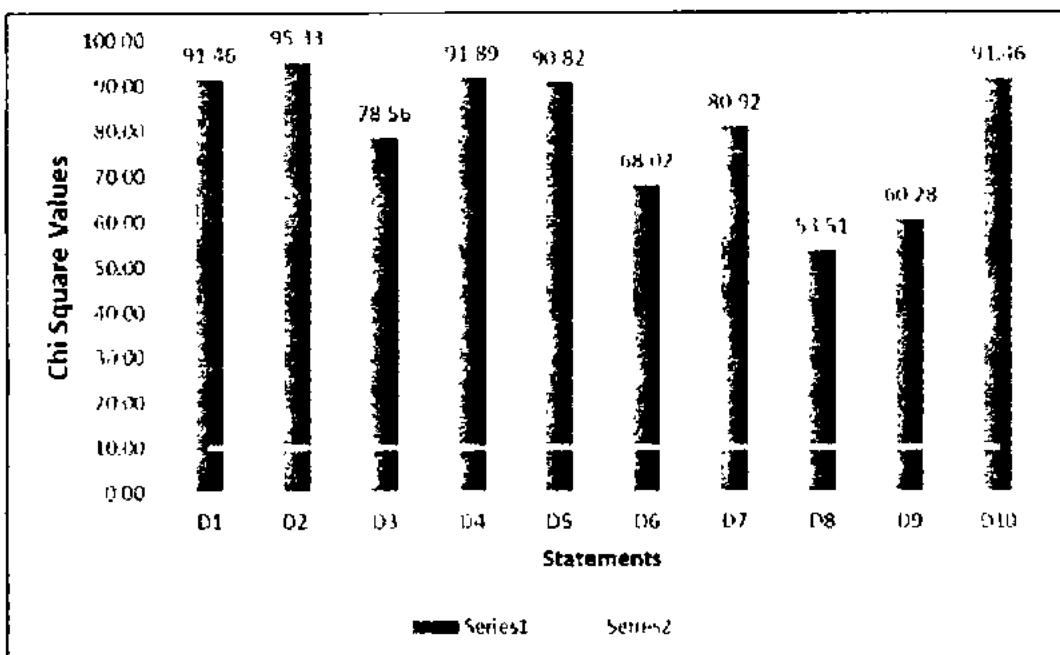
Chi square values in Figure 4.9 shows that science teacher's disposition regarding the use of educational technology in teaching learning process is positive for all 10 statements against critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 10 statements are accepted.

4.1.1.3 Skill level of science teachers in using Educational Technologies with referenceto4Cs

Sections below provides the detail about the skill level of science teachers in using Educational Technologies with reference to 4Cs (Communication, Collaboration, Critical thinking and Creativity.

Table 4.4. *Cumulative Percentage Responses for Communication.*

Statements	Cumulative Percentage Scores					Mean
	A	U	O	R	N	Scores
E1. I can effectively deliver my lecture in the class by using ICT tools.	29%	62%	2%	3%	3%	4.11
E2. I usually take lead in group discussions with my colleagues by utilization of ICT.	17%	52%	22%	9%	0%	3.78
E3. There is flow and clarity in my written notes and assignments when I use ICT	32%	55%	9%	3%	1%	4.13
E4. I can express my ideas effectively by using models and pictures.	46%	45%	8%	1%	1%	4.33
E5. ICT tools help me to judge the emotions of my students during the lecture	20%	29%	25%	22%	4%	3.38

i.Communication.

Table 4.10 shows the Skill level of Science Teachers in using Educational Technologies with reference to Communication. It shows the five (5) statements that science teachers

were supposed to respond under the communication category for Skill level of science teachers in using educational technologies, on a Likert scale of five (5) items including Strongly Agree (SA), Agree (A), Undecisive (UD), Disagree (DA) and Strongly Disagree (SDA).

Figure 4.10. *Cumulative Percentage Responses for Communication.*
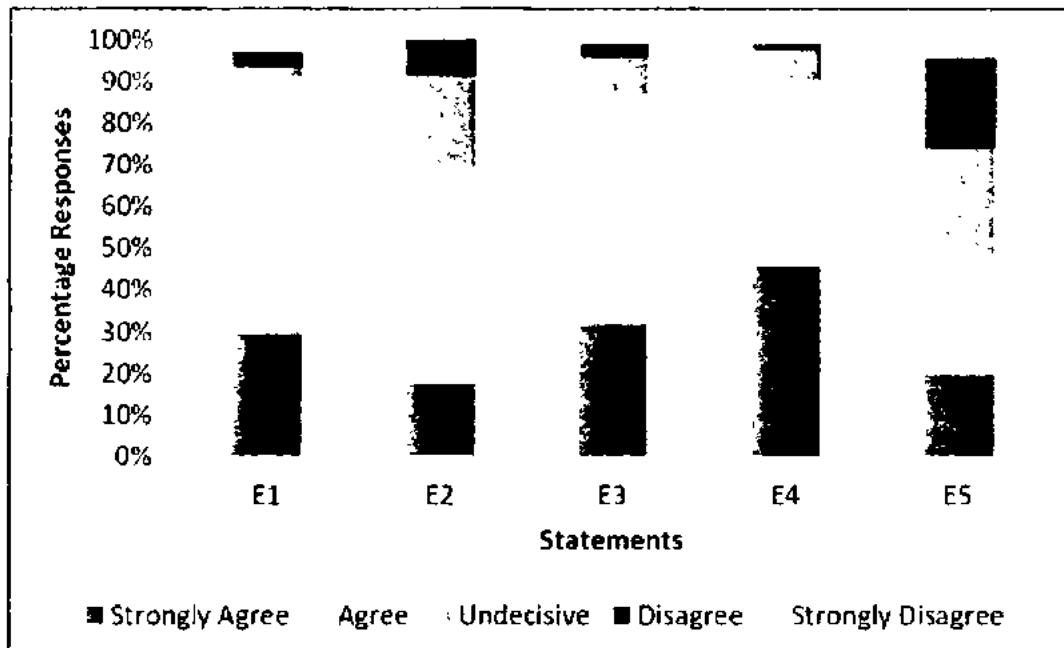
Figure 4.10 shows Cumulative Percentage Responses about Skill level of Science Teachers in using Educational Technologies with reference to Communication. This shows that in 4 out of 5 statements, 60% or more teachers either strongly agree or agree. Whereas for one statement i.e., E5 (ICT tools help me to judge the emotions of my students during the lecture) this percentage is around 50% for SA and A.

Figure 4.11. *Cumulative Percentage Average Responses for Communication skill.*
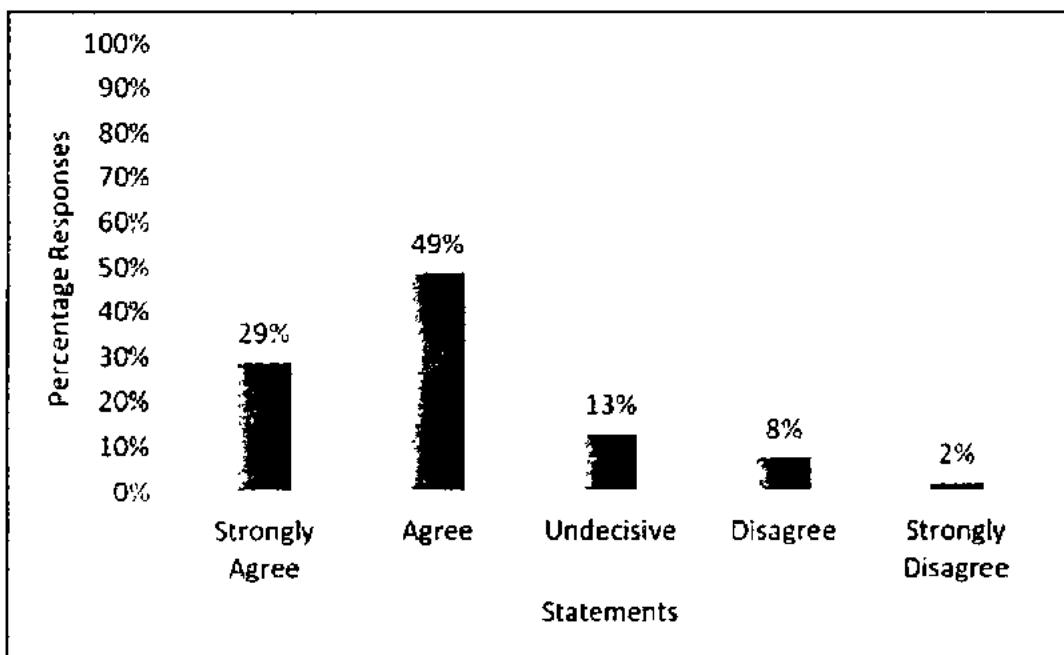


Figure 4.11 shows the cumulative percentage average of teachers' responses for all 5 statements i.e. Cumulative Percentage Average Responses about Skill level of Science Teachers in using Educational Technologies with reference to Communication. This shows that 29% teachers strongly agree with their, "Communication Skill level in using Educational Technologies,"49% teachers agree, 13% are undecisive, 8% disagree and only 2% strongly disagree.

Figure 4.12. *Comparison of Mean Scores for Communication skill.*
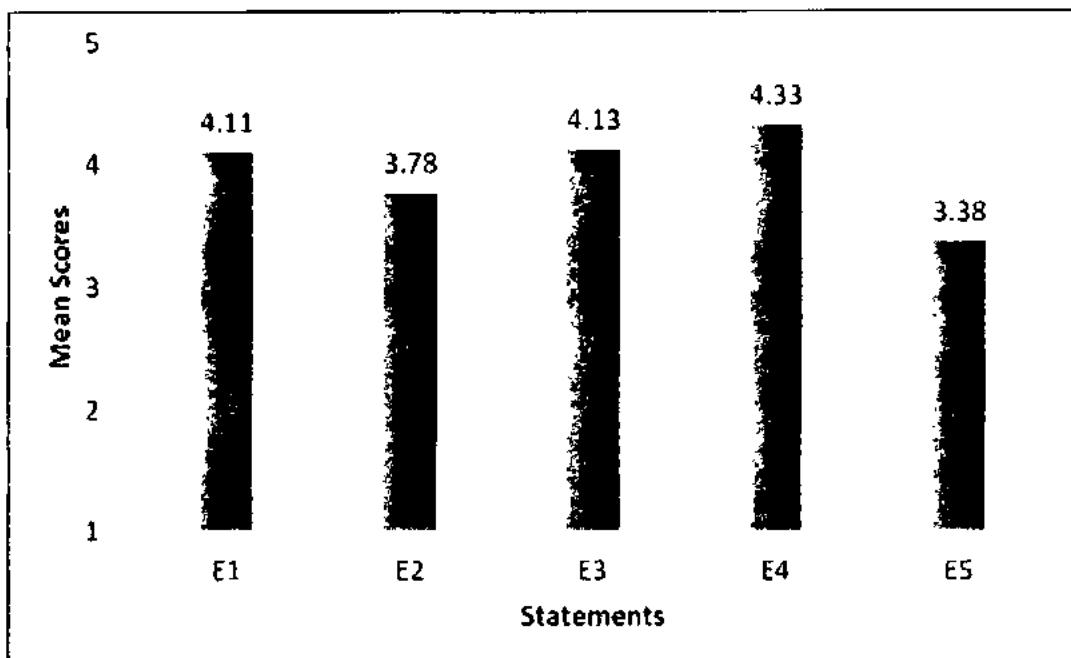
Figure 4.12 shows the comparison of means for five statements i.e. Comparison of Mean Scores about Skill level of Science Teachers in using Educational Technologies with reference to Communication. This shows that teachers' communication skill level in 3 out of 5 statements lies between Strongly Agree and Agree. Whereas for two statements i.e., E2 (I usually take lead in group discussions with my colleagues by utilization of ICT) and E5 (ICT tools help me to judge the emotions of my students during the lecture) lies between Agree and undecisive

Figure 4.13. *Chi Square values about Skill level with reference to Communication.*
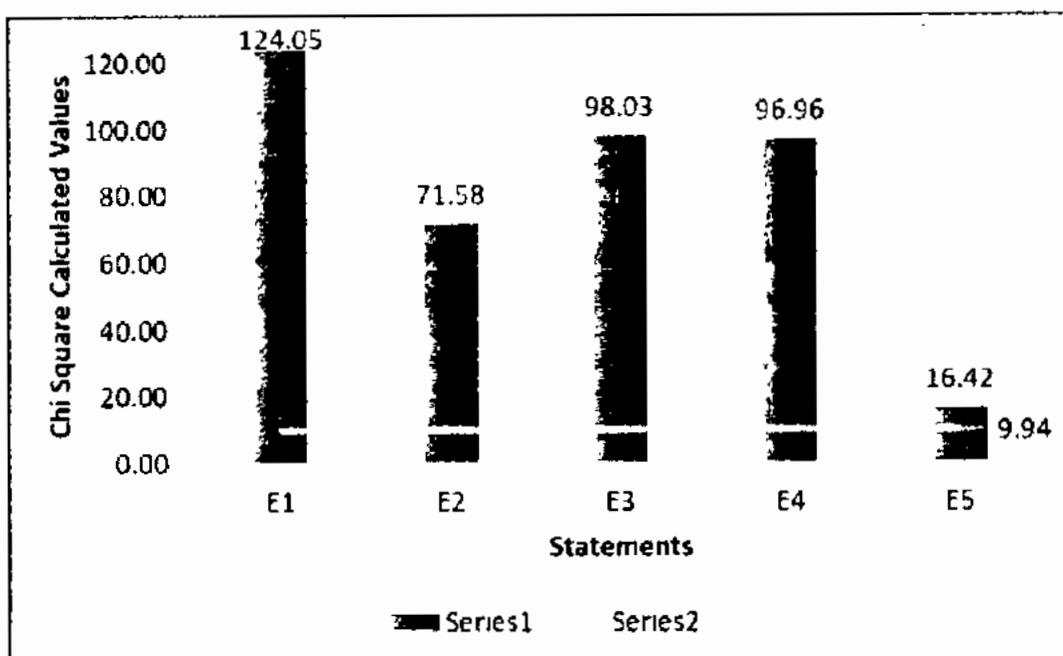
The Chi square values in Figure 4.13 shows that science teacher's attitude towards the communication skills in the use of educational technology is positive for all 5 statements against critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 5 statements are accepted.

ii. Collaboration.

Table 4.5. *Skill Level of Science Teachers with reference to Collaboration.*

Statements	Cumulative Percentage Scores					Mean
	SA	A	UD	DA	SDA	Scores
E6. ICT is helpful for me to improve working relationship among the group members of the team.	26%	53%	9%	8%	4%	3.89
E7. I gain more knowledge while working in group in an ICT based environment.	23%	64%	8%	5%	0%	4.04
E8. I use ICTs to enhance the team spirit among students	23%	47%	21%	10%	0%	3.83
E9. Each group member does share his fair effort to complete the task in time with the help of ICT.	21%	47%	23%	10%	0%	3.78
E10. ICT makes Peer group working a flexible and effective source of learning for the students.	23%	54%	15%	8%	0%	3.92

Table 4.5 shows the five (5) statements that science teachers were supposed to respond under the collaboration category for Skill level of science teachers in using education technologies, on a Likert scale of five (5) items including Strongly Agree (SA), Agree (A), Undecisive (UD), Disagree (DA) and Strongly Disagree (SDA).

Figure 4.14. *Cumulative Percentage Responses &Collaboration skill.*
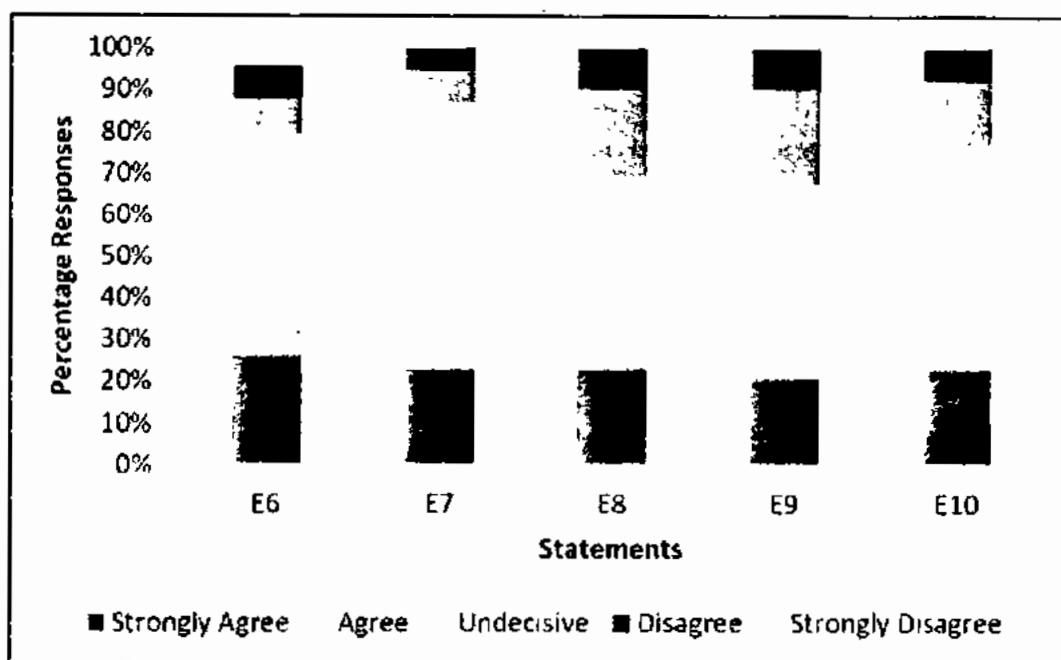
Figure 4.14 shows the cumulative percentage responses of teachers for each statement.i.e Cumulative Percentage Responses about Skill level of Science Teachers in using Educational Technologies with reference to Collaboration. This shows that in all 5 statements, 60% or more teachers either strongly agree or agree.

Figure 4.15. *Cumulative Percentage Average for Collaboration skill.*
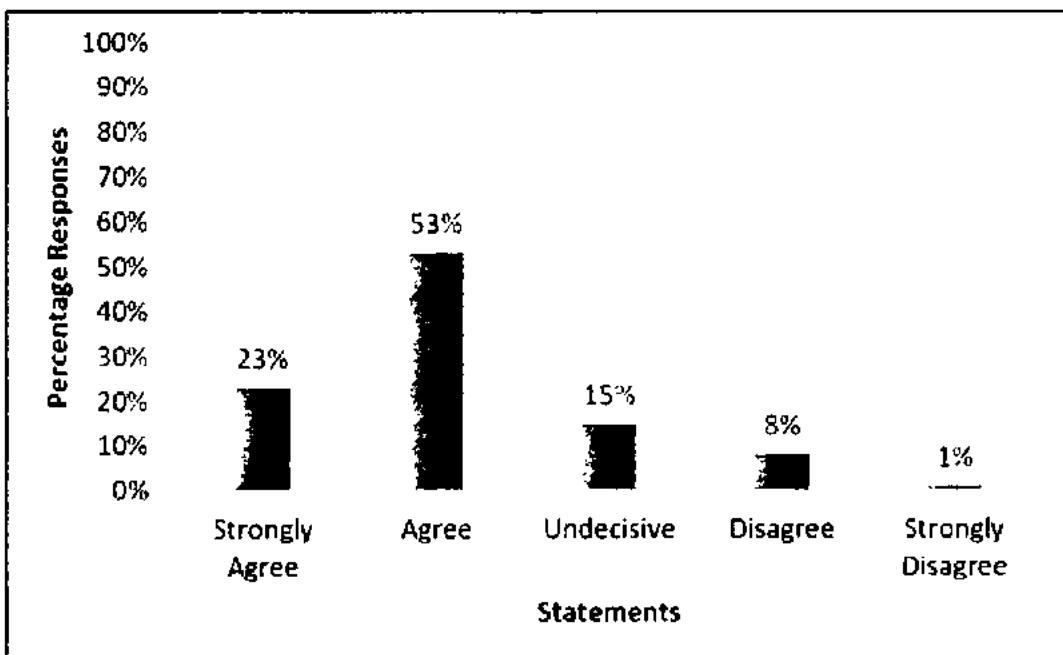
Figure 4.15 shows the cumulative percentage average of teachers' responses for all 5 statements i.e. Cumulative Percentage Average Responses of Teachers about Skill level of Science Teachers in using Educational Technologies with reference to Collaboration. This shows that 23% teachers strongly agree with their, "Collaboration Skill level in using Educational Technologies,"53% teachers agree, 15% are undecisive, 8% disagree and only 1% strongly disagree.

Figure 4.16. *Comparison of Mean Score for Collaboration skill.*
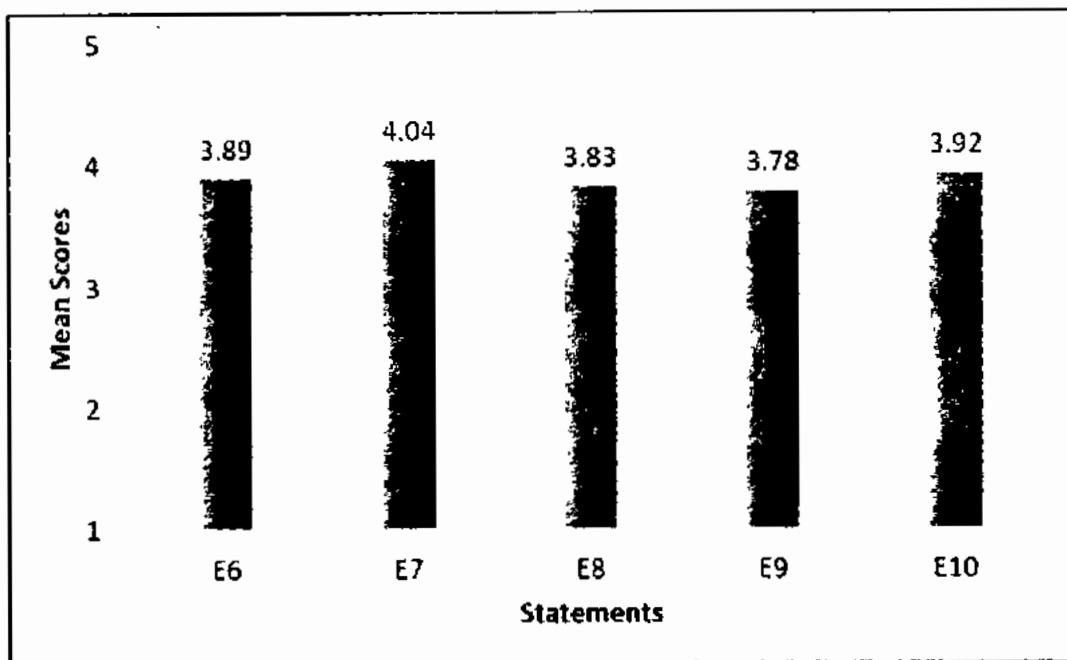
Figure 4.16 shows the comparison of means for five statements i.e. Comparison of Mean Score about Skill level of Science Teachers in using Educational Technologies with reference to Collaboration. This shows that teacher's collaboration skill level in all 5 statements lies between Agree and undecisive categories.

Figure 4.17. *Chi Square for Collaboration skill.*
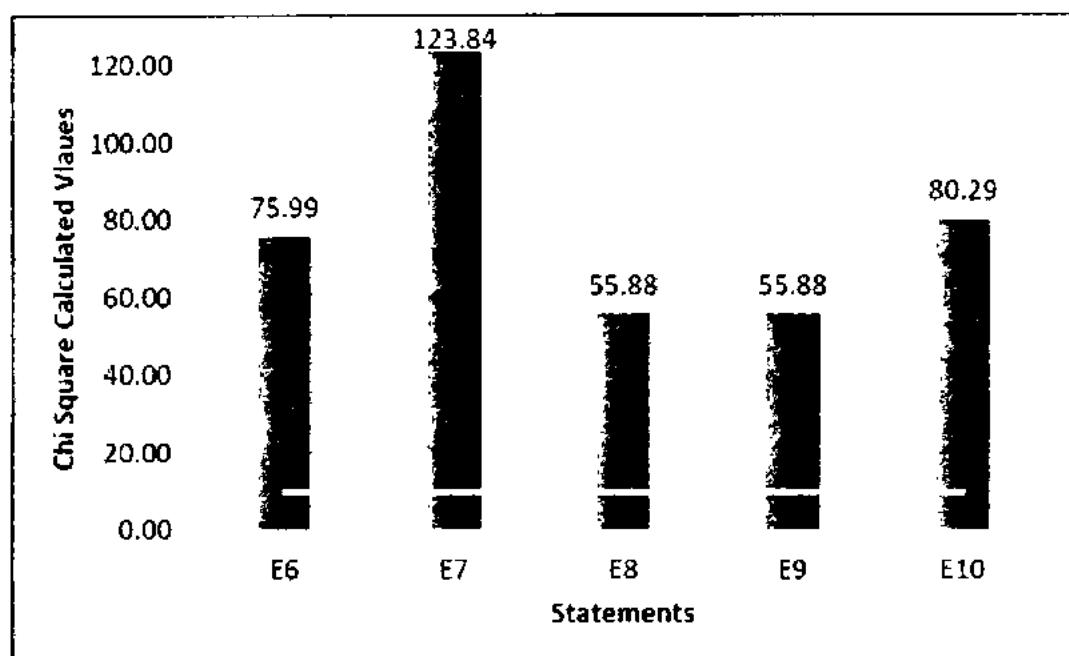
Chi square values in Figure 4.17 shows that science teacher's attitude towards the collaboration skills in the use of educational technology is positive for all 5 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 5 statements are accepted.

iii. Critical Thinking.

Table 4.6. *Skill level of Science Teachers with reference to Critical Thinking.*

Statements	Cumulative Percentage Scores					Mean Scores
	SA	A	UD	DA	SDA	
E11.The students become aware of their weak and strong points during their lesson in an ICT based environment	21%	35%	21%	22%	2%	3.50
E12.Utilizing ICT tools, the learner gets opportunity to test the diversity of opinions during his class without any fear.	18%	60%	15%	7%	0%	3.90
E13.The student becomes able to pinpoint his mistakes by the use of ICT during teaching learning process.	23%	40%	22%	14%	1%	3.70
E14.The utilization of ICT tools creates challenging approach towards learning target.	28%	53%	15%	2%	1%	4.05
E15.By the utilization of ICTs, the students can get the reason behind the idea very easily.	36%	47%	12%	4%	1%	4.12

Table 4.6 shows the five (5) statements that science teachers were supposed to respond under the communication category for Skill level of science teachers in using education technologies, on a Likert scale of five (5) items including Strongly Agree (SA), Agree (A), Undecisive (UD), Disagree (DA) and Strongly Disagree

Figure 4.18. *Cumulative Percentage Responses for Critical Thinking.*
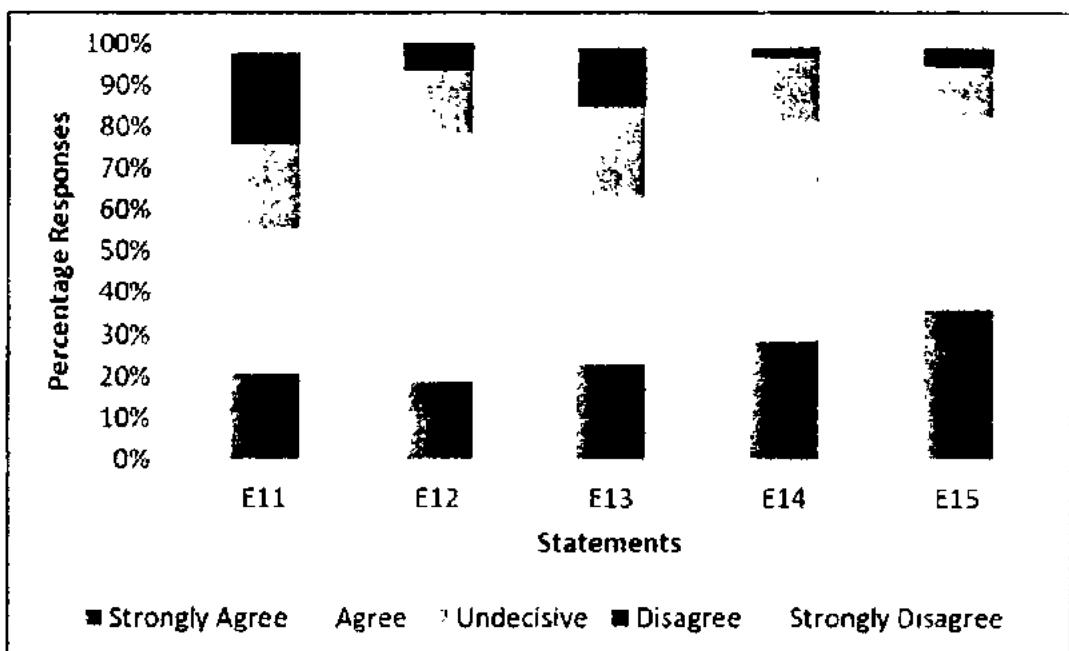
Figure 4.18 shows the cumulative percentage responses of teachers for each

Statement i.e. Cumulative Percentage Responses about Skill level of Science Teachers

in using Educational Technologies with reference to Critical Thinking. This shows that

in 4 out of 5 statements, 60% or more teachers either strongly agree or agree. Whereas

in one statement i.e., E11 (The students become aware of their weak and strong points

during their lesson in an ICT based environment) the ratio is below 60%.

Figure 4.19. *Cumulative Percentage Average Responses for Critical Thinking.*
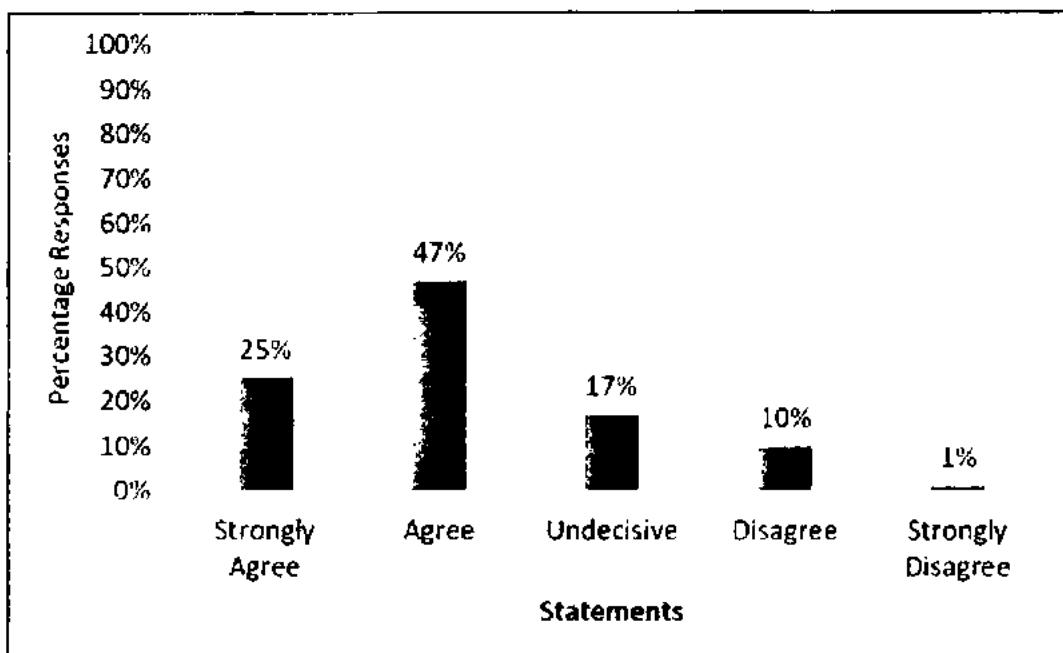
Figure 4.19 shows the cumulative percentage average of teachers' responses for all 5 statements i.e. Cumulative Percentage Average Responses about Skill level of Science Teachers in using Educational Technologies with reference to Critical Thinking. This shows that 25% teachers strongly agree with their, "Critical Thinking Skill level in using Educational Technologies,"47% teachers agree, 17% are undecisive, 10% disagree and only 1% strongly disagree.

Figure 4.20. *Comparison of Mean Score for Critical Thinking.*
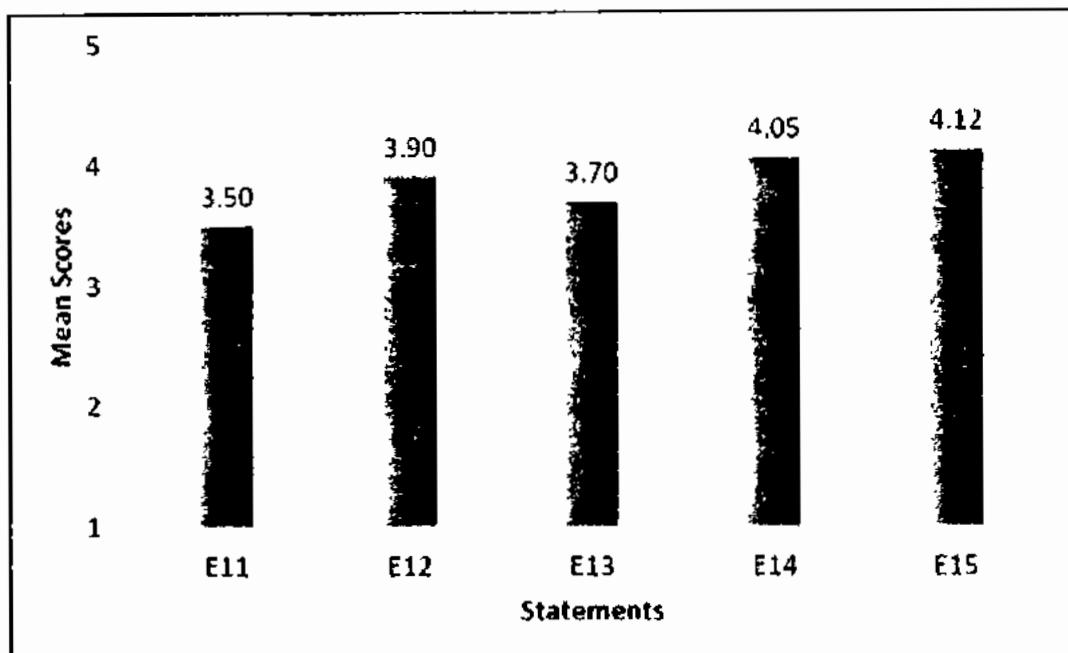
Similarly, Figure 4.20 shows the comparison of means for five statements. i.e.
Comparison of Mean Score about Skill level of Science Teachers in using Educational
Technologies with reference to Critical Thinking This shows that teachers' critical
thinking skill level in all 5 statements lies between Agree and Undecisive categories.

Figure 4.21. *Chi Square values about Skill level for Critical Thinking.*
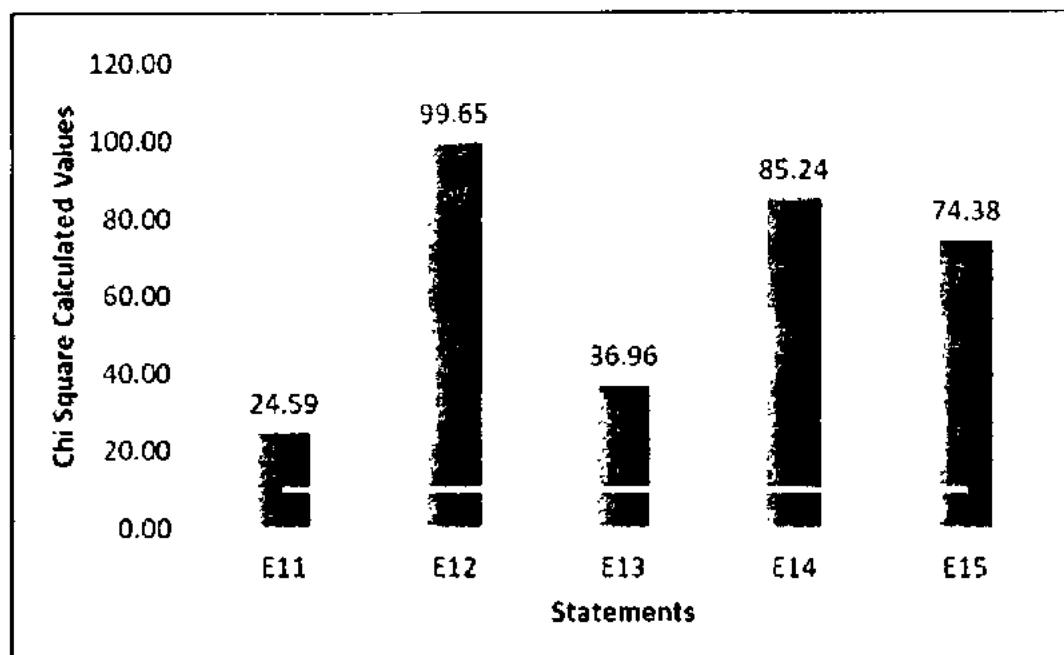
Chi square values in Figure 4.21 shows that science teacher's attitude towards the critical thinking skills in the use of educational technology is positive for all 5 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 5 statements are accepted.

iv. **Creativity.**

Table 4.7. *Skill level of Science Teachers with reference to Creativity.*

Statements	Cumulative Percentage Scores					Mean
	SA	A	UD	DA	SDA	Scores
E16.ICT tools support me to generate new ideas by combining them with existing Ideas	35%	51%	8%	4%	2%	4.12
E17.My interpretation skills have enhanced by using ICT	39%	51%	7%	3%	0%	4.26
E18.ICT transforms my invisible images in real mental images	38%	40%	15%	5%	1%	4.09
E19.ICTs motivate me for implementation of ideas for change	25%	64%	9%	2%	0%	4.12
E20. I can take risk to bring a change for the improvement of students' learning by using ICT tools	24%	57%	14%	3%	2%	3.97

Table 4.7 shows the five (5) statements that science teachers were supposed to respond under the Creativity category for Skill level of science teachers in using education technologies, on a Likert scale of five (5) items including Strongly Agree (SA), Agree (A), Undecisive (UD), Disagree (DA) and Strongly Disagree (SDA).

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Figure 4.22. *Cumulative Percentage Responses for Creativity.*
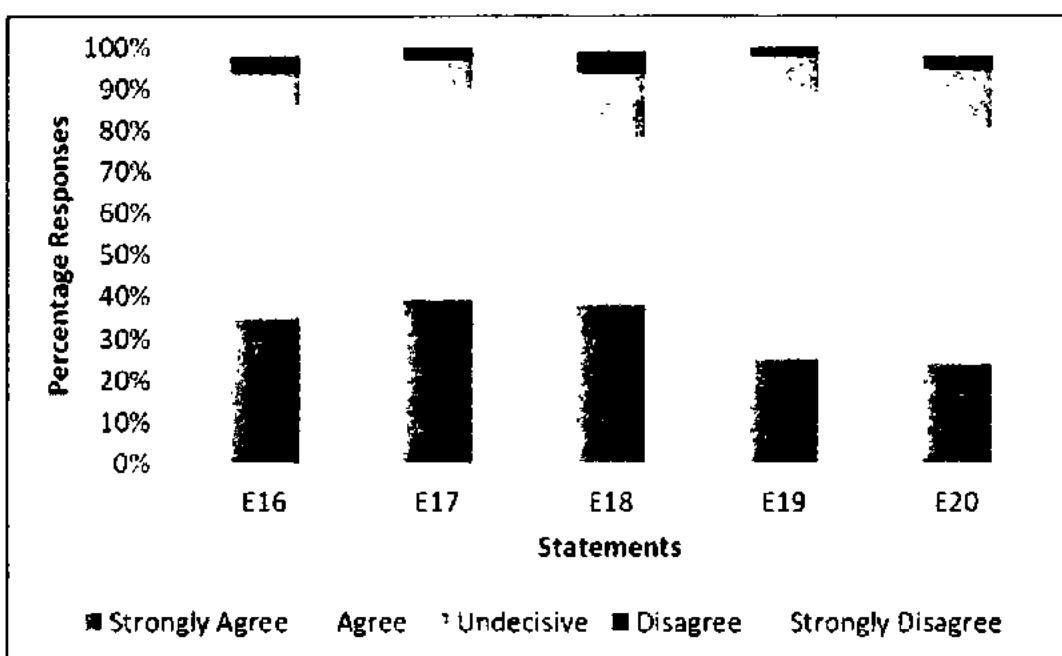
Figure 4.22 shows the cumulative percentage responses of teachers for each statement i.e. Cumulative Percentage Responses about Skill Level of Science Teachers in using Educational Technologies with reference to Creativity. This shows that in all 5 statements, 80% or more teachers either strongly agree or agree.

Figure 4.23. *Cumulative Percentage Average Responses & Creativity skill.*
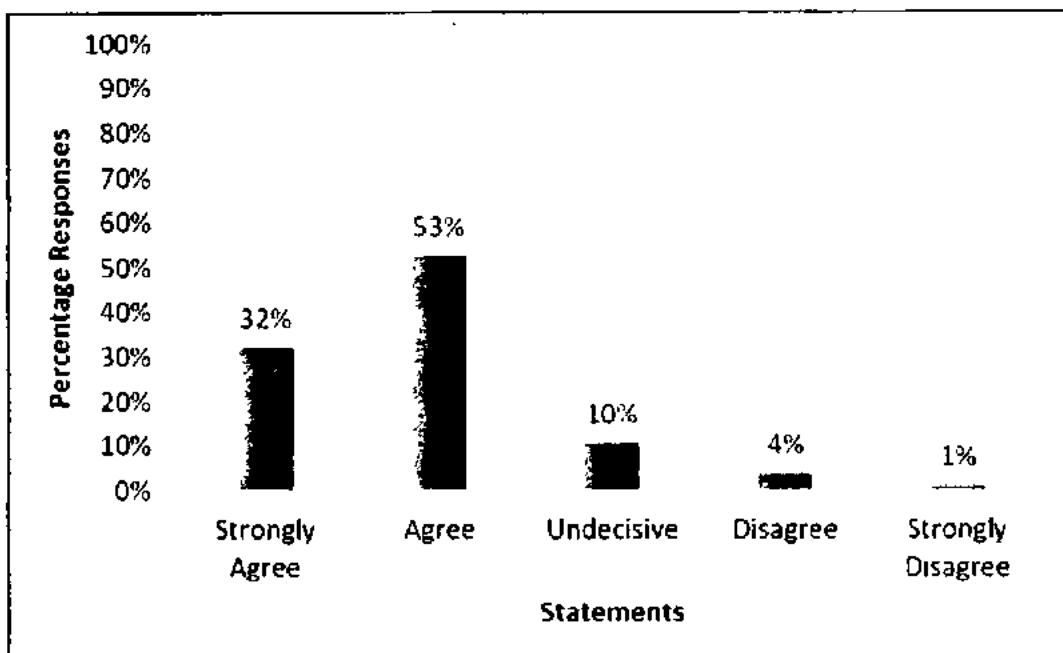
Figure 4.23 shows the cumulative percentage average of teachers' responses for all 5 statements i.e. Cumulative Percentage Average Responses about Skill Level of Science Teachers in using Educational Technologies with reference to Creativity. This shows that 32% teachers strongly agree with their, "Creativity Skill level in using Educational Technologies,"53% teachers agree, 10% are undecisive, 4% disagree and only 1% strongly disagree.

Figure 4.24. *Comparison of Mean Score for Creativity skill.*
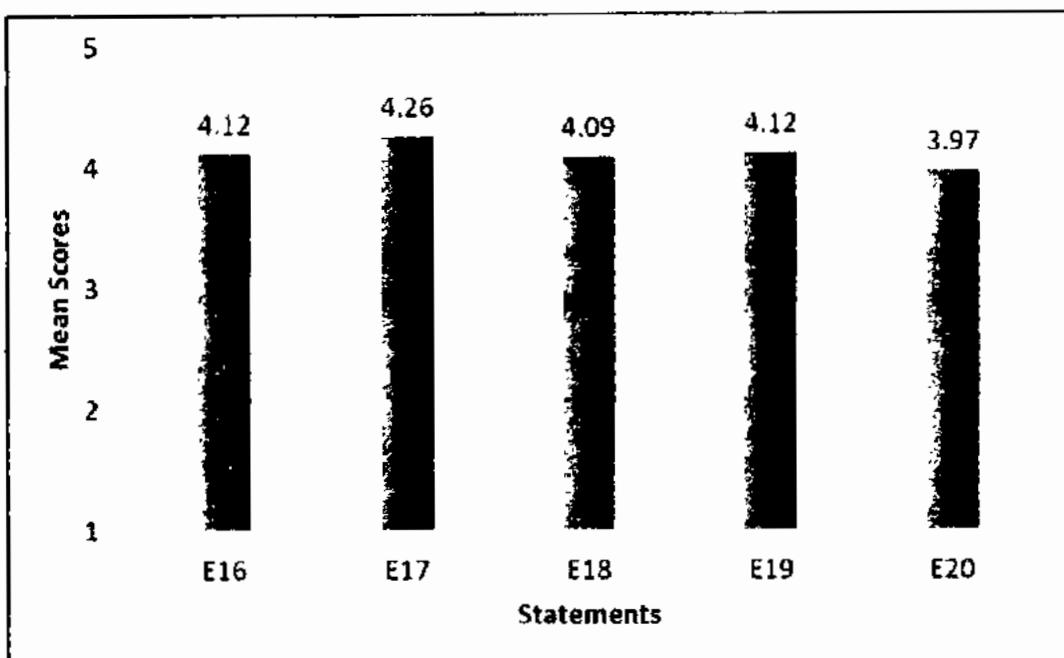
Figure 4.24 shows the comparison of means for five statements .i.e. Comparison of Mean Score about Skill Level of Science Teachers in using Educational Technologies with reference to Creativity. This shows that teachers' creativity skill level in all 5 statements lies around Agree.

Figure 4.25. *Chi Square values about Skill Level for Creativity.*
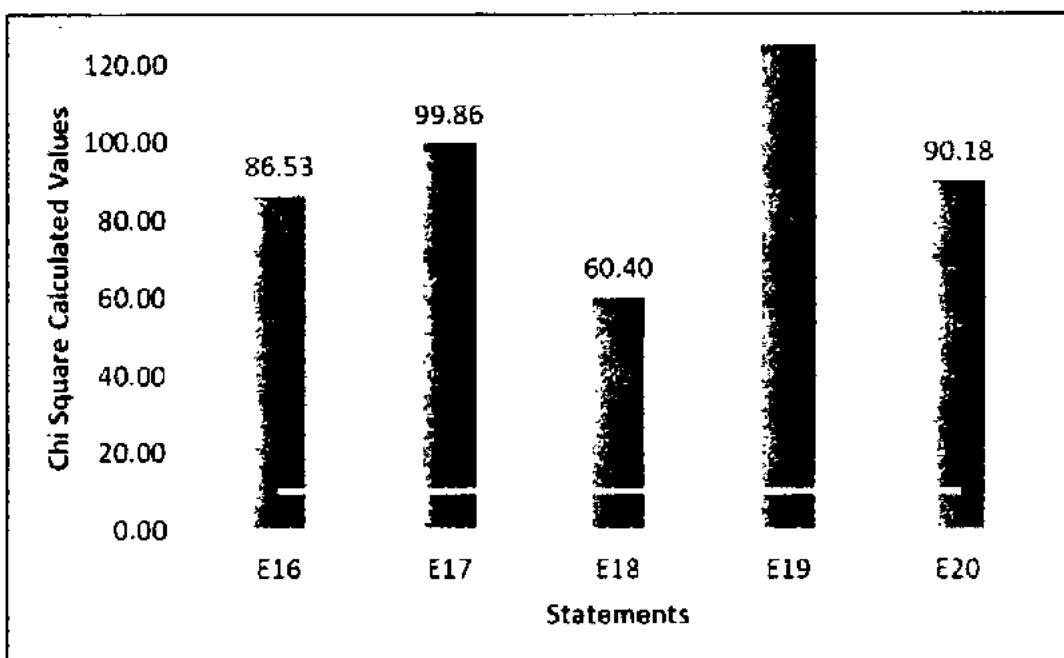
Chi square values in Figure 4.25 shows Chi Square values about Skill Level of Science Teachers in using Educational Technologies with reference to Creativity. It shows that science teacher's attitude towards the creative skills in the use of educational technology is positive for all 5 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 5 statements are accepted.

4.1.1.4 Current trends of using Educational Technologies in ScienceTeaching Learning process

Table 4.8. *Current Trends and Practices of using Educational Technologies.*

Statements	Cumulative Percentage Scores					Mean Scores
	SA	A	UD	DA	SDA	
F1. Social learning technologies are the potent source of Communication between Students and Science teacher	28%	55%	11%	4%	2%	4.02
F2. Lectures in film format are a fun and productive way of facilitating the students for better understanding of science concepts	31%	53%	11%	2%	2%	4.42
F3. Zoom app enable the Science teacher to secure his remote work and to get easy access to the main center	19%	53%	19%	5%	3%	3.80
F4. Google class room is the most popular and influential media for conveying actual Scientific phenomena	18%	40%	25%	12%	5%	3.54
F5. Emerging and Mass Notification System (EMNS) is a best platform for communication of a single lecture of a science teacher to a large number of students	18%	39%	32%	11%	0%	3.65
F6. Cloud based learning technologies increase the performance and	16%	51%	24%	9%	1%	3.72

Statements	Cumulative Percentage Scores					Mean
	SA	A	UD	DA	SDA	Scores
achievement of the Science Students						

Table 4.8 shows the six (6) statements that science teachers were supposed to respond under the Creativity category for Skill level of science teachers in using education technologies, on a Likert scale of five (5) items including Strongly Agree (SA), Agree (A), Undecisive (UD), Disagree (DA) and Strongly Disagree (SDA).

Figure 4.26. *Cumulative Percentage Responses for Current Trends and practices.*
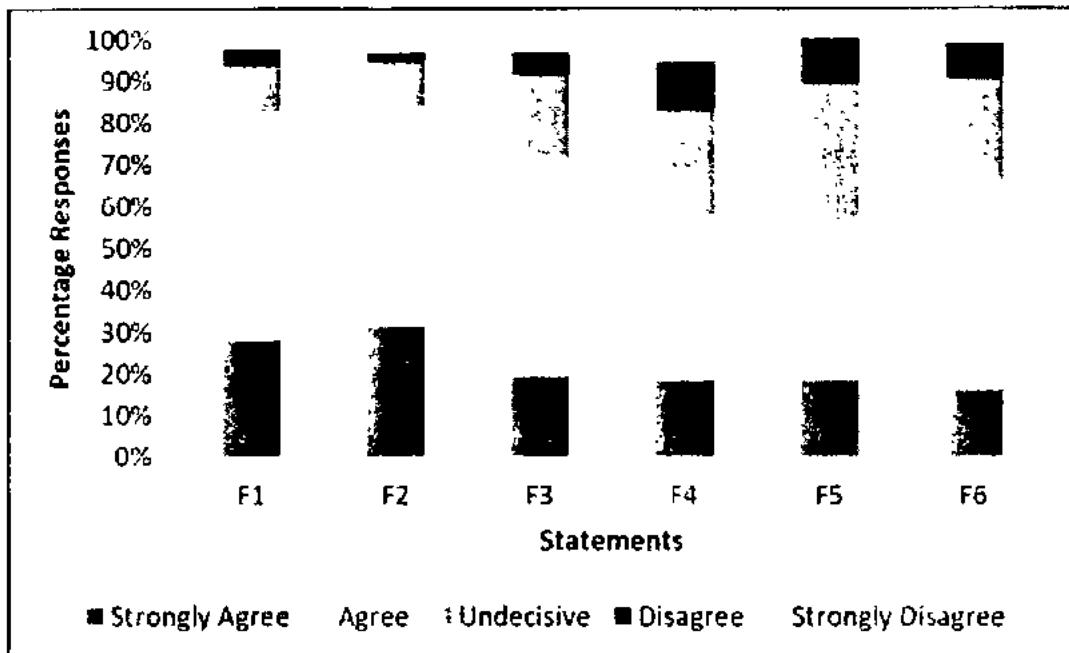
Figure 4.26 shows the cumulative percentage responses of teachers for each statement.i.e. Cumulative Percentage Responses about Current Trends and practices of using Educational Technologies in Science Teaching Learning process. This shows that in 4 out of 6 statements, up to 70% teachers either strongly agree or agree. Whereas, in two statements i.e., F4 (Google class room is the most popular and influential media for conveying actual Scientific phenomena) and F5 (Emerging and Mass Notification System (EMNS) is a best platform for communication of a single lecture of a science teacher to a large number of students) this percentage is around 60%.

Figure 4.27.*Cumulative Percentage Average Responses Current Trends & practices.*
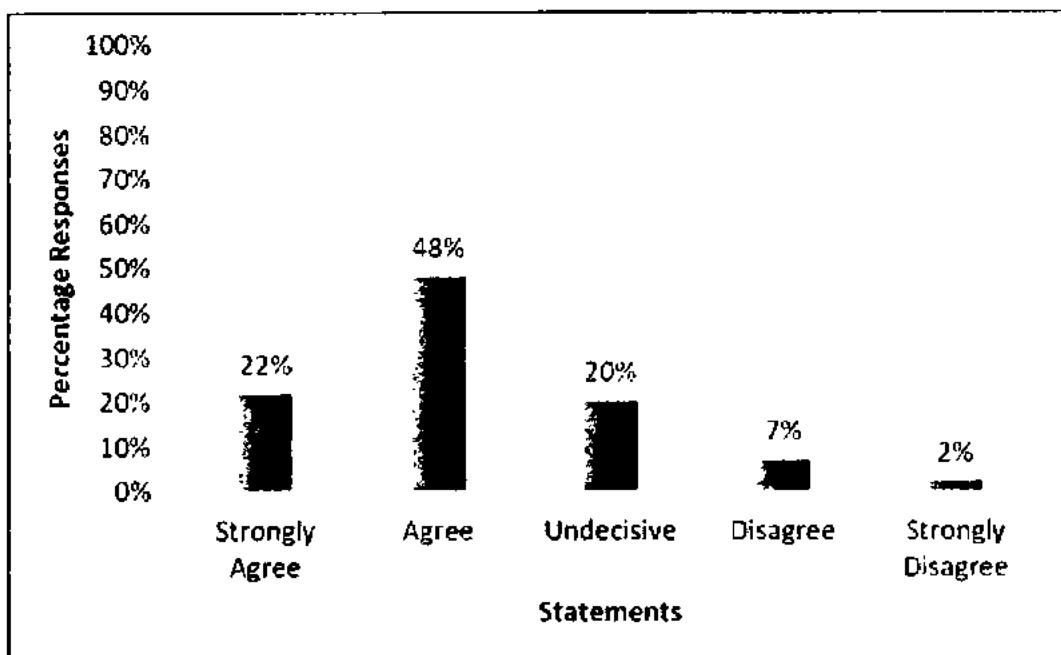
Figure 4.27 shows the cumulative percentage average of teachers' responses for all 6 statements i.e. Cumulative Percentage Average Responses about Current Trends and practices of using Educational Technologies in Science Teaching Learning Process. This shows that 22% teachers strongly agree with the efficacy of current trends and practices of using Educational Technologies in Science Teaching Learning process, 48% teachers agree, 20% are Undecisive, 7% disagree and only 2% strongly disagree.

Figure 4.28. *Comparison of Mean Score about Current Trends and practices.*
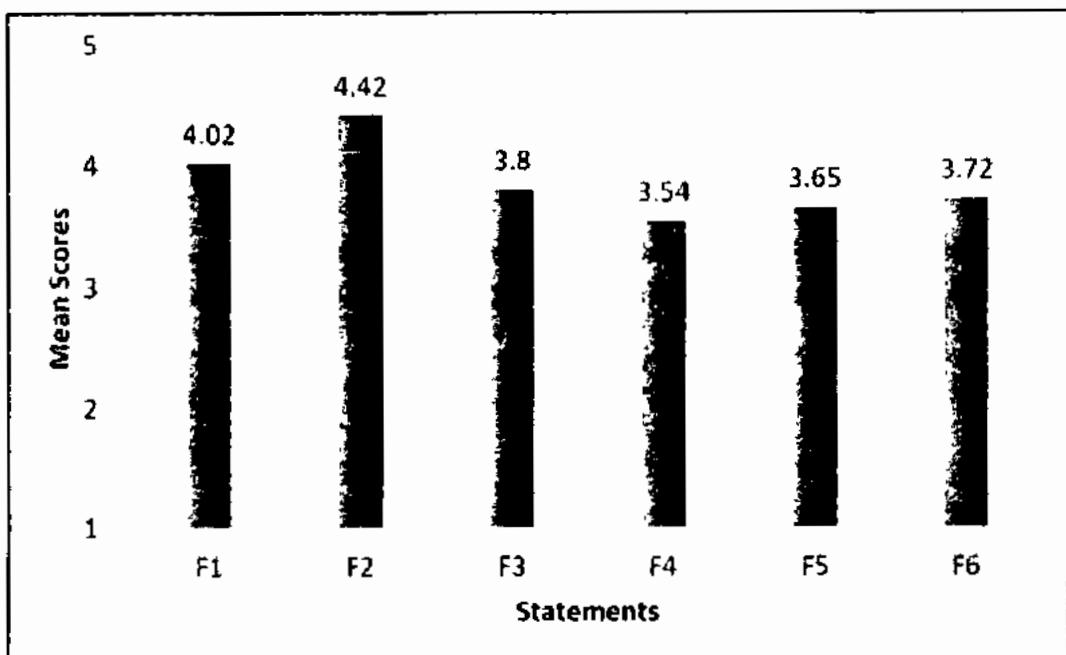
Figure 4.28 shows the comparison of means for six statements i.e. Comparison of Mean Score about Current Trends and practices of using Educational Technologies in Science Teaching Learning process. This shows that teacher's perception about current trends and practices of using Educational Technologies in Science Teaching Learning process in all 6 statements lies around Agree.

Figure 4.29. *Chi Square values about Current Trends and practices.*
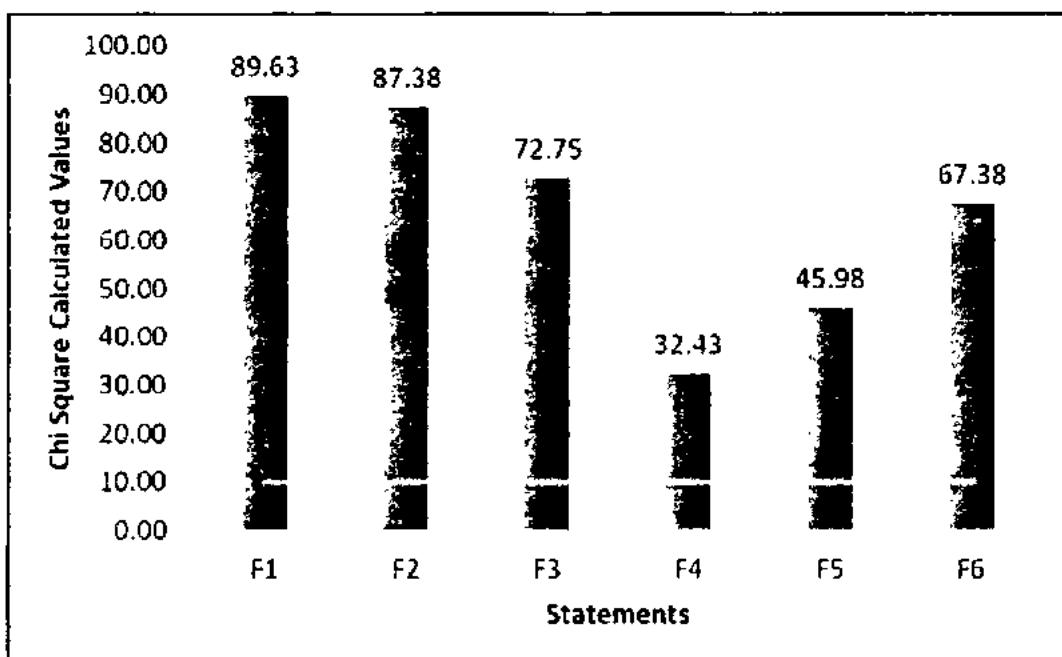
Chi square values in Figure 4.29 shows that science teacher's attitude towards the current trends and practices of using Educational Technologies in Science Teaching Learning process is positive for all 6 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 6 statements are accepted.

4.1.2. Analysis Student Questionnaire

Student questionnaire was used to collect data from science student about the teaching and learning process they usually observe in their science classrooms. In total 297 students provided their feedback. Section below provides item-wise analysis of the tool.

Table 4.9. *Use of personal computer for making notes and assignments.*

| Respondents | Responses | | | | | Analysis | |
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	52%	26%	22%	2.29	0.8	44.91	5.99

*p≤0.05

Regarding the statement, it is easier for me to take notes and organize the class assignments using my personal computer, Table 4.9 shows that 52% students find it easier to take notes and organize the class assignments using their personal computers, while 26% are neutral about the statement and 22% disagree with this statement. While, students mean score for this statement is 2.29 as compared to highest score as 3 with a standard deviation of 0.8.

Similarly, calculated (Chi Square) value 44.91 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that respondents are inclined towards taking notes and organize the class assignments using their personal computers and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted

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Table 4.10. *Usefulness of hands on activities in science teaching.*

| Respondents | Responses | | | | | Analysis | |
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	73%	16%	11%	2.63	0.7	215.70	5.99

*p≤0.05

Regarding the statement, Hands on Activities make my Science Topics easy and understandable, Table 4.10 shows that 73% students agree that hands on activities make their science topics easy and understandable, while 16% are neutral about the statement and 11% disagree with this statement. While, students mean score for this statement is 2.63 as compared to highest score as 3 with a standard deviation of 0.7.

Similarly, calculated (Chi Square) value 215.70 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that respondents are inclined towards hands on activities to make their science topics easy and understandable and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.11.*Videos for enhancement of motivation of science learning.*

| Respondents | Responses | | | | | Analysis | |
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	54%	26%	20%	2.34	0.8	58.20	5.99

*p≤0.05

Regarding the statement, Videos of the related topics are effective source of

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increasing my Motivation for learning science concepts, Table 4.11 shows that 54% students agree that videos of the related topics are effective source of increasing their motivation for learning Science concepts, while 26% are neutral about the statement and 20% disagree with this statement. Whereas, students mean score for this statement is 2.34 as compared to highest score as 3 with a standard deviation of 0.8.

Similarly, calculated (Chi Square) value 58.20 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows the respondents inclination towards videos of the related topics as effective source of increasing their motivation for learning Science concepts and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.12. *ICT tools are time consuming.*

Respondents	Responses			Analysis			
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	38%	37%	25%	2.13	0.8	9.60	5.99

*p≤0.05

Regarding the statement, Demonstration by Electronic Devices require too much time to plan learning activities, Table 4.12 shows that 38% students agree that demonstration by electronic devices require too much time to plan learning activities, while 37% are neutral about the statement and 25% disagree with this statement. Whereas, students mean score for this statement is 2.13 as compared to highest score as 3 with a standard deviation of 0.8.Similarly, calculated (Chi Square) value 9.6 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that respondents consider the time factor a barrier to plan learning activities

through demonstration by the electronic devices. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.13. *WhatsApp is a beneficial tool for science learning*

Respondents	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	44%	22%	38%	1.98	0.9	16.63	5.99

*p≤0.05

Regarding the statement, Science Students can benefit more for their studies by using WhatsApp, Table 4.13 shows that 44% students agree that they can benefit more for their studies by using WhatsApp, while 22% are neutral about the statement and 38% disagree with this statement. Whereas, students mean score for this statement is 1.98 as compared to highest score as 3 with a standard deviation of 0.8.

Similarly, calculated (Chi Square) value 16.63 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that respondents considers that WhatsApp a useful tool for their studies. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.14. *Science Students like poster and videos*

Respondents	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	51%	31%	18%	2.33	0.8	50.24	5.99

*p≤0.05

Regarding the statement, Posters and Videos shown for the explanation of

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Science Topics are liked by the Science Students, Table 4.14 shows that 51% students agree that posters and videos shown for the explanation of science topics are liked by them, while 31% are neutral about the statement and 18% disagree with this statement. Whereas, students mean score for this statement is 2.33 as compared to highest score as 3 with a standard deviation of 0.8.

Similarly, calculated (Chi Square) value 50.24 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows respondents inclination towards use of posters and videos shown for the explanation of science topics. They consider these aids useful for science learning. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.15. *ICT tools increase concentration of Science Students.*

| Respondents | Responses | | | | | Analysis | |
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	45%	37%	18%	2.27	0.7	35.70	5.99

*p≤0.05

Regarding the statement, Science Students are more engaged and feel less disturbing in the presence of ICT Based Environment, Table 4.15 shows that 45% students agree that they are more engaged and feel less disturbing in the presence of ICT based environment, while 37% are neutral about the statement and 18% disagree with this statement. Whereas, students mean score for this statement is 2.27 as compared to highest score as 3 with a standard deviation of 0.8.

Similarly, calculated (Chi Square) value 35.70 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows respondents inclination

towards ICT based environment where they feel more engaged and less disturbing. They consider it useful for science learning. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.16. *Power Point Presentation is useful for science learning.*

| Respondents | Responses | | | Mean | SD | Analysis | |
	Agree	Neutral	Disagree			Chi Square Calculated*	Chi Square Tabulated
297	54%	28%	18%	2.35	0.8	57.60	5.99

*p≤0.05

Regarding the statement, The use of Power Point Presentation is very helpful for the students to perceive their concepts of Science Subjects, Table 4.16 shows that 54% students agree that the use of Power Point presentation is very helpful for them to perceive their concepts in science subjects, while 28% are neutral about the statement and 18% disagree with this statement. Whereas, students mean score for this statement is 2.35 as compared to highest score as 3 with a standard deviation of 0.8.Similarly, calculated (Chi Square) value 57.60 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows respondents inclination towards use of Power Point presentation to perceive their concepts of science subjects..As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.17. *Multimedia exploits prior knowledge of the science students.*

Respondents	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	42%	32%	25%	2.17	0.8	13.15	5.99

*$p \leq 0.05$

Regarding the statement, the use of Multimedia provides us clear demonstration of Science Experiment prior to its actual execution, Table 4.17 shows that 42% students agree that the use of Multimedia provides them clear demonstration of science experiment prior to its actual execution, while 33% are neutral about the statement and 25% disagree with this statement. Whereas, students mean score for this statement is 2.17 as compared to highest score as 3 with a standard deviation of 0.8.

Similarly, calculated (Chi Square) value 13.15 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows respondents inclination towards the use of Multimedia in science, which provides them clear demonstration of science experiment prior to its actual execution so they consider it useful for science learning. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.18. *Overhead Projector increases Motivation for science Learning.*

Respondents	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
297	51%	33%	16%	2.34	0.7	52.55	5.99

*p≤0.05

Regarding the statement, Our Motivation for Learning has increased due to the use of Overhead Projector by the Science Teacher for Demonstration, Table 4.18 shows that 51% students agree that their motivation for learning increased due to the use of Overhead projector by the Science teacher, while 33% are neutral about the statement and 16% disagree with this statement. Whereas, students mean score for this statement is 2.34 as compared to highest score as 3 with a standard deviation of 0.7.

Similarly, calculated (Chi Square) value 52.55 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows respondents inclination towards the use overhead projector by their science teacher as a motivating factor to increase their learning. They consider it useful for science learning. As the trend of the participants is towards agree, hence the statement is accepted.

Cumulative Students Responses

Figure 4.30. *Attitude of secondary level Science Students.*
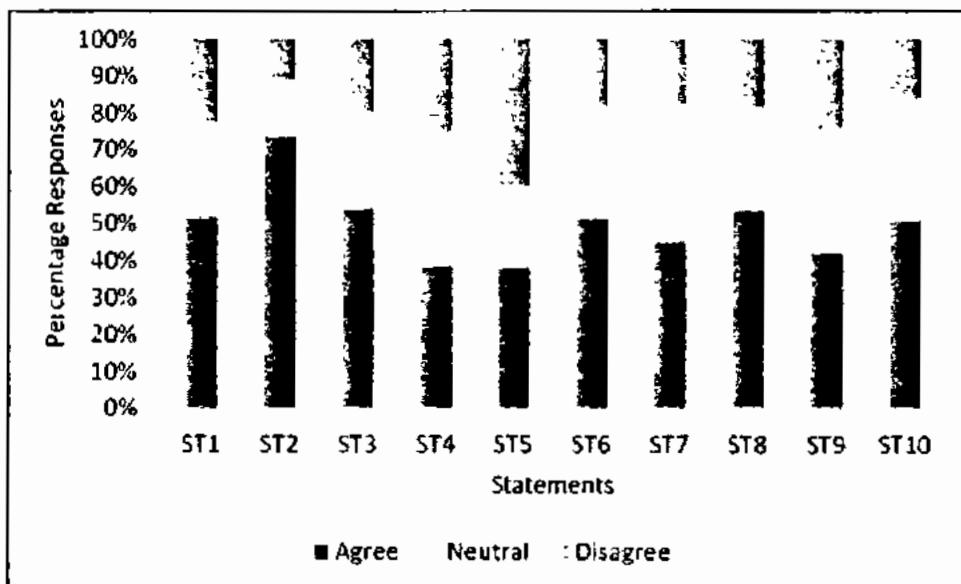
Figure 4.30 shows the cumulative students' responses for all 10 statements of the questionnaire i.e. Attitude of secondary level Science Students regarding the use of Educational Technology for Teaching Learning process. This indicates that 50% students (cumulative average) have positive attitude towards use of ICT tools in teaching learning process, 29% are neutral and 21% disagree to its use for various reasons.

4.1. Analysis of Qualitative Data

4.2.1. Analysis of Classroom Observation

This section provides analysis of classroom observation tool used to collect data from the classrooms of science teachers. In total 13 teachers were observed while teaching in their science classroom.

4.2.1.1. Availability of ICT tools in the classroom

Figure 4.31. *Availability of ICT Tools in the Classrooms*
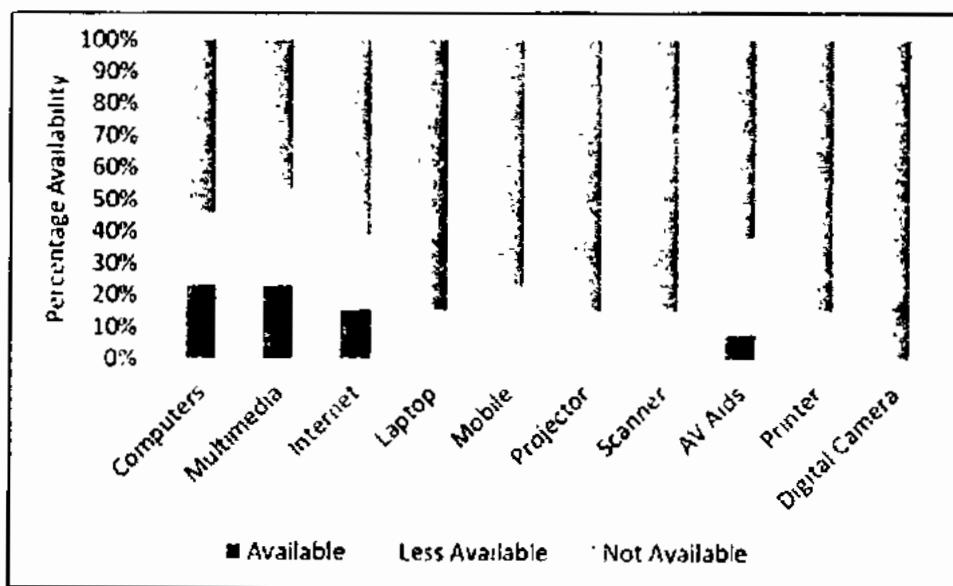
Figure 4.31 shows that in majority colleges ICT tools are not available to science teachers. Whereas in some colleges, ICT tools are available in less quantity and there are only few colleges where these tools are available in enough quantity.

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4.2.1.2. Knowledge and understanding of using ICT tools for science teaching

Figure 4.32 *Knowledge and Understanding of Teachers to Use ICT*
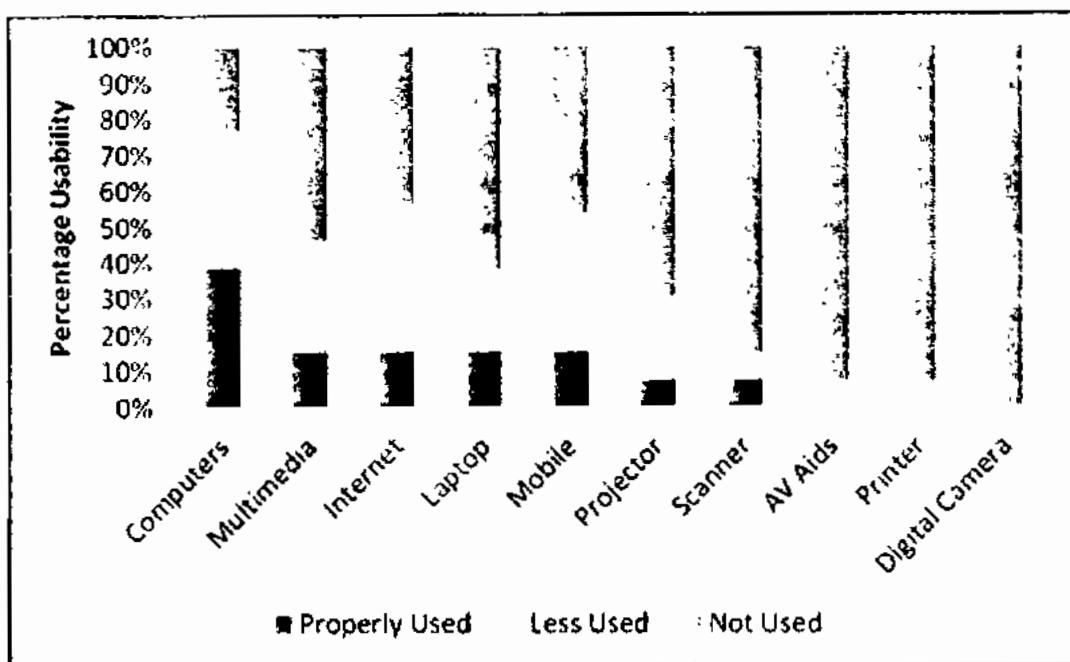
Figure 4.32 shows that majority teachers don't use ICT tools for science teaching. Some use partially and only few use these tools properly.

4.2.1.3. Disposition of Science Teacher towards ICTs during Teaching LearningProcess

Section below provides analysis of different indicators observed during classroom observation under disposition of science teachers towards ICT during teaching learning process.

Table. 4.19. *ICT tools eases science teacher during teaching.*

Teacher Observed	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	77%	15%	08%	2.69	0.63	11.25	5.99

*$p \leq 0.05$

Regarding the statement, Science Teacher Feels Comfortable by Using ICT Tools in Teaching Learning Process, Table 4.19 shows that 77% Science teachers feel comfortable in teaching learning process by using ICT tools, while 15% are neutral about the statement and 08% disagree with this statement. Teachers mean score for this statement is 2.69 as compared to highest score as 3 with a standard deviation of 0.63.

Similarly, calculated (Chi Square) value 11.25 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most respondents feel comfortable in teaching learning process by using ICT tools and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.20. *Teacher uses ICT tools to increase Motivation for Science Learning.*

Teacher Observed	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	85%	15%	0%	2.85	0.38	15.87	5.99

*$p \leq 0.05$

Regarding the statement, Science Teacher tries to increase Student Motivation for Science Learning using ICT tool, Table 4.20 shows that 85% Science teacher tries to increase student motivation for science learning using ICT tools, while 15% are neutral about the statement and no one disagrees with this statement. Teachers mean score for this statement is 2.85 as compared to highest score as 3 with a standard deviation of 0.38.

Similarly, calculated (Chi Square) value 15.87 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most respondents try to increase student motivation for science learning using ICT tools and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.21. *ICT tools are source of reflection for the teacher on its own behavior.*

Teacher Observed	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	69%	31%	0%	2.69	0.48	9.40	5.99

*p≤0.05

Regarding the statement, Science Teacher can reflect on its own behavior and practice to improve Teaching Skills with the help of ICT tools, Table 4.21 shows that 69% Science teachers reflect on their own behavior and practice to improve teaching skills with the help of ICT tools, while 31% are neutral about the statement and no one disagrees with this statement. Teachers mean score for this statement is 2.69 as compared to highest score as 3 with a standard deviation of 0.48.

Similarly, calculated (Chi Square) value 9.40 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most respondents reflect on their own behavior and practice to improve teaching skills with the help of ICT tools and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.22.*MS Excel is useful to solve complex mathematical calculation of science.*

Teacher Observed	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	46%	38%	15%	2.31	0.75	2.01	5.99

*p≤0.05

Regarding the statement, Science Teacher uses MS Excel to solve complex mathematical calculation of science, Table 4.22 shows that 46% Science teachers use MS Excel to solve complex mathematical calculation of science, while 38% are neutral about the statement and 15% disagrees with this statement. Teachers mean score for this statement is 2.31 as compared to highest score as 3 with a standard deviation of 0.75.

Similarly, calculated (Chi Square) value 2.01 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most respondents don't use MS Excel to solve complex mathematical calculation of science and they have negative attitude about it. As the trend of the participants is towards disagree, hence the statement is rejected.

Table 4.23. *Science Teacher behaves as a Facilitator.*

Teacher Observed	Responses					Analysis	
	Agree	Neutral	Disagree	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	62%	38%	0%	2.62	0.51	7.55	5.99

*p≤0.05

Regarding the statement, Science Teacher behaves as a Facilitator in Technology Enriched Classroom, Table 4.23 shows that 62% Science teachers behave as a facilitator in technology enriched class room, while 38% are neutral about the statement and no one disagrees with this statement. Teachers mean score for this statement is 2.62 as compared to highest score as 3 with a standard deviation of 0.51.

Similarly, calculated Chi Square) value 7.55 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most respondents behave as a facilitator in technology enriched class room and they have positive attitude about it. As the trend of the participants is towards agree, hence the statement is accepted.

4.2.1.4. Skill level of Science Teachers in using Educational Technologies with Reference to 4Cs

Section below provides analysis of classroom observation about Skill level of science teachers in using Educational Technologies with reference to 4Cs i.e., Communication, Collaboration, Critical thinking and Creativity.

Table 4.24. *Usage of Models and Pictures for Communication*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	23%	77%	0%	2.23	0.44	12.17	5.99

*$p \leq 0.05$

Table 4.24 shows that 23% Science teachers have high usage of models and pictures in teaching science, while 77% have medium use and no one is in low category of usage. Teachers mean score for this statement is 2.23 as compared to highest score as 3 with a standard deviation of 0.44.

Similarly, calculated (Chi Square) value 12.17 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards using models and pictures. As the trend of the participants is towards agree, hence the statement is accepted.

Table 4.25. *Usage of A. V. Aids for Communication*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	38%	46%	15%	2.23	0.73	2.01	5.99

*p≤0.05

Table 4.25 shows that 38% Science teachers have high usage of A. V. Aids in teaching science, while 46% have medium use and 15% have low usage. Teachers mean score for this statement is 2.23 as compared to highest score as 3 with a standard deviation of 0.73.

Similarly, calculated (Chi Square) value 2.01 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards using A. V Aids. As the trend of the participants is towards low, hence the statement is rejected.

Table 4.26 *Answer Questions Session during Class for Communication*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	54%	38%	08%	2.46	0.66	4.32	5.99

*p≤0.05

Table 4.26 shows that 54% Science teachers hold question answer session during class, while 38% have medium use and 08% have low usage. Teachers mean score for this statement is 2.46 as compared to highest score as 3 with a standard deviation of 0.66.

Similarly, calculated (Chi Square) value 4.32 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards question answer session during class. As the trend of the participants is towards low, hence the statement is rejected.

Table 4.27. *Peer Group involvement in Activities for Collaboration*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	23%	69%	08%	2.15	0.55	8.02	5.99

*p≤0.05

Table 4.27 shows that 23% Science teachers have high use of peer group involvement in activities, while 69% have medium use and 08% have low usage. Teachers mean score for this statement is 2.15 as compared to highest score as 3 with a standard deviation of 0.55.

Similarly, calculated (Chi Square) value 8.02 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards peer group involvement in activities. As the trend of the participants is towards positive side, hence the statement is accepted.

Table 4.28 *Group Work in using ICTs for Collaboration*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	23%	62%	15%	2.08	0.64	4.78	5.99

*p≤0.05

Table 4.28 shows that 23% Science teachers highly used group work in using ICTs, while 62% have medium use and 15% have low usage. Teachers mean score for this statement is 2.08 as compared to highest score as 3 with a standard deviation of 0.64.

Similarly, calculated (Chi Square) value 4.78 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards group work in using ICTs. As the trend of the participants is towards lower side, hence the statement is rejected.

Table 4.29. *Student Teacher Interaction for Collaboration*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	85%	15%	0%	2.85	0.38	15.87	5.99

*p≤0.05

Table 4.29 shows that 85% Science Teachers have high level of interaction with their students, while 15% have medium use and there was no one in low category. Teachers mean score for this statement is 2.85 as compared to highest score as 3 with a standard deviation of 0.34.

Similarly, calculated (Chi Square) value 15.87 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degree of freedom. This shows that most teachers have positive attitude towards high interaction with students in their science classroom. As the trend of the participants is towards higher side, hence the statement is accepted.

Table 4.30. *Awareness of Weak and Strong Points of Students for Critical Thinking*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	46%	46%	08%	2.38	0.65	3.86	5.99

*p≤0.05

Table 4.30 shows that 46% Science teachers have high awareness of weak and strong points of students, while 46% have medium awareness and 08% have low awareness. Teachers mean score for this statement is 2.38 as compared to highest score as 3 with a standard deviation of 0.65.

Similarly, calculated (Chi Square) value 3.86 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards awareness of weak and strong points of students. As the trend of the participants is towards lower side, hence the statement is rejected.

Table 4.31.*Usage of new Strategies and Methods for Critical Thinking*

| Teacher Observed | Responses | | | | | Analysis | |
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	17%	75%	08%	2.08	0.51	11.25	5.99

*p≤0.05

Table 4.31 shows that 17% Science teachers have high usage of new strategies and methods, while 75% have medium and 08% have low usage. Teachers mean score for this statement is 2.08 as compared to highest score as 3 with a standard deviation of 0.51.

Similarly, calculated (Chi Square) value 11.25 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards usage of new strategies and methods. As the trend of the participants is towards higher side, hence the statement is accepted.

Table 4.32. *Presentation through Power Point for Critical Thinking*

Teacher Observed	Responses					Analysis	
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	08%	62%	30%	1.77	0.60	5.70	5.99

*p≤0.05

Table 4.32 shows that 8% Science teachers have high usage of presentation through power point, while 62% have medium and 30% have low usage. Teachers mean score for this statement is 1.77 as compared to highest score as 3 with a standard deviation of 0.60.

Similarly, calculated (Chi Square) value 5.70 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards usage of presentation through Power Point. As the trend of the participants is towards lower side, hence the statement is rejected.

Table 4.33.*MS Word for Text Formatting for Creativity*

Teacher Observed	Responses			Analysis			
	High	Medium	Low	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	38%	38%	22%	2.15	0.80	0.62	5.99

*p≤0.05

Table 4.33 shows that 38% Science teachers have high usage of MS word for text formatting, while 38% have medium and 22% have low usage. Teachers mean score for this statement is 2.15 as compared to highest score as 3 with a standard deviation of 0.80.

Similarly, calculated (Chi Square) value 0.62 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards usage of MS word for text formatting. As the trend of the participants is towards lower side, hence the statement is rejected.

4.2.1.5. Instructional Technology

Section below provides analysis of classroom observation about use of Instructional Technology in the classroom.

Table 4.34. *Usage of Modern Technology in the Classroom*

Teacher Observed	Responses					Analysis	
	Constantly	Occasionally	Never	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	15%	77%	08%	2.08	0.49	11.25	5.99

*$p \leq 0.05$

Table 4.34 shows that 15% Science teachers constantly use modern technology in the Class room, while 77% use occasionally and 08% have never used. Teachers mean score for this statement is 2.08 as compared to highest score as 3 with a standard deviation of 0.49.

Similarly, calculated (Chi Square) value 11.25 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards usage of modern technology in the Class room. As the trend of the participants is towards higher side, hence the statement is accepted.

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Table 4.35.*Motivation of Science Students using Multimedia*

Teacher Observed	Responses					Analysis	
	Constantly	Occasionally	Never	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	31%	54%	15%	2.15	0.69	2.93	5.99

*p≤0.05

Table 4.35 shows that 31% Science Teachers constantly increase student increase student motivation using Multimedia, while 54% use occasionally and 15% have never used. Teachers mean score for this statement is 2.15 as compared to highest score as 3 with a standard deviation of 0.69.

Similarly, calculated (Chi Square) value 2.93 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards usage of multimedia for the motivation of science students. As the trend of the participants is towards lower side, hence the statement is rejected.

Table 4.36 *Understanding of science teaching & educational technology.*

Teacher Observed	Responses					Analysis	
	Constantly	Occasionally	Never	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	31%	69%	0%	2.31	0.48	9.40	5.99

*p≤0.05

Regarding the statement, Understanding of Science Teaching Methodology in Technology enriched environment, Table 4.36 shows that 31% Science teachers constantly increase student understanding of science teaching methodology in technology enriched environment, while 69% use occasionally and there are no teachers who use it. Teachers mean score for this statement is 2.31 as compared to highest score as 3 with a standard deviation of 0.48.

Similarly, calculated (Chi Square) value 9.40 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards increasing student understanding of science teaching methodology in technology enriched environment. As the trend of the participants is towards higher side, hence the statement is accepted.

Table 4.37. *Teaching by Deductive Reasoning way*

Teacher Observed	Responses					Analysis	
	Constantly	Occasionally	Never	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	31%	69%	0%	2.31	0.48	9.40	5.99

*p≤0.05

Table 4.37 shows that 31% Science teachers constantly teach by deductive reasoning way, while 69% use occasionally and there are no teachers who use it. Teachers mean score for this statement is 2.31 as compared to highest score as 3 with a standard deviation of 0.48.

Similarly, calculated (Chi Square) value 9.40 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards teaching by deductive reasoning way. As the trend of the participants is towards higher side, hence the statement is accepted.

Table 4.38. *Engage Science Students in Hands-on activities*

Teacher Observed	Responses					Analysis	
	Constantly	Occasionally	Never	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	38%	62%	0%	2.38	0.51	7.55	5.99

*$p \leq 0.05$

Table 4.38 shows that 38% Science teachers constantly engage Science Students in hand on activities, while 62% use occasionally and there are no teachers who use it. Teachers mean score for this statement is 2.38 as compared to highest score as 3 with a standard deviation of 0.51.

Similarly, calculated (Chi Square) value 7.55 is greater than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers have positive attitude towards engaging Science Students in hand on activities. As the trend of the participants is towards higher side, hence the statement is accepted.

Table 4.39. *Activities through Problem – Based Learning*

Teacher Observed	Responses					Analysis	
	Constantly	Occasionally	Never	Mean	SD	Chi Square Calculated*	Chi Square Tabulated
13	46%	46%	08%	2.38	0.65	3.86	5.99

*p≤0.05

Table 4.39 shows that 46% Science teachers constantly use activities through problem-based learning, while 46% use occasionally and there are 8% teachers who never use it. Teachers mean score for this statement is 2.38 as compared to highest score as 3 with a standard deviation of 0.65.

Similarly, calculated (Chi Square) value 3.86 is less than the tabulated value i.e., 5.99 at 0.05 level with 2 degrees of freedom. This shows that most teachers don't have positive attitude towards using activities through problem-based learning. As the trend of the participants is towards higher side, hence the statement is rejected.

4.2.2. Analysis of Head of Institutions Interview Tools

In total 9 head of institutions were interviewed. Question wise findings are listed below

4.2.2.1. Availability of ICT resources in the Institution

Figure 4.33. *Availability of ICT resources in the Institution by School Heads*
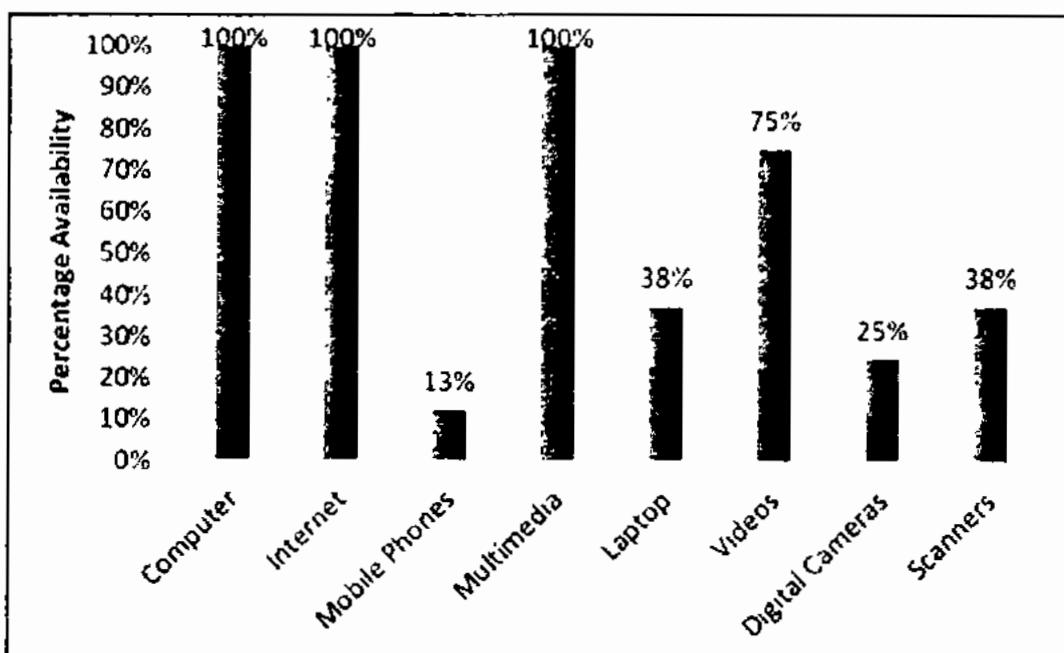
Figure 4.33 shows that computer, internet and multimedia are available in all institutes, videos in 75% institutes, laptops and scanners in 38% institutes, digital cameras in 25% institutes and mobile phones in 13% institutes.

4.2.2.2. Utilization of ICT resources by the Science Teachers

Figure4.34. *Utilization of ICT resources by Science Teachers in Islamabad*

Model Colleges
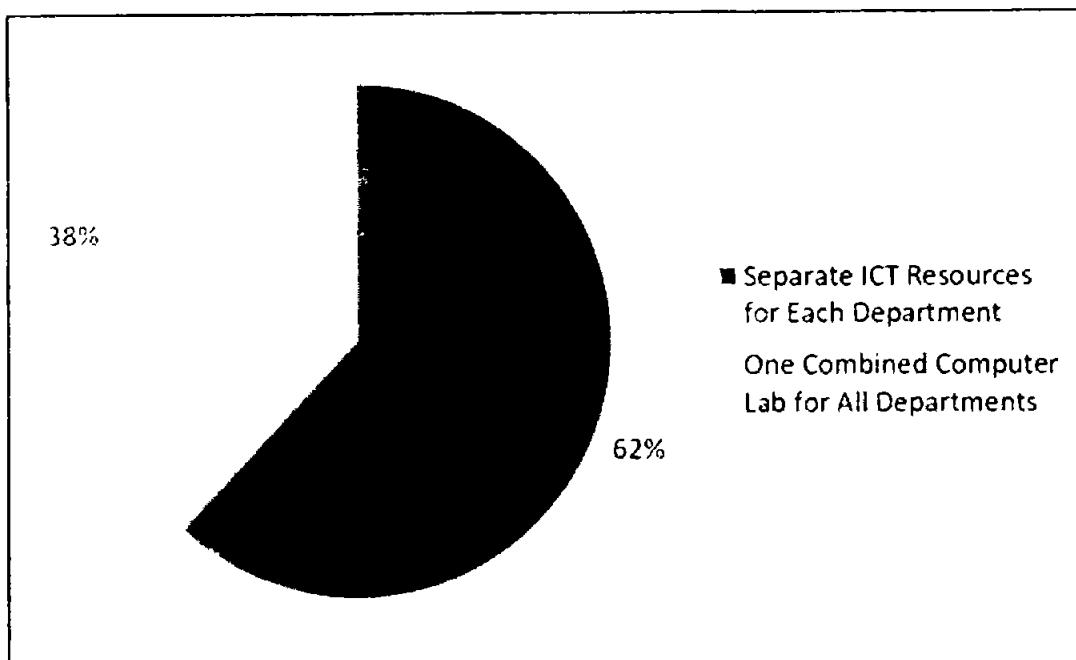
Figure 4.34 shows that in 62% Islamabad Model Colleges, teachers have separate department wise ICT resources, whereas in 38% colleges, there is one combined computer lab for all departments.

4.2.2.3. Head of Institution opinion about Science Teachers' knowledge and Understanding of ICT tools in teaching learning process

Six out of 9 (75%) head of institutions shared that their science teachers possess proper knowledge, understanding and experience of using ICT tools, whereas other two head of institutions (25%) expressed the need of training for their science teachers to improve their knowledge and understanding of ICT tools in teaching learning process.

4.2.2.4. Science Teachers reluctance to use Educational Technology in teaching Learning process

Data analysis shows that 62% head of institutions were confident about their

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science teachers' enthusiasm and motivation to use educational technology in teaching

learning process, whereas 38% head of institutions shared that their science teachers

are reluctant to use educational technology in teaching learning process.

4.2.2.5 Head of institutions Opinion about the conducive environment in their

Institution for the Science Teachers to materialize the concept of 4Cs

Head of institutions Opinion about the conducive environment in their institution for

the Science Teachers to materialize the concept of 4Cs (Communication, Collaboration,

Critical thinking and Creativity) in Teaching

Data analysis shows that in 75% institutions Science teachers have conducive

environment to materialize the concept of 4Cs (Communication, Collaboration, Critical

thinking and Creativity) in teaching as rated by the head of institutions teachers and in

25% institutions science teachers don't have conducive environment.

4.2.2.5. Opinion about mandatory practice for all the Science Teachers to use ICT

Tools in teaching learning

Data analysis shows that in 25% institutions using ICT tools in teaching learning

process is mandatory practice and in 75% institutions it is not mandatory.

4.2.2.6. Major challenges in the use of ICTs for Science teaching

Figure 4.35. *Major challenges faced by Science Teachers*
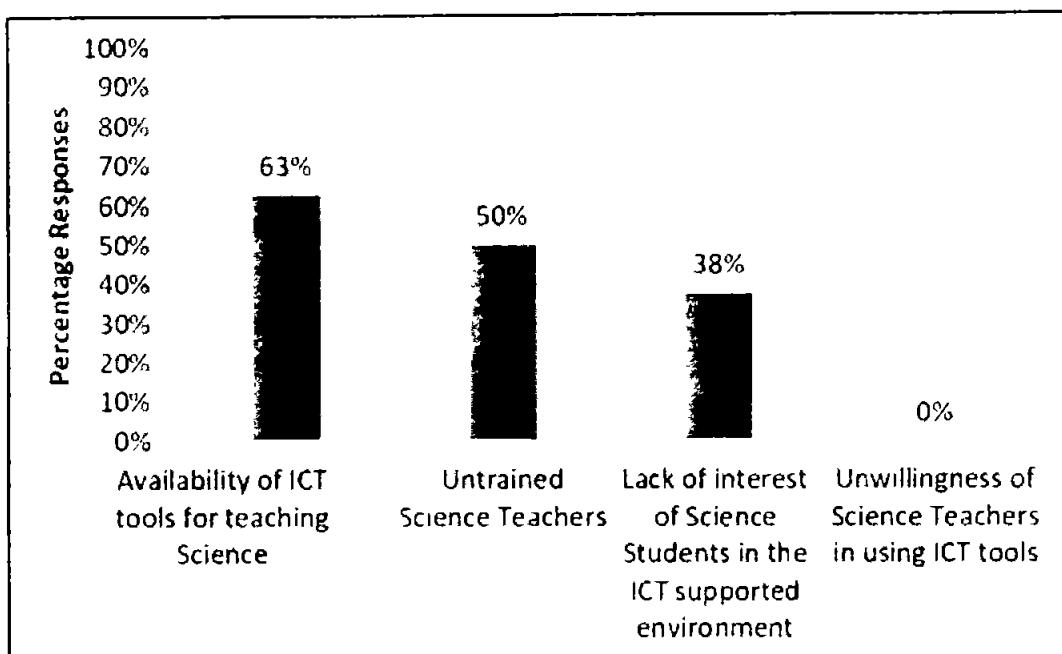
Figure 4.35 shows that in 63% situations availability of ICT tools is a major challenge to teach science, in 50%, situations of untrained teachers is a major challenge and in 38% situations, lack of student interest in the ICT supported environment was ranked as major challenge by head of institution, whereas unwillingness was not reported as a challenge by any head of institution.

4.2.2.7. Scheduled training programs for the Science Teachers to enhance their Professional competency regarding the use of ICT tools

Data analysis shows that in 50% institutions, there is provision for the science teachers to receive regular scheduled training to enhance their professional competency regarding the use of ICT tools, whereas neither Federal Directorate of Education nor Ministry of Federal Education and Professional Training has any regular scheduled training program for the science teachers so far in their annual calendar of activities.

Second part of this question was an open-ended question, head of institutions

were requested to share their feedback as per their context. In total five (5) out of 9 head of institutions responded to this question.

i. Four out of 5 head of institutions shared that use of Educational Technology for Science Teaching should be made compulsory

ii. Two out of 5 head of institutions shared that Training should be arranged for science teachers One out of 5 head of institutions shared that provision of ICT tools is needed regarding the use of Educational Technologies for Science Teaching.

CHAPTER 5

SUMMARY, FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The teachers of today's technology enriched environment are encouraged to use ICT tools by the government, school management and parents for teaching learning process for better. In particular, the teaching of science classroom of 21st century requires the use of educational technology for its practical activities and hand on experiments. It is a matter of great distress that there is very little literature which can guide the science teacher in the availability and selection of educational technology for effective science teaching and learning process. Due to insufficient information about the availability, knowledge and skill of the science teacher in using educational technology for science teaching, it is very difficult to make productive decisions to avoid loss of money, time and the confidence of the science teacher. The teacher of the modern age, as a facilitator can guide his students to access variety of information's to communicate with the others by innovative ways of demonstrating their learning (Flick & Bell, 2012).

The purpose of this study was to provide researched based guidance to the administration, policy makers, the prospective and perspective science teachers to help them in decision making to transform a traditional classroom into technology supported classrooms for the effective science teaching in Pakistan. The aim of this study was "To analyze the use of Educational Technology for Science Teaching in Pakistan" in the light of National Professional Standard on ICT: "Effective communication and

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proficient use of Information Communication Technologies". This standard on ICT is one of the ten National Professional Standards being used as gadgets for the measurement of quality of Education in Pakistan.

The substantial aim of this study was to assess the three components of the National Professional Standard: Knowledge & Understanding, Disposition and Performance /Skills (4C'S) with regard to the use of Educational Technology by the Science Teacher for Teaching Learning process. The overall four objectives of the present study were: To evaluate the Knowledge and Understanding of Science Teachers regarding the use of Educational Technology in teaching learning process in Islamabad Model Colleges Islamabad, To examine the Skill level of Science Teachers in using Educational Technology with reference to 4Cs (Communication, Collaboration, Critical thinking and Creativity) as 21st century learning skills for teaching learning process , To evaluate the Disposition of Science Teachers regarding the use of Educational Technology in Teaching Learning process, to analyze the current trends of using Educational Technology in Teaching Learning process.

It was a mixed method approach. This mixed study has Sequential explanatory design following Quan - Qual model. All the Heads of institutions, Science Students and Science Teachers of Secondary level (Grade-X) in Islamabad Model Colleges were the population of this study. Simple random sampling technique was used to select the sample from the head of different institutions, Science teachers and Science students. The entire process of sampling was done in a single step with each subject selected independently of the other members of the population. The sample of this population included 09 Head of Institutions, 95 Science Teachers and 300 Science Students (150 Male and 150 Female). Over all four research tools were developed, questionnaire for

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the science teacher, questionnaire for the science students, classroom observation and interview from the head of institution. Realizing the pivotal role of the science teacher, the substantive objective of this study was to analyze the knowledge, disposition and skill level of the teacher for teaching science. The quantitative data was analyzed with the help of SPSS in the form of % Age, Mean, Frequency, Standard Deviation (SD) and Chi Square while for qualitative data analysis, thematic analysis was be performed.

The finding of this study exposed that larger class size, insufficient availability of educational tools, non-provision of training programs, lack of patronage of the head of institution, inadequate support of the administration and non-theoretical based curricula are responsible for the poor understanding and knowledge, weak level of skills and fragile disposition of the science teacher.

Based on the data analysis from the previous chapter, summary of all 4 tools, answers to all 7 questions and then conclusion drawn from the discussion are explained in this chapter.

5.2. Findings

The section below provides summary of findings for all four tools based on data analysis from Chapter Four.

5.2.1. Findings regarding knowledge and understanding of science teachers (Objective-1)

Science Teacher questionnaire analysis shows that knowledge and understanding of Science Teachers regarding the use of Educational Technology in teaching learning process at secondary level is positive for 11 out of 13 statements against the critical value of 9.94 at 0.05 confidence level with 4 degrees of freedom, as given in Figure 4.5. Therefore, 11 statements are accepted;

iii. Lecture cum discussion method is made interesting using Multimedia

iv. Science teachers make group discussion for difficult concepts and problems using WhatsApp

v. Video conferencing is used for a debate during the teaching of science (debating).

vi. Project based learning in small groups is made effective for science students using ICT tools

vii. Science Teachers give demonstrations about scientific phenomena with the help of models in the laboratory

viii. Science Teachers use direct method by writing notes on blackboard or transparency to explain Science concepts

ix. Students' ideas are taken in to consideration by the Science Teacher through observation using electronic devices.

x. Hands on activities is effective than lectures to teach scientific concepts.

xi. Science teachers can share notes of science subjects with their students through google drive

xii. MS Word is helpful for framing of lecture/quizzes

xiii. Utilization of YouTube is best for visual presentations of difficult topics of science

Whereas two statements i.e., "ICT tools are utilized for brainstorming of Science Students" and "teacher facilitates discussion about difficult concepts using videos" have low chi square values as compared to critical value of 9.94. Therefore, both the statements were rejected. This shows that science teachers have lesser knowledge in these two areas i.e., knowledge and understanding of science teacher for

using ICT tools for brain storming of his students and use of videos to explain the difficult topics of science is very weak.

Interview from head of institution revealed that six out of 9 (67%) science teachers possess proper knowledge, understanding and experience of using ICT tools, whereas other two head teachers (22%) expressed the need of training for their science teachers to improve their knowledge and understanding of ICT tools in teaching learning process.

5.2.2. Findings about Disposition of Science teachers regarding the use of Educational technology in teaching learning process (Objective-2)

Science Teacher questionnaire analysis shows that teacher's disposition regarding the use of educational technology in teaching learning process is positive for all 10 statements against critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom, as shown in Figure 4.9. Therefore, all 10 statements are accepted.

Under disposition, 5 aspects were observed during classroom observation. Data analysis shows that 4 out of 5 aspects are accepted i.e., feel comfortable in teaching learning process by using ICT tools, try to increase student motivation by using ICT tools, reflect on their behavior and practices to improve teaching skills with the help of ICT tools and can behave as a facilitator in technology enriched classroom, as shown in Table 4.20, 4.21, 4.23 and 4.24. Therefore, it can be concluded that science teachers are using these 4 aspects confidently in their technology enriched classroom. However, one aspect i.e., use of MS Excel to solve complex mathematical calculation of science is not being used properly by the teachers for some reasons showing their poor knowledge and understanding to use MS Excel in teaching learning process, as shown Table 4.22.

Similarly, head of institution's interview analysis shows that 38% science teachers in their institutions are reluctant to use educational technology in science teaching learning process. Whereas 62% head of institutions were confident about their science teachers' enthusiasm and motivation to use educational technology in teaching learning process.

5.2.3. Findings regarding Skill level of Science Teachers in using educational Technology with reference to 4Cs (objective-3)

Science teachers' skills level in using educational technologies were measured with reference to 4Cs i.e., Communication, Collaboration, Critical thinking and Creativity.

5.2.3.1 Communication. Science Teacher questionnaire analysis shows that science teacher's attitude towards the communication skills in the use of educational technology is positive for all 5 statements against critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom, as given in Figure 4.13. Therefore, all 5 statements are accepted.

On the other hand, the classroom observation tool shows that under communication, only one aspect out of three i.e., usage of models and pictures was accepted, as shown in Table 4.24 and other two i.e., usage of A. V. Aids and holding question answer session during science teaching were rejected, as shown in Table 4.25 and 4.26. Therefore, it can be concluded that teachers are more comfortable in using models and pictures, while teaching science they are less comfortable in using A. V. Aids and holding question answer sessions.

5.2.3.2. Collaboration. Chi square values in Figure 4.17 shows that science teacher's opinion towards the collaboration skills in the use of educational technology is positive for all 5 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom. Therefore, all 5 statements are accepted.

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Similarly, classroom observation shows that one aspect out of three i.e., group work in using ICT was rejected, as shown in Table 4.28. This shows that teachers either have poor skill to collaborate their students to work in the form of groups to make teaching learning process more effective.

5.2.3.3. Critical Thinking. Teachers' opinion about critical thinking skills in the use of educational technology is positive for all 5 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom, as shown in Figure 4.21. Therefore, all 5 statements are accepted.

Whereas in classroom observation. under critical thinking, two out of three aspects i.e., awareness of weak and strong points of students, and presentation through power point were rejected, as shown in Table 4.30 and 4.32. This means teachers are not comfortable in applying these two aspects while teaching science using ICT Tools.

5.2.3.4. Creativity. Teachers' opinion about creativity in the use of educational technology is positive for all 5 statements against the critical value of 9.94 at 0.05 confidence level and 4 degrees of freedom, as shown in Figure 4.25. Therefore, all 5 statements are accepted.

Under creativity, use of MS word for text formatting was rejected, as shown in Table 4.33. This shows that teachers' creativity level is low to use MS word for creating and formatting of text during science teaching learning process.

5.2.4. Findings regarding analysis of the current trends of using Educational Technology in teaching learning process at secondary level (objective-4)

Chi square values in Figure 28 shows that science teacher's opinion about current trends and practices of using educational technologies in science teaching learning process is positive for all 6 statements against the critical value of 9.94 at 0.05

confidence level and 4 degrees of freedom. Therefore, all 6 statements are accepted.

However, analysis from classroom observation shows rejection of two aspects out of 5 i.e., motivation of science students using multimedia and activities through problem-based learning, as shown in Table 4.35 and 4.39. This shows lack of teachers' skill in using these two aspects effectively while teaching science in their classrooms.

Whereas, data analysis from the head of institution's interview shows that in 25% Islamabad model colleges, the practice of using modern educational technology for science teaching is mandatory whereas in 75% Islamabad model colleges, it is not mandatory. The science teachers have their own will either they use or not ICT tools for science teaching. They are not officially bound to do so.

5.3. Discussion

The aim of this study was to analyze the use of educational technology by the teachers for the effective science teaching in the light of national professional standard on ICT i.e. to assess all the three components of national professional standard: knowledge & understanding, Disposition and skill level of science teacher with reference to 4 Cs: (Communication, Collaboration, Critical thinking and Creativity). Seven research questions were formulated to meet the four objectives of this study. The qualitative and quantitative data obtained from all the four tools about knowledge & understanding, Disposition and skill level of the science teachers, were integrated by triangulation to deduce the overall aim of this study.

5.3.1. Knowledge and understanding of a science teacher: The findings of this study revealed that the science teachers of Islamabad model colleges for boys and girls are not well versed with the emerging trend of using ICT tools for science teaching on regular basis and it is also not mandatory for the science teachers whether they use or

not these tools due to one or the other reason regardless of knowing its effective role in science teaching process. This study also reflects that the weak learning outcome of science students in Islamabad model colleges for boys and girls are actually due to poor knowledge and understanding of the science teachers using educational technology especially during experimental work. The class room observation sessions of this study unfolded that the science teachers were not using even the available ICT tools or the available tools were not used properly during teaching learning process. This shows that the science teachers have poor knowledge of using ICT tools. The interview tool of this study also supported the non-usage of ICT tools by the science teachers as a regular practice.

The significance of ICT tools for effective science teaching is proved by the responses from the questionnaire of science students which was one of the research tool of this study. The acceptance of all the ten statements of students' questionnaire is strong evidence that ICT tools have no doubt influential role to motivate and enhance the knowledge of science students. This point of view is also supported by the study of Alazam, Bakar, Hamah and Asmiran (2019). Their study signifies the practice of using educational technology in science class room as vibrant tool which encourages the students to enhance their motivation level for thoughtful consideration of challenging concepts in a stress-free way. This argument is also supported by the science education reforms of the American Association for the Advancement of Science, which states, it is mandatory for the science teacher to have sufficient knowledge to integrate technology and inquiry-based teaching learning process in to their instruction so that science students can be prepared for the 21st century demands. The National Science Education Standards (NSES) demand that teachers should apply "a variety of

technologies, to support student inquiry-based learning (Krajcik & Nova 2017). Similarly, the study made by Almekhlafi and Almeqdadi (2019) also fully supports the findings of this study. They are of the view that major hindrances in integration and effective use of ICT tools in teaching learning process are: non-availability of computers inside the class room, noncooperation of administration and lack of technical assistance by the institution. Conclusively it can be added here that the knowledge of challenges and issues related with the use of ICT tools for teaching learning process helps the teachers to devise a strategy to overcome the obstacles to become a successful educational technology user.

5.3.2. Disposition: The findings of this study regarding disposition of science teachers for the use of ICT tools reflected that the science teachers are reluctant to use educational technology for the science teaching process as a vibrant tool. There is no regular and mandatory practice of using ICT tools. The interview from the head of institutions showed that there is no compulsion for the science teachers to use ICT tools for science teaching and also there is no scheduled training programs throughout the year to enhance the professional competency of the science teachers which might be the reasons for not using educational technology by the science teachers. In this regard, the findings of British Educational and Communication Technology Agency (BECTA) revealed that by the active involvement of science teachers practically in the projects, workshops etc. the attitude of the science teachers can be made positive towards technology use during teaching learning process. The scheme launched In UK as an initiative of Laptops for Teachers (LFT) so that teachers and students access to computers can be enhanced, confirmed the above statement about teachers' positive attitudes and confidence by having their own laptop computers to be used during

teaching learning process (BECTA, 2017).

5.3.3. Skill level: The findings of this study regarding the skill level of science teachers unfolded that the science teachers of Islamabad model colleges for boys and girls have poor skill levels of all the 4Cs.During classroom observation sessions, it was observed that the science teachers are not well versed with skill to enhance communication level of students by Group Work using ICT tools, answer question session, Student Teacher Interaction, to develop collaboration skill, Awareness of Weak and Strong Points of Students as a critical thinking skill, skill to use A-V aids, Presentation through Power Point, Word for Text Formatting as a creativity skill etc. This is evident by these findings of the study that we are still unable to prepare and motivate our students for the 21st century workplace.

The study of Craft(2017) strongly validates the significance of using educational technology for effective science teaching by having knowledge of 4Cs.According to his findings, The knowledge and understanding of basic science subjects like mathematics, physics, chemistry and the teaching of social sciences, can be excellently boosted by 21st century 4 Cs skills (Critical thinking, Communication, Collaboration, and Creativity).To materialize these aims, we need to support science teachers in refining his knowledge and understanding of using ICT tools and the authorities of education system to device policies to implement innovative strategies in the science class rooms with the help of educational technology. The 21st century skills partnership demands to prepare the students as a problem solver, critical thinker, ICT literate, flexible, creator, and collaborator, communicator competent and financially literate, requiring their teachers to adopt their curriculum and digital technology practices to meet 21st century demands (Gilakjani, et al. 2019).

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5.3.4. Trends towards the use of emerging educational Technologies: The findings of classroom observations for this study also revealed that the knowledge of science teachers not up to mark for using modern technologies like Google & zoom class room in teaching learning process, creation of blogs, Emerging and Mass Notification System (EMNS) as a best platform for communication of a single lecture etc. Over all, the findings of this study revealed that the science teachers of Islamabad Model Colleges for boys and girls don't have complete knowledge of national professional standard on ICT and Educational technology is not in regular practice of science teachers which is evident by their poor knowledge of using ICT tools in teaching learning process, reluctance to incorporate the educational technology for making their lecture interesting and to boost up the level of 4 Cs among the students to prepare them for 21s century workplace.

5.4. Conclusions

In the light of statistical analysis and findings, the following conclusions were drawn:

1. Science Teachers, Students and Head of institutions strongly agree with the importance of using ICT tools for effective science teaching.

2. All the respondents of this study believe that the use of ICT tools in teaching science is helpful to increase the motivation, confidence and conceptual clarity of the students especially in understanding of complex scientific phenomena.

3. Most of the Islamabad Model Colleges have deficiency of ICT tools and the existing infrastructure is not well equipped with the emerging technological tools to facilitate effective teaching of science in this modern era. Provision of ICT tools and equipment is needed to increase use of ICT for effective

teaching of all the science subjects including biology, chemistry and physics.

4.   The science teachers of Islamabad Model Colleges are not well versed with the use of ICT tools for effective teaching learning process and hence need proper training for their professional development to enhance their competency for the use of modern ICT tools in teaching learning process.

5.   The findings of this study also unfolded that there is dire need to enhance the pedagogical content knowledge of ICT tools and their effective use for science teaching by developing a strategic plan for the improvement of effective science teaching through the refresher programs and mandatory training sessions.

6.   Lack of up to the mark knowledge of using modern ICT tools for science teaching is also a barrier for the perspective science teachers as digital immigrants of 21st century. This study is evident that most of science teachers are unable to select appropriate educational technology to be employed to make their lesson interesting and conducive for their students.

7.   The disposition of science teachers regarding the use of ICT tools in not at excellent level. Some of the science teachers are unable to use MS Excel to solve Complex Mathematical scientific Calculation.

8.   The classroom observation sessions revealed that the science teachers of Islamabad Model Colleges are not well versed with skills to enhance communication of students by Group Work using ICT tools, answer question session & Student Teacher Interaction to develop collaboration skill, critical thinking skill to know about the weak and strong Points of

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Students, skill to use A-V aids, Presentation through Power Point, Word for Text Formatting as a creativity skill etc.

9.   Patronage of institutional head can play revolutionary role in the uplift of standard of quality education. The findings of this study revealed that only few heads of institutions take serious interest in this regard which is one of the barriers in the use of ICT tools in teaching of science. The results showed that only few heads of institutions have arrangement for the training of their science teachers within their institutions on self-supporting basis. The presence of technologically trained science teachers in their institutions is the evidence of their effort.

10.   This was also observed during this study that there is no compatibility between educational theories like constructivism and the ICT tools to be utilized for the effective science teaching which is necessary to develop knowledge, collaborative learning, replication and to provoke the learning requirements of the learners.

11.   The findings of this study also revealed some of the major hurdles in making the use educational technology for the science teaching learning process more effective include: traditional teaching methodology, no compulsion from the institution for the use optional use of ICT tools, Lack of self-motivation of the science teachers to use the ICT tools, uneasy access to ICT tools, excessive failure of electricity.

12.   A conducive environment has significant role in materializing the practice of using educational technology for making teaching learning process more effective. The interviews of heads of institutions revealed that there is no

conducive environment for the science teachers due to shortage and limited accessibility to ICT tools particularly for the teaching of science subjects.

5.4.1 Triangulation of Qualitative and Quantitative Data

The triangulation combines qualitative and quantitative data and complements those results to a comprehensive picture of the phenomenon under study. It is preferable to use it in mixed methods research to increase the validity of the research by minimizing the shortcomings of each method individually. The aim of this study was to analyze the use of educational technology by the teachers for the effective science teaching in the light of national professional standard on ICT i.e. to assess all the three components of national professional standard: knowledge & understanding, Disposition and skill level of science teacher with reference to 4 Cs: (Communication, Collaboration, Critical thinking and Creativity). Seven research questions were formulated to meet the four objectives of this study. The qualitative and quantitative data obtained from all the four tools about knowledge & understanding, Disposition and skill level of the science teachers, were integrated by triangulation to deduce the overall aim of this study.

The overall findings of this study revealed that the reasons for the weak knowledge and skills of science teachers using educational technology for effective science teaching include: the poor use of personal computer, laptop for preparing notes and assignments, presentations and AV aids, science models, multimedia, Internet browsing, WhatsApp for sharing text and videos, word- processing (MS word) for writing, MS Excel for preparing class lists, results & mark sheets, science laboratory apparatus etc. No doubt, the Technological advancement is the commanding factor behind the present- day knowledge driven economies of the modern world. Both

advanced and developing countries are giving prime importance to equip and utilize the Educational Technologies in the form of information and communication technologies according to their resources to fulfil the educational demands of 21st century. Now the class room has become one of the most flourishing markets for new technology. Realizing the significance of the emerging technologies, the educational institutions are forced to stay competitive by providing technology enriched learning environment to the students.

The reluctance of science teachers of Islamabad Model Colleges for using ICT tools is evident by the non-conducive environment to utilize ICT tools .The science teachers don't involve themselves for making practice of using educational technology for the science teaching. This indicated their poor knowledge, optional use of ICT tools and non-provision of organized training programs by the institution or FDE for science teachers for their continuous professional development.

The findings of this study regarding the skill level of science teachers unfolded that the science teachers of Islamabad model colleges for boys and girls have poor skill levels of all the 4Cs.During classroom observation sessions, it was observed that the science teachers are not well versed with skill to enhance communication level of students by Group Work using ICT tools, answer question session, Student Teacher Interaction, to develop collaboration skill, Awareness of Weak and Strong Points of Students as a critical thinking skill, skill to use A-V aids, Presentation through Power Point, Word for Text Formatting as a creativity skill etc. This is evident by these findings of the study that we are still unable to prepare and motivate our students for the 21st century workplace.

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Overall

The science teachers of Islamabad Model Colleges for boys and girls don't have sufficient knowledge of national professional standard on ICT and Educational technology is not in regular practice of science teachers which is evident by their poor knowledge and usage of emerging educational technologies in teaching learning process, reluctance to incorporate the educational technology for making their lecture interesting and to boost up the level of 4 Cs among the students to prepare them for 21s century workplace.

5.6. Recommendations

This section comprises the recommendations in practical form for each of the four Objectives of this study one by one: Remedy for the improvement of poor Knowledge and Understanding of Science Teacher regarding use of educational technology for science teaching (first Objective):

1.   Allocation of appropriate funds for the establishment of technology enriched classrooms and laboratories to create conducive environment.

2.   Availability of ICT tools to exploit Concept of educational technology

3.   Easy accessibility of ICT tools for teachers and students in the institution as well as in the home

4.   Provision of subsidized ICT tools for the science teachers and students

5.   Effective role of NGOs in updating their classrooms and arranging seminars, webinars and workshops as training programs during summer vacations.

6.   Patronage of the school administration

The remedial steps necessary to meet the deficiencies of second objective of this Study are:

i.   Frequent and goals-focused Institutional training is vital to any teacher's Success for the professional development of the science teacher

ii. Regular practice of science teaching by Collaborative teaching learning method

iii. Compulsion from the Head of institution for the use of innovative ICT tools in science teaching learning process

iv. Inclusion of New ideas and interesting information in the lecture

v.   Encouragement and motivation of science teacher by the head of institution

vi   Appraise and develop the mechanism for the assessment of the performance of the Science teacher periodically regarding the efficacy of teaching learning process

The ways how to improve skill level of the science teacher also demands meaningful steps. Since the skill level comprises four different types of skills, generally called 4Cs (Communication, collaboration, critical thinking and creativity). Therefore, each skill requires different techniques for their improvements:

i.   Ways to improve Communication skill Resources.

   a. Easily available and open to everyone,

   b. Increase Precision in Demonstrations by the science teacher,

   c. Need for Light Speed Research, Teacher vigilance... that Students learn at their Speed,

   d. Making Learning Fun,

   e. Proper periodic Assessment of Students,

   f. Homework Assignments through Internet,

   g. Online grading Systems,

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h. Motivation for the use of Classroom Tablets,

i. Keeping students engaged by interesting videos of the related topics,

j. Help students with different learning styles and Prepare students with life skills.

ii. Ways to improve Collaboration skill:

   a. Submit assignments as blogs.

   b. Submit assignments as podcasts or videos,

   c. Work with a classroom on the other side of the world,

   d. Gamify skills like problem-solving,

   e. Create infographics to explain complicated topics,

   f. Record and playback reading and Interactive attendance

iii. Ways to improve Critical thinking skill:

   a. Use of Interactive activities in teaching learning process to stimulate student interest and improve academic achievement,

   b. Incorporation of Multiple representations and models to clarify complex scientific concepts and procedures and Teaching in Technology-rich environments foster self-regulated learning

iv. Ways to improve Creativity skill:

   a. Blogs for creative thinking,

   b. Cartoon and Comic Strip Tools,

   c. Mind-Mapping and Brainstorming tools,

   d. Infographics,

   e. Use of Video and Audio tools in teaching learning process,

   f. Incorporation of Digital tools to explain difficult scientific phenomenon

The recommendation regarding the remedial steps required for the improvement in the use of emerging technologies for the effective science teaching, the classroom of any educational institution must be well equipped with the following ICT tools: Augmented Reality, Virtual Reality, 3D Printing, Robotics., Adaptive Learning Algorithms, Asynchronous Learning, Micro learning, associated micro credentials), Live Streaming (school to school, school to expert, remote teaching and learning.

5.5. Future Researches

These areas can be explored for the future research:

1.   The study can be extended by making mandatory for the science teachers to take Web-based training courses, teleconferencing, blended (hybrid) training courses.

2.   This study was delimited to the Islamabad Model Colleges for Boys and Girls working under the ambit of Federal Directorate of Education, Islamabad. However, the same study can be done by taking all the secondary level public sector Federal Government educational institutions of Islamabad. The comparison of public sector and private sector educational institutions in terms of knowledge & understanding, disposition and skill level of using ICT tools for the science teaching learning process may be another aspect of this study. Similarly taking advantage of this study, the comparison of technology enriched classrooms and their efficacy at higher secondary as well as at university level can also be extended.

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APPENDICES

APPENDIX-A: QUESTIONAIRE FOR THE SCIENCE TEACHERS

Respected Sir/Madam

The aim of this questionnaire is "**To analyze the use of Educational Technology forScience Teaching in Pakistan**" in the light of National Professional Standard on ICT: "**Effective Communication and Proficient use of Information Communication Technologies**". This standard on ICT is one of the ten National Professional Standards being used as gadgets for the measurement of Quality of Education in Pakistan. The substantial objective of this study is to assess the three components of the National Professional Standard: Knowledge & Understanding, Disposition and Performance /Skills (4C'S) with regard to the use of Educational Technology by the Science Teacher for teaching learning process. In most of the questions, there are five choices. Please do tick (√) what you think the most appropriate according to your knowledge and experience. All the information collected will be kept confidential. The participation in this study is voluntary.

Mohammad Abid Khan, Ph D Scholar

Department of Education

Faculty of Social Sciences

International Islamic University Islamabad

Part-I: Personal Information

Name: (Optional):_____Name   of   Institution:

_____

Gender	Male	Female

Academic Qualification	MSc	MS/M.Phil	PhD
Professional Qualification	B.Ed	M.Ed	Others
Science Subject Taught	Physics	Chemistry	Biology

Teaching Experience (in years)	1-5	6-10	11-15	16-20	21- above

Part-II: Knowledge and Understanding:

Please read the statements carefully and tick (√) the most appropriate option.
Never=N (1), Rarely=R (2), Occasionally= O (3), Usually=U (4),   A=   Always (5)

"Knowledge and Understanding" of Science Teacher regarding the Use of Educational Technology in teaching learning process					
S. No	Statement	N(1)	R(2)	O(3)	U(4)	A(5)
1.	Lecture cum discussion method is made interesting using Multimedia					
2.	Science teachers make group discussion for difficult concepts and problems using WhatsApp					
3.	Video conferencing is used for a debate during the teaching of science (debating).					
4.	ICT tools are utilized for brainstorming of Science Students					
5.	Project based learning in small groups is made effective for science students using ICT tools					
6.	Science Teachers give demonstrations about scientific phenomena with the help of models in the laboratory					
7.	Science Teachers use direct method by writing notes on blackboard or transparency to explain Science concepts					
8.	Students' ideas are taken in to consideration by the Science Teacher through observation using electronic devices.					
9.	Teacher facilitates discussion about difficult concepts using videos					
10.	Hands on activities is effective than lectures to teach scientific concepts.					

11.	Science teachers can share notes ofscience subjects with their studentsthrough google drive					
12.	MS Word is helpful for framing oflecture/quizzes					
13.	Utilization of YouTube is best for visualpresentations of difficult topics of Science					

Part- III: Disposition

Strongly Disagree (SDA)...1, Disagree (DA) ....2, Undecided (UD)....3
    Agree (A)......................4, Strongly Agree (SA). 5

"Disposition" of Science Teacher regarding the use of EducationalTechnologies in Teaching Learning process.

S. No	Statement	SDA(1)	DA(2)	UD(3)	A(4)	SA(5)
1.	ICT tools have changed the methodology of science teacher as a facilitator in modern classroom					
2.	ICT tools have made lectures more interesting, easier and timesaving for teaching Science					
3.	MS Power Point is an effectivepresentation tool for science teachers to give the students a clear concept of science topics					
4.	Overhead projector creates conducive learning environment allowing the view of small document to be shared with a large group of science students					
5.	Multimedia as a combination of texts, audios, videos, graphics and animation is a powerful source ofbrainstorming					
6.	I feel easy by using videos in laboratory for demonstration ofdifferent experiments					
7.	Being a Science teacher, I take interactive white board as a valuable instructional tool forclear understanding of Scientific phenomena					
8.	Zoom App is an effective interaction source to improve students' motivation for learning Science topics					
9.	Google Classroom is essential toprepare Science students to live and work in 21st century					
10.	ICT tools have improved learners' autonomy in learningScience					

Part-IV: Skill level (4Cs: Communication, Collaboration, Critical thinking and Creativity)

"Skill level" of science teachers in using Educational Technologies with referenceto 4Cs (Communication, Collaboration, Critical thinking and Creativity).

I. Communication Skills

S. No	Statement	SDA(1)	DA(2)	UD(3)	A(4)	SA(5)
1.	I can effectively deliver my lecture in the class by using ICT tools.					
2.	I usually take lead in group discussions with my colleagues by utilization of ICT.					
3.	There is flow and clarity in mywritten notes and assignments when I use ICT					
4.	I can express my ideas effectively by using models and pictures					
5.	ICT tools help me to judge the emotions of my students duringthe lecture					

ii.Collaboration Skills

S. No	Statement	SDA(1)	DA(2)	UD(3)	A(4)	SA(5)
1.	ICT is helpful for me to improve working relationship among the group members of the team					
2.	I gain more knowledge while working in group in an ICT basedenvironment					
3.	I use ICTs to enhance the teamspirit among students					
4.	Each group member does share his fair effort to complete the taskin time with the help of ICT					
5.	ICT makes Peer group working aflexible and effective source of learning for the students					

iii.Critical Thinking Skills

S. No	Statement	SDA(1)	DA(2)	UD(3)	A(4)	SA(5)
1.	The students become aware oftheir weak and strong points during their lesson in an ICT based environment					
2.	Utilizing ICT tools, the learner gets opportunity to test the diversity of opinions during hisclass without any fear.					
3.	The student becomes able to pinpoint his mistakes by the useof ICT during teaching learning process.					
4.	The utilization of ICT tools creates challenging approach towards learning target.					

5.	By the utilization of ICTs, the students can get the reason behindthe idea very easily.					

iv.Creativity Skills

S. No	Statement	SDA(1)	DA(2)	UD(3)	A(4)	SA(5)
1.	ICT tools support me to generatenew ideas by combining them with existing ideas					
2.	My interpretation skills haveenhanced by using ICT					
3.	ICT transforms my invisible images in real mental images					
4.	ICTs motivate me for implementation of ideas forchange					
5.	I can take risk to bring a change for the improvement of students'learning by using ICT tools					

Part V: Current Trends of using educational technologies

Strongly Disagree (SDA)…1, Disagree (DA) ....2, Undecided (UD)….3
Agree (A).....................4, Strongly Agree (SA). 5

S. No	Statement	SDA(1)	DA(2)	UD(3)	A(4)	SA(5)
	"Current trends and practices" of using Educational Technologies in Science Teaching Learning process.					
1.	Social learning technologies arethe potent source of Communication between Students and Science teacher					
2.	Lectures in film format are a fun and productive way of facilitatingthe students for better understanding of science concepts					
3.	Zoom app enable the Science teacher to secure his remote workand to get easy access to the maincenter					
4.	Google class room is the most popular and influential media for conveying actual Scientific Phenomena					
5.	Emerging and Mass Notification System (EMNS) is a best platform for communication of a single lecture of a science teacherto a large number of students					
6.	Cloud based learning technologies increase the performance and achievement of the Science Students					

APPENDIX-B: SCIENCE STUDENT'S SURVEY

Name: (Optional)..............................Class......................

Gender: Male/Female

Note: Please tick only one option

Disagree (DA) – 1   Neutral (N) – 2,   Agree (A) - 3

Attitude of Science Students regarding the use of Educational Technologies				
S. No	Statement	DA (1)	N (2)	A (3)
1.	It is easier for me to take notes and organize theclass assignments using my personal computer			
2.	Hands on activities make my science topics easyand understandable.			
3.	Videos of the related topics are effective source of increasing my motivation for learning Scienceconcepts.			
4.	Demonstration by Electronic devices require toomuch time to plan learning activities			
5.	Science Students can benefit more for theirstudies by using WhatsApp			
6.	Posters and videos shown for the explanation ofscience topics are liked by the Science students			
7.	Science Students are more engaged and feel lessdisturbing in the presence of ICT based environment			
8.	The use of Power Point presentation is veryhelpful for the students to perceive their concepts of science subjects			
9.	The use of Multimedia provides us clear demonstration of science experiment prior to itsactual execution			
10.	Our motivation for learning has increased due tothe use of Overhead projector by the Science teacher for demonstration			

APPENDIX-C: INTERVIEW FROM THE HEADS OF INSTITUTION

Name of Head of institution..

Name of institution..

Date..

Q#1. What are the ICT resources available for science teaching in your institution?

S. No	ICT tools	Yes/No
1	Computer to prepare notes and assignments for teachers	
2	Internet Access to science teachers in the institution	
3	Computer to prepare notes and assignments for teachers	
4	Mobile phones provided officially	
5	Multimedia for teaching science physics, chemistry andbiology)	
6	Laptop for developing lesson plans in the institution	
7	Video conferencing systems	
8	Digital cameras to capture useful videos	
9	Printers	
10	Digital cameras to capture useful videos	

Q#2. How are the ICT resources being utilized by the science teachers in your institution?

       a)   Separate Department wise or
       b)   In one computer lab for all departments.

Q#3. What is your opinion about Science Teachers of your institution regarding their

      Knowledge and understanding of ICT tools in teaching learning process?

_____

_____

_____

_____

Q#4. Are the Science Teachers reluctant to use Educational Technology in teaching learning process?   Yes / No

Q#5. Is it a mandatory practice for all the Science Teachers to use ICT tools in teaching learning Process in your institution?   Yes / No

Q#6. Is there a conducive environment at your institution for the Science Teachers to materialize the concept of 4Cs (Communication, Collaboration, Critical thinking and Creativity) in Teaching learning process?   Yes / No

Q#7. What are the major challenges in the use of ICTs for Science teaching in your institution?

      i. Availability of ICT tools for teaching Science? Yes / No

      ii. Unwillingness of Science Teachers in using ICT tools? Yes / No

      iii. Untrained Science Teachers? Yes / No

      iv. Lack of interest of Science Students in the ICT supported environment Yes /No

Q#8. Is there any regular scheduled training programs for the Science Teachers toenhance their Professional competency regarding the use of ICT tools?

      i. By the institution Yes / No

      ii By the Federal Directorate of Education Yes / No

      iii) By the Ministry of Federal Education and Professional Training. Yes / No

Q#9. Any other comments from the Head of institution regarding the use of Educational Technologies for Science Teaching.

_____

_____

_____

_____

_____

Signature: _____

APPENDIX-D: CLASSROOM OBSERVATION FORM

Name of the Institution: ....

Name of Science Teacher: ....

Class: ....Subject Taught: ....

Date: .... No. of students in the class: ....

1. Availability of ICT tools in the classroom

S. No	Construct	Availability		
		Available	Less Available	Not Available
1.	Computer			
2.	Multimedia			
3.	Internet			
4.	Laptop			
5.	Mobile phone			
6.	Projector			
7.	Scanner			
8.	Videos			
9.	Printer			
10.	Digital Cameras			

ii. **Usability (Knowledge and understanding)** of using ICT tools for science teaching

S. No	Construct	Usability		
		Properly Used	Less Used	Not Used
1.	Computer			
2.	Multimedia			
3.	Printer			
4.	Internet			
5.	A-V Aids			
6.	Laptop			
7.	Projector			
8.	Scanner			
9.	Digital camera			

iii. **Disposition** of Science Teacher towards ICTs during teaching learningprocess DA......Disagree N..... Neutral A... Agree

S, No	Statement	DA	N	A

1.	Science Teacher feels comfortable by using ICTtools in teaching learning process			
2.	Science Teacher tries to increase student motivation for science learning using ICT tools			
3.	Science Teacher can reflect on its own behavior and practice to improve teaching skills with thehelp of ICT tools			
4.	Science Teacher uses MS Excel to solve Complex mathematical calculation of science			
5.	Science Teacher behaves as a facilitator in technology enriched class room			

iv. Skill level (4Cs) of Science Teacher

S.No	Statement	Low	Medium	High
	I. Communication			
1.	Usage of Models and pictures.			
2.	Usage A-V aids			
3.	Answer Questions session during Class			
	ii.Collaboration			
4.	Peer group involvement in activities			
5.	Group work in using ICTs			
6.	Student teacher interaction			
	iii.Critical Thinking			
7.	awareness of weak and strong points ofstudents			
8.	Usage of new strategies and methods			
	iv.Creativity			
9.	presentation through Power Point			
10.	MS word for text formatting			

v. Instructional Technology

S, No	Statement	Constantly	Occasionally	Never
i.	Usage of modern technology in the Class room			
ii.	Motivation of science students using Multimedia			
iii.	Understanding of Science teaching methodology in technology enriched Environment			
iv.	Teaching by deductive reasoning Way			
v.	Engage Science Students in hand on Activities			
vi.	Activities through problem-based Learning			