A study on use of Information and Communication Technology (ICT) in Teaching of Mathematics in the Secondary Schools of Vadodara city

A

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DECLARATION

I, Tarang Pathak hereby declare that the Dissertation study titled **"A Study on Use of Information and Communication Technology (ICT) in Teaching of Mathematics in the Secondary Schools of Vadodara City"**; is my original research work and no whole or partial part in the dissertation has been taken from anywhere. Wherever contributions of others are involved, every effort is made to indicate this clearly with due reference to the literature, acknowledgement of collaborative research and discussions. The work was done under the guidance of Prof. Satish Pathak.

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CERTIFICATE

It is certified that, the dissertation entitled, **"A Study on Use of Information and Communication Technology (ICT) in Teaching of Mathematics in the Secondary Schools of Vadodara City"**, which is being submitted by **Mr. Tarang Pathak** for the degree of Master of Education through the Department of Education, Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, is carried out by him under my supervision and guidance. He has completed the thesis with best of his capacities. I certify that this is his original work and find it fit for the submission and evaluation.

Vadodara
April, 2020

(Prof. Satish P. Pathak)
Guiding Teacher

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(Tarang Pathak)

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ABBREVIATIONS

CD	Compact Disc
DVD	Digital Video Disc
E-mail	Electronic Mail
FGD	Focus Group Discussion
GHSEB	Gujarat Higher Secondary Education Board
ICT	Information, Communication and Technology
NAS	National Achievement Survey
NCERT	National Council of Education, Research and Training
NCF	National Curriculum Framework
NCFSE	National Curriculum for School Education
NPE	National Policy on Education
OCM	Organisation of Commerce and Management
OECD	Organisation for Economic Co-operation Development
OHP	Overhead Projectors
PC	Personal Computer
PISA	Programme for International Student Achievement
RMSA	Rashtriya Madhyamik Shiksha Abhiyaan
SSA	Samagra Shiksha Abhiyaan
SWOT	Strengths, Weaknesses, Opportunities and Threats
TV	Television
UNESCO	United Nations Educational, Scientific and Cultural Organisation

CHAPTER 1

CONCEPTUAL FRAMEWORK

CHAPTER - I

CONCEPTUAL FRAMEWORK

1.0 INTRODUCTION

Education is an important instrument for change in developing and developed countries. It provides a better quality of life for any citizen for their living environment. According to United Nations Educational Scientific and Cultural Organisation (UNESCO, 2003), Information and Communication Technology (ICT) is viewed as a "major tool for building knowledge societies". At the school education level, it could be a mechanism that could provide a way to rethink and redesign the educational systems and processes, thus leading to quality education for all. ICT has changed the modalities of the ways in which education can be accessed and imparted. Over the last two decades, its exponential growth in the educational sector – ranging from schools to higher education is simply evident (Tata Trust and IT for Change, 2018). As a result, the teaching-learning process has undergone a paradigm shift. The manifestation of this shift is clearly visible in the way students have adopted the ICT to suit their learning styles; however, with majority of teachers this shift seems to be happening at a much slower rate.

While these changes demand teachers and learners to undergo a transformation, the curriculum too does not remain isolated from being affected. Practically, the fundamental subjects such as Mathematics, Science and English have a tradition of strong dominance over other subjects in the secondary schools. Both, Kothari Commission (1964-66) and National Policy on Education (NPE–1986) stressed on the crucial need of Mathematics and Science in secondary education. It further suggested that "Mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically. Apart from being a specific subject it should be treated as a concomitant to any subject involving analysis and reasoning." ICT and Mathematics both, being so integral to the students' lives, it becomes imperative that their integration in the context of how ICT supplements the teaching and learning of Mathematics should be studied.

This integration is extremely important at secondary level because at this level concepts of Algebra, Geometry and Trigonometry involve abstraction, structuration and generalization. (National Curriculum Framework, NCF 2005).Since with the help of ICT students can be provided more visual impetus, repetition and self-paced learning, they canappreciate Mathematics as a discipline and develop sound understanding of the concepts and applications.

1.1 CONCEPT OF ICT

While definitions of ICT are varied, it is logical to refer to the general definition first and then in the context of education:
UNESCO defines ICT as "forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means."

This definition leads to visualising the functions of ICT for creation, processing, storage, display, transmission and exchange of the information. Table 1.1 showsa snapshot of some of the tools which facilitate the integration of ICT.

Table1.1 Functions of ICT and related tools

Functions	Tools
Creation	Personal Computers, Digital camera, Scanner, Smartphone
Processing	Calculator, Personal Computer (PC), Smartphone
Storage	Compact Disc (CD), Digital Video Disk (DVD), Hard Drive, Universal Serial Bus (USB) Drive, Cloud Storage
Display	Television, Projector, Smartphone
Transmission	Internet, Video conferencing, Mobile technology, Radio
Exchange	Electronic-mail (E-mail), Blogs, Forums

According to the National Policy on ICT in School Education (2012), ICT is defined as: "a set of devices, tools, content, resources, forums, and services, digital and those that can be converted into or delivered through digital forms, which can be deployed for realising the goals of teaching and learning, enhancing access of resources, building of capacities, as well as management of the educational system."

This is a very comprehensive definition of ICT which encompasses not only the pedagogical use of ICT but also its role in capacity building (of students and teachers) and the management of education system. Further it needs to be understood that ICT need not be perceived as limited to the hardware devices connected to computers and software applications. Rather, it also includes the interactive digital content, internet and other satellite communication devices, radio and television services, web-based content repositories, interactive forums, learning management systems, and management information systems.

1.2 IMPORTANCE OF ICT IN EDUCATION

According to Chhabra (2014), "use of ICTs can catalyze the paradigmatic shift in both content and pedagogy that is at the heart of education reform in the 21st century." The efficacy of the ICT in education lies in the way it is integrated in the teaching-learning process. ICT can promote the acquisition of the knowledge and skills that will empower students for lifelong learning. The importance of ICT as mentioned in some of the policy documents is stated below:

"Modern communication technologies have the potential to bypass several stages and sequences in the process of development encountered in earlier decades. Both the constraints of time and distance at once become manageable. Modern educational technology must reach out to the most distant areas and the most deprived sections of beneficiaries simultaneously with the areas of comparative affluence and ready availability." (NPE, 1986)

"The judicious use of technology can increase the reach of educational programmes, facilitate management of the system, as well as help address specific learning needs and requirements. Possibilities of teaching and learning at varied paces, self-learning, dual modes of study, etc. could all benefit from the use of technology." (National Curriculum Framework, 2005)

"ICT should be made more accessible to teachers, students and administration for learning, training, research, management and monitoring." It also recognized that to enable equitable and universal access to knowledge resources, libraries should be encouraged to create more digital resources by digitizing relevant reading material in

different languages, which can be shared at all levels. (National Knowledge Commission, 2009)

“ICT offers engaging and fast-evolving learning environments, blurs the boundaries between formal and informal education and prompts teachers to develop new ways of teaching and enabling students to learn. Ultimately, it requires education to re-think what skills and competencies students need to become active citizens and members of the workforce in a knowledge society.” (UNESCO – ICT Competency Framework for Teachers, 2011)

The National Policy on ICT in School Education (2012) stressed on the wider participation of all sections of society in strengthening the school education process through appropriate utilisation of ICT. While it identified ICT as an omnibus support system for school education, it also stressed on the fact that “using computers and the Internet as mere information delivery devices grossly underutilizes its power and capabilities. “There is an urgent need to develop and deploy a large variety of applications, software tools, media and interactive devices in order to promote creative, aesthetic, analytical and problem-solving abilities and sensitivities in students and teachers”. (National Policy on ICT in School Education, 2012)

“There is no question that the power of ICT needs to be harnessed to aid the cause of teaching and learning in the field of education.” (NPE Draft, 2016) While it realized the power of ICT, it also admitted the fact that, its impact on improving the quality in India has not been significantly noticeable.” Subsequently, it provided insightful recommendations about how ICT can be

- an aid to the teacher in the classroom
- an aid in remedial education
- used in training of teachers

Through the importance laid by various policies and commissions, it is evident how significant the ICT integration in education is. ICT has huge potential in extending the learning of students and it is up to the competency and capacity of the teachers as to how far they use it to supplement their teaching. The spirit of these policies has been, to support constructivist classroom pedagogies; make learning connected to local contexts, responsive to learners’ needs, and make the school culture democratic and

participatory. From experience, it is perceived that the students and teachers are using ICT to a large extent in a non-formal mode; however, this is happening in an isolated manner on individual basis. A conscious endeavour of utilising ICT more effectively in schools can benefit the larger cohort – especially in subjects like Mathematics which are generally labeled as the most ‘‘*feared*’, ‘*hated*’ and ‘*theoretical in nature’*.

1.3 NATURE AND CHARACTERISTICS OF MATHEMATICS

According to the National Council of Educational Research and Training (NCERT, 2010) Mathematics is described as the science of pattern and order. It is a discipline of reasoning as it relies on logic rather than observation. Mathematics is hierarchical in nature as its knowledge is developed through a sequential mode from the basic to intermediate to more advance level. **Figure 1.1 shows** the characteristics of Mathematics which help us visualize its hidden nature:

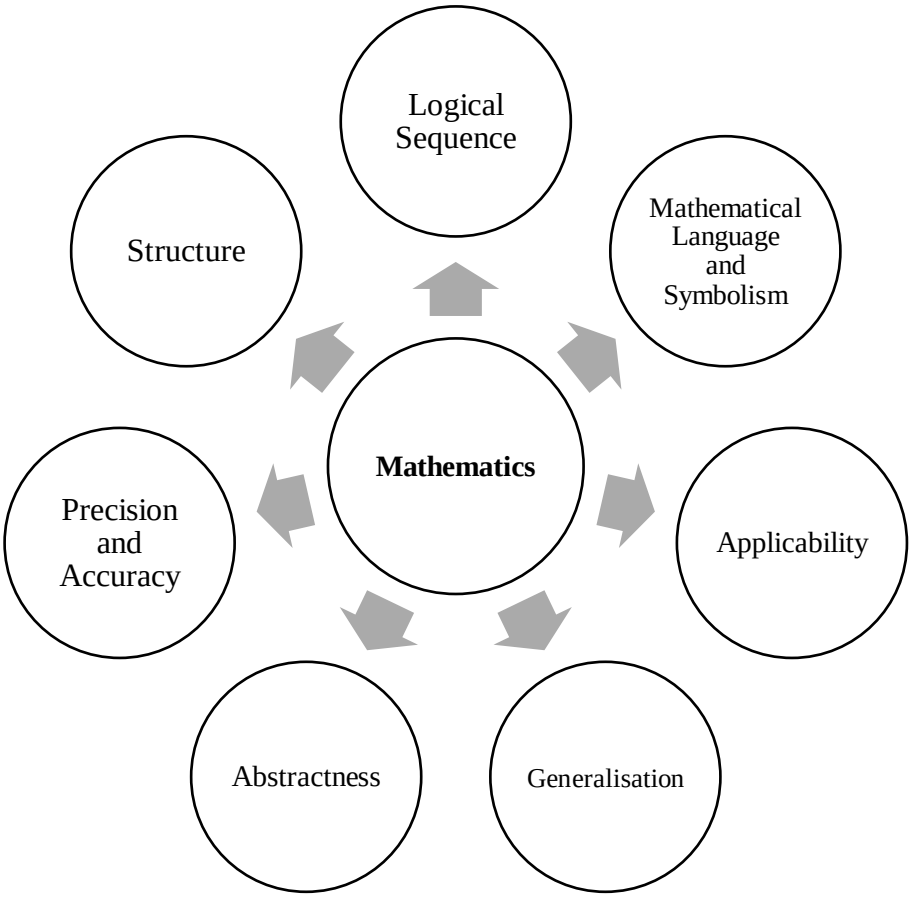


Figure 1.1 Characteristics of Mathematics
Source: Rathnabai (2014)

The nature of Mathematics revealed by these characteristics generally is not perceived in a direct manner. Rather they are manifested through the various topics and concepts included in the Mathematics curriculum at different levels of schooling. A conscious awareness of these characteristics and a deliberate effort to showcase them can enrich the pedagogy of teachers and thereby provide students to perceive and appreciate the beauty of Mathematics.

1.4 SIGNIFICANCE OF MATHEMATICS AT SECONDARY LEVEL

Mathematics is a compulsory subject at classes IX and X which constitute the secondary stage of school education. According to the Rashtriya Madhyamik Shiksha Abhiyaan (RMSA, 2009), which is now subsumed in to Samgra Shiksha Abhiyaan (An Integrated Scheme for School Education, 2018), Secondary Education is a crucial stage in the educational hierarchy as it helps students to fundamental Mathematical competencies required for day-to-day functioning and also prepares students for higher education. The curriculum aims derived from the report of RMSA (2009) for the Secondary School Mathematics are:

(i) To develop the ability to conceptualise, inquire, reason and communicate mathematically, and to use Mathematics to formulate and solve problems in daily life as well in Mathematical contexts.
(ii) To develop the ability to manipulate numbers, symbols and other Mathematical objects.
(iii) To develop the symbol sense, spatial sense and a sense of measurement as well as the capability in appreciating structures and patterns.
(iv) To develop a positive attitude towards Mathematics and the capability in appreciating the aesthetic nature and cultural aspect of Mathematics.

An insightful thinking and observation can lead to visualise how the characteristics of Mathematics mentioned in the **Figure 1.1** are adeptly embedded in to the aims of Secondary School Mathematics.

1.5 CURRICULAR FEATURES OF MATHEMATICS

Mathematics curriculum for secondary schools is the means to achieve the above mentioned aims and therefore it becomes necessary to study its features. According to National Curriculum Framework for School Education (NCFSE, 2000), at secondary stage:

- Mathematical terminology is highly stylized and rigorous.
- Students need to integrate various problem-solving techniques of Mathematics involving more than one content area e.g. algebra and trigonometry or geometry and mensuration, etc.
- Mathematical modeling, data analysis and interpretation require high level of logical and analytical skills along with a reasonable level of literacy.
- Students need to visualise, comprehend and solve multi-dimensional mathematical problems generally on a 2-dimensional plane i.e. on a black/white board or in a notebook.

In order to meet these Mathematics curricular requirements, students at secondary level: are expected to get accustomed to a variety of new symbols and terminology, required to think in abstract terms, extend their imagination, and solve problems that involve integrating the knowledge of two or more content areas simultaneously. These expectations are challenging for some students and as a result creates gap in their understanding.

1.6 GAPS IN UNDERSTANDING MATHEMATICS

The gaps however are not solely due to the students' inability to understand the mathematical concepts; there are other factors also that pose challenges to the learning of Mathematics. In a study on "Learning problems and their causes in Mathematics", conducted by Ali (2016), the factors were broadly categorized into: Student related and Teacher related factors.

1.6.1 Student related Factors

- Lack of prior knowledge of basic arithmetic operations, prove to negatively reinforce the learning of mathematics.
- Mathematics anxiety which refers to the perceived fear of mathematics as a hard subject creates a psychological complex in students' brain. This hinders the thinking processes required for mathematics, and subsequently shifts their interest away.
- According to a study conducted by Acharya (2007) many students experience difficulty with word problems. For some, the problem lies with an inability to read and comprehend the problem. Others have trouble distinguishing relevant from non-relevant information, whereas some cannot translate the words into mathematical operations.

1.6.2 Teacher related Factors

- Pedagogical expertise along with 'Content' expertise helps students to comprehend Mathematical concepts more effectively. Lack of either of them negatively impacts the learning of Mathematics.
- Teacher's attitude, behavior, practices and personality have huge impact on the readiness and interest to learn Mathematics.
- For example, if the teacher is not perceived as approachable by the students and they are afraid of seeking assistance when experienced with difficulties, this may lead to further gaps in the understanding of Mathematics. This eventually has a snow-ball effect leading to the avoidance of Mathematics.

Despite Mathematics being accepted universally as one of the most important subjects, a large proportion of secondary students seem to suffer from Mathematics anxiety and struggle solving mathematical problems. Considerable research work is being carried out to address this issue and ICT by many educationists is seen as a ray of hope for strengthening the teaching–learning process of Mathematics.

1.7 SCOPE OF USING ICT IN TEACHING MATHEMATICS

Barve and Barve (2012) put emphasis on the fact that ICT significantly contributes in developing the higher order skills of critical thinking, analysis, and scientific inquiry which are essentially the focus of Mathematics learning at secondary level. Hollebrands et.al. (2011) stressed that strategic use of technology strengthens mathematics teaching and learning. Sivakova, Kochoska, Ristevska, & Gramatkovski (2017) found that students who used multimedia computer software showed less math anxiety and retained Mathematics skills longer." Hollebrands et.al. (2011) classified ICT into "Conveyance Technologies" and "Mathematical Action Technologies". The Conveyance technology is being used across different subject areas catering to various functions such as: Presentation, Communication, Sharing, Collaboration, Monitoring and Assessment. The latter is deliberately used to enhance the teaching and learning of Mathematics.

Teachers of Mathematics pointed out ways in which use of ICT could expedite and – more broadly – facilitate the more routine components of classroom activity, increasing the productivity of pupils and improving the quality of work they produced, allowing them to be carried out more quickly and reliably, with greater ease, and to higher quality. The Table 1.2describes the scope of ICT for the teaching–learning of Mathematics:

Table 1.2 Scope of ICT in Mathematics

Scope of ICT for….	Example in relation with Mathematics
Improving the effectiveness of working process	Spreadsheets enable to handle data, because they can quickly get tables and produce charts faster. It is time saving and keeps the pace going.
Supporting process of checking, trailing and refinement	Pre-Programmed Mathematical Software have the potential to make the Mathematics class more interactive and support strategies of problem solving through 'trial and improvement' in which conjectured – often estimated – solutions can be repeatedly tested and modified accordingly until acceptable. Approaches of this type can be viewed as valuable both for introducing new ideas in an investigative way, and for reinforcing them as part of a revision programme.
Enhancing the variety and appeal of classroom activity	Once the skill and knowledge of drawing graphs using pen-paper is developed, integrating technology to discover different types of graphs can motivate students and develop curiosity to explore further understanding of the topic.
Focusing on overarching issues and accentuating important features	ICT can automate subsidiary tasks – typically those involving routine data handling, calculating and graphing – freeing users to give their attention to more overarching matters. For e.g. Drawing various curves and showing them what happens when you start altering the equation helps to make a conjecture and visualise the process of generalisation.

1.8 ADVANTAGES OF ICT FOR TEACHING MATHEMATICS

ICT provides dynamic opportunities for instruction in Mathematics classrooms. The learning process can be enhanced by making the concepts come alive through engaging and interactive media. Additional support to address the needs of all learners and create customized learning experiences is also possible because of technology.

The National Curriculum (UK, 2010) for mathematics says: “Pupils should be taught the knowledge, skills and understanding through choosing appropriate ICT tools and using these to solve numerical and graphical problems, to represent and manipulate geometrical configurations and to present and analyse data.”Nayak (2012) found that the move from traditional paper-based mathematical notations to on-screen notations (including algebraic symbols, graphs, tables, and geometric figures) had a dramatic effect on the perception of students’ learning. In comparison to the use of paper and pencil which supports only static and isolated notations, use of ICT allows for “dynamic, linked notations” with several helpful advantages. Here are some important ways that students and teachers can benefit when ICT is incorporated:

- Multimedia brings learning to life. The videos, animations, interesting movies and other media into the learning process help students develop skills and understandings.
- ICT provides additional opportunities for learners to see and interact with mathematical concepts. Students can explore and make discoveries with games, simulations and digital tools.
- Increased access to ICT allows for more customized learning experiences. Because no two learners are exactly alike, ICT can provide individual students with content and supports that are particularly helpful to their individual needs. Students can view lessons, tutorials, screen-casts, and other instructional media on their own device and at their own pace.
- Through ICT students can also interact with people outside of the classroom to help broaden their understandings and perspectives about what they are studying.
- With countless online resources, ICT can help teachers to enhance the traditional ways of teaching and to keep students more engaged. Virtual lesson plans, grading software and online assessments can help teachers save a lot time. This valuable time can be used for working with students who are struggling.
- Teachers can incorporate differentiation and allow students to learn on their own pace while catering to the needs of the students who need to be academically challenged.

Sivakova, Kochoska, Ristevskaand Gramatkovski(2017) identified the three significant areas of Mathematics at secondary level and suggested how ICT integration supports the students’ learning.

- For Algebra, the use of graphing packages links the formula, tables of numbers and graphs readily speeding up the graphing process. This can encourage children to observe patterns, make connections and help justify of generalisations.
- For Geometry, integration of ICT enables children to manipulate diagrams dynamically. This encourages them to predict the results and to visualise the geometry as they generate their own mental images.
- For Statistics and Probability, statistical packages enable children to work with real data which can be represented in a variety of ways. This assists in interpretation and analysis.

Through the scope and advantages discussed above, it is evident how ICT can make the teaching-learning of Mathematics more effective. There has been significant researches done in this area by various researchers across India and in abroad and therefore reviewing those studies can help the researcher to strengthen the current study. In the present study, the researcher has made an attempt to study the extent to which the ICT is being used in the teaching of Mathematics in the Secondary schools of Vadodara city.

1.9 RATIONALE OF THE STUDY

ICT in the present time has become an integral part of our living and therefore even a slightest thought of exclusion of ICT throws us thousands of years back in the past. Along with the multitude of benefits that technology has to offer, the rapidly increasing pace at which it is evolving throws challenges to the traditional habits – particularly to the process of teaching and learning. More so these habits have even a greater hold on the fundamental subject like Mathematics.

An assessment of Mathematics, Science and Reading for 15-year-old students from all over the world is carried out every three years by The Programme for International Student Assessment (PISA), an initiative of the Organisation for Economic Co-operation and Development (OECD). In the year 2015, students from 70 nations participated in a scholastic performance test on Mathematics, Science and Reading. The findings revealed that students of 39 nations scored below global mean score in Mathematics. It means that more than 50percent of the secondary students worldwide have difficulty in comprehending Mathematical concepts. The same trend continues on the local front also.

The Table 1.3 shows Comparison of the average achievement of X^{th} grade students of Gujarat with that of national average in Mathematics, as determined by the National Achievement Survey (NAS) conducted by the NCERT in the year 2018.

Table 1.3

Average achievement of X^{th} Grade students of Gujarat under NAS

Subject	Content Domain	State Average (Percent correct)	National Average (Percent Correct)	Significant difference
Mathematics	Mathematics (overall)	32	34	⬇
	Algebra	32	35	⬇
	Geometry	33	35	⬇
	Mensuration	33	34	⬇
	Trigonometry	31	37	⬇
	Coordinate Geometry	27	29	⬇
	Number System	27	30	⬇
	Statistics	31	33	⬇
	Probability	36	35	⬆

Source: NCERT (2018)

It can be seen from the Table 1.3 that, average achievement of the students of Gujarat found less than the National average in all content domains, except one. Further the data reveals that, 75 percent of the students of Gujarat scored below 35percent in the NAS test. Only 32percent of the students could recognize or recall the required Mathematical concepts, 33percent could interpret the information represented in the graphical form and 30percent carried out the procedure required to solve the Mathematical problem. These alarming statistics highlights the need for the intervention and implies that the Mathematics education at the Secondary school level requires serious attention.

A study was conducted to identify the supporting and hindering school level factors for the use of ICT in secondary school mathematics lessons in the context of PISA (2012) on the top five countries from which students outperformed in Mathematics. (Eickelmann, Gerick and Koop, 2017) The relationship between the ICT and performance of students in Mathematics was examined with the factors: (i) the IT equipment of schools, (ii) teacher's attitude toward the use of ICT, (iii) school leadership and (iv) aspects of school goals and educational strategies. The findings revealed that the teachers' attitude towards using the ICT in Mathematics teaching had a significant influence on the achievement of the students.

With this perspective, the researcher was inspired to discover what the ground reality is. Over the three decades, i.e. since the NPE 1986, the Government has been emphasizing the importance of ICT in the teaching–learning process. If it has been doing the needful in terms of infrastructural development through its *Digital India* initiatives like: 'ePathshala', 'National Mission on Education Using ICT', 'Online Labs (Olabs)', 'Shaala Darpan', 'Shala Siddhi'; then, what are some of the factors which are proving to be a hindrance to the progress of students?

In order to study the efficacy of the ICT in secondary schools, the research would like to begin with identifying how well-equipped the schools are with the ICT resources and what is the working condition of those gadgets. The researcher would further like to study the extent to which the teachers are using ICT in the teaching of Mathematics by considering the parameters like frequency of ICT used in Mathematics teaching and finally the teacher's technical knowledge and readiness for using the ICT.

1.10 CONCLUSION

The conceptual framework related to *'Concept of ICT', 'Importance of ICT in Education', "Advantages of ICT'* and *'Scope of using ICT in teaching of Mathematics'* has been described under this chapter. Based on the developed conceptual framework, rationale of the study has been strengthened logically to establish significance of the study. Further the review of the related literature has been described in the next chapter.

CHAPTER 2

REVIEW OF RELATED LITERATURE

CHAPTER - II

REVIEW OF RELATED LITERATURE

2.0 INTRODUCTION

The present chapter includes a review of previous researches related to the present study. Researcher has taken an attempt carefully to review the research journals, books, dissertations, thesis and other sources of information related to the objectives of the study. Through reviewing related literature, the researcher came to know about the recommendations of the previous researches. Researcher takes an advantage of the knowledge, which has been already accumulated from the constant human endeavor in the form of past researches. Review of the related literature allows the researcher to be acquainted with the current knowledge in the area of the present research. The review of related literature updates the researcher through providing background for understanding latest knowledge on the topic under research. Through the review of previous studies, one can have a clear perspective of the process. By reviewing the related literature, the researcher can avoid the selection of the problem areas which have already been selected earlier. Review of related literature enables the researcher to define the limits of his research study. It helps researcher to delimit and define the problem properly. It helps the investigator with the new understanding and insight which subsequently helps him in proper planning of the study, adopting the suitable methodology, developing tools for the data collection and adopting proper techniques for analysis and interpretation of the data. The review or related literature gives the researcher an understanding of the research methodology which refers to the way the study has to be conducted.

2.1 REVIEW OF RELATED LITERATURE

Review of related literature is an essential prerequisite to actual planning and execution of any research project. Further through the reviews, the researcher can understand that the study being undertaken does not exist in vacuum and that considerable work on similar type of studies has been done. These reviews can guide the researcher to enhance his study by contemplating on what further developments the investigator should focus on.

Keeping in mind all above, the investigator has reviewed related studies conducted in the field of ICT integration in schools. The reviews are classified broadly into two categories namely; (i) Studies conducted in India and (ii) Studies conducted in abroad.

2.1.1. Review of the Studies Conducted in India

Thillakaand (2000) conducted and experimented quantitative method to examine the influence of computer-based multimedia programme on achievement in Mathematics among high school students and to find out the difference in achievement in Mathematics between high achievers and low achievers from both relative retention of learning in Mathematics. A Sample of 62 was collected from IX Class students. It was observed from the results that (1) there was a significant influence of computer-based multimedia programme on the achievement in Mathematics among high school students. (2) There was significant change in their attitude towards mathematics after learning trigonometry through computer-based multimedia and text-based self-study material. (3) There was significant difference in achievement of mathematics between high achievers and low achievers for both experimental and control groups.

Rajakumaran et.al (2010) examined a study to assess the "Role of ICT in teaching and learning Mathematics". It was found that ICT enable the students to manipulate diagrams dynamically and it encouraged them to visualize the geometry as they generate their own mental images. It is also enhanced opportunity for students to be introduced to interesting problems and associated mathematical subject matter much earlier than before possible.

Barve and Barve (2012) conducted a study on "The role of technology in Teaching–Learning Mathematics". It was conducted in the Nasik City and the objective was to develop and implement a training program module which assisted Mathematics teachers of secondary schools in empowering them to integrate technology effectively. Forty Mathematics teachers of secondary schools participated in this study. The findings of the study were that teachers developed clarity about the integration and purpose of ICT in Mathematics felt confident about using ICT in Science also – which majority of the participated were teaching.

Narasimha (2012) examined the status of ICT utilization in Secondary Schools of North Coastal Districts in Andhra Pradesh. The three main objectives of the study

were: (i) to identify the status of usage of ICT by the secondary school teachers,(ii) identify enablers and obstacles of full integration of ICT in the field of education and (iii) inform the policy makers the views of teachers on current ICT policy and its influence on their teaching style. A stratified random sampling technique was employed and the sample comprising of 600 teachers was taken from three districts of Andhra Pradesh. A descriptive survey research method was employed. One of the main findings of the study teachers although convinced and showed passion for the use the ICT, traditional education methods dominated. Although the ICT infrastructure was found, but there was a lack of technical knowledge among teachers and negligible training was provided to make them competent to integrate ICT in their subject.

Swamy (2012) tried to find out the status of ICT in teacher education institutions. A survey was conducted to identify the status on the use of ICT in educational institutions. Structured questionnaire was formulated in order to know different ICT skills and competencies. Study found that there is lacuna in internal interaction among teachers, students, or among teachers and students using email. The respondents said that they communicate with their teachers through mobile phones. On the whole, the study found that more than 90% of the students had effectively used ICT for acquisition of knowledge in their teacher education course.

Ghosh (2018) studied the usage of ICT among Higher Secondary School students in Howrah District. The major objective of the study was to identify how ICT was integrated in the teaching–learning process by teachers and students both. The methodology adopted was a descriptive type research and technique followed on Survey method. The main finding of the study was that the lack of infrastructure of ICT was the main cause behind ineffective use of ICT in the teaching– learning process.

Singh (2018) conducted a study on "Usage of ICT for teaching students of XI commerce in Vadodara". The main objectives of the research were (i) to study the status of ICT usage for teaching Organisation of Commerce and Management (OCM) in standard XI, (ii) to study the effectiveness in using ICT and the need of in–service training of teachers for using ICT/multimedia gadgets. The study was delimited to the Gujarat Secondary and Higher Secondary Education Board (GSHSEB) schools

offering the OCM subjects. Purposive sampling technique was used and ten English medium schools of the Vadodara city were selected. In order to collect the data from students, 20% of the standard XI students studying the OCM subjected were selected. Findings revealed that the schools were adequately resourced; however, the ICT integration was not evident in the pedagogy of the teachers.

2.1.2 Review of the Studies Conducted Overseas

In his study on the use of mathematics software by eighth grade students, Fitz Patrick (2001) found that students frequently benefited from the use of the multiple pathways to learning text, graphics, and speech. When using Destination Math (DM), these modes for representation of problems were found to be motivational for students with the tutorial software. According to FitzPatrick (2001), the software allowed students to regularly engage in various forms of math-talk with their peers and frequently offer or receive assistance with a math problem. In the study, students were more likely to seek help from one another than from the teacher during the math lesson and students supported each other in various ways.

Vahey, Tatar and Roschelle (2004) investigated the capabilities of representational infrastructures of handheld computers for collaborative practices activities in mathematics. Data was collected on 25 students enrolled in an advanced 8th grade mathematics class over one month. Results indicated that the students' conceptual understanding improved as NetCalc handheld computer technology was integrated in the instruction of mathematics; the use of the handheld device helped students integrate their knowledge into graphical interpretations and students were able to create links between graphical representations and motion simulations (Vahey, Tatar, and Roschelle, 2004). According to Vahey, Tatar, and Roschelle (2004), the integration of computer technology in mathematics instruction in middle school can lead to increased student learning of complex and conceptually difficult mathematical concepts like calculus.

Papanastasiou and Ferdig (2006) conducted an international study on 15-year-old students from 32 countries to examine the potential relationship between computer use and mathematical literacy using data from the Program for International Students

Assessment. The study was conducted with reference to the level of comfort that the students had with computers, the student's frequency of use of computer, the reasons for which the students used computers and the frequency of different types of computer software used. The overall results of this study revealed that the "passive" or mechanical use of the computer alone does not highly correlate with increased academic growth, specifically in mathematical literacy acquisition.

Petras (2010) studied the perception of Science and Mathematics teachers about the how ICT impacts their teaching through a descriptive study. The research design adopted was the descriptive survey in which purposive sampling was carried out. The population consisted of eighth grade Science and Mathematics in the public-school districts in St. Louis County. Out of the 162 schools to which the questionnaire for data collection via electronic mode was sent, 49 teachers responded and thus formed the sample of the study. Descriptive statistics, correlation and binary regression were the statistical tools that were used for the study. One of the major findings of the study was that teacher's pedagogy and their (ICT) as instructional tools are factors in helping teachers and schools meet the challenge of preparing students with the essential skills necessary for success in the 21st century. Yet many teachers were not using the technology due to the pressure of high achievement test scores mandated by federal legislature, No Child Left Behind. This was found as one of the hurdles in innovative student projects creative thinking through the use of ICT.

Hudson and Porter (2010) examined the beliefs, attitudes and knowledge (professional development experience and needs) of mathematics teachers towards using computer technology and how this translates into teachers using or not using computers in the classroom. In addition, the study also examined whether or not there were facilitating or inhibiting factors leading to embedding computer use in teaching mathematics, hence improving mathematics learning. A mixed-model approach was used in this study. The sample constituted of 26 high schools comprising 114 teachers including the head teachers. A statistical model analysis, 'logistic regression analysis' was used to predict the use of computer in the mathematics classroom. The results of this study on the beliefs of teachers did not show any effect on teachers' adoption of using and not using computers. This means that a teacher who preferred to be trained in the use of the ICT welcomes lesson preparation with technology integration is more

likely to adopt computer use in mathematics teaching and learning. The study also indicated that past and current computer policies and professional development programs integrating the use of ICT in mathematics seemed not effective in making teachers adopt the use of computer technology in their teaching practices. There should be a thorough monitoring technique or strategy that includes implementation, feedback and evaluation of technology by the stakeholders of the secondary education sector. Possibly a more structured and ongoing professional development programs for mathematics teachers should be aligned to their needs and beliefs. Therefore, it is highly recommended that a leadership role of school executives should be a preference when implementing and encouraging teachers to use ICT in the mathematics classrooms.

Sangra and Gonzalez-Sanmamed (2010) studied the "Role of ICT in improving teaching and learning processes in primary and secondary schools". The main objectives that were considered for the study were (i) to analyse what is happening at schools regarding the integration and use of ICT and (ii) to examine teachers' perceptions about whether teaching and learning processes can be improved through the use of ICT. The parameters that were of significant importance in this study were (a) use of ICT in teaching practice, (b) attitude towards ICT, (c) training experience and training needs and (d) ICT infrastructure.

A multiple-case-study research methodology was applied. From a previous exploratory research, four different types of schools were determined. Some interesting findings emerged out of this study. Statistical evidence was found in supporting the statement that ICT in teaching favours several teaching and learning processes. It also showed that those schools which have integrated ICT as an innovation factor, the level of contribution of ICT to the improvement of teaching and learning was higher. Further the researchers commented that in order to attain this highest level implied that a school not only has to modernise the technological tools, but also has to change the teaching models: the teacher's role, issues regarding classroom organization, the teaching and learning processes, and the interaction mechanisms.

2.2 IMPLICATIONS FOR THE PRESENT STUDY

Under the present study, the researcher has classified the reviewed studies broadly into two categories (i) reviews of the studies conducted in India and (ii) reviews of the studies conducted overseas. Primarily the gist of all the related literatures reviewed indicates that ICT has huge potential in making the teaching–learning of Mathematics more effective. While it has the potential, whether that potential is being fully exercised to produce desired result and benefit the main clientele – the students and teachers is a matter of concern prevalent across the reviewed studies. Since, the use of ICT in Mathematics is a vast area; further categorization of the reviewed studies is done to consolidate the reviews. Those categories are:

(i) Studies that were based on examining the efficacy of ICT as a contributor to the learning of students.
(ii) Studies that analysed the perception of teachers towards use of ICT.
(iii) Studies that investigated the status of use of ICT.

All four reviewed studies based on the integration of ICT for the purpose of enhancing the students' knowledge, (Thillaka, 2000), (FitzPatrick, 2001), (Vahey, Tatar, and Roschelle, 2004), (Papanastasiou and Ferdig, 2006) and (Rajakumaran et.al,2010) indicated that the use of ICT lead to further the students' conceptual understanding and contributed positively in students' achievement.

(Sangra and Gonzalez, 2010), (Hudson and Porter, 2010), (Barve and Barve, 2012) and (Petras, 2012) examined the beliefs, attitude and the perception of teachers about the use of ICT in Mathematics. A common conclusion was found that while teachers agreed to the fact that teacher's pedagogy and their (ICT) as instructional tools are factors in helping teachers and schools to meet the challenge of preparing students with the essential skills necessary for success in the 21st century, yet many teachers are not using technology due to various factors. A thorough monitoring technique or strategy that includes implementation, feedback and evaluation of technology plans by the stakeholders of the secondary education sector is required.

(Narsimha, 2012), (Swamy, 2012), (Ghosh, 2018) and (Singh, 2018) focused on the status of usage of ICT by secondary school teachers and identified that although

teachers were convinced and showed passion for the use of ICT, traditional educational methods still dominated. Lack of technical knowledge among teachers, not enough training and lack of infrastructure of ICT were some of the factors that prevented the use of ICT in the Indian classrooms.

2.3 CONCLUSION

Through the reviewed literature, the researcher identified that there certainly is an enthusiasm about the use of ICT into teaching of Mathematics at a global and national level. Based on the literature it was found that despite the enthusiasm for ICT integration in to Mathematics teaching, the traditional methods still dominated the classrooms. Therefore, through the present study, the researcher attempted to investigate how far the effect had rippled to the Mathematics teachers of Vadodara city. Further, the next chapter describes the methodology undertaken to carry out the study.

CHAPTER III

RESEARCH METHODOLOGY

CHAPTER-III

METHODOLOGY

3. INTRODUCTION

The central aspect of any research embodied in its methodology, which shares the idea about how the study was conducted step by step. It refers to the plan and procedures used by the researcher for conducting the present study. This chapter is methodology oriented where the researcher has concentrated on the plan and procedure adopted in order to obtain answers of the research questions and to attain the objectives of the present study. This chapter includes Objectives of the study, Explanation of the Terms, Operationalization of the Terms, Delimitations of Study, Population of the study, Sample of the study, Design of the study, Phases under the Plan and procedure, Tools for data Collection, Procedure of Data Collection and Data Analysis. The comprehensive detail of the methodology with reference to above aspects has been described as under.

3.1 OBJECTIVES OF THE STUDY

The following objectives are framed for the present study.

(i) To study the current status of the use of ICT in terms of the availability of the devices and its working condition in the Secondary schools of Vadodara city.

(ii) To study the use of ICT in teaching of Mathematics in Secondary schools of Vadodara city in terms of the frequency of ICT Resources used.

3.2 EXPLANATION OF THE TERMS

a) Information and Communication Technology: (ICT) in the present study refers to any electronic device used in the teaching of Mathematics. It is inclusive of but not limited to:

- Desktops/Laptops
- Internet Connectivity
- Overhead Projector
- Smart Board
- Television
- Digital Camera

b) Use of ICT: Use of ICT under the present study refers to the use of electronic devices stated above, for the purpose of enhancing students' Mathematical abilities, knowledge and skills.

3.3 OPERATIONAL DEFINITION OF THE TERM

Status: Under the present study, the term 'status' is defined as the availability of the ICT resources, its working condition and the frequency of the ICT resources used by the teachers and / or students in the teaching – learning process of Mathematics.

3.4 DELIMITATIONS OF THE STUDY

The present study was delimited to the Grant-in-Aid English medium schools of Vadodara city affiliated to the Gujarat Secondary and Higher Secondary Education Board (GSHSEB), for the academic year 2019–20.

3.5 POPULATION OF THE STUDY

The population for the present study consisted of forty-four (44) English medium schools of Vadodara City affiliated to the GSHSEB. Out of these 44 schools, 33 schools were Grant-in-Aid schools while remaining 11 schools are Non-Granted (private). Thus, the Principal of the schools, teachers of Mathematics in all these schools and all of the students studying in Standard IX of these schools were the population of the study.

3.6 SAMPLE OF THE STUDY

In order to have a fair representation of the population, 10 schools were selected through random sampling technique. Across the selected schools for the study, 10 Principals, 26 Mathematics teachers, and 10 students from the IX^{th} grade from each school (total 100 students) constituted the sample for the study. The students were selected by using random sampling technique.

3.7 RESEARCH DESIGN

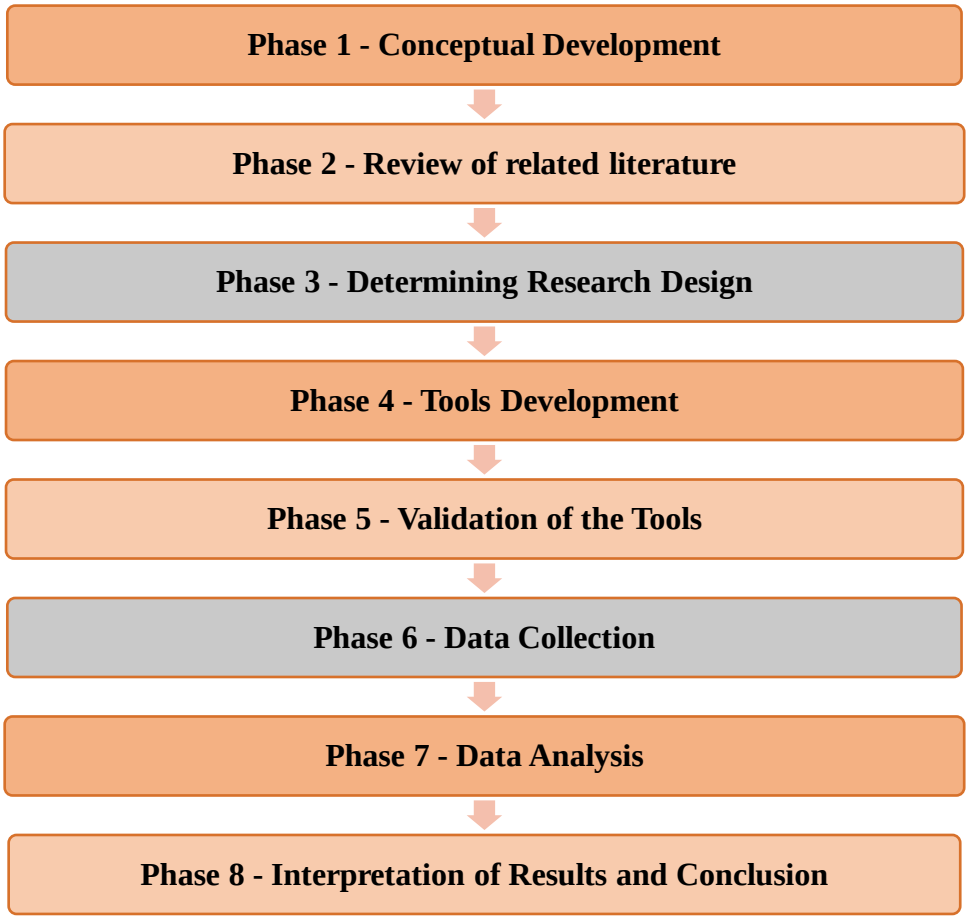
Once the problem and objectives of the study were decided; the next important and consequential matter in research to be determined was selecting an appropriate

research design for the study. The present study was a Descriptive survey research which was conducted for the description of a specific situation and studying opinions of a specific group of the participants (principals, teachers and students), which has allowed the researcher not only to present the prevailing situation but also to interpret and report the existing facts on the ground. According to Best and Kahn (2006), descriptive survey type studies are used to find out '*what is'* and therefore the detailed information is required for answering the research questions. So looking to the study and its objectives, a Descriptive survey design was found the most appropriate method to collect the detailed information in relation to achieve the stated objectives of the study.

3.8 PLAN AND PROCEDURE OF THE STUDY

The study was planned in a phase manner as presented below in the Figure 3.1:

Figure 3.1 Different Phases of the Study



As mentioned in the Figure 3.1, the research study was planned in a phase manner with the initiation of the conceptual framework. The brainstorming exercise in the

beginning about identifying the topic of research followed by the SWOT analysis helped to narrow down the domain of the area for the study. Once the topic was decided, a conceptual framework was built in order to understand the concept of ICT with regard to the teaching of Mathematics. In the second phase, the related literature was reviewed and analyzed in order to gain a better understanding of the study and to learn about the research gaps in connection with the present research. Further in the next phase deliberation on the appropriate research design was carried out. According to Best and Kahn (2006), survey is an effective way to gather information about the status of the practices being executed in educational institution and therefore Descriptive Research design was selected for the purpose of the present study. Followed by it under Phase 4 and 5, the tools were developed by the investigator and were validated on the basis of the experts' opinions. The next big task was of the data collection which was carried out in Phase 6. The investigator collected the data personally with the help of tools and techniques developed under the Phase 4. Once the data were collected, the major job of Data Analysis was carried out in Phase 7. In the last phase, that is Phase 8, results or findings were derived on the basis of the interpretations made through analyzed data and the conclusions were arrived at.

3.9 TOOLS AND TECHNIQUES

Several studies on the topics related to the study were consulted in order to develop the tools required for achieving the objective of the present study. With regards to the objectives, the following tools and techniques were found suitable for the collection of the data:

a) Checklist

b) Semi-structured Interview (For the Principal)

c) Questionnaire (For the Teachers)

d) Focus Group Discussion (FGD for the Students)

All the tools were developed by the investigator. The Checklist was used for collecting the data to achieve Objective 1, while Semi-structured interview schedule, Questionnaire and the Focus Group Discussion were used to collect data to achieve Objective 2.

3.9.1 Checklist

The Checklist developed by the investigator consisted of a list of the ICT gadgets that are expected to be used in the school. Through this tool the status of the ICT gadgets in terms of availability of the ICT resources, the adequacy of the ICT resources against the number of students and the working condition of the ICT gadgets has to be recorded.

3.9.1.1 Development of Checklist

The main criterion behind developing the Checklist was to check the actual status of the ICT gadgets. Hence, that was mentioned in the tool in terms of availability of the ICT resources, the adequacy of the ICT resources against the number of students and their working condition. Since the materials to be observed were tangible in nature, the working condition of the same was categorized as either poor, average, good and excellent. The Checklist was validated with the help of Experts in the relevant field. The list of experts can be seen from the Appendix -F. The developed Checklist can be accessed by referring to the Appendix- B.

3.9.2 Semi-structured Interview

A Semi-structured interview consisted of seven questions related to how Principals envision the use of ICT at their schools and thereby could lead towards the quality and the diversity of ICT resources to be used for teaching of Mathematics.

As indicated by Mathers et al. (2000), Semi-structured interview provides opportunities for both interviewer and interviewees to discuss the topics in more details. This type of interview also let interviewer to elaborate on the key important issues and pose more frequent inquiries during the conversation. Hence, the Semi-structured interview schedule was designed with the aim of eliciting information about the above stated purposes.

3.9.2.1 Development of Semi-structured Interview

An opinion was sought about what Principals felt about difficulties faced (if any) by the teachers of Mathematics while incorporating ICT and whether any professional development opportunities were provided to the teachers. Hence, a Semi-structured interview schedule was decided to develop by the investigator considering some pertinent questions. This allowed the investigator to be prepared and appear competent during the interview. It is through the Semi-structured interviews, that Principals could more easily discuss sensitive issues and give a bigger picture of the situation at hand. Thus, a series of questions was predefined as a Semi-structured interview to employ as a technique to collect the information from the principals. All questions under the Semi-structured interview were formulated in connection with the research objectives. The developed Semi-structured interview schedule was validated on the basis of the Experts' suggestions. The list of experts can be seen from the Appendix -F and the developed Semi-structured interview can be referred from the Appendix C.

3.9.3 Questionnaire

The questionnaire for teachers was an elaborate one – starting with some basic demographic questions about their age group and experience of teaching Mathematics. Followed by that, the questionnaire included total fifteen questions related to their proficiency over the use of ICT gadgets, the willingness to use ICT for teaching of Mathematics and the frequency of it being used per week. In order to study the status of ICT it was important to know frequently the teachers use ICT for Mathematics and how proficient they are about using ICT. In order to have their honest response, a questionnaire was used to collect the information. The reason being - in some cases teachers might be persuaded to lie in order to hide from being embarrassed for not using/not being able to use ICT. Alternatively, they are likely to provide an honest response about their ICT competency and of the frequency of use of ICT.

3.9.3.1 Development of Questionnaire

For collecting data from teachers, a questionnaire was decided to be designed so that teachers can respond to the questions in their own time. Further, accessibility of the

teachers was also thought about when deciding the tool for the data collection from the teachers. They are extremely busy with classes and other duties and therefore a questionnaire could give them the ease of providing responses at their convenience.

After the development of the initial draft of the questionnaire, it was given to a panel of experts to judge its validity. After that, all the questions under the given draft were discussed with them with regard to their appropriateness, relevance and capacity to describe the major purposes of the study. Based on the feedback and suggestions of the experts, all those questions requiring modifications were modified by the investigator. Thus, the final questionnaire consisting of total fifteen questions, was developed. The list of all experts involved in the phase of validation can be seen from the Appendix– F. The questionnaire can be accessed by referring to the Appendix- D.

3.9.4 Focus Group Discussion

Under the present study, it was important to know how students perceive the use of ICT for teaching of Mathematics and whether they felt any advantage in ICT being used by the teacher. As such the Checklist, Semi-structured interview with Principal and the Questionnaire from the teachers would have been sufficient however, a Focus Group Discussion can very well justify the validity of the responses given by the teachers and Principals and prove as a method of cross verification. Hence, some relevant questions have been listed to discuss with the students as a part of FGD. The list of questions for Focus Group Discussions can be accessed from Appendix E.

3.9.4.1 Development of Focus Group Discussion

In regards to collecting the data from the students the technique that was decided was focus group discussions - a qualitative approach for gaining students' perception about the use of ICT for the learning of Mathematics. The purpose of FGD is to create a comfortable atmosphere for the people to discuss a topic and express their ideas, experiences and attitude about it. FGD can be used for a variety of purposes such as making decisions, assessment and evaluation, problems finding, planning for future, etc. (Kruger & Casey 2000). Focus group discussion would allow students' representation and thereby assist in verifying the responses provided by the other stake holders.

3.10 DATA COLLECTION

Prior to visiting the schools from which the data were to be collected, a formal permission letter on the letterhead of the Department of Education, Faculty of Education and Psychology duly signed by the authority was obtained. The data were collected through the survey by the Investigator personally from the selected schools. With the prior permission of the concerned school Principal, Checklist was used to collect the data related to the ICT gadgets available in the schools. The questionnaire was handed over to the Section In-Charge who got it filled from the Mathematics teachers. The concerned Section In-Charge also made the necessary arrangement for conducting the Focus Group Discussion with the group of students. Focus Group Discussions were conducted with the students of the selected schools from which the data were collected. There were 10 students in each group. It was important to know how students perceive the use of ICT for teaching of Mathematics and whether they felt any advantage in ICT being used by the teacher. Thus, the data were collected in terms of the actual status of the ICT gadgets in the schools, Principals' views about the use of ICT in their schools and the diversity of ICT resources to be used for teaching of Mathematics, teachers' views regarding their proficiency over the use of ICT gadgets, the willingness to use ICT for teaching of Mathematics and the frequency of it being used per week and finally perceptions of the students about the use of ICT for teaching of Mathematics and their advantage for the teachers.

3.11 DATA ANALYSIS

Looking to the nature of the collected data, they were analyzed qualitatively as well quantitatively. The data collected through the Checklist were analyzed in terms of the adequacy of the ICT gadgets in the school. Responses from the teachers were analyzed by using Frequency and Percentages. Data collected through open ended questions under the Semi-structured Interview for the Principals and the Focus Group Discussions with the students, were analyzed through content analysis by identifying themes and categorization.

3.12 CONCLUSION

In this chapter on Research Methodology, '*Objectives of the study', 'Explanation of the terms', 'Operational definitions', 'Delimitations of the study', 'Population', 'Sample', 'Research Design', 'Plan and Procedure of the study', 'Tools and Techniques for data collection', 'Data Collection' and 'Data Analysis'* have been described. Research methodology formed the basis for the descriptive study which is undertaken to achieve the objectives and provided vital information which would be further analysed in the next chapter.

CHAPTER IV

DATA ANALYSIS AND INTERPRETATION

CHAPTER - IV
DATA ANALYSIS AND INTERPRETATION

4.0 INTRODUCTION

The organization, analysis and interpretation of data and formulation of conclusions are crucial steps to get a meaningful picture out of the raw data that is in the possession of the investigator. It is from this analysis that the results can be drawn. The present chapter provides the analysis and interpretation of the data with respect to the objectives of the study. Analysis of the data means studying and tabulating materials in order to determine inherent facts or meaning. It involves the breaking up of complex factors into simpler parts and putting the parts together in a new arrangement for the purpose of interpretations. The data are studied from as many angles as possible to explore the new facts. The interpretation of the data means arriving at what the result is, show its meaning, significance and answer to the original problem.

4.1 DATA ANALYSIS AND INTERPRETATION

For the systematic presentation of the results, the objective wise data analysis was done and interpretations were made on the basis of the analyzed data under the present study.

4.1.1 Data Analysis with respect to Objective 1

In order to achieve the Objective-1 (To study the current status of the use of ICT in terms of the availability of the devices and its working condition in the Secondary schools of Vadodara city.), the investigator collected the data related to availability of the ICT gadgets, the adequacy of the resources and the working conditions of the ICT resources. For collecting the said information checklist was used. The availability of the resources was recorded as the number of gadgets available in the school. The adequacy of the resources was decided based on the number of teachers utilizing the resources for the students against the number of resources in the schools. It was

categorized as shown in the Table 4.1 And the working condition of the ICT gadgets was decided based on the criteria given in the Table 4.2.

Table 4.1Adequacy of the ICT resources

Sr. No.	Adequacy
1	Not Enough
2	Shared Inadequately
3	Sufficient

Table 4.2 Working condition of ICT resources in the school

Sr. No.	Condition of the ICT gadget	Description of the condition
1	Poor	Non-functional, broken and accessories missing
2	Average	In operational condition, however the resource appears to lack timely maintenance or the attached accessories are missing
3	Good	In operational condition, however the resource appears to require more timely maintenance
4	Excellent	In operational condition and well maintained

The analysis of the ICT resources with reference to the above stated criteria has been done to achieve the stated objective. For a quicker, effective and meaningful understanding; the collected data for each and every ICT resource were analyzed with the help of tabulation and graphical representation. Presented overleaf is a resource wise analysis of the data collected in terms of the Number of that particular ICT Resource, its adequacy and its working condition.

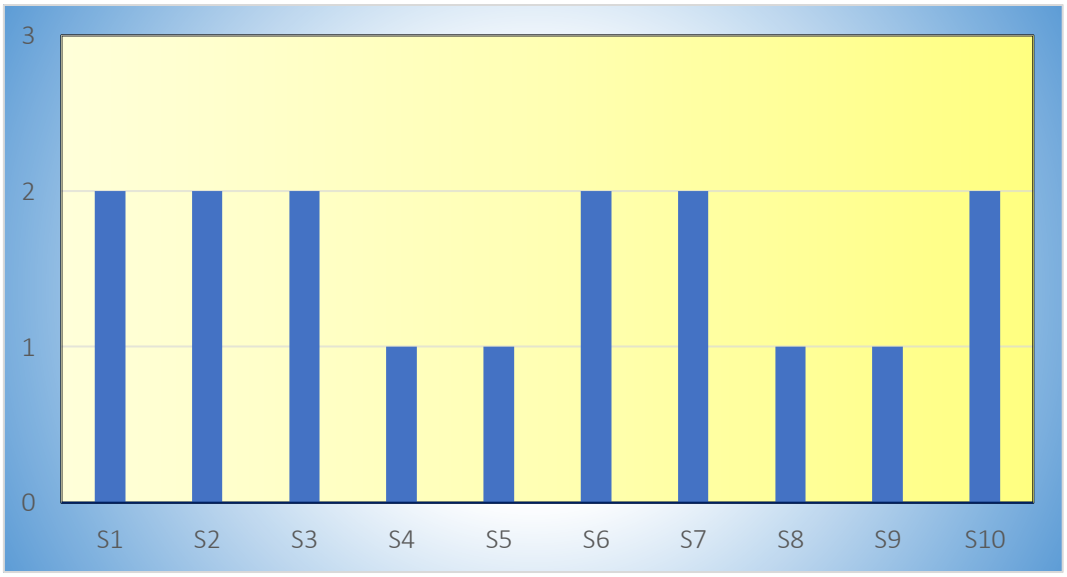
4.1.1.1 ICT Resource: Computer Laboratory

Table 4.3: Computer Laboratory

Schools	Quantity	Adequacy	Working Condition
S1	2	2	3
S2	2	3	4
S3	2	2	4
S4	1	1	1
S5	1	1	1
S6	2	2	2
S7	2	3	3
S8	1	1	3
S9	1	1	2
S10	2	2	3

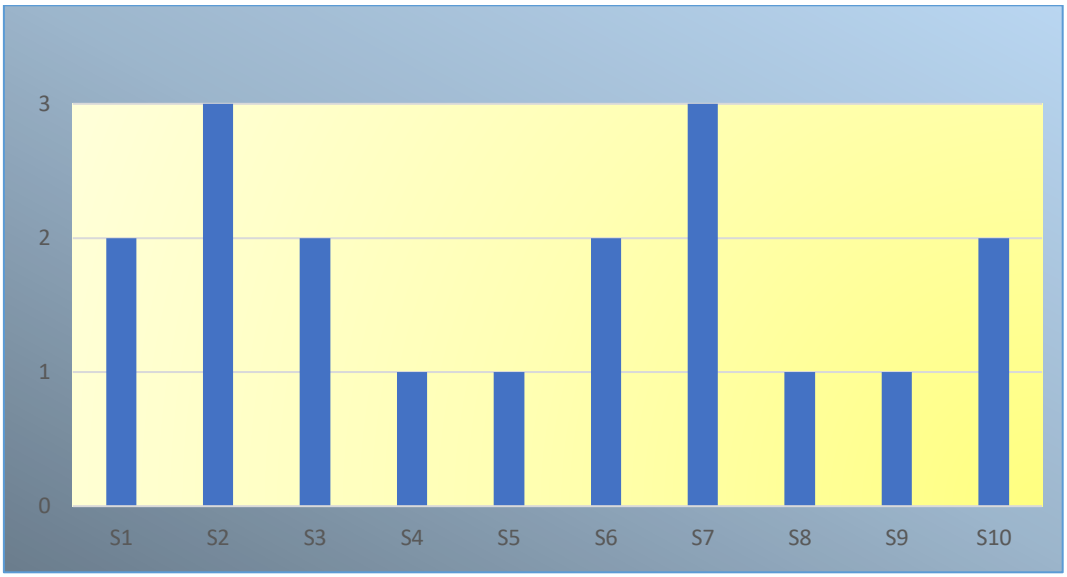
Table 4.3 provides the data about the Computer laboratories of the schools in terms of its number, adequacy and working condition.

Graph 4.1: Number of Computer Laboratories



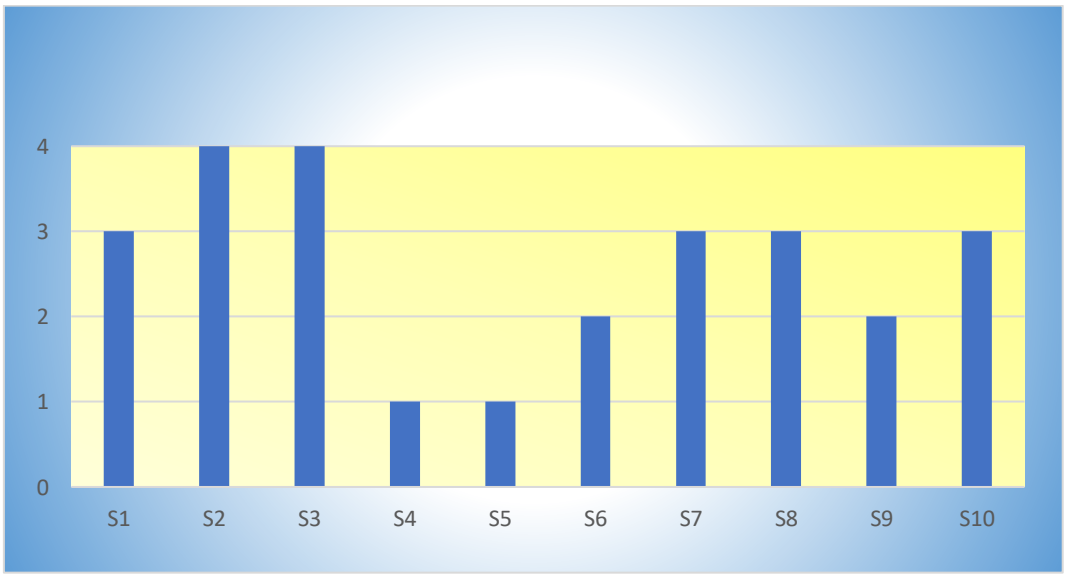
From Graph 4.1 it can be seen that majority of the schools are equipped with 2 computer laboratories. However, 4 out of 10 schools were found to have only one computer laboratory.

Graph 4.2: Adequacy of Computer Laboratories



It can be interpreted from the Graph 4.2 that the schools having 2 computer labs were able to meet the demand of the students however the remaining ones were either shared inadequately or did not meet the demands of the students.

Graph 4.3: Working Condition of Computer Laboratories



The Graph 4.3 indicates that the working condition of the computer laboratories was good except for two schools which need to upgrade their facilities.

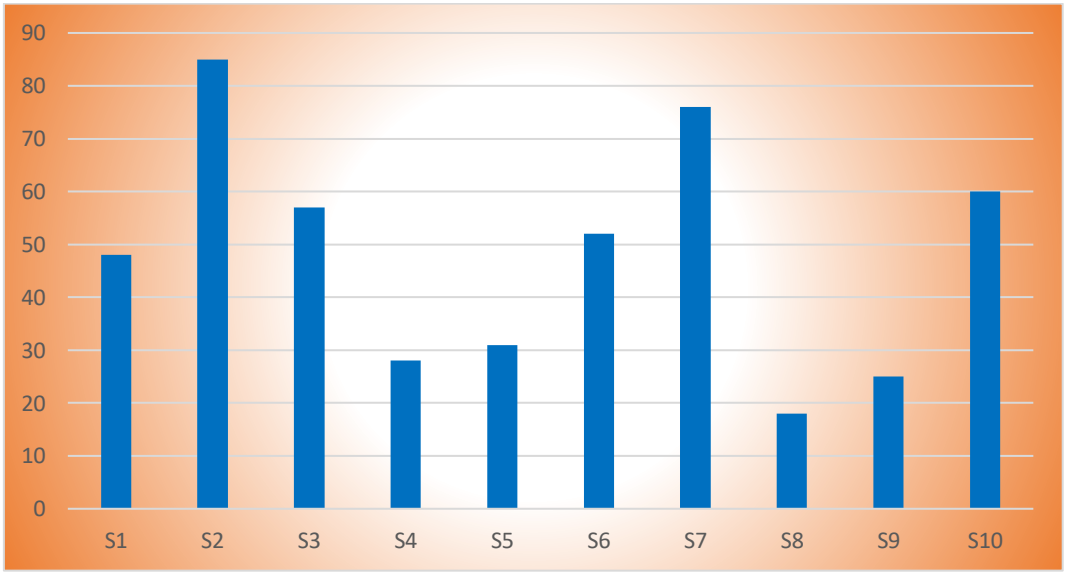
4.1.1.2 ICT Resource: Desktops

Table 4.4: Desktops

Schools	Quantity	Adequacy	Working Condition
S1	48	2	3
S2	85	3	4
S3	57	3	4
S4	28	1	2
S5	31	1	2
S6	52	2	3
S7	76	3	4
S8	18	2	3
S9	25	2	3
S10	60	3	4

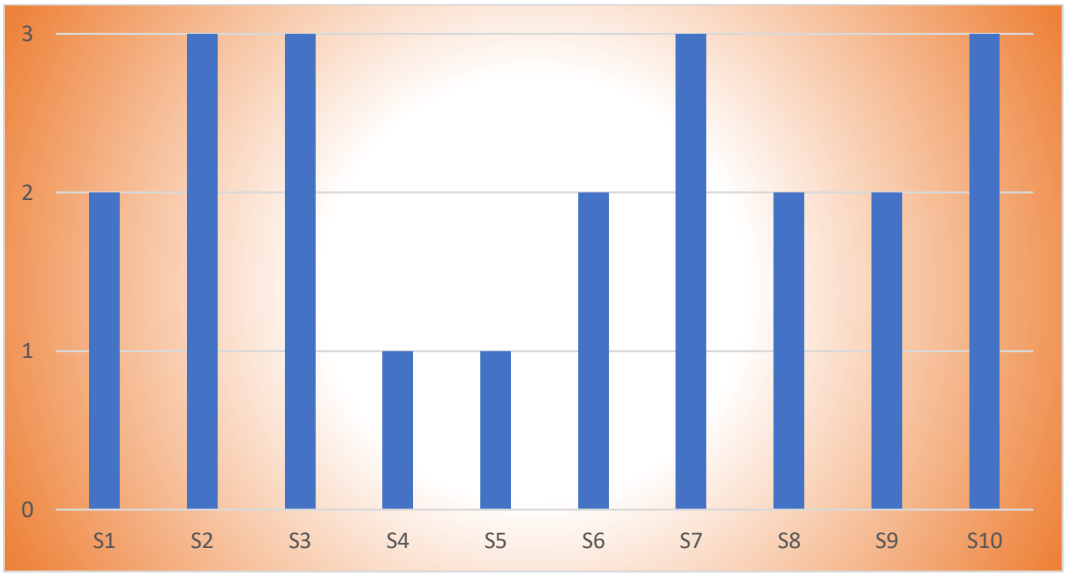
Table 4.4shows that there was a wide range of number of desktops at surveyed schools with considerable variation in the adequacy and working condition.

Graph 4.4: Number of Desktops



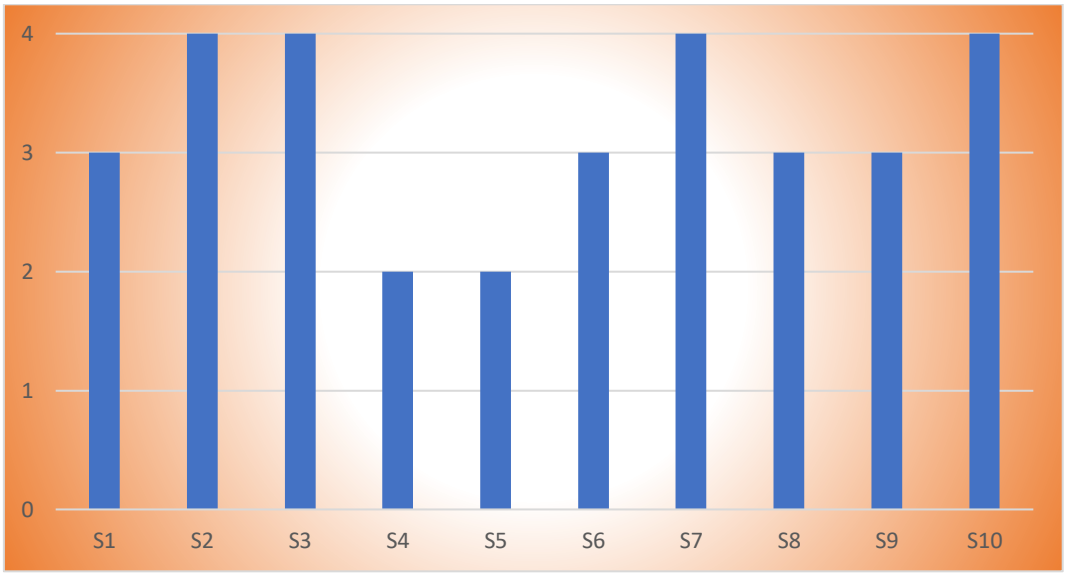
It can be seen from Graph 4.4 that, the least number of desktops available in the eighth school (S8); while the highest number of desktops was available in S2 (i.e. 85). Six schools were having on an average 50 desktops.

Graph 4.5: Adequacy of Desktops



Graph 4.5 shows that, 4 schools had sufficient number of desktops and other 4 schools were shared inadequately whereas remaining 2 schools had not enough numbers of desktops.

Graph 4.6: Working condition of Desktops



It can be seen from Graph 4.6 that except for two schools where the condition of desktops was average, in rest of the schools the desktops were maintained in good to excellent condition.

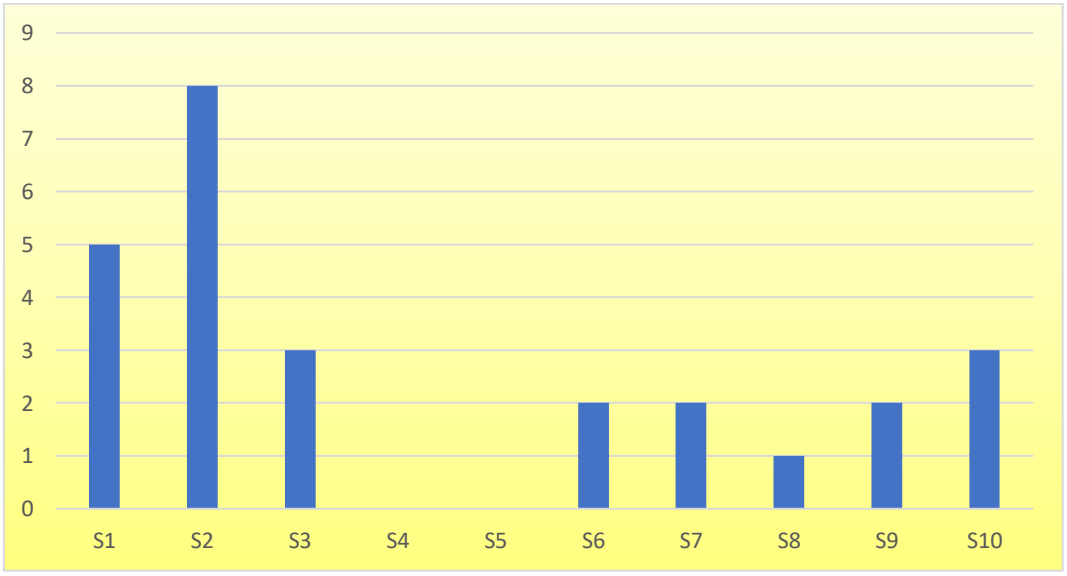
4.1.1.3 ICT Resource: Overhead Projectors

Table 4.5: Overhead Projectors

Schools	Quantity	Adequacy	Working Condition
S1	5	1	4
S2	8	3	4
S3	3	1	4
S4	0	1	0
S5	0	1	0
S6	2	1	3
S7	2	1	3
S8	1	1	3
S9	2	1	3
S10	3	1	4

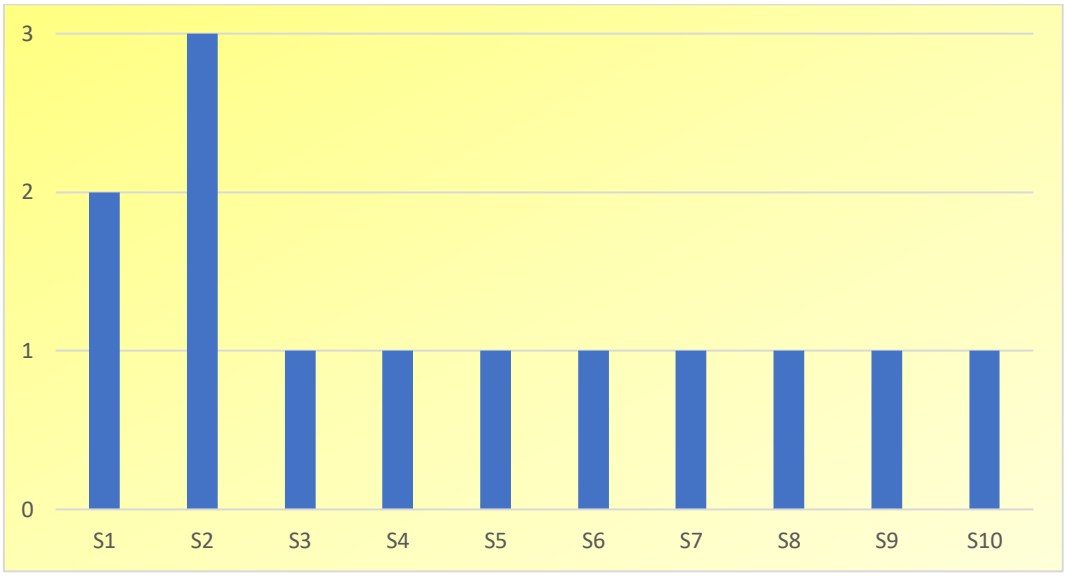
Table 4.5 represents that eight schools out of ten have 3 or fewer Overhead Projectors. It is an indication that Overhead projectors are not a common ICT resource in the schools.

Graph 4.7: Number of Overhead Projectors



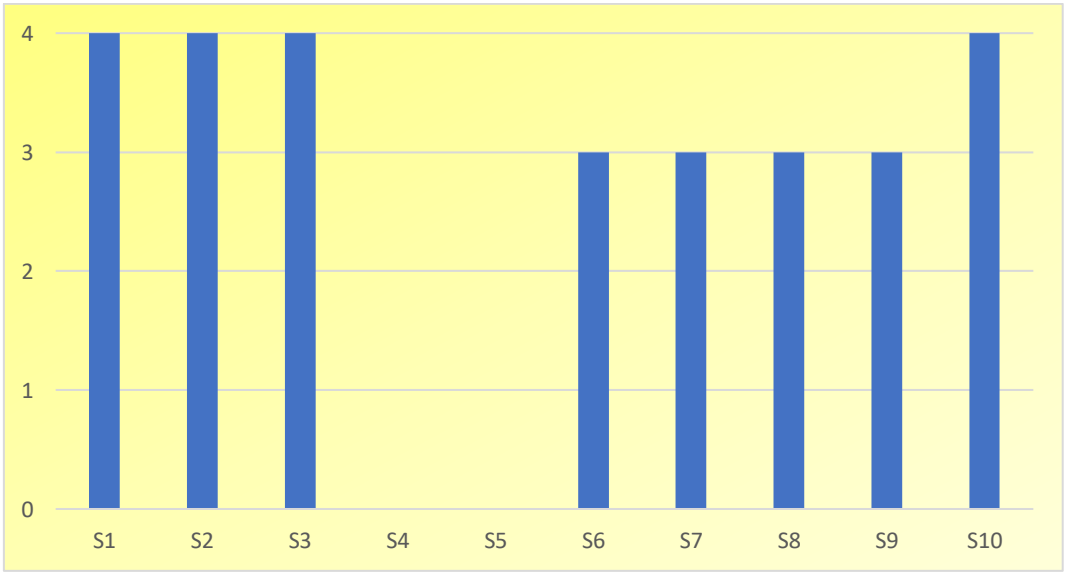
Graph 4.7 shows that Overhead Projectors (OHPs) are in scarce number in schools. Only two schools were found to have 5 or more OHPs. Moreover, it can also be noticed that two schools did not possess Overhead projectors.

Graph 4.8 Adequacy of Overhead Projectors



It can be seen from Graph 4.8, that the school with 8 OHPs (S2) were found to be adequate in number, whereas 5 OHPs in one of the schools were shared inadequately. In rest of the schools there were not enough OHPs found.

Graph 4.9 Working condition of Overhead Projectors



Graph 4.9 represents that the OHPs in the schools were maintained either in good or excellent condition.

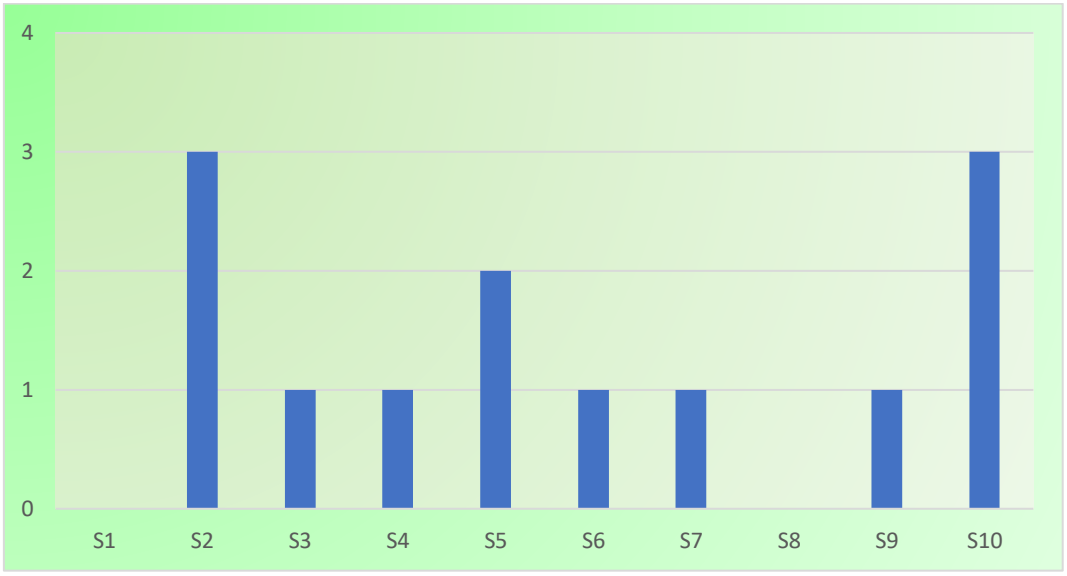
4.1.1.4 ICT Resource: Smart Boards

Table 4.6: Smart Boards

Schools	Quantity	Adequacy	Working Condition
S1	0	1	0
S2	3	2	4
S3	1	1	3
S4	1	1	2
S5	2	1	2
S6	1	1	3
S7	1	1	3
S8	0	1	0
S9	1	1	3
S10	3	2	4

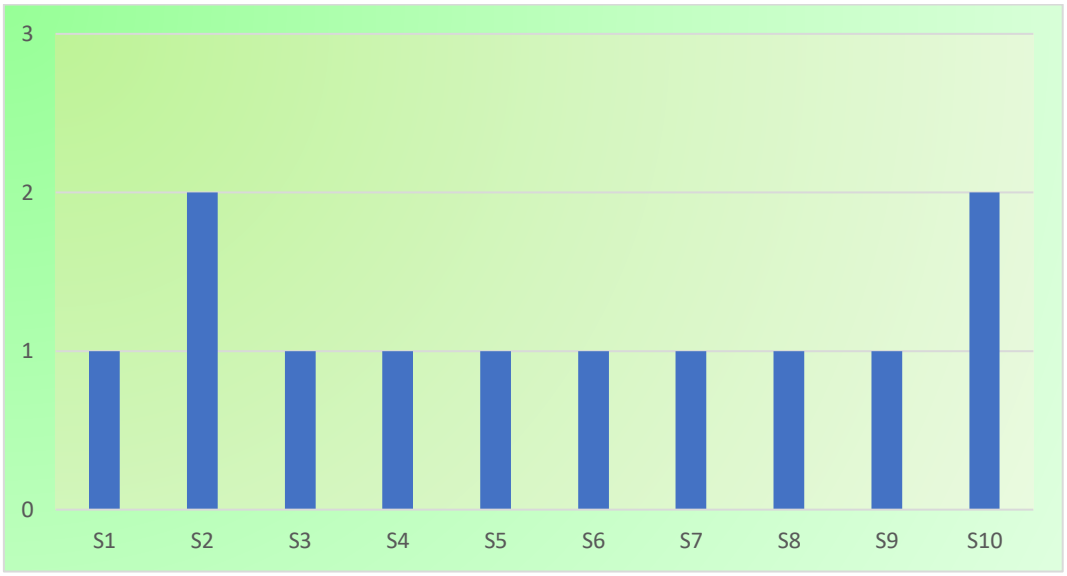
Table 4.6 suggests that alike Overhead Projectors, Smart Boards also are yet to find popularity among the surveyed schools.

Graph 4.10 Number of Smart Boards



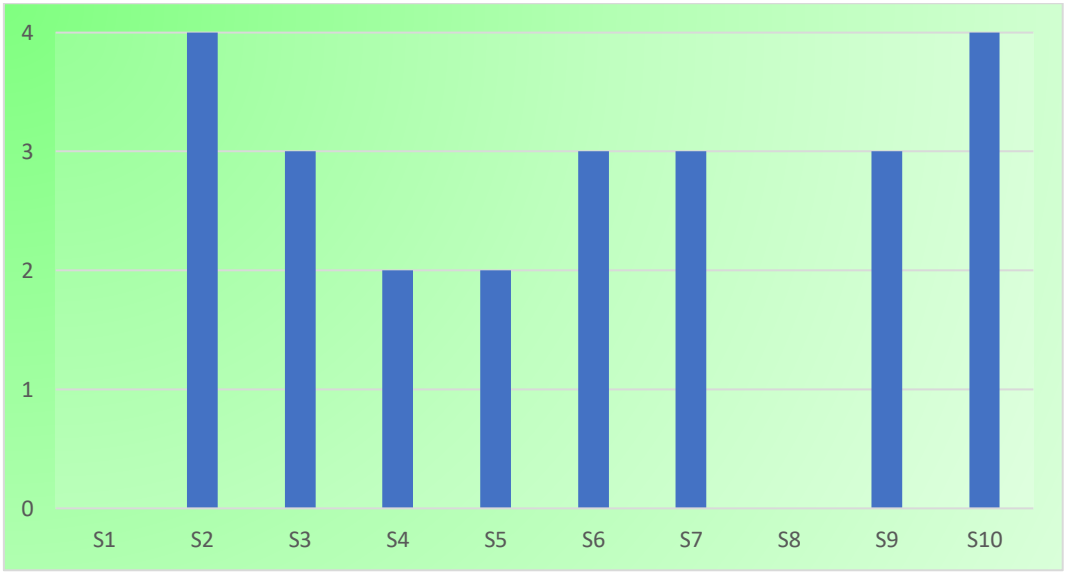
It can be seen from Graph 4.10 that the maximum number of Smartboards that were found in schools was only 3. Further. two schools were found to have no Smartboards and 5 schools had only one Smartboard.

Graph 4.11 Adequacy of Smart Boards



It can be observed form Graph 4.11 that Smart Boards in the schools are scarce. It was discovered that they were shared inadequately and were not enough.

Graph 4.12 Working condition of Smart Boards



Graph 4.12 indicates that the schools which possessed Smart Boards, majority of them maintained them either in a good or excellent condition.

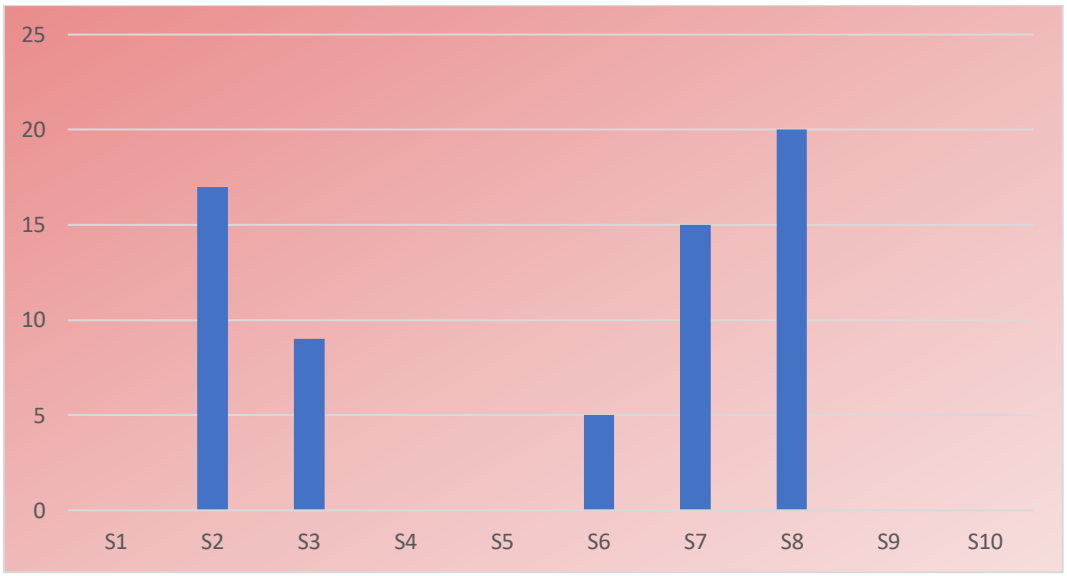
4.1.1.5 ICT Resource: Digital Video Discs (DVDs)

Table 4.7: Digital Video Discs (DVDs)

Schools	Quantity	Adequacy	Working Condition
S1	0	1	0
S2	17	3	4
S3	9	3	4
S4	0	1	0
S5	0	2	0
S6	5	1	3
S7	15	3	3
S8	20	1	4
S9	0	1	0
S10	0	1	0

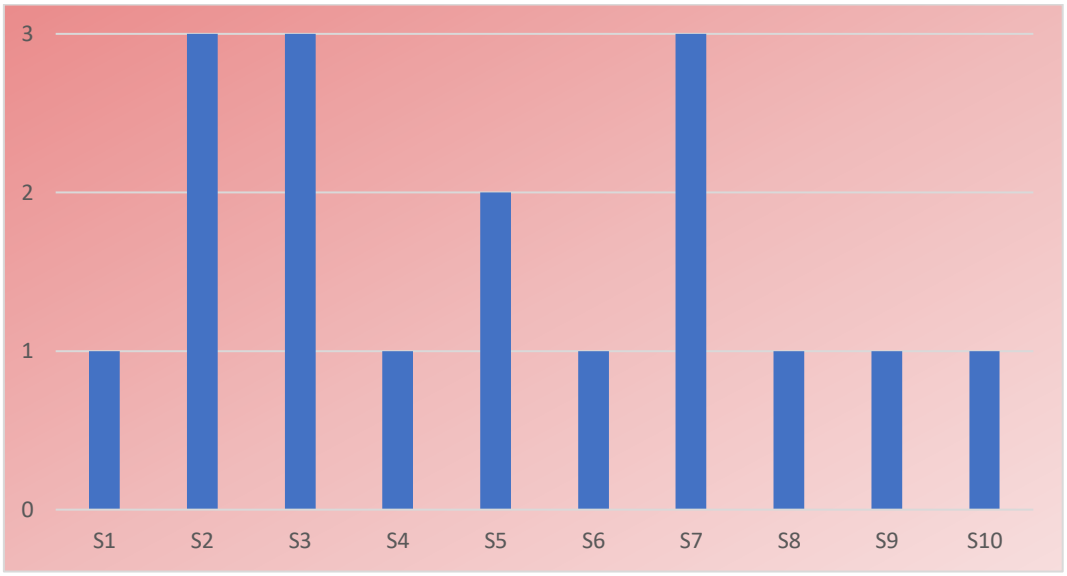
Table 4.7 indicates that DVDs are not a very popular tool anymore, a smaller number of them were found in the schools that were surveyed.

Graph 4.13: Number of DVDs



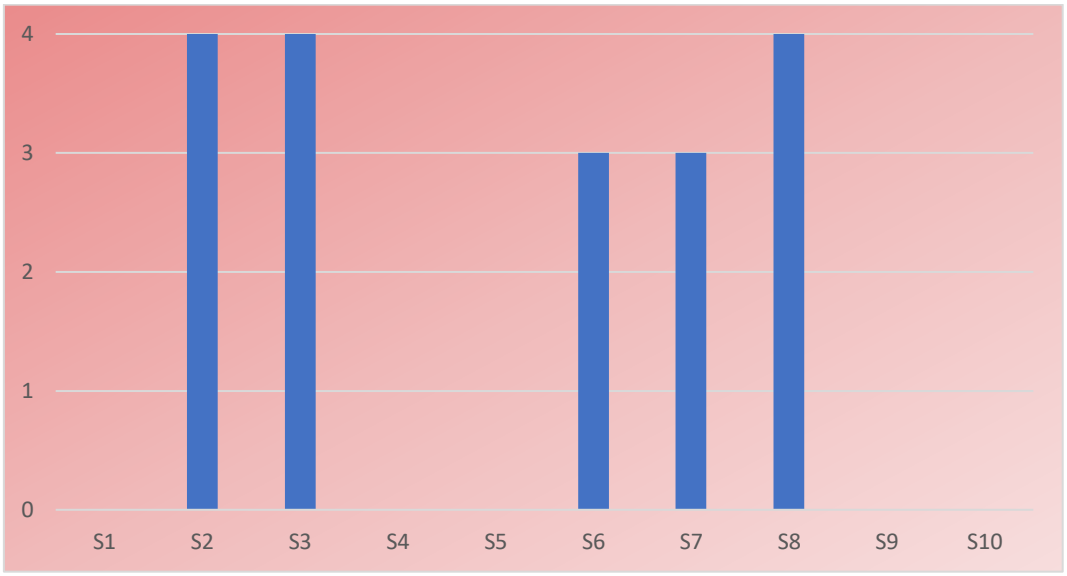
Graph 4.13 shows that only 5 schools had up to a maximum of 20 DVDs in their possession. Since most of the digital resources now a days can be carried through portable USB drives or in memory cards, DVDs are almost getting extinct.

Graph 4.14: Adequacy of DVDs



Graph 4.14 indicates that the three schools that were found in a greater number of DVDs felt they were sufficient in number. However, clearly the rest of the schools had not enough DVDs.

Graph 4.15: Working condition of DVDs



As observed in Graph 4.15, DVDs were maintained in good or excellent condition either in their plastic case or in the paper envelope.

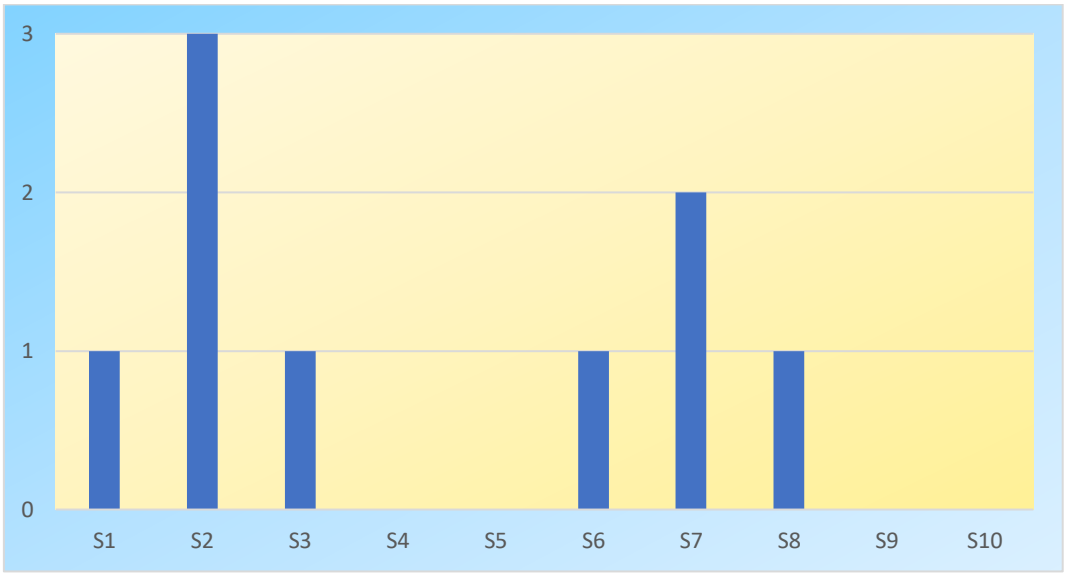
4.1.1.6 ICT Resource: Television Sets

Table 4.8: Television Sets

Schools	Quantity	Adequacy	Working Condition
S1	1	1	4
S2	3	2	4
S3	1	1	4
S4	0	1	0
S5	0	1	0
S6	1	2	2
S7	2	2	4
S8	1	2	3
S9	0	1	0
S10	0	1	0

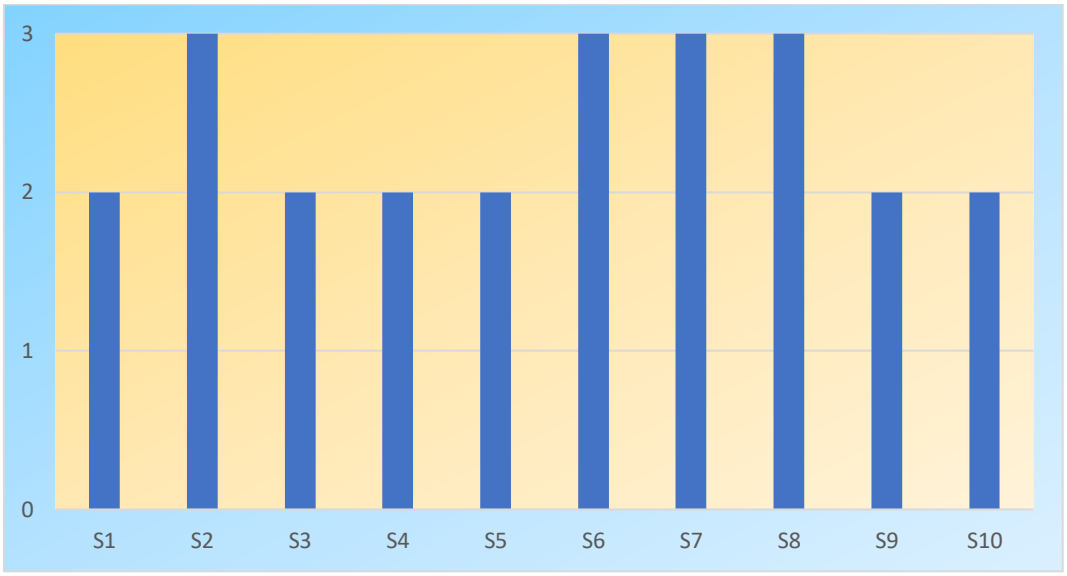
Table 4.8 shows the quantity, adequacy and working condition of the television sets across the 10 schools.

Graph 4.16: Number of Television Sets



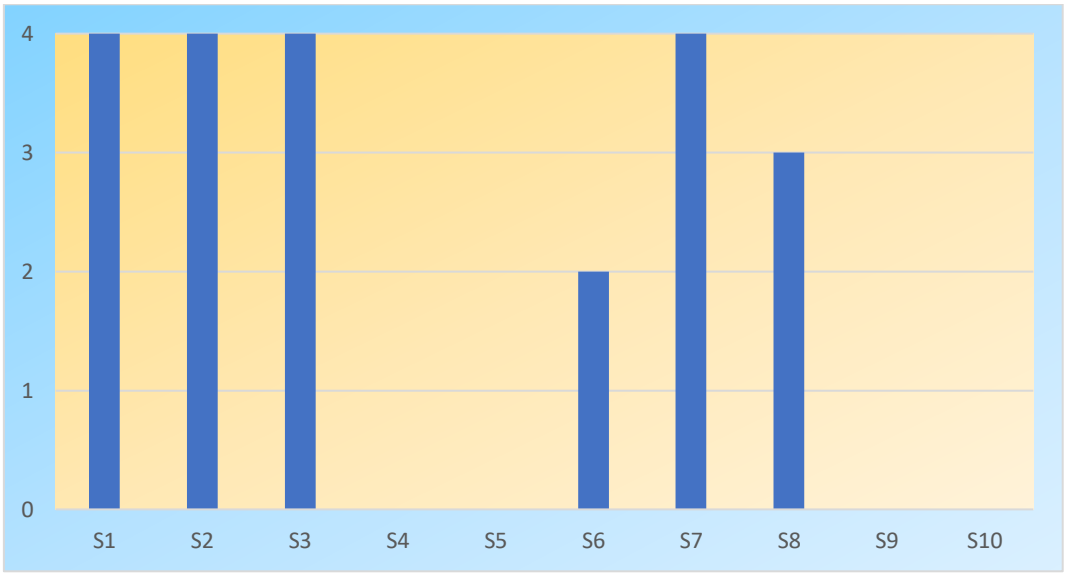
Graph 4.16 indicates that a maximum of 3 television sets were found in one of the schools, whereas 4 schools did not have television set.

Graph 4.17: Adequacy of Television Sets



Graph 4.17 indicates that despite low in number, for four schools the television sets were sufficient in number. For other schools it was shared inadequately. In most of the schools, television sets were found in the reception area. Therefore, even if it was counted as a resource, whether it was used as a resource for Mathematics teaching is questionable.

Graph 4.18: Working condition of Television Sets

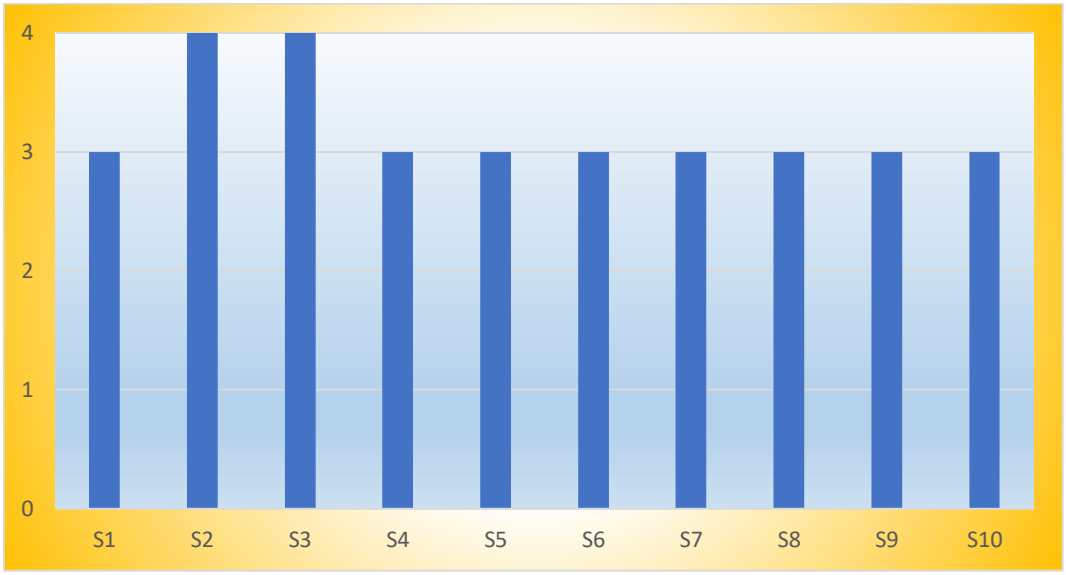


According to Graph 4.18, most of the television sets were maintained by the schools in excellent condition.

4.1.1.7 ICT Resource: Digital Camera

With regards to the number of digital cameras, each school was found to have one camera in their possession. Two of them had a professionalcamera and others had a general-purpose digital camera. As far as the functionality is concerned one digital camera was found to be adequate as it was mainly used by teacher and not by students. Photographs were clicked by the school staff and were used to generate problem solving questions for students.

Graph 4.19: Working condition of Digital Camera



As seen in the Graph 4.19, all schools were found to maintain their Digital Camera in a good condition, however two of the school personnel took extra care in maintaining the Digital Camera and were found in excellent condition.

4.1.1.8 ICT Resource: Internet Connectivity

All schools were equipped with the Internet facility. In present time it has become a necessity for any institution to have internet enabled facility as most of the transactions occur in online mode. In fact, all facilities had adequate band width require to sustain the load of the work of the students and all schools were found to have the internet in excellent condition. Most of the schools were found to have a bandwidth of at least 20 megabits per second (mbps).

4.1.2 Data Analysis with respect to Objective 2

In order to achieve Objective-2 (To study the use of ICT in terms of the frequency of ICT Resource used for teaching Mathematics), the investigator collected the data related to frequency of the ICT gadgets used for the teaching of Mathematics in the Secondary school so Vadodara City. The data were collected through a questionnaire from the teachers of the Mathematics teaching in the English medium schools affiliated to the GSHSEB board. From the sample of 10 schools, there were a total of 26 Mathematics teachers who provided the data. Out of 26 teachers, 18 were female teachers and 8 were male teachers.

4.1.2.1 Analysis of Teacher's Responses

Table 4.9 briefly describes the demographics of the Mathematics teachers who participated in this survey.

Table 4.9: Demographics of Mathematics Teachers

Age Group	< 30	31 to 40	41 to 50	> 50
No. of Teachers	2	12	10	2
No. of years of Experience	< 1	1 to 5	6 to 10	> 10
No. of Teachers	0	4	17	5
Hours/Week of Teaching Maths	≤ 5	6 to 10	11 to 15	≥ 16
No. of Teachers	0	0	5	21
Avg. No. of Students per class	≤ 30	31 to 40	41 to 50	> 50
No. of Teachers	0	0	22	4

It is important to understand the demographics of the teacher as teacher's age, no. of experience, no. of hours of teaching Mathematics per week and No. of students per

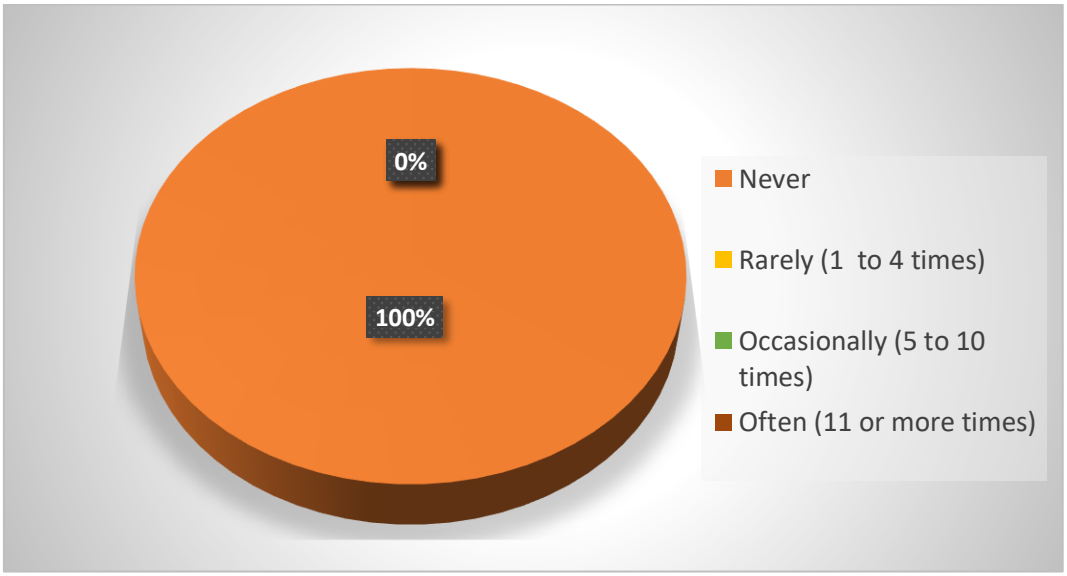
class are also likely to affect the teacher's ability to integrate ICT in their pedagogy. From Table 4.8, it can be seen that majority of the teachers were in the age group 31 to 50 and most of them had at least 6 years of teaching experience as opposed to 4 teachers who were relatively less experienced. Most of the teachers were teaching Mathematics for between 11 to 16 hours or more as many of them were assigned second subject. Mostly all, except 4 teachers had 41 to 50 students in the class.

Table 4.10: Frequency of ICT Resources used

ICT Resource	Frequency / Month			
	Never	Rarely (1 to 2 times)	Usually (3 to 5 times)	Always (For all lessons)
Computer Laboratory	26	0	0	0
Desktops	7	17	2	0
Overhead Projectors	17	7	2	0
Smart Boards	17	7	2	0
Internet	14	10	2	0
Television Sets	26	0	0	0
Digital Camera	26	0	0	0

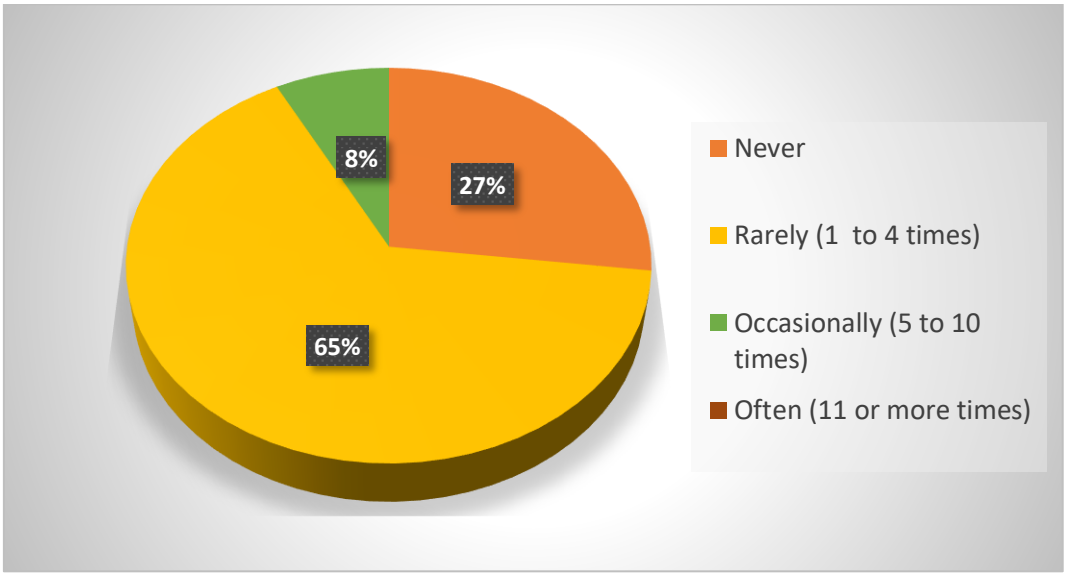
Table 4.10 represents the frequency of the ICT resources used by the teachers in a month for the purpose of Mathematics teaching.

Graph 4.20: Frequency of Computer Laboratory



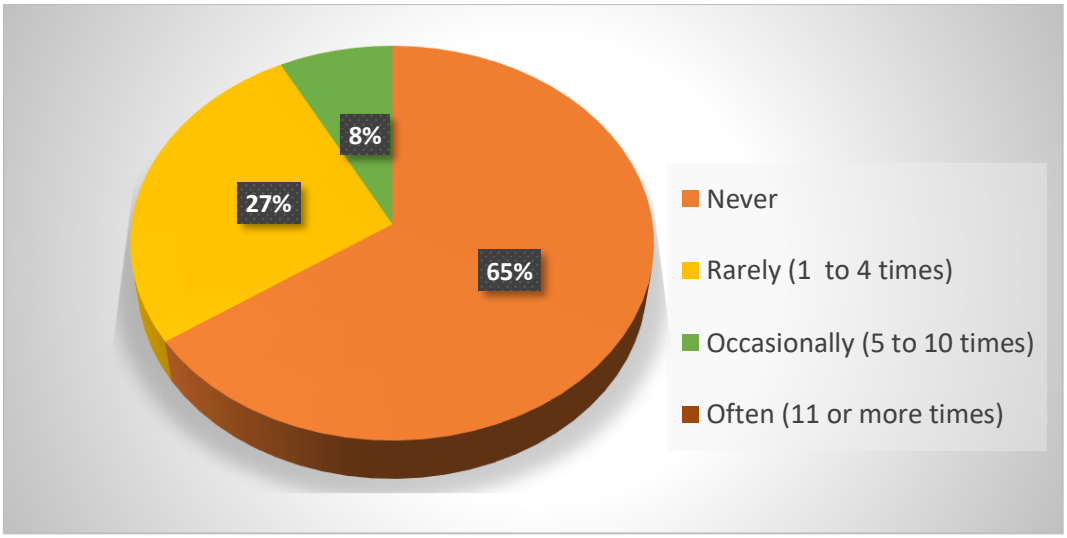
Graph 4.20 indicates that the computer laboratory was never used specifically for the purpose of teaching and learning of Mathematics. However, it was extensively used at all schools mainly for the purpose of teaching and learning of "ICT" as a subject.

Graph 4.21: Frequency of Desktops



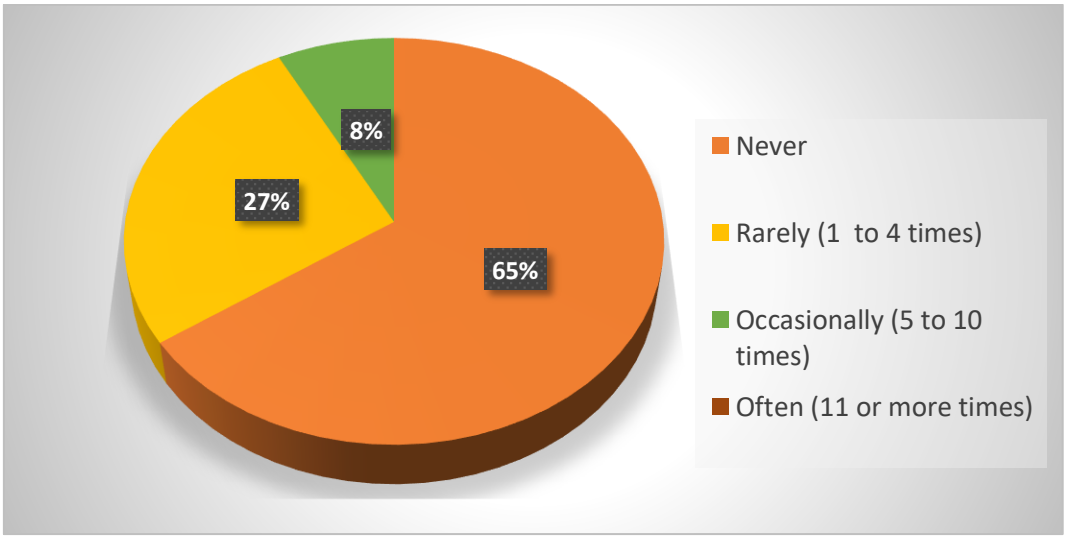
As seen in Graph 4.21, 65 percent of the teachers reported that they use desktops only 1 to 4 times a month, 27percent reported they never used Desktops and only 8percent mentioned that they used desktops more than 11 times a month.

Graph 4.22: Frequency of Overhead Projectors



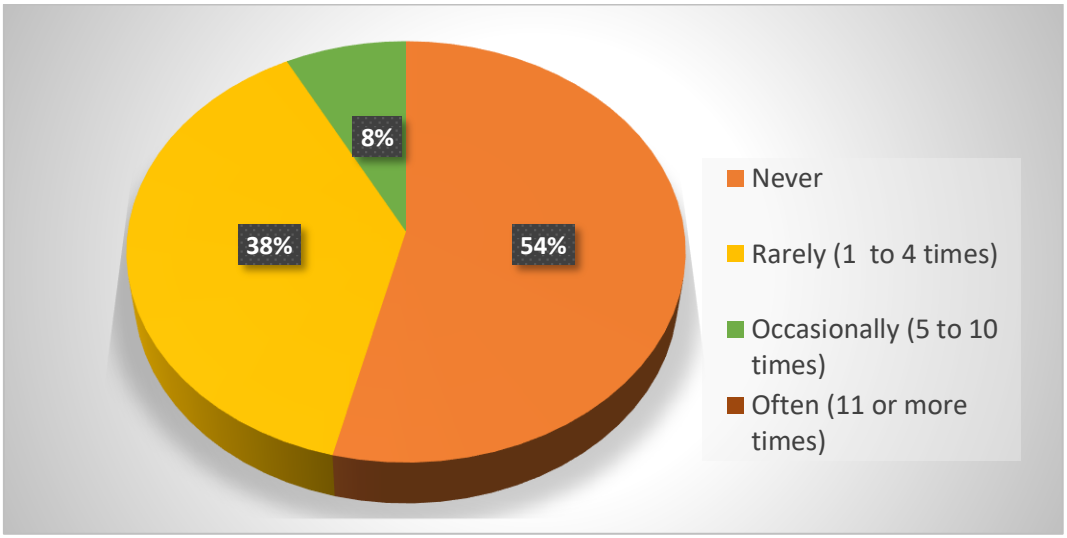
Graph 4.22 shows that only 8percent of the teachers reported to use Smart Boards often which is in correlation with the use of the desktop. Further 69 percent of the teachers mentioned that they do not use Overhead Projectors.

Graph 4.23: Frequency of Smartboards



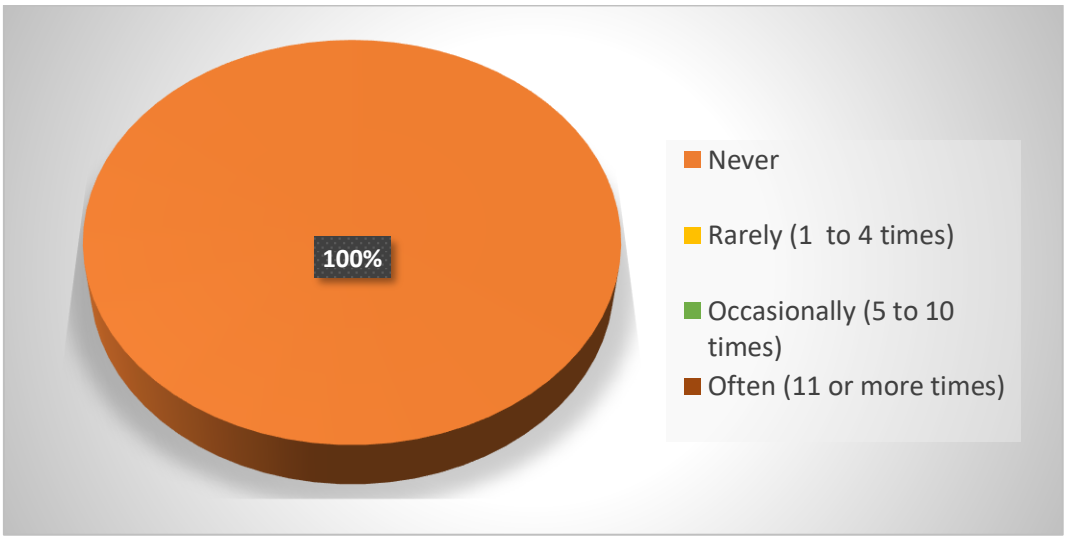
It can be observed in Graph 4.23 that 65 percent of the teachers mentioned that they never use Smartboards. It is likely that this figure is high due to unavailability of the resource. 27 percent of the teachers which is the exactly same as the percentage of teachers using the Overhead Projectors and therefore it is a possibility that teachers might be using Smartboard as a screen for projecting their content. Further 8 percent of the teachers reported to be using the Smartboard more than 11 times in a month.

Graph 4.24: Frequency of Internet



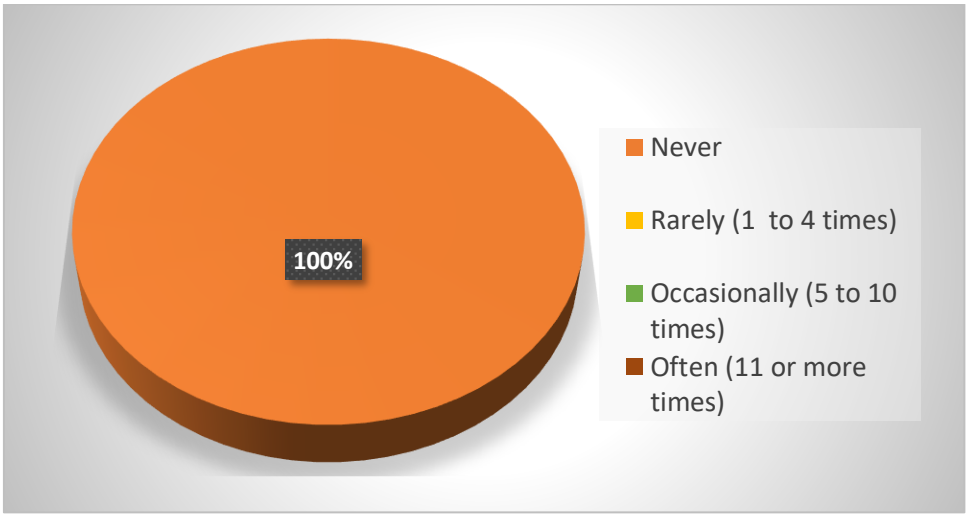
According to Graph 4.24, the figure 8 percent is consistent with the teachers who use desktops, overhead projectors, smartboards and who also require Internet Connectivity. 38 percent of the teachers mentioned that they rarely require Internet Connectivity for teaching Mathematics and 54 percent said that they are altogether good without Internet.

Graph 4.25: Frequency of Television Sets



Graph 4.25 indicates that none of the teachers perceive Television Set as an ICT resource for teaching of Mathematics. The desktops, OHPs and Smartboards seem to have replaced the Television as an ICT Resource.

Graph 4.26: Frequency of Digital Camera



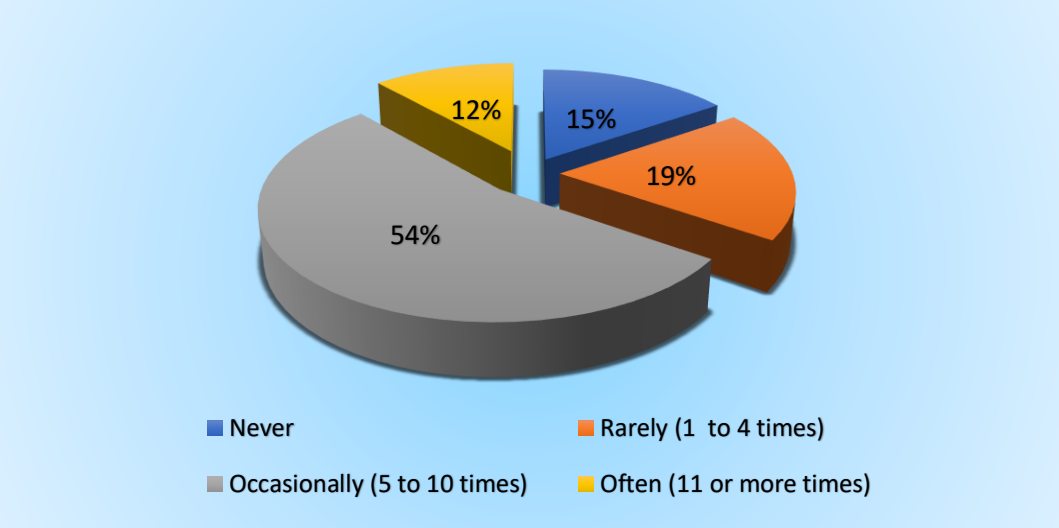
Graph 4.26 shows that Digital Camera is not being used by teachers for the purpose of Mathematics teaching. Apparently, it is a single utility device whose all features are now been included in the Smart Phone and therefore teachers are likely to use their Smart Phones for clicking photographs for using in their teaching of Mathematics.

In order to study the objective, further along with the frequency of the ICT resources, the data was also collected about how often the teachers of Mathematics carried out some basis tasks in a month using the ICT resources. Table 4.11 presented overleaf describes the activities and its frequency:

Table 4.11: Frequency of the tasks carried using ICT Resources

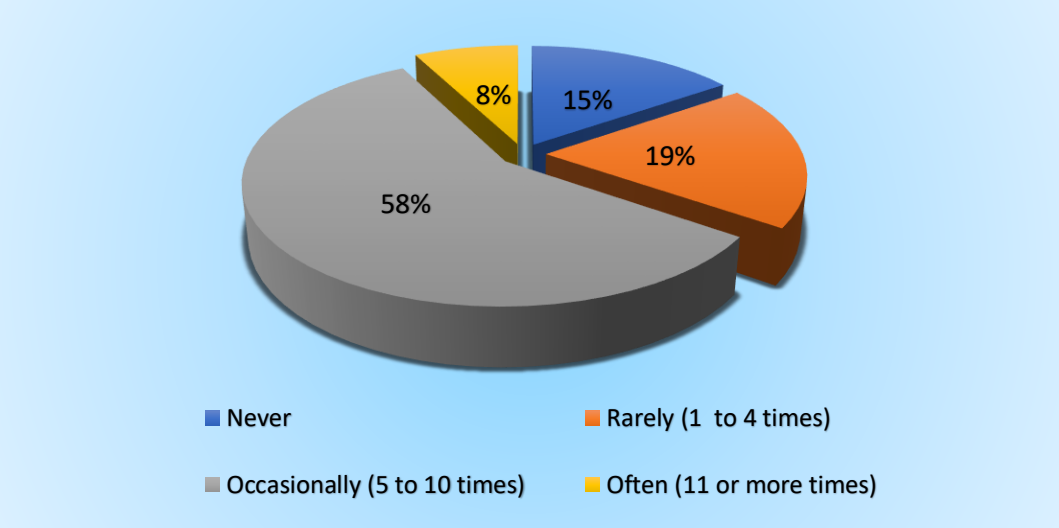
Tasks carried out by Mathematics teachers	Never	Rarely (1 to 4 times)	Occasionally (5 to 10 times)	Often (11 or more times)	Total Teachers
Use teaching material in the text format	4	5	14	3	26
	15%	19%	54%	12%	
Use material in the multimedia format (e.g. audio/video)	4	5	15	2	26
	15%	19%	58%	8%	
Search the Internet to collect information to prepare lessons	5	6	13	2	26
	19%	23%	50%	8%	
Download material from the internet for teaching Mathematics.	5	8	11	2	26
	19%	31%	42%	8%	
Create your own digital learning material (worksheets, presentations, assessment tasks)	5	18	2	1	26
	19%	69%	8%	4%	
Assign a task that provides opportunity to students to use ICT.	21	5	0	0	26
	81%	19%	0%	0%	
Communicate online with parents via email/Learning Management System	22	4	0	0	26
	85%	15%	0%	0%	

Graph 4.27: Frequency of Text Format



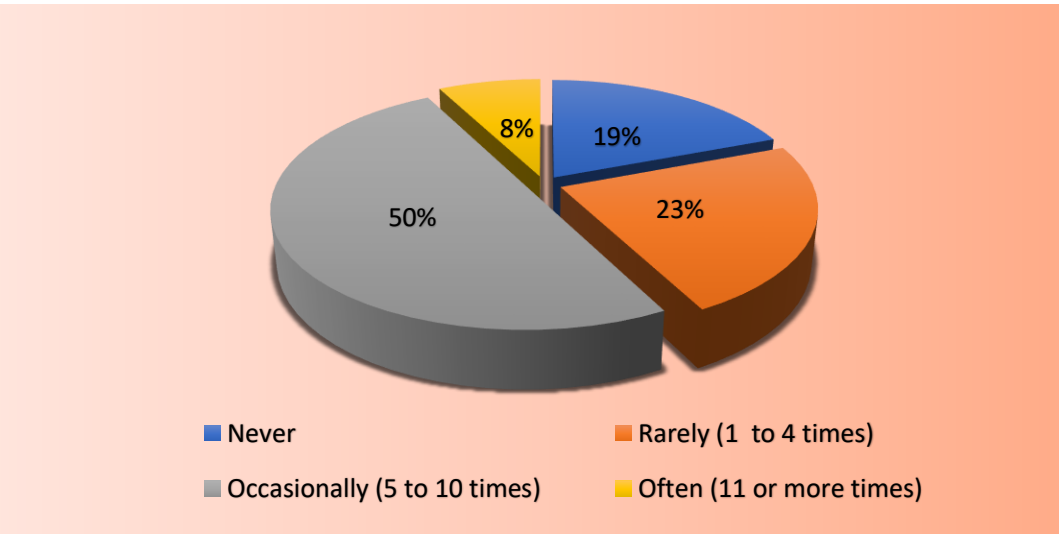
Graph 4.27 represents that 54percent of the teachers occasionally use material in the text format with the help of ICT. The percentage of teachers who use ICT often is as low as 12 percent.

Graph 4.28: Frequency of Multimedia Format



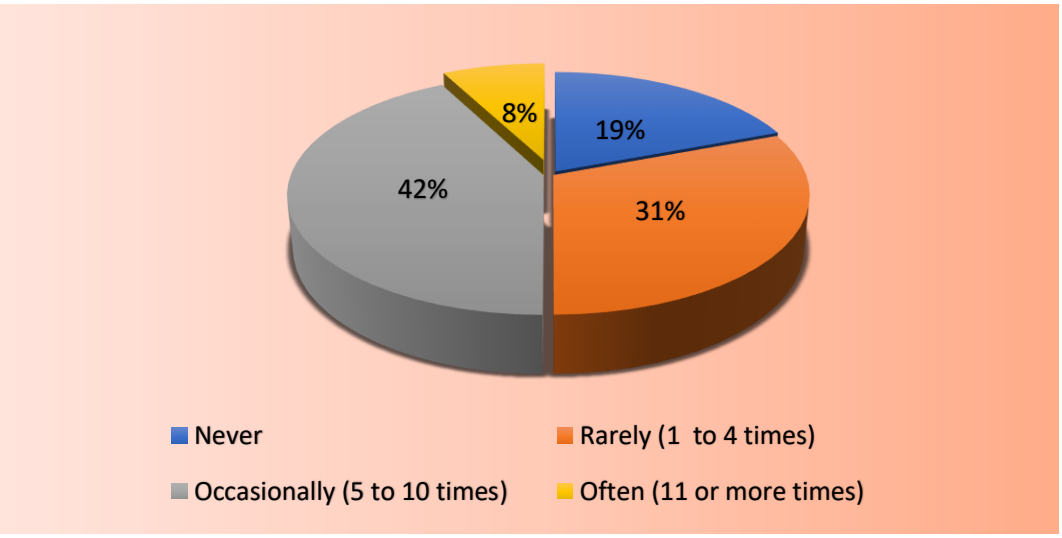
Graph 4.28 exhibits similar proportions like that of the text format when it comes to using ICT resources in the multimedia format. The percentage of teachers who often use multimedia format is only 8 percent. In contrast to that a double of that proportion that is 15 percent neither use text format nor multimedia format while teaching Mathematics.

Graph 4.29: Frequency of Internet usage for Lesson Preparation



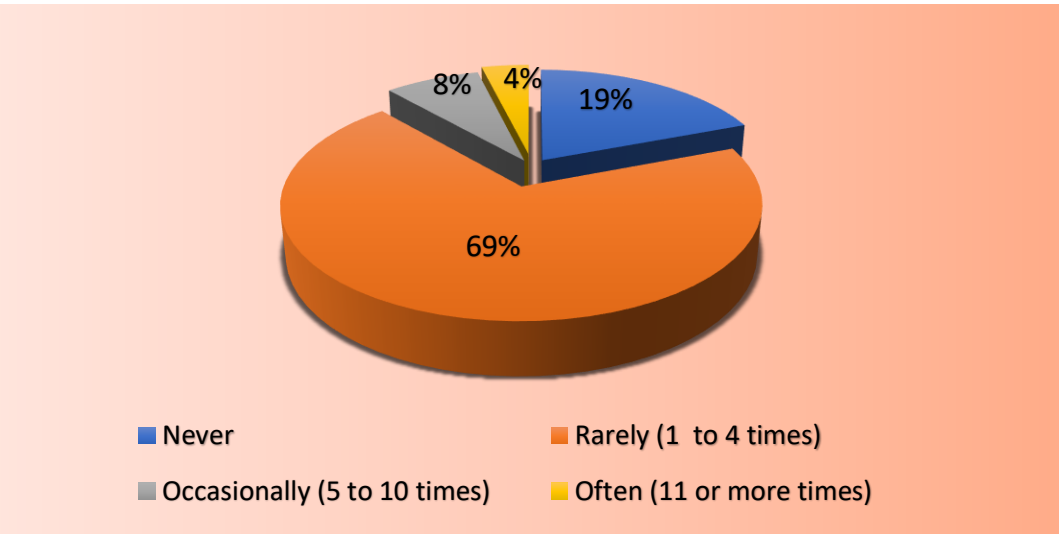
Graph 4.29 reveals that only half of the teachers occasionally use internet for lesson preparation. From the remaining 50 percent, nearly 42 percent of the teacher either don't use internet at all or rarely use it.

Graph 4.30: Frequency of downloading material



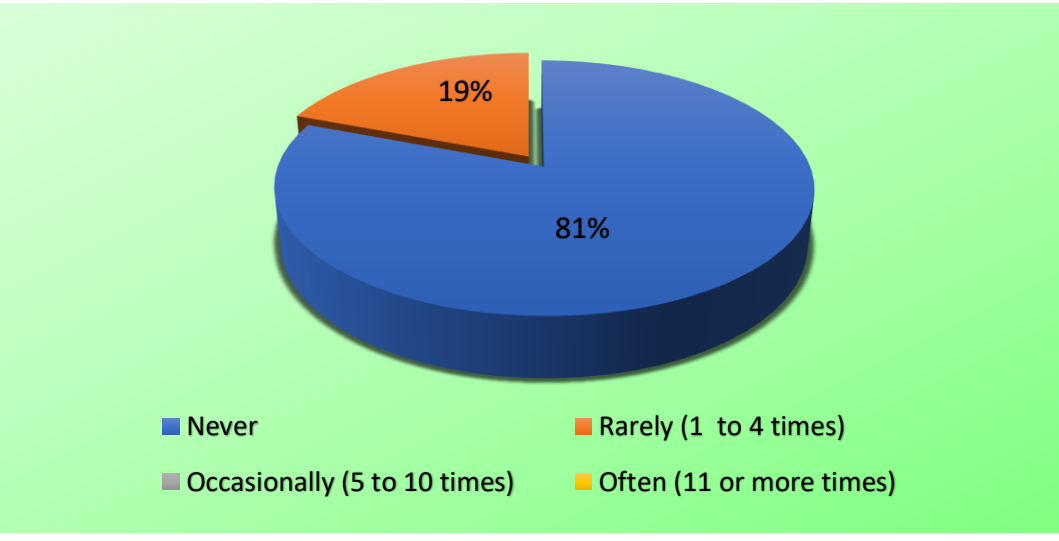
From Graph 4.30, it can be observed that proportion of teachers who often download content is also significantly low (8percent). In contrast to that a total of 42percent of the teachers occasionally use ICT for downloading the content from the internet for the purpose of teaching Mathematics.

Graph 4.31: Frequency of own digital material



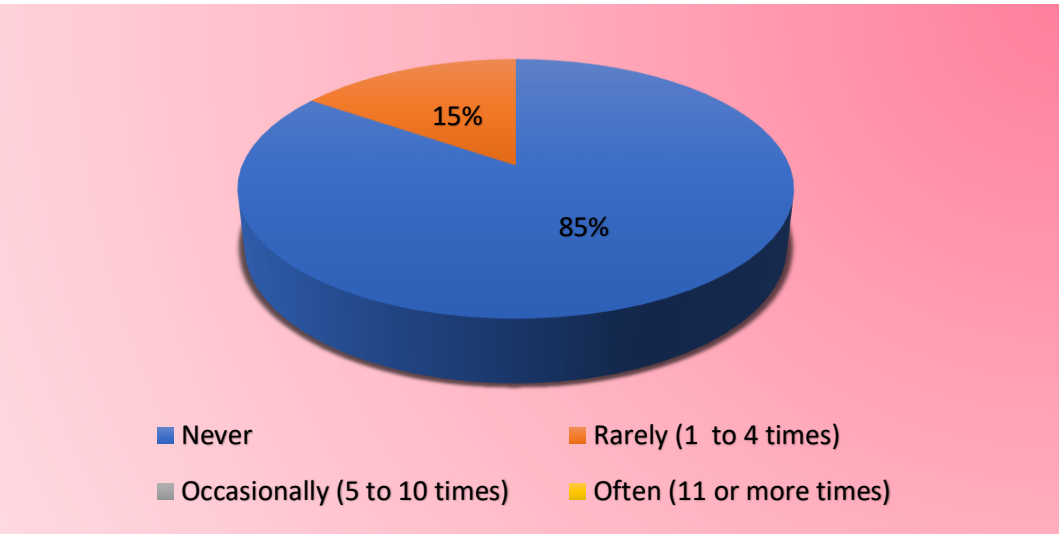
Graph 4.31 exhibits that only 4percent of the teachers create their own digital learning material often using ICT. A big proportion that is 69percent rarely created their own learning material. This material could be a worksheet that the teacher could be creating or an assessment task which could be work processed or a PowerPoint Presentation.

Graph 4.32: Frequency of tasks assigned for using ICT



From Graph 4.32, it can be seen that 81percent of the teachers never provided students with an opportunity for using ICT. And the remaining 19% of the teachers rarely gave students a chance where they were required to use ICT in Mathematics.

Graph 4.33: Frequency of communication using ICT



Graph 4.33 reveals that only 15 percent of the teachers communicated with parents via an online mode. Although technology has become a part of our life however, for the purpose of communication with parents, it seems that the traditional mode of communication which is diaries and circulars still dominate.

4.1.2.2 Analysis of the Focus Group Discussions

The objective 2 was further studied through analyzing the data collected from the students from the Focus Group Discussions (FGD). From each school approximately 10 students participated in the FGD. Therefore, the sample consisted of 100 students.

When students were asked about their perception of ICT, most of them misunderstood ICT as a subject rather than the broader umbrella term which encompasses the electronic gadgets. Some of the students were not able to inform the full form of ICT. They knew that the 'T' in ICT stood for Technology however they were unaware about what 'I' and 'C' stood for.

In regards to their opinion about naming a few ICT gadgets that they see around the school almost everyone identified Desktop computers as popular ICT devices. Students from 4 schools identified Smartboards and Overhead Projectors also ICT gadgets. Many did not realise that Internet Connectivity, Television and Digital Camera also were ICT gadgets.

When the question was put forth about the use of ICT for the purpose of teaching of Mathematics, 85 percent of the students responded that their teachers used ICT minimally in their Mathematics classes. Most of them said that teachers adopted a very tradition method of chalk-and-talk for teaching Mathematics. Students from only 2 schools mentioned that their teachers walked extra mile in using ICT. Teachers who used ICT included videos and PPTs in their teaching to provide a more visual stimulus to the students and make the abstract nature of Mathematics more comprehendible.

With regards to the utilization of computer laboratory for teaching and learning of Mathematics, the answer was "Never". In fact, students mentioned that the computer laboratory was used only when they had ICT and was never utilized for exploring Mathematical concepts.

The responses from students were very interesting in regards to the question about whether they thought that ICT can be used for learning of Mathematics and how? Almost 50 percent of the students said that they already use their parents' smart phones to watch videos to understand some of the difficult concepts and also visit some educational websites on a more regular basis. They wished that their teachers used ICT more often for the teaching of Mathematics.

4.1.2.3Analysis of the Principals' Responses

In response to their understanding of ICT in educational, most of the Principals were able to give an elaborate opinion about the importance of ICT in education and that keeping pace with the technological advancement was so much a need of an hour. Mostly all Principals gave an extensive list of the gadgets that facilitated ICT in their schools which ranged from a computer to the Smartboards.

With regards to the activities carried by teachers in their schools, many Principals provided a very general answers like: Teachers mainly use ICT during exam time for setting up papers, for preparing and showing PowerPoint Presentations or when they want students to watch a documentary or a film. Very few Principals were able to

name Software like Photoshop, Programming software Java, Python, Scratch, Storyboard, Corel Draw, Tally, etc. which were taught to the students at their schools.

Since some Principals did not have Mathematics background, specifically, for teaching Mathematics, they were not aware about apart from using a PPT or showing a video, how else ICT can be integrated by teachers into their pedagogy. The Principals with Mathematics background were familiar with Mathematical software like Matlab, Geogebra, DesMos, etc. however, the students did not seem to benefit from that as they were not installed either on the desktops in the Computer Laboratory or in the individual workstations located in the staffroom for teachers.

With regards to the question about whether teachers faced any problem in using ICT in their teaching – learning process, many Principals answered diplomatically. They mentioned that all problems and grievances of teachers were immediately resolved and thus far none of the teachers has had any issues in regards to using ICT.

As far as the Professional Development of the Teachers was concerned, Principals mentioned that they regularly send their Teachers for Training and Development conducted by the GSHSEB and GCERT as a part of their in-service training programs. Once a year, all teachers undergo some or the other form of training is what was informed by the Principals.

4.2 CONCLUSION

The present chapter focuses on the analysis of the data looking to the nature of data and interpretations made on the basis of the analyzed data. The analysis done under this chapter helped the investigator for deriving the findings of the present study. Based on this, the major findings and conclusion have been made and discussed in the upcoming chapter.

CHAPTER V

SUMMARY, FINDINGS AND SUGGESTIONS

CHAPTER - V

SUMMARY, FINDINGS AND CONCLUSION

5.0 INTRODUCTION

Education is an important instrument for change in developing and developed countries. It provides a better quality of life for any citizen for their living environment. According to United Nations Educational Scientific and Cultural Organisation (UNESCO, 2003), Information and Communication Technology (ICT) is viewed as a "major tool for building knowledge societies". At the school education level, it could be a mechanism that could provide a way to rethink and redesign the educational systems and processes, thus leading to quality education for all. ICT has changed the modalities of the ways in which education can be accessed and imparted. Over the last two decades, its exponential growth in the educational sector – ranging from schools to higher education is simply evident (Tata Trust and IT for Change, 2018). As a result, the teaching-learning process has undergone a paradigm shift. The manifestation of this shift is clearly visible in the way students have adopted the ICT to suit their learning styles; however, with majority of teachers this shift seems to be happening at a much slower rate.

While these changes demand teachers and learners to undergo a transformation, the curriculum too does not remain isolated from being affected. Practically, the fundamental subjects such as Mathematics, Science and English have a tradition of strong dominance over other subjects in the secondary schools. Both, Kothari Commission (1964-66) and National Policy on Education (NPE–1986) stressed on the crucial need of Mathematics and Science in secondary education. It further suggested that "Mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically. Apart from being a specific subject it should be treated as a concomitant to any subject involving analysis and reasoning." ICT and Mathematics both, being so integral to the students' lives, it becomes imperative that their integration in the context of how ICT supplements the teaching and learning of Mathematics should be studied.

This integration is extremely important at secondary level because at this level concepts of Algebra, Geometry and Trigonometry involve abstraction, structuration and generalization. (National Curriculum Framework, NCF 2005).Since with the help of ICT students can be provided more visual impetus, repetition and self-paced learning, they can appreciate Mathematics as a discipline and develop sound understanding of the concepts and its applications.

5.1 RATIONALE OF THE STUDY

ICT in the present time has become an integral part of our living and therefore even a slightest thought of exclusion of ICT throws us thousands of years back in the past. Along with the multitude of benefits that technology has to offer, the rapidly increasing pace at which it is evolving throws challenges to the traditional habits – particularly to the process of teaching and learning. More so these habits have even a greater hold on the fundamental subject like Mathematics.

An assessment of Mathematics, Science and Reading for 15-year-old students from all over the world is carried out every three years by The Programme for International Student Assessment (PISA),an initiative of the Organisation for Economic Co-operation and Development (OECD). In the year 2015, students from 70 nations participated in a scholastic performance test on Mathematics, Science and Reading. The findings revealed that students of 39 nations scored below global mean score in Mathematics. It means that more than 50percent of the secondary students worldwide have difficulty in comprehending Mathematical concepts. The same trend continues on the local front also.

The **Table 5.1**shows Comparison of the average achievement of X^{th} grade students of Gujarat with that of national average in Mathematics, as determined by the National Achievement Survey (NAS) conducted by the NCERT in the year 2018:

Table 5.1

Average achievement of Xth Grade students of Gujarat under NAS

Subject	Content Domain	State Average (Percent correct)	National Average (Percent Correct)	Significant difference
Mathematics	Mathematics (overall)	32	34	⬇
	Algebra	32	35	⬇
	Geometry	33	35	⬇
	Mensuration	33	34	⬇
	Trigonometry	31	37	⬇
	Coordinate Geometry	27	29	⬇
	Number System	27	30	⬇
	Statistics	31	33	⬇
	Probability	36	35	⬆

Source: NCERT (2018)

It can be seen from the Table 5.1 that, average achievement of the students of Gujarat found less than the National average in all content domains, except one. Further the data reveals that, 75 percent of the students of Gujarat scored below 35 percent in the NAS test. Only 32 percent of the students could recognize or recall the required Mathematical concepts, 33 percent could interpret the information represented in the graphical form and 30 percent carried out the procedure required to solve the Mathematical problem. These alarming statistics highlights the need for the intervention and implies that the Mathematics education at the Secondary school level requires serious attention.

A study was conducted to identify the supporting and hindering school level factors for the use of ICT in secondary school mathematics lessons in the context of PISA (2012) on the top five countries from which students outperformed in Mathematics. (Eickelmann, Gerick and Koop, 2017) The relationship between the ICT and performance of students in Mathematics was examined with the factors: (i) the IT equipment of schools, (ii) teacher's attitude toward the use of ICT, (iii) school leadership and (iv) aspects of school goals and educational strategies. The findings

revealed that the teacher's attitude towards using the ICT in Mathematics teaching had a significant influence on the achievement of the students.

With this perspective, the researcher was inspired to discover what the ground reality is. Over the three decades, i.e. since the NPE 1986, the Government has been emphasizing the importance of ICT in the teaching–learning process. If it has been doing the needful in terms of infrastructural development through its *Digital India* initiatives like: ePathshala, National Mission on Education Using ICT, Online Labs (Olabs), Shaala Darpan, Shala Siddhi; then, what are some of the factors which are proving to be a hindrance to the progress of students?

In order to study the efficacy of the ICT in secondary schools, the research would like to begin with identifying how well-equipped the schools are with the ICT resources and what is the working condition of those gadgets. The researcher would further like to study the extent to which the teachers are using ICT in the teaching of Mathematics by considering the parameters like frequency of ICT used in Mathematics teaching and finally the teacher's technical knowledge and readiness for using the ICT.

5.2 STATEMENT OF THE PROBLEM

A study on use of ICT in teaching of Mathematics in the Secondary schools of Vadodara city

5.3 OBJECTIVES OF THE STUDY

The following objectives are framed for the present study.

(i) To study the current status of the use of ICT in terms of the availability of the devices and its working condition in the Secondary schools of Vadodara city.

(ii) To study the use of ICT in teaching of Mathematics in Secondary schools of Vadodara city in terms of the frequency of ICT Resources used.

5.4 EXPLANATION OF THE TERMS

a) Information and Communication Technology: (ICT) in the present study refers to any electronic device used in the teaching of Mathematics. It is inclusive of but not limited to:

- Desktops/Laptops
- Internet Connectivity
- Overhead Projector
- Smart Board
- Television
- Digital Camera

b) Use of ICT: Use of ICT under the present study refers to the use of electronic devices stated above, for the purpose of enhancing students' Mathematical abilities, knowledge and skills.

5.5 OPERATIONALIZATION OF THE TERM

Status: Under the present study, the term 'status' is defined as the availability of the ICT resources, its working condition and the frequency of the ICT resources used by the teachers and / or students in the teaching – learning process of Mathematics.

5.6 DELIMITATIONS OF THE STUDY

The present study was delimited to the Grant-in-Aid English medium schools of Vadodara city affiliated to the Gujarat Secondary and Higher Secondary Education Board (GSHSEB), for the academic year 2019–20.

5.7 POPULATION OF THE STUDY

The population for the present study consisted of forty-four (44) English medium schools of Vadodara City affiliated to the GSHSEB. Out of these 44 schools, 33 schools were Grant-in-Aid schools while remaining 11 schools are Non-Granted (private). Thus, the Principal of the schools, teachers of Mathematics in all these schools and all of the students studying in Standard IX of these schools were the population of the study.

5.8 SAMPLE OF THE STUDY

In order to have a fair representation of the population, 10 schools were selected through a simple random sampling technique. Across the selected schools for the study, 10 Principals, 26 Mathematics teachers, and 10 students from the IX^{th} grade from each school (total 100 students) constituted the sample for the study.

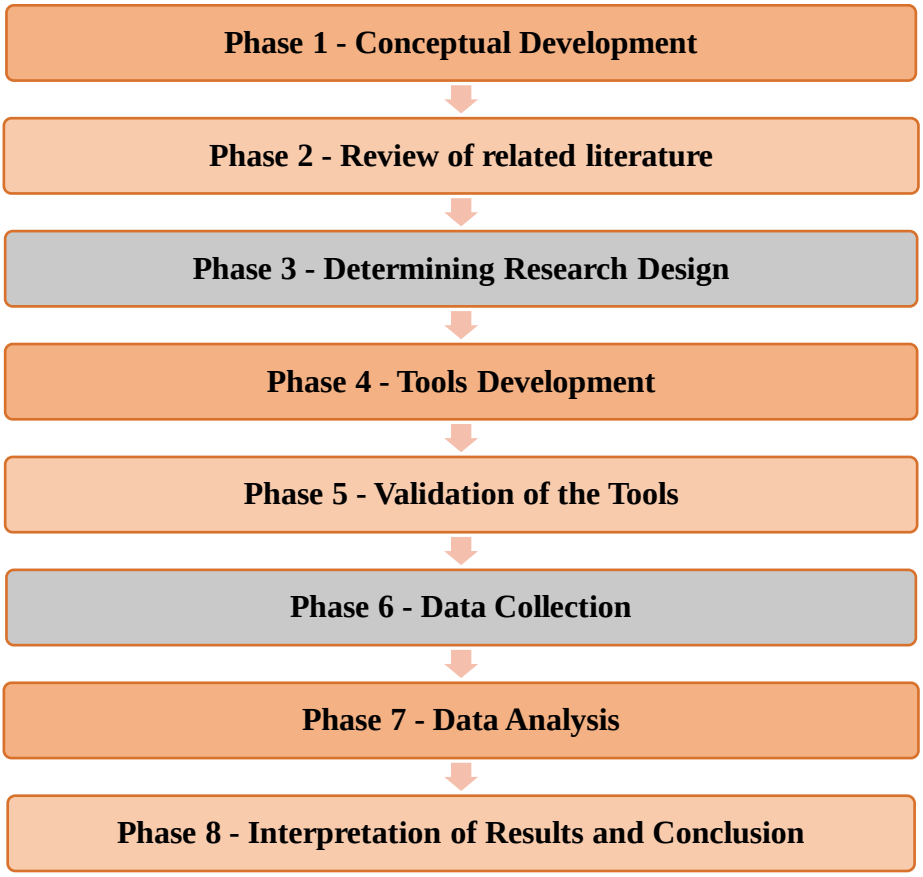
5.9 RESEARCH DESIGN

Once the problem and objectives of the study were decided; the next important and consequential matter in research to be determined was selecting an appropriate research design for the study. The present study was a Descriptive survey research which was conducted for the description of a specific situation and studying opinions of a specific group of the participants (principals, teachers and students), which has allowed the researcher not only to present the prevailing situation but also to interpret and report the existing facts on the ground. According to Best and Kahn (2006), descriptive survey type studies are used to find out '*what is'* and therefore the detailed information is required for answering the research questions. So, looking to the study and its objectives, a Descriptive Survey design was found the most appropriate method to collect the detailed information in relation to achieve the stated objectives of the study.

5.10 PLAN AND PROCEDURE OF THE STUDY

The study was planned in a phase manner as presented in the Figure 5.1. As mentioned in the Figure 5.1, the research study was planned in a phase manner with the initiation of the conceptual framework. The brainstorming exercise in the beginning about identifying the topic of research followed by the SWOT analysis helped to narrow down the domain of the area for the study. Once the topic was decided, a conceptual framework was built in order to understand the concept of ICT with regard to the teaching of Mathematics. In the second phase, the related literature was reviewed and analyzed in order to gain a better understanding of the study and to learn about the research gaps in connection with the present research. Further in the next phase deliberation on the appropriate research design was carried out.

Figure 5.1 Different Phases of the Study



According to Best and Kahn (2006), survey is an effective way to gather information about the status of the practices being executed in educational institution and therefore Descriptive Research design was selected for the purpose of the present study. Followed by it under Phase 4 and 5, the tools were developed by the investigator and were validated on the basis of the experts' opinions. The next big task was of the data collection which was carried out in Phase 6. The investigator collected the data personally with the help of tools and techniques developed under the Phase 4. Once the data were collected, the major job of Data Analysis was carried out in Phase 7. In the last phase, that is Phase 8, results or findings were derived on the basis of the interpretations made through analyzed data and the conclusions were arrived at.

5.11 TOOLS AND TECHNIQUES

Several studies on the topics related to the study were consulted in order to develop the tools required for achieving the objective of the present study. With regards to the objectives, the following tools and techniques were found suitable for the collection of the data:

a) Checklist

b) Semi-structured Interview (For the Principal)

c) Questionnaire (For the Teachers)

d) Focus Group Discussion (FGD for the Students)

All the tools were developed by the investigator. The Checklist was used for collecting the data to achieve Objective 1, while Semi-structured interview schedule, Questionnaire and the Focus Group Discussion were used to collect data to achieve Objective 2.

5.11.1 Checklist

The Checklist developed by the investigator consisted of a list of the ICT gadgets that are expected to be used in the school. Through this tool the status of the ICT gadgets in terms of availability of the ICT resources, the adequacy of the ICT resources against the number of students and the working condition of the ICT gadgets has to be recorded.

5.11.1.1 Development of Checklist

The main criterion behind developing the Checklist was to check the actual status of the ICT gadgets. Hence, that was mentioned in the tool in terms of availability of the ICT resources, the adequacy of the ICT resources against the number of students and their working condition. Since the materials to be observed were tangible in nature, the working condition of the same was categorized as either poor, average, good and excellent. The Checklist was validated with the help of Experts in the relevant field. The list of experts can be seen from the Appendix -F. The developed Checklist can be accessed by referring to the Appendix- B.

5.11.2 Semi-structured Interview

A Semi-structured interview consisted of seven questions related to how Principals envision the use of ICT at their schools and thereby could lead towards the quality and the diversity of ICT resources to be used for teaching of Mathematics.

As indicated by Mathers et al. (2000), Semi-structured interview provides opportunities for both interviewer and interviewees to discuss the topics in more details. This type of interview also let interviewer to elaborate on the key important issues and pose more frequent inquiries during the conversation. Hence, the Semi-structured interview schedule was designed with the aim of eliciting information about the above stated purposes.

5.11.2.1 Development of Semi-structured Interview

An opinion was sought about what Principals felt about difficulties faced (if any) by the teachers of Mathematics while incorporating ICT and whether any professional development opportunities were provided to the teachers. Hence, a Semi-structured interview schedule was decided to develop by the investigator considering some pertinent questions. This allowed the investigator to be prepared and appear competent during the interview. It is through the Semi-structured interviews, that Principals could more easily discuss sensitive issues and give a bigger picture of the situation at hand. Thus, a series of questions was predefined as a Semi-structured interview to employ as a technique to collect the information from the principals. All questions under the Semi-structured interview were formulated in connection with the research objectives. The developed Semi-structured interview schedule was validated on the basis of the Experts' suggestions. The list of experts can be seen from the Appendix -F and the developed Semi-structured interview can be referred from the Appendix C.

5.11.3 Questionnaire

The questionnaire for teachers was an elaborate one – starting with some basic demographic questions about their age group and experience of teaching Mathematics. Followed by that, the questionnaire included total fifteen questions related to their proficiency over the use of ICT gadgets, the willingness to use ICT for teaching of Mathematics and the frequency of it being used per week. In order to study the status of ICT it was important to know frequently the teachers use ICT for Mathematics and how proficient they are about using ICT. In order to have their honest response, a questionnaire was used to collect the information. The reason being - in some cases teachers might be persuaded to lie in order to hide from being embarrassed for not using/not being able to use ICT.

5.11.3.1 Development of Questionnaire

For collecting data from teachers, a questionnaire was decided to be designed so that teachers can respond to the questions in their own time. Further, accessibility of the teachers was also thought about when deciding the tool for the data collection from the teachers. They are extremely busy with classes and other duties and therefore a questionnaire could give them the ease of providing responses at their convenience.

After the development of the initial draft of the questionnaire, it was given to a panel of experts to judge its validity. After that, all the questions under the given draft were discussed with them with regard to their appropriateness, relevance and capacity to describe the major purposes of the study. Based on the feedback and suggestions of the experts, all those questions requiring modifications were modified by the investigator. Thus, the final questionnaire consisting of total fifteen questions, was developed. The list of all experts involved in the phase of validation can be seen from the Appendix– F. The questionnaire can be accessed by referring to the Appendix- D.

5.11.4 Focus Group Discussion

Under the present study, it was important to know how students perceive the use of ICT for teaching of Mathematics and whether they felt any advantage in ICT being used by the teacher. As such the Checklist, Semi-structured interview with Principal and the Questionnaire from the teachers would have been sufficient however, a Focus Group Discussion can very well justify the validity of the responses given by the teachers and Principals and prove as a method of cross verification. Hence, some relevant questions have been listed to discuss with the students as a part of FGD. The list of questions for Focus Group Discussions can be accessed from Appendix E.

5.11.4.1 Development of Focus Group Discussion

In regards to collecting the data from the students the technique that was decided was focus group discussions - a qualitative approach for gaining students' perception about the use of ICT for the learning of Mathematics. The purpose of FGD is to create a comfortable atmosphere for the people to discuss a topic and express their ideas, experiences and attitude about it. FGD can be used for a variety of purposes such as making decisions, assessment and evaluation, problems finding, planning for future,

etc. (Kruger & Casey 2000). Focus group discussion would allow students' representation and thereby assist in verifying the responses provided by the other stake holders.

5.12 DATA COLLECTION

Prior to visiting the schools from which the data were to be collected, a formal permission letter on the letter head of the Department of Education, Faculty of Education and Psychology duly signed by the authority was obtained. The data were collected through the survey by the Investigator personally from the selected schools. With the prior permission of the concerned school Principal, Checklist was used to collect the data related to the ICT gadgets available in the schools. The questionnaire was handed over to the Section In-Charge who got it filled from the Mathematics teachers. The concerned Section In-Charge also made the necessary arrangement for conducting the Focus Group Discussion with the group of students. Focus Group Discussions were conducted with the students of the selected schools from which the data were collected. There were 10 students in each group. It was important to know how students perceive the use of ICT for teaching of Mathematics and whether they felt any advantage in ICT being used by the teacher. Thus, the data were collected in terms of the actual status of the ICT gadgets in the schools, Principals' views about the use of ICT in their schools and the diversity of ICT resources to be used for teaching of Mathematics, teachers' views regarding their proficiency over the use of ICT gadgets, the willingness to use ICT for teaching of Mathematics and the frequency of it being used per week and finally perceptions of the students about the use of ICT for teaching of Mathematics and their advantage for the teachers.

5.13 DATA ANALYSIS

Looking to the nature of the collected data, they were analyzed qualitatively as well quantitatively. The data collected through the Checklist were analyzed in terms of the adequacy of the ICT gadgets in the school. Responses from the teachers were analyzed by using Frequency and Percentages. Data collected through open ended questions under the Semi-structured Interview for the Principals and the Focus Group Discussions with the students, were analyzed through content analysis by identifying themes and categorization.

5.14 MAJOR FINIDINGS OF THE STUDY

Based on the objectives and the tools with which the data was collected findings of the present study can be broadly classified objective wise:

Objective 1: To studying the current status of the use of ICT in terms of the availability of the devices and its working condition in the Secondary Schools of Vadodara city.

- The schools having 2 computer labs were able to meet the demand of the students however the remaining ones ran short of this resource. The working condition was generally good except for two schools which require to upgrade their facilities.
- In regards to the number of desktops, schools were found not to have enough desktops for their students and were shared inadequately. The working condition of the desktops was from average to good.
- Overhead projectors were found in scare quantity in schools; however, the condition of the OHPs in the schools in which they were found was maintained in excellent condition.
- Very limited quantity of Smartboards was found in the schools that were surveyed. They were shared inadequately with students and were maintained in a good condition.
- DVDs and Audio CDs by many schools are now considered as an obsolete technology and therefore not enough were maintained by the schools. The ones that were maintained were in excellent condition.
- Television sets too were in limited numbers in schools and were mainly found at the reception area rather than the classrooms.
- Each school had minimum 1 Digital Camera; however, they were not being utilised due to the advance features now available in Smart phones. All digital cameras were maintained in good condition.

Objective 2: To study the use of ICT in terms of the frequency of ICT Resource used for teaching Mathematics at the Secondary schools of Vadodara city.

- Computer laboratories were never used by teachers for the purpose of Mathematics teaching.

- Very few teachers used desktops and OHPs for teaching Mathematics often. Most of the teachers followed the traditional chalk-and-talk method and did not use desktops.
- Smartboards are being used merely as white screens for projections and that too on rare occasions by the teachers.
- Despite Internet being so popular, very less proportion of teachers use Internet for the purpose of teaching Mathematics.
- Television Sets and Digital Cameras are considered as obsolete technologies are being replaced by Smartboards and Mobile Phones respectively. Therefore, many teachers did not even recognise as an ICT resource for teaching Mathematics.
- With regards to the activities carried out using ICT resources by teachers very less proportion of teachers used ICT for the material in the text format and multimedia format.
- Internet usage for lesson preparation and downloading material from the Internet for the purpose of Mathematics teaching was carried by extremely less proportion of teachers.
- Very few teachers created their own digital material e.g. worksheets, assessment tasks or PowerPoint presentations.
- Students lacked the opportunity from the teachers for utilising ICT for the purpose of Mathematics learning.
- Communication with parents was minimal using ICT resources.

5.15 DISCUSSION AND IMPLICATIONS

In today's world, there hardly is any field which is not being impacted by the development of technology. Education in many ways is known to use ICT for various purposes such as teaching, learning, dissemination, evaluation, collaboration etc. Over the two decades ICT has become an integral part of today's education system and is considered by the educationists around the globe to supplement teachers with their pedagogy. The reviewed literature too resonates to the fact that ICT has huge potential in making the teaching-learning process of Mathematics more effective. In particular, (Thillakaand, 2000), (FitzPatrick, 2001), (Vahey, et.al. 2004), (Papanastasiou and Ferdig, 2006) and (Rajakumaran, et.al. 2010) indicated that the use of ICT lead to

further the students' conceptual understanding and contributed positively in students' achievement. However, with a special focus on the status of the usage of ICT by secondary school teachers, some of the review literatures viz. (Narsimha, 2012), (Swamy, 2012), (Ghosh, 2018) and (Singh, 2018) identified that traditional educational methods still dominated. Lack of technical knowledge among teachers, not enough training and lack of infrastructure of ICT were some of the factors that prevented the use of ICT in the Indian classrooms. With India being so diverse culturally, politically and financially that the infrastructure, pre-service and in-service training of teachers, ICT skills of teachers would have a very broad range which provides a wider scope for the study to be conducted on the use of ICT in Mathematics teaching in the secondary schools of Vadodara city.

According to the objective wise analysis of the first objective 4.1.1 which is about studying the status of ICT resources in the secondary schools of Vadodara city in terms of quantity, adequacy an working condition of the ICT resources, majority of the schools have 2 computer laboratories which is adequate as per the number of students of respective schools. Most of them are well maintained. In regards to the quantity of desktops the number varied from school to school however, 40% of the schools had maintained adequate number of desktops and 60% of the schools had either shared them inadequately among students and did not have enough to cater to the ICT needs of the students. Only 1 school had sufficient number of OHPs. Majority of the schools surveyed had 3 or less OHPs in their schools. All OHPs were maintained in a good condition. Smartboards are still not very common in schools. Except 2 schools all schools either only had 1 Smartboard or none. The former 2 schools also only had 3 Smartboards. Obviously, they are not enough in number; however, being an expensive relatively newer resource for schools, all of them were maintained in a good to excellent condition. DVDs now a days seem to be an outdated technology as most of the data now is either available directly from the internet or can be carried in more portable devices like USBs, Memory Cards and Smart phones. As a result, only 5 schools out of 10 were found to have those resources. It is trivial to say that since it is not the resource which is so commonly used now, they are not stored by schools in enough number. However, the schools which have this resource maintains in a lock and key cabinets in plastic cases in excellent condition. Only 6 of the Grant-in-Aid schools possessed television sets. In 4 of the schools it was placed

either in a Common Assembly Hall or at the Reception of the school. With the OHPs being more popular the need of television as an ICT resource is felt less. Every school survey had at least 1 Digital Camera and was maintained in excellent working condition. Since all Smartphones now come enabled with a camera, Digital Camera – a single utility device is an obsolete ICT resource in schools.

The second objective 4.1.2. is about studying the use of ICT in teaching of Mathematics in terms of the frequency of ICT Resource used for teaching Mathematics at the Secondary schools of Vadodara city. For investigating this objective, data related to the demographics of the teachers was also collected which would give an idea about their gender, age, years of experience and number of classes per week. Majority of the teachers were found in the age group 31 to 50 with at least 6 years of experience as Mathematics teacher. Almost all teachers had 41 to 50 students in a class and were teaching 16 or more hours in a week. The rationale behind collecting this data is to know the background of teachers and their workload and thereby identify whether it might be a factor affecting the frequency of the ICT resources used in teaching of Mathematics. As noticed from the data, the teachers that are surveyed were relatively young and are expected to possess some basic level of know-how for integrating ICT resources in their teaching. From the data provided by the teachers, it was found that the computer laboratory was never used for the teaching of Mathematics. The computer laboratory however was mainly used for teaching and learning of "ICT" as a subject but never specifically for the purpose of Mathematics. In fact, Mathematics has plenty of scope for students to use computers for e.g. Excel for Statistical investigations, GeoGebra – a Geometrical and Graphical software allows students to play with equations and see how varying the variables impact the graph. In order to give all students to experience this, students could benefit from taken to the computer laboratory.

In regards to the desktops, it was identified that only 8% of the teachers use desktops occasionally that is from 5 to 10 times a month, whereas 92% of the teachers use desktops less than 5 times in a month. This was exactly the same frequency which was found for the use of OHPs also. It obviously is an indication that OHPs are used along with the desktop. Smartboards are not so popular in schools which was found through its limited use by only 8% of the teachers that too approximately 5 to 10

times a month. Television and Digital Camera were never used specifically for teaching of Mathematics. This is possible due to the fact that there is an alternative to these resources such as OHPs and Smartphones respectively which have made the use of Television and Digital Camera extremely limited.

In order to know how teachers used the ICT resources for teaching of Mathematics, the frequency of certain basic activities which teachers generally carry out in a month for the teaching learning process was analysed. With regards to using the ICT for Mathematics teaching in text format and multimedia format only 10% of the teachers used ICT often. The proportion of teachers often using Internet for lesson preparation and often downloading the content specifically for teaching Mathematics was also found to be significantly low – only 8%. However, approximately 46% of the teachers occasionally used ICT for the above wo mentioned activities. As far as creating their own learning material was concerned that is preparing a worksheet or an assessment task or a PowerPoint presentation, only 12% of the teachers occasionally or often created it. Rest of the 88% either rarely prepared the material or used material prepared by others. The culture where students get an opportunity for using ICT in Mathematics does not seem to have been built yet. 81% of the teachers never gave students that opportunity and the remaining 19% rarely give them that opportunity in the form of making a PowerPoint presentation.

In the present age of technology, it is disappointing to know that proportion of teachers using technology often does not even reach 2-digit figures. The activities which were carried out by teachers for Mathematics were mainly using the teaching material in the text-format, multimedia format (i.e. audio-video), browsing internet for lesson planning and downloading the Mathematics content from the internet. Only 12% of the teachers created their own learning material using the ICT resources. The most discouraging fact was that approximately 80% of the teachers never assigned tasks to the students which would opportune students to use ICT for Mathematics learning. Communication with parents through ICT was also found to be least preferred by the teachers or rather not conducive to the parent community.

While analyzing responses from the Focus Group Discussions of students some interesting points emerged. Many of the students were able to identify the ICT

gadgets found around school very quickly. However, most of them seemed lost when questions were asked about the use of ICT in Mathematics. Students were about to comment on the use of ICT resources for the teaching and learning of ICT as a "subject", but mentioned that there was minimal use of ICT resources by their teachers for Mathematics. The responses from students were very fascinating in regards to the question about whether they thought that ICT can be used for learning of Mathematics and how? Almost 50% of the students said that they already use their parents' smart phones to watch videos to understand some of the difficult concepts and also visit some educational websites on a more regular basis. They wished that their teachers used ICT more often for the teaching of Mathematics.

Almost all Principals agreed about the importance of ICT in education and mentioned at length how keeping pace with technology was not only the need of any hour but for building competent digital citizens of future also. In regards to the use of ICT for Mathematics, many Principals did not seem very confident and provided information about how ICT is being taught at their school. A majority of Principals explained limited use of ICT such as showing a PPT or a video or displaying a worksheet of Mathematics. Those with Mathematical background knew about the Mathematical software Matlab, Geogebra, DesMos, etc. however, the students did not seem to benefit from that as they were not installed either on the desktops in the Computer Laboratory or in the individual workstations located in the staffroom for teachers.

In regards to the problems faced by the teachers in using ICT in their teaching – learning process, many Principals answered diplomatically. They mentioned that all problems and grievances of teachers were immediately resolved and thus far none of the teachers has had any issues in regards to using ICT. Regarding the Professional Development of the Teachers, it was found that Principals sent their Teachers for Training and Development program once a year which is conducted by the GSHSEB and GCERT as a part of their in-service training programs. Clearly looking at the current situation, to what extent the Training has developed the teachers' competency in using ICT for Mathematics is a matter of further research.

5.16 SUGGESTIONS FOR FURTHER RESEARCH

From the findings and the conclusion drawn from the study, the investigator realised the following areas where further study is possible:

1. This study was limited to Grant-In-Aid schools of Vadodara city. It can be extended to other schools also and a comparative study could be carried out.
2. A study on the competency level of ICT Teachers can be carried out in order to know how proficient and capable the teachers are in using ICT for various subjects.
3. A study can be carried out for identifying problems faced by teachers while using ICT in various subjects.
4. A study can be carried out for the various Professional Development programs provided to teachers for using ICT in their respective subjects.
5. An evaluative study could be carried out in relation to the extent to which teachers utilize the knowledge and the skills developed through the training and development provided to teachers for the use of ICT for their subject.

5.17 CONCLUSION

From the analysis of the collected data, its interpretation and from the major findings the following conclusions can be drawn:

1. The status of the use of ICT to teach Mathematics at Secondary level by the teachers of Vadodara city in terms of the availability of the devices was not found in sufficient number. There is significant scope for the ICT infrastructural development for the Grant-In-Aid schools of Vadodara city. Working condition of majority of the ICT resources was found good and regular maintenance would ensure a longer lifespan for the devices.

2. In terms of the frequency of the ICT gadgets used for teaching Mathematics at the Secondary Schools of Vadodara city, it was found that teachers are not using the ICT resources as often as they should. Students want their teachers to use ICT in Mathematics as they find ICT to supplement their learning and help them understand some of the abstract Mathematical concepts through audio-visual stimulus.

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APPENDICES

Appendix A

Department of Education (CASE & IASE)
Faculty of Education and Psychology
The Maharaja Sayajirao University of Baroda
Vadodara – 390 002
Phone No.: 0235 2795516

Tarang Pathak
M.Ed. – II Student
The M. S. University of Baroda
Date: 16th December 2019

To,

The School Principal

Subject: Request to collect data for M.Ed. Dissertation 2019 - 2020

Dear Sir/Madam,

I, Tarang Pathak the student of the Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, pursuing a dissertation entitled "Use of Information and Communications Technology in teaching of Mathematics in the Secondary Schools of Vadodara City " to be submitted for the partial fulfillment of M.Ed. Degree for the year 2019-2020, hereby request you to kindly permit me for collecting data from your esteemed institution.

The data will be kept l be related to the list of schools located in Vadodara City. The data will be kept highly confidential and will be used for the research purpose only.

Your cooperation in this regards will be highly appreciated.

Thanking you,

Yours Sincerely,

Tarang Pathak

Prof. Satish Pathak
Guide
Department of Education (CASE)
The Maharaja Sayajirao University of Baroda

Dean
Faculty of Education and Psychology
The Maharaja Sayajirao University of Baroda

Appendix B

CENTRE FOR ADVANCED STUDY IN EDUCATION (CASE)
Department of Education
Faculty of Education and Psychology
The Maharaja Sayajirao University of Baroda
Vadodara

Checklist

To study the status of using ICT in teaching of Mathematics in the Secondary Schools of Vadodara City

(to be filled by the Investigator through observation with the help of a teacher and/or principal of the school to be surveyed)

Name of the school :_____

Address :_____

Total number of students in Secondary Section: _____

Total number of Mathematics teachers in Secondary Sections: _____

Part A: Availability of ICT Resources in the School

ICT Resources Available for Teachers	YES	NO	Number/s Available/Remarks
Computer Laboratory			
Desktop/Laptops			
Overhead projectors			
Smart Boards			
Internet connectivity			
DVDs/Video CD			
Television Set			
Digital Camera			

Part B: Adequacy of the ICT Resources in the School

ICT Resources Available for Teachers	Sufficient	Shared inadequately	Not enough
Computer Laboratory			
Desktop/Laptops			
Overhead projectors			
Smart Boards			
Internet connectivity			
DVDs/Video CD			
Television Set			
Digital Camera			

Part C: Working condition of the ICT Resources in the School

ICT Resources Available for Teachers	Excellent	Good	Average	Poor
Computer Laboratory				
Desktop/Laptops				
Overhead projectors				
Smart Boards				
Internet connectivity				
DVDs/Video CD				
Television Set				
Digital Camera				

Description of the condition:

- *Excellent* – In operational condition and well maintained
- *Good* – In operational condition, however requires more timely maintenance
- *Average* – In operational condition, however lacks timely maintenance / accessories missing
- *Poor* – Non-functional, broken, accessories missing

Appendix C

CENTRE FOR ADVANCED STUDY IN EDUCATION (CASE)
Department of Education
Faculty of Education and Psychology
The Maharaja Sayajirao University of Baroda
Vadodara

Semi-structured Interview

This Semi-structured interview is for the Principal about the use of ICT in teaching of Mathematics in each school across Vadodara city. The study is mainly focused on the frequency, quality and the diversity of ICT gadgets used in teaching and learning of Mathematics.

All responses will be treated with strict confidentiality.

I sincerely appreciate you taking precious timeout from the busy schedule and devoting it to provide the information. You input and insights are really invaluable for the present study.

Name of the school: _____

1. What is your understanding of the use of ICT in education?
2. Which gadgets are there in your school to facilitate ICT in education?
3. For what activities do the teachers generally use ICT in your school?
4. What is your opinion about the use of ICT in teaching of Mathematics?
5. Are you aware of any teachers from your school who are proficient in using ICT for teaching of Mathematics? If so, can you tell how does the teacher uses it?
6. Is there any difficulty faced by the teachers for using ICT in the teaching-learning process?
7. Does your school provide professional development / training / course to the teachers? If yes, can you please briefly mention a few of them?

Appendix D

CENTRE FOR ADVANCED STUDY IN EDUCATION (CASE)
Department of Education
Faculty of Education and Psychology
The Maharaja Sayajirao University of Baroda
Vadodara

Questionnaire

This questionnaire is to be filled by Mathematics Teachers about the use of ICT in schools across Vadodara city. The study is mainly focused on the frequency, quality and the diversity of ICT gadgets used in teaching and learning of Mathematics.

Requesting you to read and answer each question carefully. All responses will be treated with strict confidentiality.

I sincerely appreciate your taking precious time out from the busy schedule and devoting it to provide the information. You input and insights are really invaluable for the present study.

Please put a ☑ in the box provided: ☐ * indicates – information must be provided

1. * Name of the school: _____

2. Name of the Teacher: _____

3. *Age: (a) 30 or Under ☐ (b) 31 to 40 ☐ (c) 41 to 50 ☐ (d) Above 50 ☐

4. *Gender: (a) Male ☐ (b) Female ☐

5. *Teaching Hours per week per subject:

(a) Less than 5 ☐ (b) 6 to 10 ☐ (c) 11 to 15 ☐ (d) 16 or more ☐

6. *Average number of students per class:

(a) Less than 30 ☐ (b) 31 to 40 ☐ (c) 41 to 50 ☐ (d) 50 or more ☐

7. *Number of years of experience as a Teacher (inclusive of this school):

(a) Less than 1 year ☐ (b) 1 to 5 years ☐ (c) 6 to 10 years ☐ (d) more than 10 years ☐

Questionnaire – Part 1

For the next set of questions, use below given description for the use of ICT resources per month

- Never – Do not use ICT at all
- Rarely – 1 to 4 times
- Occasionally – 5 to 10 times
- Often – 11 or more times

8. How often do you take students to Computer Laboratory for teaching/learning of Mathematics?

   (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

9. How often do you use Desktop/Laptop for teaching/learning of Mathematics?

   (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

10. How often do you use Overhead Projector for teaching/learning of Mathematics?

    (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

11. How often do you use Smartboard for teaching/learning of Mathematics?

    (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

12. How often is Internet Connectivity essential for teaching/learning of Mathematics?

    (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

13. How often do you use Television for teaching/learning of Mathematics?

    (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

14. How often do you use Digital Camera for teaching/learning of Mathematics?

    (a) Never ☐ (b) Rarely ☐ (c) Occasionally ☐ (d) Often ☐

Questionnaire – Part 2

15. How often do you carry out the following activities using ICT? (Choose any one option)

Description of the frequency:

- Never – Do not use ICT at all
- Rarely – 1 to 4 times
- Occasionally – 5 to 10 times
- Often – 11 or more times

Activities	Never	Rarely	Occasionally	Often
(a) Use teaching material in the text format	☐	☐	☐	☐
(b) Use material in the multimedia format (e.g. audio/video)	☐	☐	☐	☐
(c) Search the Internet to collect information to prepare lessons	☐	☐	☐	☐
(d) Download material from the internet for teaching Mathematics.	☐	☐	☐	☐
(e) Create your own digital learning material (worksheets, presentation, assessment tasks) for students	☐	☐	☐	☐
(f) Assign a task that provides opportunity to students to use ICT	☐	☐	☐	☐
(g) Communicate online with parents (via email/Learning Management System)	☐	☐	☐	☐

Appendix E

CENTRE FOR ADVANCED STUDY IN EDUCATION (CASE)
Department of Education
Faculty of Education and Psychology
The Maharaja Sayajirao University of Baroda
Vadodara

Focus Group Discussion

This Focus Group Discussion is for collecting data from students on the use of ICT in schools across Vadodara city. The study is mainly focused on the frequency, quality and the diversity of ICT gadgets used in teaching and learning of Mathematics.

All responses will be treated with strict confidentiality.

I sincerely appreciate your taking precious time out from the busy schedule and devoting it to provide the information. You input and insights are really invaluable for the present study.

School Name: _____

1. What is your understanding about the term ICT?
2. Can you name a few ICT gadgets that you see around in your school?
3. Does your teacher use any ICT gadgets during teaching of Mathematics? How?
4. Have you ever visited the school computer laboratory specifically for learning of Mathematics?
5. Do you think ICT can be used for learning and teaching of Mathematics? How?

Appendix F

List of Experts

Sr. No.	Name of Expert	Designation	Institute
1	Prof. Satish Pathak	Professor	The Maharaja Sayajirao University of Baroda, Vadodara
2	Dr. Trushna Kapadia	Teacher	Navrachana International School, Vadodara
3	Mr. Sunil Tiwari	Teacher	Navrachana International School, Vadodara
4	Mr. Dilip Sharma	Teacher	Navrachana International School, Vadodara
5	Ms. Minal Shah	Teacher	Navrachana International School, Vadodara