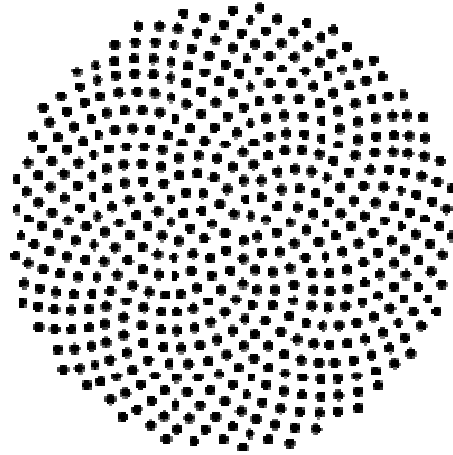# CMC: A Model Computer Science Curriculum
for K-12 Schools

3rd Edition, Released June 2013

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Department of Computer Science and Engineering

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CMC: A Model Computer Science Curriculum for K-12 Schools

3rd Edition   June, 2013

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Computer Science Curriculum, 2013, 3rd Edition

Preface

This document prescribes a curriculum (called **CMC**) for K-12 Computer Science in schools. While CMC is written in the context of schools in India, it can be also used by schools in other countries. Textbooks based on CMC are being used by more than a hundred schools in India, as of March 2013.

Schools in India have been offering Computers as a subject to their students for the last 10 years or so. While the syllabi for 9th – 12th grades are defined by various examination Boards, there is no formal curriculum for 1st – 8th grades. The NCERT (National Council of Educational Research and Training) specifies the computer literacy competencies and skills to be developed at Primary, Middle and Secondary levels. However these specifications are broad, leading to variations in their interpretation across textbooks and schools. Hence there is a need for a detailed specification for computer curriculum. CMC, described in this document, fills this gap.

This document provides: (i) the rationale, underlying philosophy, and key features of CMC, (ii) details of topics and specific learning objectives to be addressed in each grade, (iii) recommendations for teaching-learning strategies, and (iv) one instance of how CMC was implemented through textbooks.

The first edition of CMC was released in March 2007. The second edition was released in April 2010. This document is the third edition, released in June 2013. A brief history of the development of CMC and related materials is as follows:

- 2006-2007 – This activity started in June 2006 at IIT Bombay. A survey of existing computer science curricula and textbooks in India led to identifying the need for a detailed curriculum specification. As a result, the 1st edition of CMC was developed, and released in March 2007. The draft of 1st edition was reviewed by a team of academic experts, mentioned in Annexure D.
- 2007-2008 – Teacher Handbooks based on 1st edition of CMC were created by a collaborative effort involving contributors from geographically different places. A pilot study on using the handbooks was conducted by the authors, at a school - Sri Sri Ravishankar Vidya Mandir (SSRVM), in Mumbai. The key insight was that having only teacher handbooks are not sufficient and there is a need to develop textbooks based on CMC.
- 2008-2009 – Textbooks for grades 1-4, titled Computer Masti**,** were written based on the 1st edition of CMC and released under Creative Commons License. Pilot studies were conducted by the authors, not only to teach using these books but also for teacher training in various schools. The key insight was the need to have periodic teacher training programs.
- 2009-2010 – Textbook authoring for higher grades continued. Discussions with more pedagogy experts, mentioned in Annexure D, led to the development of the 2nd edition of CMC, which was

released in April 2010. A company, InOpen Technologies, was incubated at SINE-IIT Bombay, to take up large scale teacher training and implementation in schools.

- 2010-2012: Textbook authoring for grades 1-8 was completed. The number of schools adopting these books crossed a hundred. The number of downloads of the books crossed ten thousand, from across a hundred countries. These books may be freely downloaded, for individual, non-commercial use (as per Creative Commons License specified), from www.computermasti.in Alternate link: www.cse.iitb.ac.in/~sri/ssrvm/ .

- 2012-2013: Results from field implementations led to the development of the 3rd edition of CMC. This document, the 3rd edition of CMC, was released in June 2013. It may be downloaded from www.cse.iitb.ac.in (Click on Research → Technical Reports; Document ID: TR-CSE-2013-52). Alternate link: www.cse.iitb.ac.in/~sri/ssrvm/ .

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1 INTRODUCTION

Children today are exposed to a wide presence of computers (in homes and elsewhere). Their natural curiosity leads them to explore these "interesting toys". They often learn on their own (or from friends or parents) to use a computer for a variety of purposes. This could lead to learning undesirable habits (playing on a computer for hours), incorrect usage, and unsafe usage (ignorance of the risks in Internet access). Hence it is desirable for schools to introduce learning about computers as part of the curriculum itself. It is necessary to take note of what computer usage is prevalent among children of a given age group and introduce those topics into the curriculum in a suitable manner. If this is not done, the school curriculum would lag behind what students learn in other settings, leading to boredom, in addition to the dangers of incorrect/ignorant usage. Also, new computer-based tools and technologies are constantly finding their way into popular use, so it is necessary for the curriculum to be dynamic. The curriculum needs to be adapted appropriately to the introduction of new tools, while simultaneously keeping a focus on conceptual learning. Moreover, there should not be an emphasis on learning computers at the expense of other subjects/activities, and the curriculum should be well-balanced.

Indian schools have already been offering Computers as a subject to their students for the last 10 years or so. Some schools introduce it as early as 1st grade and some introduce it in the 3rd grade or later. Unlike other subjects where there is a prescribed textbook and syllabus, there is a lot of ambiguity for teaching computer science. One reason is the lack of a well defined framework. Currently the National Curriculum Framework (NCF) 2005 [NCF 2005] defined by NCERT forms the basis for the CBSE Board syllabus [CBSE Board]. Schools tied up with this board do teach the topics mentioned in the framework. However the emphasis within topics is open to interpretation and there is wide variation in the treatment of a given topic across books. The ICSE Board has defined syllabus only for 9th to 12th grades [ICSE Board]; for the lower grades, each school can teach what the school decides as appropriate. This leads to variation in the books chosen by individual schools and hence in the topics covered at the primary and middle school level.

The topics covered currently are more driven by the market demand at that point of time. Typically, the focus is on usage and skill based content for specific applications (for example, Java, Microsoft Office). There is very little emphasis on thinking skills or concepts of broad applicability that would be useful across subjects. As the individual schools are given the flexibility of following their own curriculum and textbooks, there is a huge variation in topics that are being covered. Hence there is an urgent need to define a detailed curriculum to teach computer science in schools.

To summarize, in India, a formal curriculum for Computers does not exist for the lower grades. Yet, several textbooks have been written for Computers as a school-level subject, and many schools are offering Computers as a subject in the lower grades, leading to a variety of ways in which it is being taught. What should be taught in the lower grades is being left open to interpretation for textbook authors and schools. There is no metric by which a school or a textbook author can check whether the topics being taught and the manner in which they are being taught are suitable. Hence there is a need for detailed specifications for a school-level Computers curriculum in India.

1.1 Scope of this curriculum

This document defines the details of what we believe is an appropriate, balanced curriculum for teaching Computers in schools for Grades 1-8, according to students' level of maturity and the demands of the present century. The syllabi for 9th to 12th grades are defined by the various Boards (See Section 2.1) and hence are beyond the purview of this document. However, as shown in Section 3.3, this curriculum prepares students to take Computers as an elective subject for 9th to 12th grades for the various Boards.

This curriculum, *referred to as CMC*, emphasizes nurturing clarity of thought and learning of concepts associated with various tools, rather than just the usage skills of a specific tool. CMC explicitly include topics to facilitate and improve thinking skills, such as stepwise thinking and logical reasoning, which are not subject specific. The treatment of topics assumes that Computers is taught as an independent subject. Yet, CMC makes the connections of topics in Computers to other subjects and to real world applications explicit.

Historically, the theory and practice of curriculum has been approached in four possible ways [Smith 2000], corresponding to different purposes that a curriculum can achieve: curriculum as a body of knowledge to be transmitted, curriculum as an attempt to achieve certain ends in students, curriculum as process and curriculum as praxis. This curriculum document addresses the first three purposes.

i) Curriculum as a body of knowledge to be transmitted.
The central themes in the content are identified and justified for inclusion in this curriculum (CMC). CMC goes beyond a syllabus. It not only defines the details of the themes, sub-themes and topics to be taught at each grade, but also indicates the relative importance of different topics, the connections between the topics and the order at which they are to be studied. (Section 2.4, Section 3.1, Annexure A).
ii) Curriculum as an attempt to achieve certain ends in students.
This approach is useful for teachers and students since this approach specifies clear performance outcomes at various stages. This is addressed in CMC by specifying learning objectives for themes and sub-themes (Section 3.2) at every grade.

iii) Curriculum as a process.

In this model, the curriculum is required to provide the basis for planning a course, and the justification of various choices. These points are addressed in CMC by providing a framework for the selection of the content and guidelines for sequencing it (Section 3), and principles for developing teaching-learning strategies (Section 4). The underlying principles and philosophy on which CMC is based are also described (Section 2).

This curriculum (CMC), in its current stage, does not address the following points:

- It is desirable that a curriculum is customized to local requirements and resource availability. CMC does not yet differentiate implementation in varying contexts, such as for schools in rural and tribal areas in India.
- While there have been efforts at adapting CMC for an adult computer literacy programs, it does not address alternate requirements such as digital literacy or vocational education programs.
- It is recommended that a curriculum should describe techniques of empirically studying the effects of its implementation. CMC does not yet provide a means of experimentation and evaluation.
- CMC does not address the praxis approach, such as exploration of practice between peer-teachers or reflection by implementers as to what worked.

This document begins with a summary of some existing curricula to teach computers, followed by establishing the foundations for this curriculum (CMC), and a description of the approach in designing CMC (Section 2). Then details of content choice for various grades are given (Section 3, Annexure A). These are followed by recommendations for teaching-learning strategies (Section 4), based on the underlying philosophy, and an example of CMC implementation (Section 5 and Annexure B), in the form of text books.

2 FOUNDATIONS OF THE CMC CURRICULUM

CMC addresses the question: *"What computer-related topics should be taught in each grade and why?"* especially in the Indian context. Before exploring this question, a review of existing curricula and textbooks for teaching Computers at the K-12 grades is given below. (Indian schools use the term 'standard' in place of the term 'grade'. This document uses the term 'grade' consistently).

2.1 Existing Curricula and Textbook Options

2.1.1 Computer curricula in Indian school Boards

Schools in India are affiliated to one of CBSE, ICSE, IB, IGCSE, or State Boards. Each Board prescribes curricula and conducts standardized examinations for grades 10 and 12. A summary of computers curricula prescribed by these Boards is as follows:

- The CBSE Board follows the NCERT NCF 2005 [CBSE Board]. The NCERT (National Council of Educational Research and Training) classifies computer literacy into six categories: Fundamental Operations and Concepts, Social and Ethical Issues, IT Tools, Communication Tools, Technology Research Tools and Problem Solving. The curriculum is categorized for three levels: Primary, Middle and Secondary schools. At each level, the categories are divided into competencies and skills to be developed. However these specifications are broad and there are variations in their interpretation across textbooks and schools.

- The ICSE Board has computers as a core subject in 1st to 8th grades, and as an elective in 9th to 12th grades. The syllabi for 9th to 12th grades includes topics such as computer hardware functions, data representation and internal computer structure, computer software, social context of computing and ethical issues, algorithms, programming using a high level language and computers in everyday life. Details are available on their website [ICSE Board]. However the syllabi for the lower grades are left open. Schools are free to follow textbooks by any publisher that they find suitable. As a result there are variations in the topics covered, breadth of topics, concepts and skills taught at different schools.

- The IGCSE Board [IGCSE Board] based out of Cambridge and the IB Board [IB Board] based out of Geneva offers computer science and computer studies at various levels. However, there are not many schools in India that follow these curricula.

- Some State Boards in India have introduced computers as a subject, with varying degrees of syllabus specification. A pioneering effort is the IT@School project by the State govt. of Kerala which provides a comprehensive curriculum and teaching resources for various grades [IT@School project]. However for most other states the details of the topics to be covered and their depth are open to interpretation.

2.1.2   Computer curricula in other countries

There exist K-12 Computer Science curricula in many countries. Some examples are:

- The Association for Computing Machinery (ACM) Task Force Report [ACM K-12] provides a curriculum and well-defined methodology to integrate teaching of computers and information technology into K-12 grades. Computer skills are learnt by carrying out projects and computer-based activities in other subjects.

- The International Society for Technology in Education (ISTE) [ISTE] defines standards for evaluating skills and knowledge that students need to live productively in a digital world (NETS-S). The milestones describe what students should know and be able to do by the end of various grades, in technology operations, information fluency, problem-solving, creativity, collaboration, and ethics.

- The European Computer Driving License [ECDL] foundation offers international computer skills certification from introductory to advanced levels. The programmes contain modules which define the 'skills and competencies to be a proficient user of a computer and computer applications'.

- Governments of several countries define their own curricula, learning objectives and competencies for CS education (also called Informatics, or IT) at the school level. [Hubwieser et al 2011] note that there is a variation not only in the content to be taught and at what level, but also in the levels of specificity described. They describe a research framework (called Darmstadt model), to systematize descriptions of school CS education across countries.

Integrated models such as the one from ACM are desirable but this approach is not suitable for Indian schools. Two key limiting factors are the lack of various resources and low computer skills among the teachers. Hence a comprehensive curriculum tailor-made for the Indian context is required.

2.1.3   Computer textbooks in India

A review of some textbooks available from reputed publishers for teaching computers in Indian schools is given in Annexure C. A summary is as follows:

- Most authors have attempted to provide a good, age-appropriate treatment of any given topic. Most books contain detailed explanations for some topics suggested in the NCERT or other guidelines. The books provide useful suggestions for activities, but these activities are primarily constructed around specific tools such as MS Word or Excel. Many books contain several screenshots for the usage of software tools. Also, there is insufficient emphasis on conceptual learning. In a few cases, it is not clear whether the book is meant to be read by the students or be used as a guide by the teacher.
- There is a wide variation in the interpretation of the syllabus leading to non-uniform emphasis on various topics. Even in a given textbook, the relative emphasis of the various topics is sometimes disproportional to their importance. Sometimes the contents for an entire year deal with learning intricate details of one technology tool.
- None of the textbooks surveyed explicitly address the need to emphasize on general intellectual development and conceptual thinking skills. So no textbook was found consistently suitable, throughout the various grades and topics.
- Different schools follow different textbooks. Some do not follow any book but simply leave it to the teacher's creativity to choose the resources. As a result, there is a wide variation in the computer curriculum being taught, even among schools that are affiliated to the same Board.

2.1.4   CMC

This document is a detailed specification of a computer science syllabus, referred to as CMC. It prescribes the themes and sub-themes to be addressed in each grade, learning objectives for each topic and recommends teaching-learning methods to be followed. It is hoped that these details will enable textbook authors and teachers to exercise their creativity in the explanation of a given topic, rather than the choice of the topics themselves. In other words, they should be free to focus on the "how to teach", rather than deal with "what to teach" and "why".

2.2   Underlying Philosophy of CMC

As mentioned in Section 1.1, this document addresses three purposes of a curriculum: (i) Curriculum as a body of knowledge to be transmitted, (ii) Curriculum as an attempt to achieve certain ends in students, and (iii) Curriculum as a process. The various choices made to address these purposes are influenced by the underlying philosophy of CMC, which is as follows:

1. *Develop computer fluency, not just computer literacy.*

   While computer literacy is defined as the knowledge and ability to use computers and related technology efficiently, computer fluency means a robust understanding of what is needed to use information technology effectively across a range of applications [Committee on Information Technology Literacy, NRC. 1999]. The goal of computer fluency is to enable students to adapt to the changes in digital world rather than merely be aware about computer and its application. Hence, CMC has emphasis on understanding of the concepts behind various computer-based activities, rather than usage specific tools. The goal of such a concept-oriented approach is to equip students to be self-learners and enable them to cope with the inevitable advent of new versions, tools and technologies of the future.

2. *Develop thinking process skills, not just content mastery.*

   While content mastery (domain knowledge) is important, the need to develop thinking process skills (cognitive processes used by experts) is well established [Padilla 1990; Big6 skills]. Hence, CMC has explicit emphasis on teaching of thinking process skills, which are the basic procedures and methods used in making sense of complex situations, solving problems, conducting investigations and communicating ideas. Computer literacy skills are introduced only after motivating the need for developing the corresponding thinking process skill.

3. *Highlight the interconnectedness of knowledge, not just address a topic/subject in isolation.*

   While mastery of a topic is important, recognizing the inter-connectedness of various topics and ideas leads students to construct a more expert-like knowledge structure [Ellis and Stuen 1998]. Hence, CMC has emphasis on: (i) thematic integration, i.e., the integration of knowledge from various subjects into the Computers curriculum, and the use of computer-skills activities to strengthen knowledge in other subjects, and (ii) spiral curriculum, i.e., the content of the curriculum is organized such that themes and topics are revisited with increasing depth in each successive visit.

In addition, CMC is neutral to specific hardware platforms and software packages. However, to maximize outreach and ensure scalability, it suggests Free/Open Source (FOSS) based operating systems and applications.

To summarize, CMC addresses thinking process skills, fundamental concepts of computer science and computer literacy skills, in manner that themes and topics are revisited with increasing depth in each successive visit, and in a context that reflects the inter-connectedness of different subject domains. These key features described in the next section.

2.3   Key Features of CMC

2.3.1   Thinking process skills

Thinking process skills include basic methods and cognitive processes used by scientists, engineers, computer scientists, writers, economists and many other professionals in making sense of complex situations, solving problems, conducting investigations and communicating ideas. These skills are applicable in a wide range of problems in science, technology and engineering, as well as in everyday life. The thinking process skills addressed in CMC include: *Algorithmic thinking, problem-solving skills, systematic information gathering, brain storming, analysis and synthesis of information, multiple representation and divergent thinking.*

Thinking process skills have been widely recognized as being relevant and important for students in the 21st century. There exist recommendations from various professional bodies and accreditation boards such as ACM and ABET [ACM; ABET] that these transferable skills are required by college graduates. A body of science and mathematical education research literature recommends that students need to develop these skills to understand and practice authentic science. Various combinations of the thinking process skills have been referred to in literature as science process skills [Padilla 1990], the Big 6 [Big6 skills], and critical thinking skills.

The rationale for choosing the specific thinking process skills mentioned above is several-fold. One, algorithmic processes are the foundation of much of computer science, hence developing step-wise algorithmic thinking is key to understanding several aspects of computers itself. Algorithmic thinking and logical reasoning are applied in solving problems in several domains. Next, learning how to systematically gather information, represent it in multiple ways, and analyze and synthesize information, form the basic steps of research in any area. The skills of gathering and organizing information are key to developing information literacy. Finally, thinking process skills such as brainstorming, synthesizing information, multiple representation and decision-making, equip students with powerful skills to handle real-life situations at various ages, from planning a vacation, to buying a computer for home use, to deciding future education and career paths.

CMC includes thinking process skills as a key feature of the curriculum not only because they are required in learning the fundamentals of computers, but importantly, because they need to be *explicitly*

addressed in a curriculum if we want students to develop them. Students do not automatically acquire these skills, while learning content [Marzano et al 1988].

2.3.2 Computer literacy integrated with fundamental concepts and thinking skills

As mentioned in Section 2.2, CMC is based on the philosophy that it is necessary to address computer fluency, not just literacy. Thus CMC does not approach computer literacy simply as a list of usage skills of increasing difficulty that the students must learn one by one. Instead it approaches the learning of computer usage skills in the context of learning about fundamental computer-related concepts and thinking process skills. The first step in deciding to teach a particular usage skill lies in establishing the need for that skill, either to learn a concept or to develop a thinking process skill. At that point, the usage skill is addressed only to the extent it is required by the underlying need. Advanced aspects of the usage skill are addressed in future visits to the topic, as explained in section 2.3.4.

Moreover, educational research shows that learning is not just a rational act, but also has emotional connections [Hinton et al 2008]. Hence CMC also addresses learners' attitude towards computers. This leads to the following categorization of topics chosen for each grade:

- Concepts: Learning computer science concepts, as well as thinking process skills. These address the development of the *cognitive* faculties of the learner.
- Usage Skills: Developing hands-on skill in the use of various hardware, software, and programming languages. These address the development of *behavioral* faculties.
- Social Aspects: Understanding and applying ethical and security related issues of computer and Internet usage, developing a positive attitude towards computers, and enjoying the process of inquiry. These address the *affective* faculties.

2.3.3 Thematic integration

Thematic integration views learning and teaching in a holistic way and reflects the interactive nature of the real world [Hanlon and Ayre 2005]. It provides useful ways for teachers and students to make connections between and among subject area concepts (Ellis & Stuen 1998). When curriculum is addressed in an integrated fashion, and when more connections are made between ideas, the complexity of mental models and the amount of learning increase. Learners connect ideas they encounter, to construct a cohesive knowledge structure in their minds. Therefore, those taught using an interdisciplinary or integrated curriculum often exhibit better performance or learning than those taught according to traditional subject compartmentalized programs [Brooks and Brooks 1993; Sunal et al 1996]. Thematic integration bridges the gap between formal, abstract knowledge and real-world, informal knowledge, both of which play an important role in the learning of computers.

One way to apply thematic integration is through the development of an interdisciplinary thematic unit, supported in its development and execution through technology [Miller and Davidson 1997]. This entails use of computer-based learning tools. In countries where most students have access to desktops, laptops or other handheld devices in the classroom, thematic integration of technology primarily refers to the application of technology into other subjects [Eteokleous, 2008].

On the other hand, in countries such as India, where resources are constrained, computers are mostly implemented as a separate school subject. To address these needs, CMC suggests a thematic integration for Computers curriculum that involves reinforcing what is taught in other subjects while learning computers. In other words, CMC curriculum builds on what students learn in subjects such as Science, Maths, Geography, and so on, to acquire conceptual and procedural understanding of computers. Moreover, the natural attraction of students to acquire computer-usage skills by doing computer-based projects is leveraged to motivate them to acquire deeper knowledge in the other subjects.

2.3.4   Spiral curriculum

CMC is organized as a spiral curriculum [Bruner 1977]. It is structured such that themes and topics are revisited multiple times, with each successive visit increasing the depth to which topics are addressed. A spiral curriculum could be conceptualized as follows:

- A set of ideas or operations are first introduced in an intuitive way.
- After they have been mastered at a conceptual level, ideas are revisited in a more formal manner.
- The connection with other knowledge is developed so that students start building interconnected complex set of ideas.
- The next, higher level of mastery is treated at a more abstract level.

While a spiral curriculum entails revisiting topics multiple times, it is not simply a repetition of a topic. Each visit deepens the treatment of the ideas. Increasing levels of difficulty are addressed in successive visits of a topic. New knowledge or skills, advanced applications, and additional objectives, get added in each subsequent visit. At all times, explicit connections are made from new learning to old learning. Some benefits of a spiral curriculum are: it reinforces understanding of topics, builds from simple to complex ideas, achieves higher cognitive levels during successive encounters with a topic without overwhelming the student, and provides flexibility to personalize learning.

While attention is paid to the age appropriate manner of introducing a topic, the emphasis is not on defining precisely which topics are to be introduced at which age. It is acceptable if all students do not understand all ideas in the first visit. The goal is that since each topic is revisited more than once, each student is able to grasp the topic at some point in time.

2.3.5   Scalability

CMC is not preferential to any specific hardware platforms or software packages. However, to maximize the outreach and implementation in a cost-effective manner, CMC recommends the use of free and open source software (FOSS) operating system and applications. It has been recognized that unless an attitude and aptitude of knowledge creation is established in developing countries, they will continue to remain as mere consumers of technology [Hawkridge 1990]. Besides bringing down implementation costs, the use of FOSS facilitates a culture of freedom, builds confidence in the user to be in command of technology, and empowers them to participate in technology creation.

2.4   Process of CMC Curriculum Design

The CMC philosophy (Section 2.2) led to the identification of key features (Section 2.3). This section describes the process followed to operationalize the features into topics to be taught at each grade.

As mentioned in 2.3.2, CMC categorizes topics into Concepts, Usage Skills and Social Aspects. The process used for coming up with the curriculum details is as follows:

1. Identify what concepts, usage skills and social aspects are relevant for K-12 levels, keeping in mind the key features of integrating computer literacy with thinking skills. This led to the identification of the following themes: Familiarity with computers, Computer applications, Thinking skills, Computer programming, and Social values. These are described in detail in Section 3.1.

2. Organize the themes into sub-themes and topics to be taught in each grade by applying the spiral design (See 2.3.4). Note that age-appropriateness of the topics is addressed by the spiral design. An overview of the sub-themes as well as their mapping to the grades is given in Figure 1, with more details in Annexure A.

3. Define learning objectives for the topics in each grade. The learning objectives are measurable indicators of the performance of a student in that topic [Anderson and Krathwohl 2001]. The detailed learning objectives for each grade are given in Section 3.2.
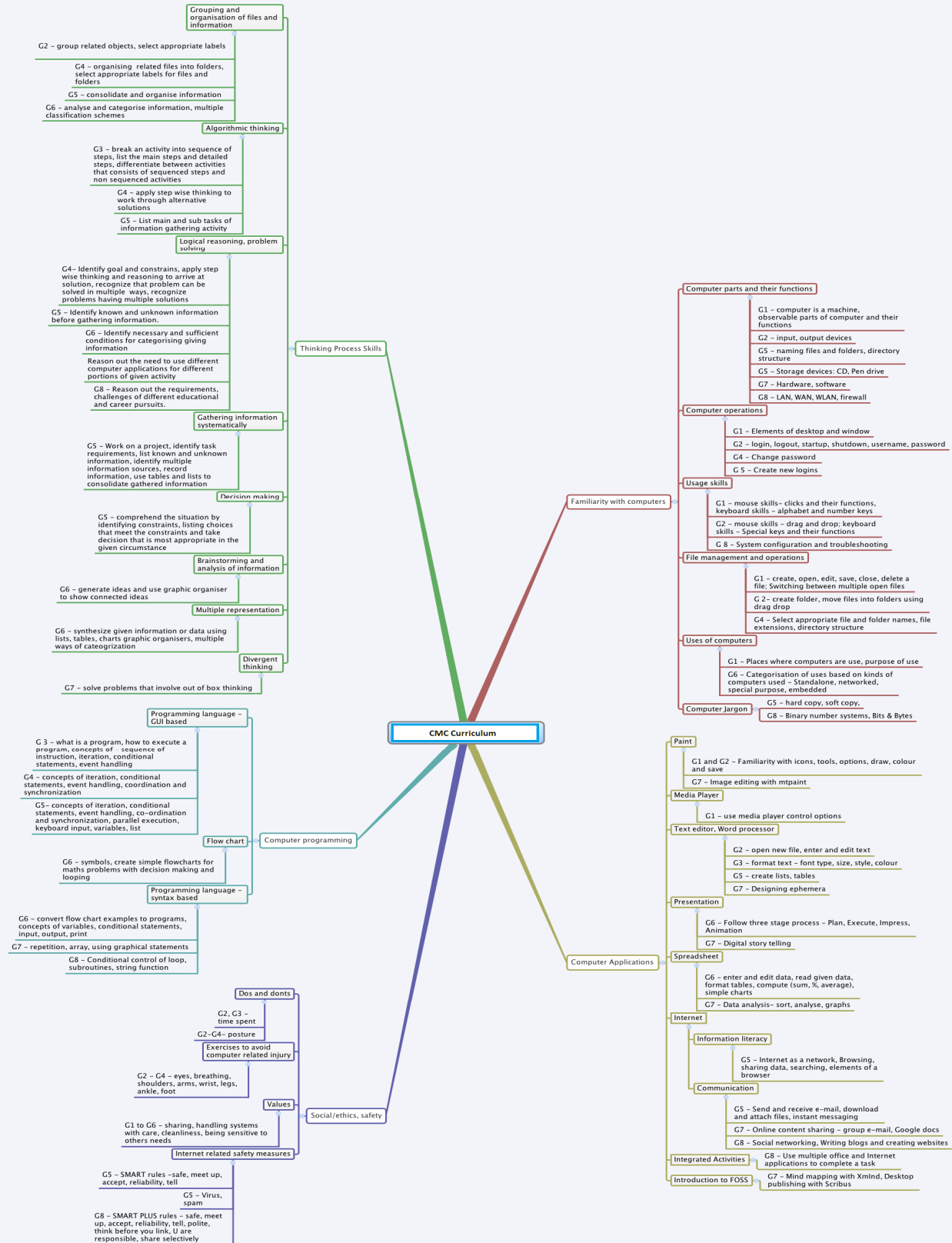
CMC Curriculum

Thinking Process Skills

Grouping and organisation of files and information
- G2 – group related objects, select appropriate labels
- G4 – organising related files into folders, select appropriate labels for files and folders
- G5 – consolidate and organise information
- G6 – analyse and categorise information, multiple classification schemes

Algorithmic thinking
- G3 – break an activity into sequence of steps, list the main steps and detailed steps, differentiate between activities that consists of sequenced steps and non sequenced activities
- G4 – apply step wise thinking to work through alternative solutions
- G5 – List main and sub tasks of information gathering activity

Logical reasoning, problem solving
- G4– Identify goal and constrains, apply step wise thinking and reasoning to arrive at solution, recognize that problem can be solved in multiple ways, recognize problems having multiple solutions
- G5 – Identify known and unknown information before gathering information.
- G6 – Identify necessary and sufficient conditions for categorising giving information
- Reason out the need to use different computer applications for different portions of given activity
- G8 – Reason out the requirements, challenges of different educational and career pursuits.

Gathering information systematically
- G5 – Work on a project, identify task requirements, list known and unknown information, identify multiple information sources, record information, use tables and lists to consolidate gathered information

Decision making
- G5 – comprehend the situation by identifying constraints, listing choices that meet the constraints and take decision that is most appropriate in the given circumstance

Brainstorming and analysis of information
- G6 – generate ideas and use graphic organiser to show connected ideas

Multiple representation
- G6 – synthesize given information or data using lists, tables, charts graphic organisers, multiple ways of cateogrization

Divergent thinking
- G7 – solve problems that involve out of box thinking

Familiarity with computers

Computer parts and their functions
- G1 – computer is a machine, observable parts of computer and their functions
- G2 – input, output devices
- G5 – naming files and folders, directory structure
- G5 – Storage devices: CD, Pen drive
- G7 – Hardware, software
- G8 – LAN, WAN, WLAN, firewall

Computer operations
- G1 – Elements of desktop and window
- G2 – login, logout, startup, shutdown, username, password
- G4 – Change password
- G 5 – Create new logins

Usage skills
- G1 – mouse skills– clicks and their functions, keyboard skills – alphabet and number keys
- G2 – mouse skills – drag and drop; keyboard skills – Special keys and their functions
- G 8 – System configuration and troubleshooting

File management and operations
- G1 – create, open, edit, save, close, delete a file; Switching between multiple open files
- G 2 – create folder, move files into folders using drag drop
- G4 – Select appropriate file and folder names, file extensions, directory structure

Uses of computers
- G1 – Places where computers are use, purpose of use
- G6 – Categorisation of uses based on kinds of computers used – Standalone, networked, special purpose, embedded

Computer Jargon
- G5 – hard copy, soft copy,
- G8 – Binary number systems, Bits & Bytes

Computer Applications

Paint
- G1 and G2 – Familiarity with icons, tools, options, draw, colour and save
- G7 – Image editing with mtpaint

Media Player
- G1 – use media player control options

Text editor, Word processor
- G2 – open new file, enter and edit text
- G3 – format text – font type, size, style, colour
- G5 – create lists, tables
- G7 – Designing ephemera

Presentation
- G6 – Follow three stage process – Plan, Execute, Impress, Animation
- G7 – Digital story telling

Spreadsheet
- G6 – enter and edit data, read given data, format tables, compute (sum, %, average), simple charts
- G7 – Data analysis– sort, analyse, graphs

Internet
- *Information literacy*
  - G5 – Internet as a network, Browsing, sharing data, searching, elements of a browser
- *Communication*
  - G5 – Send and receive e-mail, download and attach files, instant messaging
  - G7 – Online content sharing – group e-mail, Google docs
  - G8 – Social networking, Writing blogs and creating websites

Integrated Activities
- G8 – Use multiple office and Internet applications to complete a task

Introduction to FOSS
- G7 – Mind mapping with XmInd, Desktop publishing with Scribus

Computer programming

Programming language – GUI based
- G 3 – what is a program, how to execute a program, concepts of – sequence of instruction, iteration, conditional statements, event handling
- G4 – concepts of iteration, conditional statements, event handling, coordination and synchronization
- G5– concepts of iteration, conditional statements, event handling, co–ordination and synchronization, parallel execution, keyboard input, variables, list

Flow chart
- G6 – symbols, create simple flowcharts for maths problems with decision making and looping

Programming language – syntax based
- G6 – convert flow chart examples to programs, concepts of variables, conditional statements, input, output, print
- G7 – repetition, array, using graphical statements
- G8 – Conditional control of loop, subroutines, string function

Social/ethics, safety

Dos and donts
- G2, G3 – time spent
- G2–G4– posture

Exercises to avoid computer related injury
- G2 – G4 – eyes, breathing, shoulders, arms, wrist, legs, ankle, foot

Values
- G1 to G6 – sharing, handling systems with care, cleanliness, being sensitive to others needs

Internet related safety measures
- G5 – SMART rules –safe, meet up, accept, reliability, tell
- G5 – Virus, spam
- G8 – SMART PLUS rules – safe, meet up, accept, reliability, tell, polite, think before you link, U are responsible, share selectively

Figure 1: CMC curriculum at a Glance

3 CMC SYLLABUS - CURRICULUM DETAILS

3.1 Themes and Topics

As indicated in Section 1.1, this section addresses the purpose of *'curriculum as a body of knowledge to be transmitted'*. The CMC curriculum has been classified into five themes: familiarity with computers, computer applications, thinking process skills, computer programming, and social values and ethics. Each of the themes has multiple sub-themes.

- Familiarity with computers: Topics in this theme provide opportunities to become familiar with computer associated vocabulary, learn computer and file operations, and acquire usage skills.

- Computer applications: Topics in this theme build competency in applications usage, such as word processor, presentation, multimedia, spreadsheet and Internet, thereby enabling students to utilize the potential of computer as users of the technology.

- Thinking process skills: Topics in this theme build cognitive abilities of algorithmic thinking, reasoning, problem solving, information gathering, brain storming and synthesizing, using multiple representations, and divergent thinking. These abilities enable students to plan and execute complex projects, use the appropriate applications for a given project, and write well-engineered programs. In addition, these abilities equip students to deal with real life situations.

- Computer programming: Topics in this theme develop algorithmic thinking skills and enable students to become creators of technology. Computer programming is addressed in two phases, to avoid cognitive overload. A graphic user interface (GUI) based language, such as Scratch is used in the first phase, for learning of programming concepts. Text-based syntax is introduced only in the second phase, through a different language, such as Basic. The two phases are bridged by teaching how to draw flow charts and write pseudo-code.

- Social aspects – safety and ethics: Topics in this theme sensitize students to ergonomic, social and ethical issues associated with computer use. These issues are incorporated in the curriculum by way of exercises to avoid computer related injury, Internet safety guidelines, and values such as sensitivity to others and intellectual property rights.

The above themes are further detailed into sub-themes and topics at each grade level. These details are provided in Annexure A. These details would be useful for textbook authors to decide the topics to be addressed in each grade and the corresponding learning objectives. A grade-wise summary view - what topics should be taught in each grade and upto what depth – follows.

3.2 Grade-wise View of the Curriculum

Sub-sections (3.2.1 - 3.2.8) describe details of the topics to be taught in each grade in terms of learning objectives. As indicated in Section 1.1, this addresses the purpose of *'curriculum as a as an attempt to achieve certain ends in students'*.

It is expected that a teacher would be able to comfortably address these topics, by teaching one class per week for grades 1-4, and one or two classes per week for grades 5-8. It is recommended that the first few weeks of any grade be devoted to explicitly revising topics from the previous grade, since many topics in the curriculum reappear at increasing depth in each grade.

3.2.1   1st Grade

Category	At the end of the 1st grade, a student should be able to:
Concepts	• Recognize that a computer has different uses • List different uses of a computer • Identify applications for some uses (such as Paint) • List various parts of a computer (such as CPU, monitor, mouse, keyboard) • Identify associated functions of each part (such as, the function of a CPU is to control all other parts of a computer) • Describe what is a file
Usage skills	• Control functions of keyboard (arrow, enter keys) and mouse (single/ double click) • Open, close and quit applications • Use simple applications (such as Paint) • Open, edit and save files • Identify and manipulate elements of a desktop and window
Social aspects	• Identify and follow correct posture while using a computer • Follow guidelines to keep a computer clean (such as not eat/drink near a computer) • Share common resources fairly (such as taking turns while using a keyboard)

3.2.2   2nd Grade

Category	At the end of the 2nd grade, a student should be able to:
Concepts	• State functions of input and output devices • Explain Input-Processing-Output process • Apply the concept of organization to categorize items • Explain start-up and shut-down of a computer
Usage skills	• Create folders • Perform mouse actions like drag and drop • Operate navigation keys of a keyboard (such as page up/dn, backspace) • Edit text using basic features of a text editor (such as insert, delete) • Reuse text/images through cut/copy and paste • Rename/ delete/ save files • Practice start-up, login, log off and shut-down
Social aspects	• Describe steps to be taken for care of the computer • Identify and follow correct posture while using a computer • Practice exercises for shoulders, hands, neck and eyes • Respect others' privacy • Follow guidelines for secure computer use (such as password)

3.2.3   3rd Grade

Category	At the end of the 3rd grade, a student should be able to:
Concepts	• Dissect a task into constituent sub-tasks • Apply step wise thinking to perform a task (such as planning a vacation) • Explain the purpose of a computer program • Describe the elements that make up a computer program
Usage skills	• Format typed text using the mouse (such as font type, style, colour) • Execute a Scratch program and interpret the results • Write simple programs in Scratch using motion, control and looks blocks
Social aspects	• Work in teams to complete activities • Take care of one's eyes, wrists and neck • Practice relevant exercises while using a computer

3.2.4   4th Grade

Category	At the end of the 4th grade, a student should be able to:
Concepts	• Apply logical reasoning to solve a problem (that includes constraints) • Apply programming concepts (such as sequencing and control flow) • Classify, organize and store various types of content
Usage skills	• Write programs in Scratch using commands in motion, control and looks blocks • Write programs involving threads (coordination between multiple sprites) • Organize files and folders • Identify file extensions
Social aspects	• Work in teams to complete activities • Practice exercises to avoid repetitive strain injury • Practice secular tolerance

3.2.5   5th Grade

Category	At the end of the 5th grade, a student should be able to:
Concepts	• For a given task: Identify and analyze the goal, identify resources to gather the required information, and capture and organize information • Organize information using tables and lists • Distinguish between the pros and cons of softcopy versus hardcopy • Recognize uses of a network of computers (such as Internet) • Explain how information is created and shared on the Internet • State the need for websites to have a unique addresses
Usage skills	• Write advanced Scratch programs (such as build your own game) • Use a browser to navigate through web pages, using hyperlinks • Use a search engine to find information on the Internet, using keywords • Communicate through email

Social aspects	• Explain importance of login and password • Follow a correct posture while using a computer • Follow parents/ teachers guidance while browsing or searching the Internet • Inform parents/ teachers about emails from strangers • Protect against spam

3.2.6   6th Grade

Category	At the end of the 6th grade, a student should be able to:
Concepts	• Apply thinking skills: brainstorming, synthesizing, analyzing and decision making • Represent information in various forms (such as spreadsheet and mind map) • Categorize computers applications (such as standalone and Internet) • Plan a presentation • Explain the uses of a spreadsheet • Apply the concept of a flowchart to depict a process
Usage skills	• Use tools for organizing and representing information (such as mindmaps) • Create a presentation, including both content and aesthetic aspects • Create and edit data in a spreadsheet • Perform calculations and generate graphs using a spreadsheet • Draw flowcharts and write pseudo-code to represent a program • Write simple programs using appropriate syntax in BASIC
Social aspects	• State the security steps to follow during online communication • Explain the measures for responsible use of Internet resources

3.2.7   7th Grade

Category	At the end of the 7th grade, a student should be able to:
Concepts	• Explain the functions of computer internals, such as CPU, BIOS and RAM • Apply the concepts of pixels while editing images • Interpret information from tables and graphs • Process data in a spreadsheet to answer a query • Track the development of computer to its present form • Identify suitable FOSS application for a required purpose • Apply algorithmic thinking while writing programs
Usage skills	• Edit image using image editor • Incorporate multimedia files in a presentation to create a digital story • Format documents to create newsletters, invitations and posters • Apply formulas and sorting to process data in a spreadsheet • Exchange information with a group using internet • Explore features of FOSS applications • Write programs in BASIC involving conditions, loops, and manage lists and arrays
Social aspects	• State measures to adopt for responsible use of Internet resources. • Communication skills using Internet

3.2.8 8th Grade

Category	At the end of the 8th grade, a student should be able to:
Concepts	• Differentiate between the concepts of LAN, WLAN and WAN • Explain the concepts of packet switching, firewalls and security • State what is web 2.0 and give examples • Explain the uses of social networking • Apply design guidelines for creating blogs and websites • Explain the concept of binary number system • Explain the concepts of database, primary key and querying
Usage skills	• Use features of web 2.0 • Use Google tools to create and publish content online • Use a combination of office productivity tools to create a product design • Perform basic computer system administration and troubleshooting • Write advanced programs in BASIC • Create and query databases
Social aspects	• State the security steps to follow during online communication • Apply safety rules while accessing social networking sites

3.3 How CMC prepares students for Grades 9-12 for various Boards

In India, schools have to be affiliated to a Board, such as ICSE, CBSE or State, in order to conduct classes for grades 9-12. The exams for grades 10 and 12 are conducted by the respective Boards. All the schools affiliated to a given Board follow syllabi prescribed by that Board. As mentioned in Section 1, some Boards allow schools to define their own syllabi for grades 1-8 and define detailed syllabi only for grades 9-12. The ICSE, CBSE and some State Boards have defined syllabi for computers in grades 9-12, which can be found from their respective websites [ICSE, CBSE, Maharashtra State Board].

Hence, instead of independently re-defining the syllabi for grades 9-12, this section indicates how the CMC curriculum from grades 1-8 prepares a student to proceed with the Computers elective in grade 9 onwards. The ICSE syllabus for Computer Applications and the CBSE syllabus for Foundation of Information Technology are discussed below.

3.3.1 ICSE Board

The ICSE syllabus for Computer Applications for grades 9 and 10 for the year 2013 can be found at:
http://www.cisce.org/Syllabus 2013/23. Computer Applications.pdf
It lists the following six aims: "1) To empower students by enabling them to build their own applications. 2) To introduce students to some effective tools to enable them to enhance their knowledge, broaden horizons, foster creativity, improve the quality of work and increase efficiency. 3) To enable students to learn to use the World Wide Web in order to gather knowledge and communicate

with students and the academic community all over the world. 4) To enable students to learn to process words and numbers, analyze data, communicate ideas effectively and make the optimum use of computer resources. 5) To help students learn fundamental concepts of computing using object oriented approach in one computer language. 6) To provide students with clear idea of ethical issues involved in the field of computing"

The topics listed for grade 9 are: Operating System, Internet, Computing and Ethics, Office Application Software, Database Packages, Elementary Concepts of Objects and Classes, Values and Types, and Conditionals and Loops. Table 1 gives the grade at which CMC addresses students' preparation for these topics. Details of sub-topics at each grade in CMC are given in Annexure A.

Topics and sub-topics of ICSE grade 9	Prior preparation in CMC curriculum*
Operating System: Need; features and functions; Installing and un-installing software and hardware.	Grades 7 and 8
Operating System: Working with GUI; task bar icons; multiple windows; creating and arranging folders and files.	Grade 4
Internet: Working of internet; sending and receiving e-mails; web servers; search engines; working of modem; Protocols and their need (FTP, HTTP, SMTP).	Grades 5-7
Computing and Ethics: Intellectual property rights; privacy; data protection; protection against spam, malicious intent and malicious code.	Grades 5-7
Office Application Software: Word Processor, Multimedia Presentation, Spreadsheets – Editing; formatting; working with tables; using images, sound, video and custom animation; Using formulae, functions and charts.	Grades 3-8
Database Packages: The need for database management; creating, editing and saving a database; adding, deleting, modifying records and fields; performing calculations; sorting on various fields, indexing; querying; report generation.	Grade 8
Objects and Classes: Modeling entities and their behavior by objects; Class as a specification for objects; Function calls between objects.	Not addressed
Values and Types: Primitive types; operations; expressions, assignment.	Grades 7 and 8
Conditionals and Loops: if else and switch-case; for and while loops.	Grades 3 and 4 (Scratch); Grades 7 and 8 (BASIC)
Laboratory assignments: Use of Office applications; programming; designing applications for various purposes.	Grades 3-8

Table 1: ICSE grade 9 and Prior preparation in CMC

As can be seen from Table 1, many topics in CMC are revisited in multiple grades, owing to the spiral nature of the curriculum. Thus CMC lays a strong foundation for almost all the topics prescribed for grade 9 of ICSE Computer Applications. It is expected that a student will be able to naturally progress from CMC grade 8 to ICSE grade 9 and then further to grades 10-12.

3.3.2 CBSE Board

The CBSE syllabus for Foundations of Information Technology for grades 9 and 10 for the year 2013 can be found at: http://cbse.nic.in/currisyllabus/SECONDARY CURRICULUM-vol-1-2013.pdf

It consists of four units: Basics of Information Technology, Information Processing Tools, IT Applications and Societal Impacts of IT. Table 2 gives the topics and sub-topics for grade 9 and shows how the CMC curriculum prepares a student for them. topics. Details of sub-topics at each grade in CMC are given in Annexure A.

Topics and sub-topics of CBSE grade 9	Prior preparation in CMC curriculum
Basics of Information Technology (Computer): Components of computer systems; storage devices; software.	Grades 7 and 8
Basics of Information Technology (Communication): LAN, WAN, Internet, Wired and Wireless networks.	Grades 7 and 8
Information Processing Tools (OS): Operating System; Working with GUI, task bar icons; multiple windows; creating and arranging folders and files.	Grades 3-8
Information Processing Tools (Office): Word Processor, Multimedia Presentation, Spreadsheets – Editing; formatting; working with tables; using images, sound, video and animation; Using formulae, functions and charts.	Grades 3-8
IT Applications (Examples): Report writing; greeting cards and poster making; Environment awareness; Advertising; Analysis reporting.	Grades 7 and 8
Societal Impacts of IT: Benefits of ICT in various sectors; Plagiarism; Privacy; Security and Integrity of Information; Intellectual Property Rights, Careers in IT.	Grades 5-7

Table 2: CBSE grade 9 and prior preparation in CMC

 As can be seen from Table 2, CMC lays a strong foundation for almost all the topics prescribed for grade 9 of CBSE Foundations of Information Technology. It is expected that a student will be able to naturally progress from CMC grade 8 to CBSE grade 9 and then further to grades 10-12.

Mapping prior preparation in CMC to State Board grade 9 is along similar lines. These details omitted to avoid repetition.

4 TEACHING -LEARNING STRATEGY

As indicated in Section 1.1, this section addresses the purpose of *'curriculum as a process"*. Several curriculum theorists [Stenhouse 1975] have suggested that a curriculum should include not only content, but also the means to transact that content. Hence a curriculum must provide principles for the development of a teaching strategy. Once the decision is made on what is worth teaching, psychology and pedagogy principles should guide us identify effective teaching-learning strategies [Kumar 2004]. This section recommends broad strategies on which specific teaching methods and lesson plans can be developed. These strategies are established to be effective and are suitable in the context of CMC. It is recommended that textbook authors and school implementers incorporate these strategies.

4.1   Inquiry-based learning

Inquiry-based learning [Barrett 2005; Olson, S. and Loucks 2000] is an approach in which students are actively engaged in the learning process by asking questions, interacting with the real world, and devising multiple methods to address the questions. Learners are guided by questions that lead to gathering of evidence, formulating explanations from the evidence and communicate and justify the explanations. The teacher plays the role of a cognitive guide and a facilitator in the process. Inquiry-based learning is an effective way to realize the key feature of Thinking Skills (Section 2.3.1).

There are different levels of inquiry-based learning. In some forms, the problem is suggested by the teacher and the students devise their procedure to solve the problem. For example, the teacher asks students to prepare a presentation on an unfamiliar topic, such as maintaining an aquarium or embedded applications of computers. Students first identify what they already know about the topic and what they need to find out. Then they gather the relevant information from various sources, and synthesize it to create the presentation. The teacher oversees the process, provides feedback and intervenes wherever necessary. In other, more open forms of inquiry, learning is more student-driven. For example, students may want to learn about a particular technology, such as use of Google docs. The teacher helps them get started and then guides them towards the discovery of features of their interest.

Inquiry-based strategies help students to 'learn how to learn'. They develop the ability to locate, evaluate and use appropriate information, which is crucial in today's information-rich technological environment. The guidance provided by the teacher helps students to develop skills and confidence to apply concepts and use tools. Ultimately, inquiry-based strategies help students develop into independent learners.

4.2 Learning via Real-world Context

Learning is most effective when it is situated in a real-life context [Bransford et al 1992]. It engages and challenges students to make connections between their environment and the formal curriculum. Making real world connections to the content, teaching abstract principles by establishing the need for them in a real-life context, and using analogies from students' everyday lives, are practical methods to realize the underlying key feature of Thematic Integration (Section 2.3.3). Connections to students' everyday lives can be established in multiple places – within the lessons, through classroom and homework activities, by solving context-rich problems and while working on projects.

4.3 Collaborative learning

Collaborative learning (or cooperative learning, group work, team learning) is one method of getting students to actively participate in the process of learning. Several research studies show that students learn more of what is taught, retain knowledge longer, are able to solve more complex problems, and are more satisfied with the process when they learn in groups [Johnson and Johnson 1986, Toten et al 1991].

Students work on one or more tasks in small groups by planning, discussing and negotiating. Collaborative learning can take various forms: groups can be formal or informal, members can be assigned to groups by the teacher or students can self-organize, groups can last for a particular class or for a long-term duration (such as an entire semester, or for a project) and groups can be of varied sizes. Students co-construct and share knowledge, thereby forming a community of learners in the class.

4.4 Playfulness

Play is essential to development because it contributes to the cognitive, physical, social, and emotional well being of children and youth. It allows children to use their creativity while developing their imagination, dexterity, physical, cognitive, and emotional strength. Research studies have revealed that play has been found to be the most developmentally appropriate way for children to learn since it facilitates problem-solving, perspective taking, social skills, and development of the mind (Bailey 2002). The role of play and the use of games as educational tools can influence learning among children by bringing about qualities such as confidence, self-efficacy, and intrinsic motivation (Garris et al 2002). Hence CMC suggests including playfulness as an explicit basis for designing learning activities and transacting them in the classroom.

5 AN IMPLEMENTION OF THE CMC CURRICULUM

Computer Masti (CM) [Iyer et al] is a set of textbooks based on this CMC curriculum. CM textbooks are labeled as Levels I-VIII, which can correspond to Grades 1-8, if a school begins teaching Computers from Grade 1. CM books are sequenced in such a way that students who have studied them from grades 1-8 would be able to meet the requirements of various education boards of the country –CBSE, ICSE, IB, and State boards – for grade 9 onwards. CM books can be downloaded from www.computermasti.in

Each CM book contains lessons (chapters), worksheets and activities based on the themes in the curriculum recommended for that particular grade. Guided by the curriculum, CM books address students' development of thinking process skills while teaching concepts and usage skills associated with computers. Each CM book has a "Concept before Skill" approach focusing on conceptual understanding before learning the usage skills associated with specific applications. The pedagogy emphasizes inquiry-based learning, real-world contexts, collaboration and playfulness.

The following sections describe how the key features, themes and topics, and teaching-learning strategies of the CMC curriculum were realized in the CM books.

5.1   Realizing the key features of CMC curriculum

- *Thinking Process Skills (Section 2.3.1)*: Each CM textbook explicitly addresses one (or more) thinking process skills, starting from Level III. For example, stepwise thinking is a lesson in Level III, logical thinking is a lesson in Level IV, gathering and synthesizing information is a lesson in Level V, and using multiple representations is a lesson in Level VI.
- *Computer literacy integrated with fundamental concepts and thinking skills (Section 2.3.2)*: CM textbooks address computer usage skills, both hardware and software related, within the context of learning fundamental computer concepts and thinking process skills. For example, students are introduced to the Internet and its uses (Level V, Lessons 5 and 6), only after they learn the thinking skill of systematically gathering information (Level V, Lesson 2) and concepts related to organizing information (Level V, Lesson 4). Another example is that students are formally introduced to programming (Level III, Lesson 3), only after the lesson on stepwise thinking (Level III, Lesson 2), in which they apply algorithmic processes to daily life situations, such as planning a school play.
- *Thematic integration (Section 2.3.3):* CM textbooks achieve thematic integration, i.e., reinforcing what is taught in other subjects while learning computers, by use of:
    1. Analogy from other domains to establish an understanding of computer related concepts. For example, teaching about Internet network (Lesson 5, Level V) by drawing an analogy with water or electric supply networks.

2. Worksheets whose context lies in different subjects at that grade level. For example, an activity on organizing information (Lesson 6: Naming and organizing files, Level IV) asks students to classify a list of items as rivers, mountains or cities. Thus students learn geography while doing a CM activity.

3. Computer-based activities that provide a drill for knowledge acquired in other subjects. For example: while students are taught keyboard or mouse skills, they are given a drill of arithmetic operations through educational computer games such as Gcompris and TuxMath.

- *Spiral curriculum (Section 2.3.4):* The feature of spiral curriculum is applied in CM textbooks in multiple instances. Concepts are first introduced in an intuitive manner, and revisited with increasing complexity multiple times. For example, students first learn only a few basic features of text-editing, such as, entering text and using the commands of Copy-Paste (Lesson 7, Level II). At the next level, students learn about font types, sizes, styles and colors (Lesson 6, Level III). A few levels later, they learn to incorporate multimedia objects and format the layout to create posters (Lesson 5, Level VII).

- *Scalability (Section 2.3.5):* CM activities employ a Free and Open Source (FOSS) operating system (edubuntu) and nearly 50 FOSS applications (See Annexure B). All applications included in CM books have an equivalent for Windows operating systems as well.

5.2   Themes and Topics in CM textbooks

The content of the lessons in the CM textbooks follow from the themes, sub-themes and topics prescribed in the CMC (Section 3; details in Annexure A) for each grade level. Topics in each lesson are classified into concepts, usage skills and social aspects as described in Section 3.2. An example for Level V that contains a suggested week-wise teaching schedule is shown in Table 3. Similar details for other levels are given in Annexure B.

Lesson	Topic Name	Concepts	Skills	Values reinforced	Weeks
1	Revision of Level IV	Reasoning, problem solving Usage of control statements Storage and organization of files/folders	Do Exercises for legs, ankles, foot muscles Write scratch scripts Create folders	Exchange of ideas Reinforce imagination	1st-2nd
2	Step-wise Gathering of Information	Identification and analysis of goal for a given task Identification of resources to gather information Recording, categorization of information Decision making	Apply step wise thinking tools to achieve a goal Break up a task into main task and sub- tasks	Work systematically Ask for Parental guidance Make a choice within the given constraints	3rd-5th

3	Organizing Information using Lists and Tables	Organization of information Representation of information using tables, and lists Softcopy and hardcopy	Create a list, sub-list using Bullets and numbering Add/delete rows and columns in table Insert pictures in documents	Be proactive Explore independently	6th – 8th
4	Advanced Scratch Programming	Capture of input from user Conditional statements (if-else) Variables, operators and Lists (arrays)	Assign values to variables Write scripts using variables and operators Create lists	Reinforcing creativity to design new games	9th – 11th
REVISION					12-15
5	Introduction to Internet – Browsing	Network of computers : Internet Unique address for a website Sharing of information on Internet through web pages and websites Hyperlinks on websites	Use a browser to access Internet websites Open a given URL Bookmark a website o Use hyperlinks Navigation of web pages	Sharing information Observe analogy between topics and real life examples Relating observations to the context of the lesson (seen parents booking online)	16th – 18th
6	Searching the Internet	Search engine Search Keywords	Use effective keywords to search for information Follow parental/ teacher guidance while browsing	Asking questions Go beyond the lesson Look for information on other subjects	19th – 21st
7	Communication using E-mail	Communicate through Email Email address, login, password Email spam	Create an email account Send and receive emails Use options in email application Attach files to email	Keeping in touch with friends and family Differentiate between content in emails	22nd – 24th
8	Projects	All concepts from levels 1-5	All skills from levels 1-5	All of above	28-32

Table 3: Topics and schedule in CM Level V

5.3   Teaching-learning strategies in CM textbooks

A social constructivist approach, complemented by playfulness, as recommended in Section 4, forms the basis of the teaching-learning strategies in the CM textbooks. Each lesson has a narrative style, consisting of two children who learn about computers while they engage in their daily activities. A third character in the narrative, a mouse look-alike, plays the role of a facilitator for inquiry-based learning. Students make real world connections and integrate knowledge via the context in the narrative. Worksheets, activities and projects at the end of each lesson are geared towards exploration, collaborative learning, and reflection. The specific teaching-learning strategies adopted in the CM books are given in Annexure B.

6 CONCLUSION

CMC develops computer fluency and thinking skills, in a manner that highlights the interconnectedness of knowledge. It uses a spiral curriculum design to ensure that students retain their learning and progress to deeper levels. The detailed specification of learning objectives for each topic at each grade may help to standardize the competencies expected from students at each grade, and enable textbook authors to focus creativity on 'how to teach' rather than 'what to teach'. Textbooks based on CMC can equip students with computer concepts, usage skills, and also the 4Cs of 21st century skills - critical thinking, communication, collaboration and creativity [Trilling and Fadel 2009].

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ANNEXURE A: TOPICS COVERED FOR EACH GRADE FOR EACH THEME AND SUB-THEME

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Theme I: Familiarity with computers							
1. Computer parts and their functions							
• Identify the observable parts of the computer and their functions. • Recognize keys on keyboard. • Recognize buttons on a mouse.	• Understand giving of input through keyboard/ mouse, and getting output through monitor/ printer/ speaker. • Identify Input and output devices and state their function.			• Identify network components. • Identify different connection ports.	• Use external storage devices such as CD, USB.	• State the function of internal parts of a computer. • State functions of various software.	State the functions of internal parts of a network. State functions of network software.
2. Computer operations							
• Use elements of desktop: taskbar, change wall paper. • Use elements of window: title bar.	• Start a computer. • Login and logout. • Enter password. • Shutdown.		• Create folders and organize files.	• Use internet access applications.	• Install and use applications.	• Managing and administration of a single computer.	• Managing internet connectivity. • Basic trouble shooting.
3. Usage skills							
• Mouse skills: single, double, right click. • Keyboard – Enter text. Use Space, Backspace key. • Use a paint application.	• Practise mouse skills – drag and drop. • Practise keyboard skills - Caps lock, arrow, navigation shift keys. • Use a text editor.	• Use a GUI based programming application. • Keyboard and mouse skills for formatting text.	*Continue with skills from Grade 3.*	• Use internet access applications.	• Use input from devices – scanner.	• Use multimedia devices - scanners, mic, headphone and webcam.	• Use internet devices – modems and routers.

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
4. File management and operations							
• Understand what is a file. • Minimize and maximize. • Create, open, save, close, and delete a file.	• State functions of folders. • Create folders, move files into folders. • Edit files – cut, copy, paste, across files.	• Recognize that different types of information are stored in different file types.	• Assign file and folder names based on the content. • Identify and match file extensions. • Create a directory structure of folder and sub-folders.	• Differentiate between hard copy and soft copy. • Take backup.	• Backup important files in more than one way. • Manage files on different devices, such as pendrive.	• Use information from multiple files to create multimedia presentations.	• Use database files.
5. Uses of computers							
• State places where computer are used. • State what a computer can and cannot do.		• Using computer for writing programs.		• Using computer for accessing Internet.	• Identify different types of computer use - Stand-alone, networked, and embedded, and give examples.	• History of computers	
Theme II. Computer applications							
1. Multimedia							
• Identify and use Paint and Music application icons, options and tools.	• Draw, colour and save charts, posters, cards.			• Use multimedia applications.	• Create multimedia presentations.	• Use image editing software.	• Use multimedia publishing software.
2. Text editor/ Word processor							
	• Open new file. • Enter and edit text. • Cut, Copy, Paste and Undo actions	• Format text (font, type, size, style, colour).		• Create lists, tables. • Insert bullets and numbers. • Insert data, rows and columns in a table.	• Insert images into documents.	• Design newsletters and posters.	• Design and edit content for a website.

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
3. Presentation							
				• Gather information and plan content of a presentation.	• Create a new presentation and format it. • Use animations.	• Modulate content of a presentation according to time available.	• Modulate content of a presentation according to target audience.
4. Spreadsheet							
				• Create and use lists and tables.	• Interpret given data • Create spreadsheet and enter data. • Edit data, insert rows and columns. • Use formulae, such as sum, average. • Create charts.	• Use data filter. • Make complex computations using formula. • Use different kinds of charts according to the given data.	• Study given data, do trend analysis. • Use appropriate charts to plot and present data.
5. Database							
						• Use a spreadsheet as a database. • Use filters for data selection.	• Create database tables, insert data. • Querying, forms and reporting.
6. Combination of one or more of the above							
						• Work different applications – word processor, spreadsheet and presentation.	• Use online applications such as Google docs to share content and collaborate.
7. Internet applications							
				• Use browser, search engines and email applications.	• Gather, synthesize information for doing projects.	• Find, install and use applications for given purpose. • Web2.0 tools	• Use social network and blogs. • Create websites. • Cloud tools.

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
8. Communication							
				• Create email accounts. • Compose, send and receive emails.	• Share information and collaborate through emails.	• Use Web2.0 tools for communication • Follow appropriate etiquette.	• Use social network and blogs for communication.

Theme III: Thinking Process skills

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
1. Categorizing and organizing information							
	• Grouping related objects together. • Organize related files into folders.	• Create and organize folders.	• Organize given information into hierarchy. • Use folders and sub folders.	•Gather information for given task. •Consolidate and organize info to accomplish task.	• Synthesize given information. • Use multiple classification schemes.	• Present gathered information in a coherent manner. • Use multiple representations.	• Organize, present information in a user-friendly way.
2. Algorithmic thinking							
		• Break up a non computer-based activity into steps.	• Write steps to perform given task	• Apply algorithmic thinking to solve a given problem.	• Identify and choose between multiple solutions.	• Systematically divide task into sub tasks and solve	• Apply all aspects from previous grades.
3. Logical Reasoning/ Problem solving							
			• Identify goals and constraints of given problem. • Apply algorithmic thinking to solve.	• Identify known and unknown information to solve a given problem.	• Identify necessary and sufficient conditions that a solution should satisfy.	• Solve increasingly complex problems. • State assumptions under which a solution works.	• Apply all aspects from previous grades.
4. Gathering Information							
				• Identify resources that can provide information to accomplish a task. • Record, organize and synthesize information.	• Use Internet to gather information • Compile a report and present the information coherently.	• Conduct surveys of users to gather data for market research. • Use technology tools to record information.	• Carry out projects involving all aspects from previous grades.

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Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
5. Decision making							
				• Identify problem constraints. • Identify solutions that meet the constraints.	• Apply reasoning, decision making to make choices in performing real life tasks.	• Evaluate pros and cons of multiple solutions and decide among the various options.	• Apply multiple thinking skills together to solve a given problem.
6. Brainstorming, analysis of ideas and synthesis							
					• Generate multiple ideas to solve a given problem. • Organize ideas using tools.	• Do brainstorming and analysis to choose between multiple solutions to given problem.	• Apply multiple thinking skills together to solve a given problem.
7. Using multiple representations							
				• Represent given information is Lists or Tables, based on the requirement.	• Represent given information using lists, tables, charts, graphic organizers	• Use multiple representations to analyze data and convey results.	• Integrate different data forms (table, charts, picture) from different applications.
8. Divergent thinking							
						• Come up with multiple solutions to given problem.	• Come up with unusual solutions to given problem.
Theme IV: Computer Programming							
1. Programming Language							
		• Use a graphical programming language (eg: scratch). • Write and execute a simple program.	• Use a graphical programming language. • Apply concepts of if-else, loops, and event handling.	• Use a graphical programming language. • Apply concepts of keyboard input, variables, lists.	• Do syntax based programming. • Convert flow chart to programs. • Use if-else, loops.	• Do syntax based programming. • Use variables, arrays, input and output functions.	• Do syntax based programming. • Use subroutines, string functions, and make library calls.

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
2. Flow charts							
					• Identify, use flow chart symbols. • Create flowchart with decision making and loops.	• Use flow charts to write programs.	Use flow charts to write programs.
Theme V. Social aspects – safety and ethics							
1. Dos and Don'ts – safety measures							
• Follow safety measures while handling machines running on electricity.	• Follow safety measures while handling computers.			• Follow safety measures while browsing and receiving emails. • Avoid personal information on the Internet.	• Check copyright before download from Internet. • Verify information from multiple sources.		
2. Avoid computer related injury							
• Identify, follow correct posture.	• Do exercises for avoiding injury to arms, wrists, neck eyes.	• Do exercises for avoiding injury to waist, shoulders, wrist, arms, eyes.	• Do exercises for avoiding injury to eye, leg, ankle and foot muscles.	• Follow norms for amount of time spent on Internet.	• Follow norms for amount of time spent on Internet.		
3. Ethical Values							
• Share computers. • Be sensitive to others' needs	• Handle computers carefully; maintain cleanliness.	• Share computers. • Be sensitive to others needs.	• Work in a group to perform a task systematically.	• Follow Internet etiquettes for email and posts.	• Acknowledge sources of information.	• Collaborate with others in a group.	• Follow etiquettes for blog posts.

ANNEXURE B: COMPUTER MASTI (CM) TEXTBOOKS

Computer Masti (CM) [Iyer et al] is a set of textbooks based on this CMC curriculum. CM books can be downloaded from www.computermasti.in. This Annexure provides: (i) the suggested week-wise schedule for teaching with CM books, (ii) the list of FOSS applications used in the books, (iii) specific teaching-learning strategies incorporated in the activities of each grade, (iv) mapping of the topics in CM books to competencies prescribed by NCERT, and (v) details of how CM levels I-VIII prepares students for ICSE grade 9.

B(i): Suggested week-wise schedule for teaching with CM textbooks

The figures below contain screenshots from the textbooks. Each figure gives the distribution of lessons and topics in each level, classified into concepts, usage skills and values (social aspects), along with a week-by-week schedule.

Lesson No:	Topic Name	Concepts	Skills	Values reinforced	Weeks
1	Uses of Computers	o Computer as a machine that has many uses.	o Identify some places where a Computer is used. o Paint simple pictures on Tux paint.	o Developing good habits. o Awareness. o Communicating with relatives.	1st- 4th
2	Parts of Computer	o Computer has different parts.	o List the parts and functions of the main parts.	o Awareness.	5th-7th
3	Healthy Computer Practices	o Correct way of using Computers.	o Keeping the Computer clean. o Correct postures. o Be safe while using Computers.	o Taking appropriate precautions while using machines. o Being sensitive to the needs of others. o Sharing resources with each other. o Maintaining cleanliness.	8th – 10th
4	Using a Mouse	o Functions of a mouse.	o Control the pointer using right click, left click, double click.	o Taking permission.	11th – 12th
	REVISION				13th – 14th
5	Using a Keyboard	o Functions of a keyboard.	o Enter words and numbers using a keyboard.	o Attention to details (observation skills).	16th – 18th
6	Paint Using a Computer	o Icons, Tools and Tool bar [through example of paint application].	o Open, draw and save Paint files.	o Relating new knowledge to previous learning.	19th – 21st
7	More Actions Using Paint	o Describe what is a file. o Opening a new or existing file. o Saving a file. o Close an application.	o Save and print paint files o Quit the paint activity.	o Curiosity (observing – thinking – questioning).	22nd – 23rd
8	Using Music Player		o Open Music player application. o Open a music file. o Use control buttons : play, pause, stop.	o Being sensitive to others needs.	24th- 25th
9	Exploring the Desktop	o Elements of Windows, Desktop on a Computer.	o Open activities on a desktop. o Maximise, minimise and close windows. o Change wallpaper.	o Neatness.	26th- 28th

Figure B.1: Schedule for Level I

Lesson No.	Topic Name	Concepts	Skills	Values reinforced	Weeks
1	Revision of Level I	o Uses of a Computer	o Identification of parts o Correct usage	o Observation o Awareness	1st - 4th
2	Input and Output Devices	o Input, Output	o Mouse movement skills	o Sharing	5th - 7th
3	Healthy Computer Practices	o Correct ways to use Computers	Exercises for o Shoulders o Hands o Neck o Eyes	o Importance of taking care of health o Importance of Exercises o Taking precautions	8th - 10th
4	Activities using a Mouse	o Organization o Grouping of similar objects o Folder o Naming of files	o Creating a new folder o Moving files into a folder o Drag and drop of Mouse o Organizing icons on Desktop	o Taking turns o Team work	11th - 13th
5	Activities using a Keyboard	o Functions of Keys o Change the written text	Using o Arrow keys o Delete o Backspace o Caps lock o Page Up/Down	o Helping each other	14th - 16th
REVISION					17th - 19th
6	Activities using Paint	o Revision lesson	o Using features of an activity		20th - 22nd
7	Basic Features of Text Editor	o Reuse [copy] o Edit	How to o Copy o Cut o Paste o Undo	o Take turns o Share the resources	23rd - 26th
8	Computer Start up and Shut down	o Start up o Booting o Login/Password o Logout o Shut down	o Start a PC o Enter Login o Enter password o Shut down PC	o Taking permission before doing an activity	27th - 29th

Figure B.2: Schedule for Level II

Lesson No.	Topic Name	Concepts	Skills	Values reinforced	Weeks
1.	Revision of Level II	o Input and output. o Correct ways to use computers. o Organization and grouping of files. o Folders and file naming. o Text editing. o Start up and shut down. o Authentication.	o Exercises for hand, neck, eye and shoulder. o Posture while using computers. o Create, move, drag drop of files and folders. o Using arrow, delete, backspace, caps lock keys.	o Team work, sharing of resources and being careful.	1st - 4th
2.	Step-wise Thinking	o Different steps involved in an activity. o Important of sequence of the steps in an activity. o Step wise instructions given to a computer.	o Breaking down and activity into a list of main steps. o Identifying the detailed steps of every main step. o Given the various tasks of an activity, identify the sequence of tasks.	o Group activity reinforces students to think in groups and exchange ideas with each other.	5th - 9th
3.	Introduction to scratch	o Instructions within a program. o Construction of a program with a set of instructions.	o Using commands of motion, pen and sound blocks. o Write a script (program) using drag and drop of graphic blocks. o Execute the script and view the result in the stage area.	o Reinforces creativity while constructing innovative scripts.	10th - 14th
4.	Asanas while using Computers	o Importance of exercises while using computers.	o Exercises for wrists, neck, eyes and spine.	o Performing exercises together and learning from each other.	15th - 18th
	REVISION				19th - 23rd
5.	Simple Animation with Scratch	o Control instructions in a program. o Loop and conditional instructions.	o Construct a program by using instructions of control block. o Changing background of a program.		23rd - 27th
6.	Fun with Text Processing	o Text editing. o Formatting guidelines.	Formatting text : o Bold, Italics, Underline o Changing Font type, size and colour		28th - 30th

Figure B.3: Schedule for Level III

Lesson No.	Topic Name	Concepts	Skills	Values reinforced	Weeks
1.	Revision of Level III	o Step-wise thinking. o Program execution. o Sequence of programming instructions.	o Dividing a task into main and detailed sub tasks. o Drag and drop basic commands of Scratch. o Exercises for wrists, neck and spine. o Formatting text.	o Exchange of ideas and sharing of resources. o Inculcate the importance of team work and group discussion.	1st - 3rd
2.	Logical Thinking	o Reasoning. o Problem solving.	o Identifying goals, information and conditions for problem solving.	o Working systematically.	4th - 8th
3.	Programming Multiple Sprites in Scratch	o Control statements. o Coordination between program parts.	o Write scripts using Scratch controls. o Change parameters in Scratch blocks.	o Reinforcing creativity and imagination. o Working patiently.	9th - 13th
4.	Healthy Practices	o Importance of exercises. o Taking care of health while using Computers.	o Exercises for legs, ankles and foot muscles. o Exercises to improve balance.	o Value of traditional art forms and instruments o Taking care of oneself.	14th -16th
5.		Revision			17th - 18th
6.	More activities using Scratch	o Animation of concepts in other subjects.	o Writing scripts for games and stories.	o Developing secular tolerance and celebrating all festivals.	19th - 23rd
7.	Naming and Organising files	o Storage and organization of Files and Folders. o Classification of content.	o Creating folders and organizing files within folders. o Identifying type of content based on file extensions. o Classification or grouping of relevant items.	o Arranging things at home and school, in an orderly way.	24th - 28th

Figure B.4: Schedule for Level IV

Lesson No:	Topic Name	Concepts	Skills	Values reinforced	Weeks
1	Revision of Level IV	o Reasoning and problem solving o Usage of Control statements o Storage and organization of files/folders	o Do Exercises for legs, ankles, foot muscles o Write scratch scripts o Create folders	o Exchange of ideas Reinforcing imagination	1st- 2nd
2	Step-wise Gathering of Information	o Identification and analysis of goal for a given task o Identification of resources to gather information o Recording and categorization of information o Decision making	o Apply step wise thinking tools to achieve a goal o Break up a task into main task and sub-tasks	o Work systematically and ask for Parental guidance o Making a choice within the given constraints	3rd- 5th
3	Organizing Information using Lists and Tables	o Organization of information o Representation of information using tables, and lists o Softcopy and hardcopy	o Create a list, sub-list using Bullets and numbering o Create a table o Add/delete rows and columns in table o Insert pictures in documents	o Be proactive and ask for more tasks to be assigned o Explore independently	6th – 8th
4	Advanced Scratch Programming	o Capture of input from user o Conditional statements (if-else) o Program Variables, operators and Lists (arrays)	o Assign values to variables o Write scripts using variables and operators o Create lists	o Reinforcing creativity to design new games	9th – 11th
	REVISION				12th – 15th
5	Introduction to Internet – Browsing	o Network of computers : Internet o Unique address for a website o Sharing of information on Internet through web pages and websites o Hyperlinks on websites	o Use a browser to access Internet websites o Open a given URL o Bookmark a website o Use hyperlinks o Navigation of web pages	o Sharing of information o Appreciate the analogy between topics and real life examples o Keen observation of other's tasks and relating it to the context of the lesson (seen parents booking online)	16th – 18th
6	Searching the Internet	o Search engine o Search Keywords	o Use effective keywords to search for information o Follow parental/teacher guidance while browsing	o Assimilate the given information and ask the right questions o Go beyond the lesson content and look for information related to other subjects	19th – 21st
7	Communication using E-mail	o Communication through Email o Email address, login, password o Email spam	o Create an email account o Send and receive emails o Use options in email application o Attach files to email	o Keeping in touch with friends and family o Differentiate between the right and wrong content in emails	22nd – 24th

Figure B.5: Schedule for Level V

Lesson No:	Topic Name	Concepts	Skills	Weeks
1	Revision	o Gathering and organizing information o Internet as network of computers o Search engine, search keywords o Communicating through email o Security and privacy of information	o Creating and Using lists and tables o Using a browser to access Internet sites o Creating email account, send and receive email messages o Following Internet SMART rules	1st- 4th
2	Brainstorming and Mind maps	o Brainstorming for generating ideas o Representing information through Mind maps o Analyzing information to get categories and sub-categories	o Apply step wise thinking tools to create mind maps o Categorize and analyze information	5th- 7th
3	Synthesis of Information: Uses of Computer	o Standalone computer application o Internet applications o Embedded applications o Synthesis of data o Multiple ways of categorization	o Apply imaginative skills to come up with probable futuristic uses	8th –9th
4	Making Presentations	o Three stages of presentation creation: Plan: decide outline Execute: create slides Impress: verify content	o Creating slides o Insert pictures in slides o Run a slideshow o Adding animations to slide show	10th – 13th
Revision				14th -16th
Assessment				17th
5	Multiple Representation of Data: Introduction to Spreadsheet	o Spreadsheets as a table of rows and columns o Multiple representation of information through lists tables graphs mind maps	o Creating and entering data in new spreadsheets o Calculating sum, percentage and average of given numerical data o Drawing charts and graphs o Inserting and deleting new rows and columns	18th – 21st
6	Flowcharts	o Flowcharts and symbols o Sequence, selection, repetition structures	o Drawing flowcharts by using the correct symbols and structures	22nd – 24th
7	BASIC Programming	o Programming language syntax o Variables	o Writing syntax based programs o Executing a program to display output	25th – 29th
Revision				30th -31st
Assessment				32nd

Figure B.6: Schedule for Level VI

Lesson No:	Topic Name	Concepts	Skills	Weeks
1	Revision of Level VI	o Brainstorming for generation of ideas o Representing information through Mind maps o Multiple ways of categorization o Multiple representation of data o Flowcharts o Programming language syntax	o Creating mind maps o Creating slides with pictures and animations o Entering and processing data in Spreadsheets o Drawing flow charts o Writing and executing syntax based BASIC programs	1st-3rd
2	Inside Computers: Hardware and Operating systems	o CPU (Central Processing Unit) o RAM (Random Access Memory) o Secondary storage o Backup o Input/output devices o Port, Powers supply, Motherboard o BIOS (Basic Input Output System) o OS (Operating System) o Application software	o Booting the computer and exploring the system hardware and software details.	4th-6th
3	Image Editing: Creating Collage	o Image editing o Pixels	o Cropping an image o Scaling an image o Adding text to an image o Changing resolution of an image o Printing an image	7th-9th
4	Advanced Presentation: Digital story telling	o Planning multimedia presentation o Digital story telling	o Importing and inserting audio/ video files in slides o Viewing and using the notes page option o Printing slides	10th-13th
5	Word Processor: Designing Ephemera	o Planning layouts o Deciding articles for inclusion	o Designing newsletters, invitations by using word processor tools o Scanning and inserting the scanned image in a document	14th-16th
	Revision			17th
	Assessment			18th
6	Internet: Content sharing	o Email groups o File sharing o Security o Cloud Computing	o Sending group emails o Composing mails in local language o Using advanced search options in an email application o Sharing files on Internet	19th-22nd
7	Spreadsheet: Data Analysis	o Sorting o Handling multiple representations o Interpreting data	o Sorting given data o Setting sort criteria o Using functions in spreadsheet o Drawing charts o Merging and formatting cells o Printing spreadsheets	23rd-26th
8	History of Computers	o Chronology of Computer development	------	27th-28th
9	Introduction to FOSS	o FOSS (Free and Open Source Software)	o Installing and exploring Xmind and Scribus applications	29th-31st
10	BASIC Programming: Control and Repetition	o Repetition (loops) o Controlling execution of a program o Arrays	o Writing syntax based programs using repetition and control structures	32rd-34th

Figure B.7: Schedule for Level VII

Lesson No.	Topic Name	Concepts	Skills	Weeks
1	Revision	o Operating systems o Digital story creation o Cloud computing o Sorting spreadsheet data o FOSS o Repetition of instructions o Controlling execution of a program o Arrays in programming	o Booting and exploring computer hardware and software o Editing images o Inserting multimedia files in slides o Email management : group mails, search, sharing of content o Sorting spreadsheet data based on given criteria o Drawing charts and using functions in spreadsheets o Installing open source applications o Writing syntax based programs using o Repetition and control structures	$1^{st} - 2^{nd}$
2	Inside Internet	o LAN (Local Area Network) o Packet switching o WLAN(Wireless Local Area Network) o WAN(Wide Area Network) o Client server network o Firewall o Data and website security	o Setting up and connecting the various components for a LAN o Enabling software firewall o Using data security features on Internet sites	$3^{rd} - 5^{th}$
3	Social Networking	o Social Networking	o Using features provided on Social Networking Sites (SNS) o Following SMART PLUS and AWARE rules while using SNS	$6^{th} - 8^{th}$
4	Writing Blogs and Creating Websites	o Blogging o Front end and Back end of websites	o Creating Blog sites and publishing them with content o Creating simple websites using online tools	$9^{th} - 11^{th}$
5	Innovation and Creativity: Integrated Activities	o Information: gathering and analysis o Logical reasoning o Decision Making o Multiple ways of Categorisation	o Applying thinking skills to complete an activity o Using Office tools and Internet skills to perform an activity	$12^{th} - 14^{th}$
6	Binary Number System: Bits and Bytes	o Binary Numbers	o Converting words to corresponding Binary code	15th
7	System configuration and Troubleshooting	o Software Repository o User Privileges o File Permissions o Backup data o Plug and Play devices	o Locking the screen and unlocking with passwords o Installing and launching applications o Setting up user privileges o Sharing and protecting files o Troubleshooting hardware and applications o Monitoring systems and processes	$16^{th} - 19^{th}$
8	BASIC	o Conditional control of loop statements o Subroutines o String functions	o Writing simple algorithms o Writing programs using conditional control, subroutines and string functions	$19^{th} - 21^{st}$
9	Introduction to Database and DBMS	o Database o Database Management System (DBMS) o Primary Key o Query of database	o Creating a Database o Creating a table o Inserting data into table o Building query statements o Defining relationship between tables o Using Forms and Reports	$22^{nd} - 24^{th}$

Figure B.8: Schedule for Level VIII

B(ii): List of FOSS applications included in CM

No.	Name of the application	Nature of the application	CM Level*
1	GCompris	Educational game - familiarity with computer, language, math and thinking skills	1
2	Tux Paint	Drawing creation tool	1
3	Tux Type	Educational game - familiarity with computer	1
4	Childsplay	Educational game - familiarity with computer, language, math and thinking skills	1
5	Mplayer	Entertainment	1
6	Potato guy (Ktuberling)	Educational game - familiarity with computer	1
7	VLC	Entertainment	2
8	Circus Linux	Computer game - familiarity with computer	2
9	gedit text editor	Office productivity tool	2
10	LibreOffice: word processor	Office productivity tool	3
11	Scratch	Programming language	3
12	Work rave	Computer application - healthy computer practices	3
13	Hex a Hop	Computer game - thinking skills	3
14	Tux Math	Educational game - familiarity with computer, math skills	4
15	Tetravex	Educational game - familiarity with computer, thinking skills	4
16	Gbrainy	Educational game - familiarity with computer, language, math and thinking skills	4
17	Sudoku	Educational game - familiarity with computer, thinking skills	4
18	Chess	Educational game - familiarity with computer, thinking skills	4
19	Firefox internet explorer	Web browser tool	5
20	Pysycache	Educational game - familiarity with computer, thinking skills	5
21	Celestia	Educational game - familiarity with computer, science and thinking skills	5
22	Frogger	Computer game - thinking skills	5
23	Lincity-NG	Computer game - thinking skills	5
24	Pix Bros	Computer game - thinking skills	5
25	Mines	Computer game - thinking skills	5
26	Kolf	Computer game - thinking skills	5
27	Untangle (gplanarity)	Computer game - thinking skills	5
28	Marble Desktop Globe	Educational Computer application - geography and thinking skills	5
29	Pauker	Computer game - language and thinking skills	5
30	LibreOffice – presentation	Office productivity tool	6
31	LibreOffice – spreadsheet	Office productivity tool	6
32	Semantik	Mind mapping software	6
33	Omnitux	Educational Computer application - geography and thinking skills	6
34	Audacity	Audio editing tool	6
35	Kstars	Educational Computer application - geography and thinking skills	6
36	Aerial combat simulator	Computer game - thinking skills	6
37	Homebank	Computer application - managing personal accounts	6
38	Shotwell Photo	Computer application - managing personal photographs	6
39	GIMP image editor	Image editing tool	6

40	Basic 256	Programming language	6
41	Google Earth	Educational Computer application - geography and thinking skills	6
42	Mtpaint	Image editing tool	7
43	Smilebox	Multimedia scrapbook	7
44	Gmail	Advanced features of Email	7
45	Google Docs	File editing and sharing	7
46	Picassa/Flickr	Photo sharing	7
47	Xmind	Mindmapping software	7
48	Scribus	Desktop publishing software	7
48	Google+	Social networking and sharing	8
49	Blogger	Creating blogs	8
50	Google Sites	Creating websites	8
51	LibreOffice – base	Creating and using databases	8

* 'CM Level' is the level at which the application is first introduced and continued in subsequent levels.

B(iii): Specific teaching learning strategies in each CM level

S.No	Strategy and Techniques	Level							
		I	II	III	IV	V	VI	VII	VIII
1	Puppet Show	√	√	√					
2	Role Play	√	√	√	√	√			
3	Games	√	√	√	√	√	√	√	√
4	Hands on experience	√	√	√	√	√	√	√	
5	Scenario-based learning		√	√	√	√	√	√	√
6	Inductive-deductive approach		√	√	√	√	√		√
7	Problem-solving			√	√	√	√	√	√
8	Think-Pair-Share				√	√	√	√	√
9	Number heads together				√	√	√		
10	Team-Pair-Solo				√	√	√	√	√
11	Small group teaching techniques					√	√	√	√
12	Filamentality strategies				√	√	√	√	√
13	Minimalist approach				√	√	√	√	√
14	Brainstorming sessions					√	√	√	√
15	Mind mapping						√	√	√

1. **Puppet Show:** A puppet show is a strategy wherein the characters, known as puppets (may be made of cloth, stick, or paper mache), are used enact a scenario. This strategy is a powerful way to attract student's attention.

2. **Role play:** This strategy is an educational setting in which learners take on the role profiles of specific characters (such as person affected by a social issue) or entities (components of a computer system) and simulate the conditions being studied. The teacher sets up the situation and as students act out their roles they gain deeper understanding of the different perspectives.

3. **Games:** Learning through games has proved effective in educational settings. Learning through games increases students' motivation and enhances their performance.

4. **Hands on experience**: Hands on, also called "by doing", is a technique where learning occurs by performing the task instead of merely learning the theory or content. Hands on is an effective way to learn software or improve psychomotor skills.

5. **Scenario-based learning:** Scenario-based learning puts the student in a situation or context and exposes them to issues, challenges and dilemmas, and asks them to apply knowledge and practice skills relevant to the situation. The student navigates by choosing options and is given feedback based upon their choice.

6. **Inductive Deductive approach**: This is a step by step, example-based approach. For teaching a topic, a teacher first gives several examples of the topic. Then she asks students to find similarities across all the examples. Teacher then asks students to come up with the rule governing the similarities and cite more examples for the rule.

7. **Problem-solving:** Teacher poses a problem statement for which many solutions are expected. The pros and cons of these are then analyzed. This approach helps develop critical thinking and also thinking from various perspectives.

8. **Think-pair-share**: Students work through questions using three distinct steps:
    i) Think: Students think independently about the question that has been posed, forming ideas of their own.
    ii) Pair: Students are grouped in pairs to discuss their ideas and solutions. This step allows students to articulate their ideas and to consider those of others.
    iii) Share: Student pairs share their ideas with a larger group, such as the whole class. Often, students are more comfortable presenting ideas to a group with the support of a partner. In addition, students' ideas have become more refined through this three-step process.

9. **Number heads together:** Students are placed in groups and each person is given a number. The teacher poses a question and students "put their heads together" to figure out the answer. The teacher calls a specific number to respond as spokesperson for the group. By having students work together in a group, this strategy ensures that each member knows the answer to problems or questions asked by the teacher.

10. **Team-Pair-Solo:** In this strategy the students work together first as a team and then as pairs and finally solve similar problems on their own. It is used to build confidence to tackle open-ended problems, which a student may not be able to solve individually at the outset.

11. **Small group teaching :** This is a problem based teaching approach whereby the students are divided into groups and they work in groups to find a solution and then share among the other groups. Examples of small group teaching techniques are:
    i) **Three-step interview:** Each member of a team chooses another member to be a partner. During the first step, individuals interview their partners by asking clarifying questions. During the second step, partners reverse the roles. For the final step, members share their partner's response with the team.

ii) **Three-minute review:** Teachers stop any time during a lecture or discussion and give teams three minutes to review what has been said, ask clarifying questions or answer questions.

iii) **Partners:** The class is divided into teams of four. Partners move to one side of the room. Half of each team is given an assignment to master and teach the other half. Partners work to learn and can consult with other partners working on the same material. Teams go back together with each set of partners teaching the other set.

iv) **Circle the sage:** First the teacher polls the class to see which students have a special knowledge to share. For example the teacher may ask who in the class was able to solve a difficult worksheet. Those students (the sages) stand and spread out in the room. The teacher then has the rest of the classmates each surround a sage, with no two members of the same team going to the same sage. The sage explains what they know while the classmates listen, ask questions, and take notes. All students then return to their teams. Each in turn, explains what they learned from their particular sage.

v) **Jigsaw:** In this technique, students are organized like pieces in a jigsaw to form different kind of groups, where each student (piece) must be part of the solution to the jigsaw puzzle. This is done in following steps - Students are first divided into groups, wherein all the members have their own research topic to study. After each member is done with their research; each topic group is split in such a manner that new groups have a single member from each of the old topic groups. After the new groups have been assembled, each topic expert is responsible for integrating the knowledge of his/her topic specific knowledge into their previous group. Jigsaw method is a very useful tool for trying to help students to integrate knowledge and understanding from various sources and experts.

12. **Filamentality strategies:** These are web-based interactive learning strategies, whereby learners have to answer questions using web-based learning materials. One such strategy is Web Quest, in which learners are presented with a challenging task. Some or all of the information that learners interact with comes from resources on the Internet. Web Quests are designed to focus learners on using information rather than looking for it, and to support learners' thinking at the levels of analysis, synthesis and evaluation.

13. **Minimalist Approach:** Teacher uses a number of small steps, starting with a minimal introduction to the topic and helping students to explore further. The students learn the whole topic through a number of small steps

14. **Brainstorming:** This technique is used to generate large number of ideas to solve a problem. Ideas are generated at random without much criticism; most unusual ideas are also welcomed and are numbered as they are generated.

15. **Mind Mapping:** This is a strategy for helping students order and structure their thinking through mentally mapping words or/and concepts. Mind maps help to make notes that use only key words and images. Their visual quality makes them easy to remember and review.

B(iv): Mapping of CM topics to competencies prescribed by NCERT

Primary school competencies

NCERT		CM	Comments
Competency	Guidelines		
A. Fundamental Operations and Concepts			
1.Communicate about technology components using right vocabulary	Use basic vocabulary related to the use of the technology, e.g., mouse, keyboard, monitor, window, icon, printer, concept keyboard, floppy drive, CD drive, CPU.	i. (a) Parts of Computer (includes mouse, monitor, CPU, keyboard, printer) (*Level I, Lesson 2*) (b) Input and Output Devices (includes mouse, keyboard, printer, speaker, scanner) (*Level II, Lesson 2*) (c) Exploring Desktop (Windows, icons) (*Level I, Lesson 9*)	CM has considered the necessary fundamental operations and concepts such as mouse, monitor, keyboard, input and output devices, and internal technology operation. It also explains how to use mouse, keys on keyboard effectively.
2.Use input and output devices to operate computers	i. Start and shut down the computer (in both networked environment and stand alone system). ii. Use mouse, keyboard and printer.	i. Computer Start Up & Shut Down (includes how to start computer and log in- log out) (*Level II, Lesson 8*) ii. Activities using Mouse and Keyboard (*Level II, Lessons 3 & 4*)	
3. Communicate about technology operation using the right terminology	Apply basic vocabulary, like disk drive, RAM, ROM, processor, modem, ALU, CU, Interface, and so on.		All sub-topics are explicitly dealt in CM at middle school level.
4. Demonstrate function, operation of technology components	i. Use keyboard and mouse effectively. ii. Use Multimedia resources iii. Educational software including game software	i. (a) Keyboard usage (includes familiarity with keys and effective usage) (*Level I, Lesson 5*; *Level II, Lesson 5 & 6*) (b) Mouse usage (includes parts of mouse, drag and drop, single and double clicks) (*Level I, Lesson 6; Level II, Lesson 4*) ii. (a) Scratch programming (*Level III, Lesson 5; Level IV, Lessons 3 & 5; Level V, Lesson 4*) (b) Paint application (*Level I, Lessons 6 & 7*) (c) Using a music player (*Level I, Lesson 8*) iii.(a) Educational software includes 'Scratch' (*Level III, Lesson 3*) (b) Games such as GCompris and TuxMath (included as activities in *Levels I, II and III*)	The early levels of CM introduce the functional operation skills. Students develop the keyboard and mouse usage skills through different Free Open Source Software educational games. CM introduces concepts of programming through Scratch that helps students to create animation. Application software likes Tux paint, Tux Math, GCompris and Childsplay helps learners to develop computer related skills simultaneously reinforcing concepts learnt in other subjects like Mathematics, English language and EVS.

B. Social and Ethical Issues

1. Work co-operatively in the classroom	i. Share resources with other students; ii. Respect others' privacy iii. Intellectual property.	i. Do's and Don'ts with computer (*Level I, Lesson 3*) ii. AWARE poster (*Level V, Lesson 4*)	CM addresses relevant social and ethical issues in a class as well as outside the class. It emphasizes on working cooperatively, sharing your computer, Do's and Don'ts of computer handling and many more. Projects and activities encourage students to work collaboratively.
2. Practice responsible use of devices	i. Ensure that equipment is unharmed while using it. ii. Practice responsible use of hardware and software. Maintain cleanliness. iii. In case of machine malfunction, inform the teacher	i. Do's and Don'ts with computer (*Level I, Lesson 3*)	At the beginning of CM levels learners are made aware of the responsibilities while handling computers and other accessories.
3. Acknowledge Sources of information	Ensure that sources of information are properly acknowledged while using them for one's own purpose.	i. AWARE poster (*Level VI, Lesson 4*)	CM inculcates the attitude of acknowledging sources of information through this poster. This poster also creates awareness about copyright laws and Creative Commons.
4. Safeguard system against viruses	Use floppies after virus check under the teacher's supervision	i. SMART poster (*Level V, Lesson 7*)	SMART focus on five basic internet safety rules.

c. IT tools

1. Work with folders and files	i. Create folders/files. ii. Save file at desired location. iii. Open /rename files/ folders. iv. Print/ delete files	File and folder management (*Level I, Lesson 6; Level II, Lessons 4 & 7; Level IV, Lesson 6*)	Concepts necessary to work with files and folders are covered in different lessons from levels I to IV based on the complexity, and while working with different types of files.
2. Use LOGO as a programming tool	Use LOGO as a device for controlling the technology for learning programming logic.	i. Scratch to teach programming skills. (*Level III, Lesson 5; Level IV, Lessons 3 & 5; Level V, Lesson 4*)	Scratch, a GUI-based programming language, equivalent to LOGO has been introduced in order to develop programming skills.
3. Use tools for illustrations	Create picture stories, filling of the images with color pattern.	Tux Paint (*Level I, Lesson 6 & 7; Level III, Lesson 6*)	Tux paint is used to nurture creativity.
4. Use a word processor	Use word processor and its editing facilities.	Text processing (*Level II, Lesson 7; Level II, Lesson 6*)	

Middle school competencies

NCERT		CM	Comments
Competency	**Guidelines**		
A. Fundamental Operations and Concepts			
1.Communicate about technology components using right vocabulary	i. Use educational software. Access information sources like CD-ROMs, previously book marked Internet sites. ii. Communicate through e-mails under teacher's supervision. iii. Share drives in networked environment.	i & ii Communication using e-mail (includes Bookmark a webpage) (*Level V, Lesson 7*) iii. LAN (*Level VIII, Lesson 2*)	Almost all lessons in CM provide links of related websites for reference. Through projects and activities the students are expected to share different kinds of files using Internet and LAN.
2. Demonstrate an understanding of hardware software and connectivity.	Use trouble-shooting strategies or bring problems to the notice of the teacher.	Basic trouble shooting (includes configuring external devices such as printer, webcam) (*Level VIII, Lesson 5*)	CM covers safe handling of computer parts and peripherals, sharing resources.
3. Recognize problems caused by viruses.	Use anti-virus program to protect the system.	Communication using e-mail (includes computer virus) (*Level V, Lesson 7*)	CM cautions against the ill effects of virus and mentions precautions.
B. Social and Ethical Issues			
1. Practice responsible use of software and hardware.	Use equipment properly so that software media is not damaged. Recognize that someone else's work residing on the computer should not be disturbed.	Do's and Don'ts with computer	CM encourages students to be responsible users. This happens through constant reinforcement at every level.
2. Exhibit legal and ethical behavior.	i. Practice safe Internet use. ii. Follow 'Net etiquette' when using the Internet and electronic mail. iii. Respect copyright guidelines.	i. SMART poster (*Level V, Lesson 7*) ii. e-mail communication (*Level V, Lesson 7*) iii. AWARE poster (*Level VI, Lesson 4*)	CM posters develop legal and ethical behavior. Variety of projects and assignments reinforce this behavior.
3. Use anti-virus programs and update them.	Abide by laboratory norms with respect to virus check. Update anti-virus periodically. Scan hard disk periodically for viruses.	e-mail communication (*Level V, Lesson 7*)	Computer virus is dealt in level V of CM, including scanning devices before using them
C. IT Tools			
1. Use tools for publishing and presenting information.	Create word processing documents with graphical elements using available facilities.	(a) Organizing information (*Level V, Lesson 3*), Mind maps (*Level VI, Lesson 2*) (b) Word processing (*Level VII, Lesson 4*) (c) Spreadsheet (*Level VI, Lesson 5*)	This is addressed in: a. Word processor skills – format tables, pictures, b. Mind maps c. Presentation skills – Plan, Execute and Impress stages.

2. Use interfaces/tools for data collection and analysis.	i. Collect scientific data, like temperature, pH, light intensity. ii. Differentiate between Analog and Digital transmission. iii. Use digital camera.	iii. Digital storytelling (*Level VII, Lesson 3*)	i and ii are not covered. iii is covered in CM level VII
3.Use tools for analyzing model	Manipulate variables in simulations to obtain a desired outcome.		Not covered in CM
4.Use LOGO for programming	Use advanced LOGO features for exploring ideas.	i. Scratch (*Level V, Lesson 4*) ii. BASIC (*Level VI, Lesson 6; Level VII, Lesson 9*)	Scratch is similar to LOGO but more recent.

D. Communication Tools

1. Communicate with others (with help from teachers) using electronic tools.	i. Plan, design and present an academic product to the class using slide show that includes text, graphics, video and sound. ii. Communicate with others using email (Across the curriculum).	i. Digital storytelling (*Level VII, Lesson 3*) ii. Advanced Internet (*Level VII, Lesson 5*)	Presentations introduced in CM level V. Students to collaborate to create a multimedia digital story. Communication occurs through the Internet.
2. Collaborate with others using on-line resources.	Make collaborative exchanges with experts and peers. Present academic product to share data and solutions (Across the curriculum).	Advanced Internet (*Level VII, Lesson 5*)	Students use e-mail and Google docs for online content sharing, starting in level V and continues in higher levels.
3. Work in a networked environment.	Log in, log out, use password, and share resources.	i. Multiple users of the system, Internet and e-mail (*Level V, Lesson 5 and 7*) ii. Online sharing of content (*Level VII, Lesson 5*)	CM level II introduces concept of multiple users. Online login, username and password are dealt in level V onwards.

E. Technology Research Tools

1. Recognize electronic information sources.	Identify potential sources of information on a topic from the electronic library of the school (Across the curriculum).	Stepwise gathering of information (*Level V, Lesson 2*)	Step wise gathering of information involves identifying appropriate sources of information.
2. Locate information from worldwide sources.	i. Devise search strategy to locate information. ii. Reach information sources by keyword search; Boolean logic. iii. Identify the author, copyright date and publisher, on the Internet.	i. Introduction to Internet - (*Level V, Lesson 5*) ii. Searching the Internet (*Level V, Lesson 5*) iii. Communication using e-mail (*Level V, Lesson 5*)	CM prepares learners through lessons of – 1. Thinking processing skills 2. Introducing Internet 3. AWARE poster
3. Evaluate the accuracy, bias and relevance in materials collected.	i. Gather information from different sources and crosscheck for their validity and relevance. ii. Obtain permission, if necessary, to use the work of others.	AWARE posters (*Level VI, Lesson 4*)	Aware of copyright, Watch for CC license, Acknowledge resources, Reject plagiarism, Explain in own words.

F. Tools for Problem-solving

1. Use IT resources for problem-solving and self-directed learning.	Use digital means to collect, process and interpret data and explore solutions to problem.	Step-wise gathering information (*Level V, Lesson 2*)	CM focuses on developing thinking skills such as step wise and logical thinking, while working with computer applications.
2. Select tools to interpret data, and model using a spreadsheet.	Use electronic spreadsheet to create dynamic models. Make graphical representation of data and this analysis.	i. Introduction to spreadsheet (*Level VI, Lesson 5*) ii. Advanced spreadsheet (*Level VII, Lesson 5*)	CM prepares students to use spreadsheets and to represent data in tabular and graphical forms.

Secondary school competencies

NCERT		CM	Comments
Competency	**Guidelines**		
A. Fundamental Operations and Concepts			
1. Select appropriate device for a given task.	Gather data using scientific probes, use graphing calculators, etc.	Combined software activity (*Level VIII, Lesson 3*)	Activity requires use of multiple applications. Students have to choose appropriate tools to accomplish the task.
2. Make informed choice of browser and search engine.	Put up justifications for choosing an Internet service provider, a browser, or a search engine.	Searching the Internet (*Level V, Lesson 6*)	Students learn about alternative browsers and search engines.
3. Trouble shooting for peripherals.	Make connections. Replace consumables builds like printer cartridge, paper, etc.	System admin and basic trouble shooting (*Level VIII, Lesson 5*)	Students configure devices and Internet, and do troubleshooting.
B. Social and Ethical Issues			
1. Identify specific strengths and weaknesses of technology resources.	i. Make informed choice of appropriate technology systems and services. ii. Analyze impact of technology and its obsolescence.	Combined software activity (*Level VIII, Lesson 3*)	Students are sensitized about effect of technology on their environment through various activities.
2. Demonstrate legal and ethical behavior regarding the use of technology and information.	i. Use password and realize the importance of protecting it. ii. Explain impact of unauthorized intrusion and hacking. iii. Describe computer viruses. Ensure that they are not spread through insensitivity.	SMART & AWARE posters (*Level V and Level VI*)	The posters sensitize the students about the copyright and safety rules while using Internet for information. CM does not deal with unauthorized intrusion, data manipulation and hacking.

C. IT tools			
1. Communicate to a variety of audiences using IT tools.	i. Create documents with professional finesse. ii. Merge information from one document to another. iii. Create documents containing Hyperlinks.	i. Combined software activity (*Level VIII, Lesson 3*) ii. Communication using e-mail (*Level V, Lesson 7*)	This is addressed by: a. Word processor skills – b. Presentation skills – mentioned earlier.
2. Use a variety of technology tools for data collection and analysis.	i. Use technological devices for collecting data. ii. Use spreadsheets to analyze. iii. Create database reports. iv. Use application accessories such as calculator, clock.	i. Data analysis using spreadsheet (*Level VII, Lesson 5*) ii. Creating newsletter (using word processor and Scribus (*Level VII, Lesson 4 & 8*)	
3. Use tools to present and publish information with interactive multimedia features.	Design and create multimedia presentations or web materials with interactive features (e.g action buttons to play video, links to other web sites)	i. Digital story telling using presentation (*Level VII, Lesson 3*) ii. Scribus for desktop publishing and Xmind – mind mapping software (*Level VIII, Lesson 8*)	Create a digital story by adding images/ sound/ video.
4. Use tools to make models and simulations	Use CD writer and Zip drive.	Introduction to FOSS apps (*Level VIII, Lesson 5*)	
5. Manipulate images.	Use imaging software to make change in scanned image or image from digital camera.	Advanced Image editing (*Level VII, Lesson 2*)	
D. Communication tools			
1. Use on-line information resources for collaboration and communication.	Participate in news group and conferencing by experts.	Advanced Internet (*Level VII, Lesson 5*)	CM encourages learners to create files using different software applications and share with friends and family through e-mail, Google docs and other cloud based applications.
2. Collaborate with others for building content-related knowledge base.	i. Create and contribute digitized materials to a commonly agreed project archive. ii. Create links to resource materials to build group collaboration in research.	Content sharing using Internet (*Level V, Lesson 7*; *Level VII, Lesson 5; Level VIII, Lesson 3*)	Students are encouraged to share their work or create a document through collaboration using internet. A number of activities and project works ensure that online collaboration happens in the class.

E. Technology Research Tools

| 1. Develop strategy to find relevant and appropriate electronic information sources. | i. Explain difference between the use of directories and search engines. Given a concept, use online key word searches.
ii. Adapt software for personal efficiency by setting preferences for effective use.
iii. Evaluate appropriateness and effectiveness of electronic resources.
iv. Use advanced features (e.g. advanced searches, filtering). | i. Searching the Internet (*Level V, Lesson 6*)
ii. Basic trouble shooting to adapt software according to requirement (*Level VIII, Lesson 5*) | |

F. Tools for Problem-solving

| 1. Investigate technology-based options for lifelong learning | Locate and use on-line resources with respect to a personal learning plan, e.g. an area of academic interest, a hobby or health issues and prepare an investigative study report. | Step wise gathering of information (*Level V, Lesson 2*) | CM focuses on developing thinking skills such as step wise thinking, logical thinking, analysis and observation along with computer application skills. |
| 2. Use productivity tools, communication tools and research skills. | i. Identify a problem and formulate the strategy to solve the problem.
ii. Collect data from various sources, including the use of the Internet and probeware, interpret data and present findings.
iii. Develop a solution to the problem. | Combined software (*Level VIII, Lesson 3*) | An activity that requires use of multiple office applications along with online collaboration is included. Students have to choose appropriate tools to accomplish the task. |

B(v): How CM prepares students for computer applications elective in ICSE Grade 9

Topics of ICSE	Sub-topics	Preparation through CM	Comments
1. Computer Hardware	CPU, the clock, cache memory, primary memory, secondary memory, input and output devices, communication devices	i) Parts of computer (*Level I, Lesson 2*) ii) Input/output devices (*Level II, Lesson 2*) iii) History of Computers and applications (*Level VII, Lesson8*) iv) Inside computers – hardware and operating system (*Level VII, Lesson 2*)	Clock, cache memory, primary memory and secondary memory will be new concepts to be learnt in std IX. The students are already aware of sub-topics. Communication devices are included as parts of I/O devices, email and digital story telling.
2. Data representation and internal computer structure	(a) Number systems. (b) Representations for integers, real numbers, limitations of finite representations. (c) Internal structure of a computer, instruction format, registers, simple algorithms in assembly language.	Binary number system (*Level VIII, Lesson 6*).	Sub-topics (b) and (c) are not addressed in CM VIII. They will be a part of std IX syllabus.
3. Computer Software	(a) Boot process, operating systems – resource management, command processing. (b) Directories, files and hierarchical file system. (c) Programming languages (machine language, assembly language, high level language). (d) Compilers and interpreters. (e) Application software.	i) a. Start up and shut down, operations. (*Level II, Lesson 8*) b. OS (*Level VII, Lesson 2*) c. Trouble shooting (*Level VIII, Lesson 5*) ii) File management. (*Level II Lesson 4; Level IV, Lesson 6*) iii) a. Scratch – multimedia programming (*Level III, Lesson 3 and 5, Level IV, Lesson 3, 5, Level V, Lesson 4*) b. BASIC (*Level VI, lesson 7; Level VII lesson 10, Level VIII*) iv) Application software (All).	Students will have a fair knowledge about most of the sub-topics, due to the spiral nature of CM levels. New knowledge can be introduced in Std IX, as required. Students work with different application software in each CM level. See B2 for a grade-wise list.
4. Social context of computing and ethical issues	(a) Intellectual property and corresponding laws and rights. (b) Software patents, copyright, trademarks, licensing and piracy. (c) Free software foundation and its position on software, open source software. (d) Privacy, email etiquette.	i) AWARE (copyright, Creative commons, plagiarism) (*Level VI, Lesson 4*) ii) SMART (*Level V, Lesson 7*) iii) Download and use applications (includes FOSS) (*Level VII, Lesson 9*) iv) e-mail Communication (*Level V, Lesson 7*)	Students learn about safety issues while learning to use the Internet. Students learn about intellectual property rights, software patent, trademark and licensing, in various CM Levels.

Topics of ICSE	Sub-topics	Preparation through CM	Comments
5. Algorithms	(a) Concept of an algorithm (b) Properties of an algorithm (finite, definite, terminating, precise) (c) Basic ideas of the complexity of an algorithm - space complexity, time complexity.	i) Thinking process skills – Step-wise thinking, Logical reasoning, Step-wise gathering of information, Brain storming, Mindmaps *(Level III, Lesson 2; Level IV, Lesson 2; Level V, Lesson 2; Level VI, Lesson 2)* ii) Flowchart *(Level VI, Lesn 6)*	In earlier levels students have learnt thinking process skills. The thinking skills are applied by the students while preparing flowcharts. These skills and concepts will help them to learn about Algorithms.
6. Programming using a High Level language	BASIC or C++ : (a) Primitive data types, variables and assignment. (b) Expressions – Arithmetic and logical. Associativity and precedence of operators. (c) Statements, blocks, scope and visibility of variables. (d) Conditional statements. (e) Loops (for, repeat, while). (f) Standard input/output.	i) Scratch *(Level III, Lesson 3 & 5; Level IV, Lesson 3 & 5; Level V, Lesson 4)* ii) BASIC 256 *(Level VI, Lesson 7; Level VII, Lesson 10)*	Students are familiar with programming through Scratch and BASIC 256. Programming begins at Level III of CM. The Thinking Processing Skills also help them in developing program writing skills. So they can learn complex programming in Std IX.
7. Computers in everyday life	(a) Word processing, database spreadsheets, presentations. (b) Basic introduction to the Internet, browsing, e-mail.	i) Office applications a. Word Processor *(Level III, Lesson 5; Level VI, Lesson 6 Level VII, Lesson 5)* b. Spreadsheet *(Level VI, Lesson 5, Level VII, Lesson 7)* c. Presentation *(Level VII, Lesson 4, Level VII, Lesson 4)* ii) Internet and communication: a. Browsing and searching *(Level V, Lesson 6)* b. email communication *(Level V , Lesson 7)* c. Online content sharing *(Level VII , Lesson 6)* d. Social networks *(Level VIII, Lesson 5)*	The spiral curriculum of CM introduces applications multiple times in different levels of CM, with increasing complexity. Students learn to create, edit and format documents using features of different Open Office Documents. They also learn to communicate via e-mail and gather information using Internet.

B(vi): How CM prepares students for foundations of IT elective in CBSE Grade 9

Topics of CBSE	Sub-topics	Preparation through CM	Comments
1. Basics of Information Technology –1	(a) Convergence of computer communication and content. (b) Components of a computer – CPU, Memory, I/O devices, units of memory (c) Types of software – System, application (general - office, specific – inventory and utility – anti-virus).	i) Parts of computer (Level 1, Lesson2) ii) I/O devices (Level II, Lesson 2) iii) Inside computers – hardware and OS (Level VII, Lesson 2)	All sub-topics are covered. Some sub-topics may have to be learnt in more detail in std IX.
2. Information processing tools -1	(a) Basic concepts of Operating systems. (b) Using Task bar, viewing files and folders, managing desktop Windows. (c) Office tools – Word processing (creating and editing documents, using various formatting options).	i) Inside computers (Level VII, Lesson 2) ii) Exploring desktop (Level I, Lesson 9), Activities using a mouse (Level II, Lesson 4), Naming and organizing files (Level IV, Lesson 7). iii) Text processing (Level II, Lesson 7, Level III, Lesson 6, Level V, Lesson 3).	Topics introduced at lower levels and revisited at greater detail & complexity in the higher levels.
3. Applications–1	(a) Report writing, making cards and posters.	Word Processor: Designing (Level VII, Lesson 5). Innovation and creativity (Level VIII, Lesson 5).	Integrates use of multiple application tools.
4. Basics of Information Technology –2	(a) Computer networking – LAN, WLAN, WAN. (b) Multimedia data use.	Inside Internet (Level VII, Lesson2), Image editing (Level VII, Lesson 3).	Sub-topics may have to be learnt in more detail in std IX.
5. Information processing tools –2	(a) Presentation tools –concept of slide shows, creating and editing slides, using formatting options. (b) Spreadsheets – creating, editing and formatting, using simple statistical functions, inserting tables and charts.	i) Making presentations (Level VI, Lesson 4), Digital story telling (Level VII, Lesson 4). ii) Introduction to spreadsheets (Level VI, Lesson 5), Data analysis (Level VII, Lesson 7).	Topics introduced at a level and advanced features addressed in the higher levels.
6. Applications–2	(a) Creating presentations on various topics, such as product advertisement. (b) Creating reports on various topics, such as cricket score card. (c) Societal impacts of IT – plagiarism, security, privacy and IPR issues.	i) Designing ephemera (Level VII, Lesson 5). ii) Innovation and creativity (Level VIII, Lesson 5). iii) Internet applications (Level V, Lessons 5-7), SMART and AWARE posters (Levels V and VI), FOSS applications (Level VII, Lesson 9).	Projects from level V onwards require use of multiple tools and thinking skills.

ANNEXURE C: SURVEY OF EXISTING TEXTBOOKS

This annexure gives a listing of the topics covered in various textbooks in India, as per the editions mentioned below. Note that most of this annexure was created in 2010 and has not been updated for the 2013 release of this curriculum document. It is possible that some of the textbooks mentioned below have revised editions with significant changes between 2010 and 2013.

Publisher:	Oxford Univ Press	Rachna Sagar	Kalra Publications	JeevanDeep Prakashan	Frank Bros
Authors:	*Sangeeta Panchal, Alka Sabharwal*	*Vaishali Bhatnagar, Anu Pasricha, Reeta Sahu*	*M.M.Joshi, Amit Kantiwal*	*Sadhana Sharma*	*Manjeet Jauhar, Bhuvana Balasubramaniam*
Year:	2005 (Second edition)	2006 (Fourth edition)	2005 (Revised edition)	2006 (Revised edition)	2002 (First edition)
Grade:					
1st	Parts of a computer	Computer	Useful Devices	Computer	What is a computer
	Uses of computers	Parts of a computer	About Computer	Machines	Uses of computer
	Mouse	Handle with care	History of Computer	Electricity	Computers everywhere
	Keyboard	Uses of computers	Some other Parts	Information	Parts of a computer
		Keyboard	Uses of Computer	Computer and its parts	Monitor
		Mouse handling	Importance of Computer	Monitor	Keyboard
		Paint	Machines	Cursor	Input, Process, Output
			Don't's with Computer	Let's use the Keyboard	CPU
			Computer Alphabets	Mouse and Printer	Compu Maths
				CPU	
				A to Z of Computer	
2nd	Computers – Machine	What is a Computer?	Computer	Machines/Electricity	Applications of computer
	Parts of computers	Parts of a computer	Components	Man and Machine	How computers work
	Application of computer	Storage devices	Keyboard and keys	Information	Getting started with a PC
	Start and Shut down	More about computers	CPU and its usefulness	Where store Information?	Using the Keyboard
	Keyboard	Things to do	Monitor and its uses	Why we need Computers	Compu Maths
	Mouse	How does it work?	Types of Computer	What is a Computer?	
	Fun with Paint	Input-Process-Output	Languages and LOGO	Computer System	
		Keyboard	March of a TURTLE	Let's Use Keyboard	

		Mouse handling	How a computer works	Input-Output	
		Paint	Uses of computer	Maths with Computer	
		Operating a computer		Uses of Computer	
		Precautions		Some Do's and Don'ts	
3rd	Introduction to computer	Know your Computer	Introduction and History	The Computer	Man and Computer
	Keyboard	Parts of Computer	Uses of main parts.	Parts of Computer	Structure of a computer
	Operating system	Input output devices	Other basic devices.	LOGO	Input devices
	Operating a Computer	Hardware and software	Operating a computer	**11 Chapters on LOGO commands and usage**	Output devices
	Starting Paint	First step to Lab	Other operations.		Windows
	Drawing in Paint	Your windows	Languages and LOGO		Paintbrush
	Introduction to LOGO	Starting MS Paint	Intro Windows98		Compu Maths
	LOGO Commands	Fun with LOGO	Intro to WordPad		
	Writing with LOGO	Drawing, Moving cmds	Intro to Multimedia		
	Arithmetic with LOGO	Introduction to MS Word			
	Notepad	Project work			
	Project work				
4th	Computer Evolution	Computer overview	Evolution of Computer	Computer	Learning step by step
	Input an Output Devices	History of Computer	Computer: Detailed Focus	LOGO	Introduction to LOGO
	More about Windows	Working with windows	Computer Applications	**15 Chapters on LOGO commands and usage**	**6 Chapters on LOGO commands and usage**
	More about Paint	Working with MS Paint	Computer terminology	Some programs	
	More LOGO commands	Drawing with LOGO	Learning PC LOGO		
	REPEAT and PRINT	Procedures in LOGO	Windows98 – OS		
	Intro to MS Word	Advanced LOGO	Working in Paintbrush		
	Multimedia	Word Processing	Working with MS Word		
	Project work	Document Formatting	Multimedia and Internet		
		Project Work	Social Ethics		

5th	Application of computer	Computers Overview	Generation of Computers	Computer	Algorithms and flowcharts
	Data Storage Media	Input Units	Fundamental Elements	Lets write a Program	Windows ME
	More about Windows	Output Units	Output Devices	Language (BASIC)	Paintbrush
	Working with Calculator	Computer Memory	Uses of Computer	Print	Wordpad
	LOGO Procedures	Computer Software	More about Windows98	System Commands	Internet and email
	Editing Text in Word	MS-Windows98	More about Paintbrush	Constants and Variables	Compu Maths
	Formatting in MS Word	Clip art and Word art	More about MS Word	LET	Compu English
	More features of Word	Algorithm and Flowchart	Electronic Mail	Let's Try Print Again	
	Internet	Introduction to BASIC	Introducing Networks	GOTO	
	Flowcharting	BASIC statements	Social Ethics	Graphics	
	Project work	Multimedia and Internet		Project	
		Project Work			
6th	Computer Peripherals	Review of a Computer	Evolution of computers	Computer Architecture	**Not Seen.**
	More on MS Word	Uses of a computer	Fundamentals of computer	Computer Generation	
	Creating tables in MS Word	Characteristics	Elements of computers	A Quick Revision (BASIC)	
	Word Art and Draw	Classification	Working in Windows 98	Revision of Commands	
	Mail Merge	Input / output devices	Working with Word	More System Commands	
	MS Excel	Hardware and software	Flow Chart	INPUT	
	Internet	Windows98	Multimedia and Internet	Flow Chart	
	Email	Windows: My computer		For … Next	
	Basics of BASIC	Windows: Accessories		Library Functions	
	Project work	Word processing		Read – Data	
		Document Formatting		Condition and Decision	
		Clip art and word art		Counters	
		Excel and Powerpoint		On GOTO	
		Multimedia and Internet		Graphics	
		Project work			
7th	Computer peripherals	Review of Computer	Fundamentals of computer	Computer System	**Not Seen.**
	More features of Word	Generations of Computer	DOS and Windows	MS DOS	

	MS Excel	Computer memory	Introduction to Word	File, Batch file, Directory	
	Editing in MS Excel	Operating system	Multimedia and Internet	Format/Mode	
	Formatting in MS Excel	MS DOS commands	Computer Virus	Date, Time, Prompt	
	Formulas in MS Excel	Files in MS-DOS	Fundamentals of BASIC	Version,Volume, CLS	
	Intro to PowerPoint	Windows: Explorer		Wildcards	
	Internet as post office	Word processing		Directory (DIR)	
	Computer Viruses	Text formatting in Word		Path and Pathname	
	QBASIC looping statements	Mail merge in Word		**9 chapters on DOS commands**	
	Project	MS Excel Basics		Common Error Message	
		PowerPoint basics			
		Multimedia			
		Working with Internet			
		Project work			
8th	Types of Computers	Review of Computer	Fundamentals of computer	Windows	**Not Seen.**
	Advanced MS Word	Number system	Introduction to Word	Window Elements	
	Advanced MS Excel	Computer languages	Networking	Explorer	
	Charts in MS Excel	Path and Batch file	Multimedia and Internet	Control Panel	
	MS PowerPoint	External commands		My Computer, Recycle	
	Text in MS PowerPoint	Windows98		Word pad and Notepad	
	Organization in PPT	Worksheet basics		Paint	
	Graphics,Charts in PPT	Editing in Excel		Internet Explorer	
	Enlivening a PPT	Charts in Excel		Calculator, Address Book	
	Intro to MS Access	PowerPoint basics		Windows 2000	
	What's on the Internet	Slide formatting			
	E-Commerce	Computer Network			
	Graphics in QBASIC	Web browser			
	Project	HTML programming			
		Project work			

Publisher:	NAVNEET	CBM	MADHUBAN	McMILLAN	NIIT
Edition:					
Grade					
1st	1. A computer	1. How do machines work.	1.Introduction to computer	Introduction to computer	Parts of a computer
	2.The keyboard	2.The Parts of a Computer	2.Parts of A Computer	Parts of a computer	Tux Paint
	3.Windows - Desktop icons, start up-shut down	3.The Use of Computer	3.Start Your Computer	Uses of a computer	Word Pad
	4. Paint	4.The Keyboard	4.Know Your Mouse	Computers at work	
		5.The Mouse	5.Know Your Keyboard	Use of keyboard	
		6.Project – 1	6.Uses Of A Computer	Mouse	
		7.Input and Output	7.Looking after computer	Taking care of computer	
		8.Input and Output Devices			
		9.Other Devices			
		10.Caring For Computer			
		11.Starting And Shut Down			
		12.Project – 2			
2nd	1. Parts of computer	1. Computer as a machine	1.Introduction to computer	Computer Fundamental	Creating Images-MS Paint
	2. Keys on keyboard	2.The Computer	2.Parts of A Computer	Keyboard	Creating Animations
	3. Windows	3.The Parts of a Computers	3. Starts & shut down	Mouse	Typing Text
	4. Word	4.The Types of Computers	4. More about mouse	Computer application	
		5.The Mouse	5.More About Keyboard	Input and Output Devices	
		6.Project – 1	6.Computer in Our Lives	Working with Paint	
		7.The Keyboard	7. How Computer Works	Rules for Computer lab	
		8.The C.P.U.	8.Do`s And Don`ts		
		9.The Monitor, Printer	9.MS Paint		
		10.Storage Places			
		11.Project – 2			
3rd	1.Parts of computer	1. What is Computer?	1.Introduction to computer	Computer fundamentals	Working with windows
	2.The keyboard	2. Keyboard	2.Do`s And Don`ts in Lab	Hardware and Software	Turtle Graphics
	3. Windows	3. Starting a Computer	3.Uses of Computer	Working with Windows	Creating Presentations
	4. PowerPoint	4. Windows	4.Input Devices	Working with Word	

		5. Paint	5.Output Devices	More on paint	
		6. Project – 1	6.Storage Devices	Introduction to LOGO	
		7. Tools	7. Windows XP		
		8. More About Tools – 1	8. Paint master		
		9. More about tools – 2	9.Reasoning and Logic		
		10. Drawing in paint	10.Logo		
4th	1. A computer	1.My Computer	1.Hardware And Software	Computer fundamentals	Creating files and folders
	2.The keyboard	2.Windows	2.The Brain Box – CPU	Multimedia	Working with files and folders-1
	3. Windows	3.Starting with Windows	3.Types of Computer	LOGO	Working with files and folders-2
	4. Introduction to LOGO	4.The Desktop	4.More On Windows	More on Windows	Control Panel
	5. LOGO commands	5.Changing your Desktop	5.Notepad	Windows accessories	
	6. More LOGO cmds	6.Project – 1	6.Microsoft Word	Introduction to Word	
	7. Drawing with LOGO	7.The Start Menu	7.MS Power Point		
	5 more chapters on	8.The Accessories Menu	8.More on Logo		
	LOGO commands	9.Files and Folders			
		10.Windows Explorer			
		11.Introduction to Programs			
		12.Project – 2			
5th	1. Parts of computer	1. Introduction to Windows	1.Evalution of Computers	Computer memory	Searching Information
	2.The keyboard	2. An Introduction to Word	2.Computer Memory	Programming concepts	Photo editing
	3. Windows	3. Editing a Document	3.Computer Languages	DOS	Creating Charts
	4. Introduction to LOGO	4. Formatting a Document	4.Flow Charts	More on MS Word	Introduction Messenger
	5 Drawing with LOGO	5. The Features of Word	5.Introduction to Internet	More on LOGO	Communication messages
	More LOGO chapters	6. More Features of Word	6.MS Excel	Introduction to Internet	Communication msgs 2
		7. Word art and Clip art	7.More on MS Word		
		8. Columns and Tabs			
		9. Working with Tables			
		10. Printing a document			
6th – 8th	Not Seen	Not Seen	Not Seen	Not Seen	Not Seen

ANNEXURE D: CONTRIBUTORS AND ACKNOWLEDGEMENTS

The contributors at various stages of this work are as follows:

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