Model Computer Science Curriculum for Schools

Release January, 2010

IIT BOMBAY

Model Computer Science Curriculum for Schools

March, 2010

Authors

Sridhar Iyer, Malathy Baru, Vijayalakshmi Chitta, Farida Khan, and Usha Vishwanathan

Department of Computer Science and Engineering

Indian Institute of Technology Bombay

With pedagogy inputs on curriculum topics and teaching learning styles from

Dr. Sahana Murthy, IITB

Dr. Padma Sarangapani, TISS

Dr.Jayashree Shinde, SNDT

Dr.Vasudha Kamat, NCERT

Computer Science Curriculum, 2010 Edition

***Preamble**: The first version of Computer Science curriculum was released in March 2007. This document is the second version released in March 2010. This curriculum creation activity started in January 2007 at IIT Bombay, with a literature survey of existing computer science curriculum in India and abroad. This was followed by a survey of textbooks, resulting in a comparison of topics being taught at various schools/levels. The survey was followed by a draft curriculum which was rigorously reviewed by an academic team of experts [Annex E]. This was followed by the activity of Handbook creation during March-May 2007which was a collaborative effort involving authors from geographically different places. List of participants who contributed for this activity is given in Annex E. A process of how to take part in this effort was defined by creating authoring guidelines, lesson creation templates, lesson review forms which are part of the first draft available at http://www.it.iitb.ac.in/~sri/ssrvm. The detailed templates are listed in Annex F. The contents of the handbook were used for teaching in some Mumbai schools by our team and valuable inputs from them have helped us in evolving the content. From June 2007- June 2008, the handbooks were extended to textbook format and released on Open source for free download. In the month of July 2007 the first textbook title **Computer Masti [CM]** was released followed by book II in November 2008, book III in June 2009, and book IV in September 2009. According to Google statistics of the textbook website, there have been cumulative downloads in excess of from countries worldwide. Discussions with other pedagogy experts **(Prof.Jayashri Shinde, Prof.Sahana Murthy, Prof.Padma Sarangapani)** also gave us helpful insights, which had a major impact during designing topics and authoring textbooks for higher levels. Given the pilot implementation experience we have also recommended categorization of CM content by Bloom's taxonomy [ANNEX C] and an evaluation methodology for computer science textbook contents in general. As the curriculum has been tried already with schools, we have experimented in a small way to adapt a subset of the topics for adult literacy in*

an NGO; Vidya at IIT Bombay. As an extension of this work, we plan to design a curriculum framework for adult literacy [ANNEX D]. The scaling up activity of CM implementation has been taken up by an IITB start up company "InOpen Technologies". They will focus on providing end-to-end solutions to schools in terms of infrastructure, resources, training and evaluation. The pilot implementation and publishing support for textbooks has been provided by SSRVM [Shri Shri Ravi Shankar Vidya Mandir] .

Table of Contents

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, parents etc.) to use a computer for a variety of purposes. Sometimes this leads to learning undesirable habits (playing on a computer for hours), incorrect usage, as well as 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.

Now 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 itself, in a suitable manner. Otherwise the school curriculum would lag behind the learning 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 and adapt appropriately to the introduction of new tools, while simultaneously keeping a focus on conceptual learning. Moreover, there should not be emphasis on learning computers at the expense of other subjects/activities and the curriculum should be well-balanced. This document is an attempt at defining the details of what we believe is an appropriate, balanced curriculum for computer science in schools. We emphasize learning of concepts associated with various tools, rather than just the usage skills of a specific tool. We also include topics like stepwise thinking and logical reasoning to facilitate and improve thinking skills which are not subject specific.

1.1 Scope of this curriculum

Indian schools have already been offering computer science as a subject to their students for the last 10 years. Some of them introduce it as early as 1st grade and some of them introduce it in 3rd grade. Unlike other subjects where there is a prescribed textbook and syllabus, there is a lot of ambiguity for teaching computer science. One reason could be lack of a well defined top level framework. Currently the NCF defined by NCERT forms the basis for the CBSE board syllabus and the schools tied up with this board do teach the topics mentioned in the framework. However the emphasis on topics

is open to interpretation and there is wide variation in the treatment of a given topic across books. The ICSE system has defined syllabus only for 9th and 10th grades and for the lower grades, the school can teach what they feel is appropriate. This leads to variation in the books chosen by individual schools and hence the topics covered at the primary and middle school level.

Essentially the topics covered currently are more driven by the market demand at that point of time and more of usage and skill based content is covered for specific applications [eg: Java, MS Office]. There is very little emphasis on thinking skills or concepts of broad applications 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.

Currently the scope of this curriculum includes defining the computer science syllabus for schools in our country.

The scope for this edition *does not include* teaching computer skills by directly integrating the use of computers into other subjects. The scope will later be expanded to include:

- E-learning: Using computer-based tools and applications to learn other subjects.
- Customisation for Schools in rural and tribal areas in India, depending on local requirements and resource availability.
- Adult computer literacy programs

1.2 Curriculum Alternatives

A review of current K-12 computer science curricula being followed in India and abroad is given in Annex A. A summary is as follows:

- The CBSE Board follows the NCERT framework 2005 [1]. The NCERT (National Council of Educational Research and Training) classifies the computer literacy needs into 6 categories: Fundamental Operations and Concepts, Social and Ethical Issues, IT Tools, Communication Tools, Technology Research Tools and Problem Solving. At the end of each level: Primary, Middle and Secondary schools, some learning

outcomes are prescribed.

- The ICSE Board has Computers as a core subject from 1st to 8th standard. In 9th and 10th standard it is an elective subject. The syllabus for 9th and 10th is defined and available on their website [2]. Syllabus for the lower classes is 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 and skills and concepts taught at different schools.
- Many State Boards have introduced the subject but details are still to be defined.
- An international board (IB) based out of Geneva offers core computer science to grade 11 and 12 students covering topics like, computing systems fundamentals, program construction, software development, data structures and algorithms and file organization. This is followed across the world by all schools offering the IB program.
- The Advanced Placement (AP) Program in USA, offers a course and exam in introductory computer science. This course is aimed at high school students [9, 10,11,12]. The course emphasizes mainly on object-oriented programming methodology. It also covers problem solving and algorithm development, and is meant to be the equivalent of a first-semester college-level course in computer science. It also includes the study of data structures, design, and abstraction.
- Many schools abroad integrate the teaching of computers into other subjects. A well defined methodology for doing so is given in the recent ACM Task Force Report [3] on a model curriculum to integrate CS/IT into the K-12 schools. Computer skills are learnt by carrying out projects and computer-based activities in other subjects. Such an integrated model is desirable but this approach is not yet suitable for Indian schools. Two key limiting factors are the lack of various resources and low computer skills among the teachers. Hence implementing a model similar to ACM, is not feasible.
- Due to lack of time, we only did some preliminary surveys of the curriculum being followed in developing nations. Nevertheless, given the diversity and specific conditions of the Indian context, we feel that simply adopting the curriculum from elsewhere, even after some modifications, is unlikely to work.

This document is an attempt towards addressing the question: *"What computer-related topics should be taught in each standard and why?"* especially in the Indian context.

1.3 Textbook Alternatives

A review of current textbooks available for computer teaching in Indian schools is given in Annex B. A summary is as follows:

- Books from many reputed textbook publishers, including Oxford, Jeevandeep, Kalra, Rachna Sagar, Navneet, Frank Bros and ILFS were studied.
- Most of the authors have attempted to provide a good, age-appropriate treatment of any given topic. Some of the books provide a good explanation for many topics. Most books provide good suggestions for activities, but are often very specific to tools such MS Word, Excel. Many books have a lot of screenshots of the tools and 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.
- Moreover there is a wide variation in the interpretation of the syllabus leading to non-uniform emphasis. Even in a given textbook, the relative emphasis of the various topics is sometimes inappropriate. Sometimes the contents for an entire year deals with learning intricate details of one of the tools mentioned above. As a result, we did not find any textbooks, which address the need to emphasize on general intellectual development and conceptual thinking skills, consistently suitable, throughout the various standards and topics.
- Different schools seem to be following different books. Some do not follow any book but simply leave it to the teacher's creativity and resourcefulness to do the needful. As a result, there is a wide variation in the computer curriculum being taught, even among schools that are affiliated to the same Board.

This document attempts a detailed specification of the computer science syllabus along with examples of the lesson material for each topic. It is also more indicative rather than prescriptive in nature, where suggestions about what needs to be covered are given, but it is left to the teacher about how the topic is taught. It is hoped that these details will enable textbook authors 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".

1.4 Basic Approach

The approach followed for designing this curriculum is:

1. Define what should be taught in each standard and **why.** This is done by identifying (i) the age-appropriate learning goals for each standard and (ii) the examination syllabus as given by the Affiliation Board (*ICSE, in this case*).
2. Create the contents (sample lesson plans and worksheets) for each sub-topic.
3. Conduct a rigorous review of the syllabus as well as the contents created. The main criteria for the syllabus review are *soundness and completeness*, while those for the contents review are *usefulness and child-friendliness*.

The computer curriculum for each standard is broadly divided into three groups:

1. **Concepts**: Learning computer science concepts that are generally useful in many areas as well as some concepts that are specific to computer usage/functioning.
2. **Usage Skills**: Developing hands-on skill in the use of various hardware/software and programming packages/languages.
3. **Social Aspects:** Understanding ethical and security related issues of computer and Internet usage.

1.5 Underlying Philosophy

The emphasis is on understanding the concepts behind various computer-based activities, rather than just the usage skills of specific tools. It is hoped that such a concept-oriented approach will equip the children to be self-learners and enable them to cope with the inevitable advent of new tools and technologies of the future.

The design approach of this curriculum is to keep the primary section as elementary as possible, have a slight ramp up during middle school and further ramp up in secondary section to meet the syllabus prescribed for the Board exams. A summary is as follows:

[Big 6 & SWT focus]

- Primary Section (1st to 4th) – Get the children to be familiar with the computer and that it has many interesting uses. Introduce the capabilities of a standalone computer without doing any programming. Emphasis on just providing exposure to basic skills. Some elementary social aspects and the concept of logical, step-wise, thinking.
- Middle Section (5th to 7th) – Get the children to learn how to control the computer. Skilled use of a standalone computer, introduction to concepts like Information gathering, organizing and the different kinds of data representation. Introduce the power of Internet applications (email and search). Emphasis on social aspects – keeping oneself safe and ethical usage. Introduce an elementary programming

language. Introduce general concepts behind some of the skills learnt, such as algorithms etc.

- Secondary Section (8th to 10th) – Full fledged control of the standalone system and skilled navigation of the networked world. Emphasis on learning concepts of broad applicability. Other topics of the syllabus, including using a programming language, as stipulated for the Board examination.
- Higher Secondary Section (11th to 12th) – Mostly follow the syllabus given for the Board examination. Highlight the underlying concepts, without over-doing it.

For the various topics, this syllabus follows the NCERT classification as far as possible. The group "**Concepts**" is broader than and includes the NCERT category of *Fundamental operations and concepts*. The group "**Usage Skills**" corresponds to the NCERT categories of *IT tools* (increase productivity), *Communication tools* (collaboration and publishing), *Technology research tools* (locate and collect information) and *Problem solving tools* (advanced uses of the computer). The group "**Social Aspects**" is the same as the NCERT category of *Social and Ethical issues*.

An emphasis is given to hands-on, laboratory work, wherever appropriate. As a result, any given topic can be classified along three axes:

1. The grade it is intended for (primary, middle or high school).
2. The group it belongs to (skills, social aspects or concepts).
3. The mode of its teaching (theory or lab).

The book titled "What is worth Teaching?" By Krishna Kumar [5] also elucidates that the problem with curriculum is to identify 'what is worth teaching' and 'how it should be taught'. The psychology and pedagogy principles will help us to teach effectively provided the decision is made on what is worth teaching [5]. Activity oriented curriculum enables enrichment of the learning environment which is rich in stimulation and experiences [NCF 2005].

1.6 Design Methodology

- For each standard, the syllabus is defined by giving the topics that should be taught (**"what"**), the reasons for doing so (**"why"**) & a schedule (**"how"**). See Section 2.
- For each topic, the sub-topics are also listed giving an idea of what that particular

topic covers. Example: The topic Stepwise Thinking in Level 3 should cover sub topics : Different steps in an activity, sequencing of steps, step wise instructions given to a computer etc.

- Effective Teaching learning strategies for each level are also suggested [Section 4] to enable a teacher to choose a suitable strategy based on the academic setting.
- There are currently 4 *textbooks* titled **Computer Masti** that have been authored according to this curriculum and are available at http://www.cse.iitb.ac.in/~sr/ssrvm . The next ones are in the process of creation.
- It is hoped that these textbooks , along with some teacher training sessions, would be sufficient for each teacher to prepare his/her own lesson plans.

1.7 Hardware/Software Platforms

The hardware resources required for each school are commonly available. During the lab, about 3 students may share each computer at a time. In case if any special resources are required for a given topic for performing activities, they are mentioned with the lesson outline.

The syllabus is agnostic of the software platforms and vendor-neutral. Our current textbook contents are based on **Ubuntu** platform, which is a distribution of Linux preloaded with free educational software and games.

1.8 Curriculum at a Glance

Sample concept skill tables for the curriculum's textbook: from level 2 to 4 are given in Tables 1(a) to table 1(c) the syllabus is elaborated in detail in the next section.

Level 2: Table 1(a)

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.	Remain Healthy while using Computers	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.	Activity using Paint	o Revision lesson	o Using features of an activity		14th -16th
		REVISION			17th -19th
6.	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	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 -26rd
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 -29rd
9.	Projects				30th -32rd

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	Team work and sharing of resources. Taking care	1st - 4th
2.	Stepwise thinking	o Different steps involved in an activity o Importance of sequence of the steps in an activity o Step wise instructions given to a computer	o Breaking down an 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	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	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	Performing exercises together and learning from each other	15th -18th
	REVISION				19th -20th
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		23th -27th
6.	Fun with text processing	o Text editing o Formatting guidelines	Formatting text: o Bold, Italics, Underline o Changing Font type, size and colur		28th -30th
7.	Projects				30th -32nd

Level 3: Table 1(b)

Lesson No.	Topic Name	Concepts	Skills	Values reinforced	Weeks
1.	Revision of level III	o Stepwise 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 Exercies 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.	Fun with 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.	Dos and Dont's - Balancing Asanas	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
		REVISION			17th -18th
5.	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
6.	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
7.	Projects				29th -32nd

Level 4: Table 1 (c)

1.9 Suggested Implementation Methodology

- How to transact in class
- Teachers corner points
- Pedagogy points
- Patanjali Yoga Sutra

The five aspects of education are Concepts, Information, Attitude, Imagination, and Freedom. The recommended teaching methodology is based on Patanjali's Yoga sutras. The basic ideas are:

i. Pratyaksha – First give direct experience of what is to be learnt, to the extent possible
ii. Anumana – Then let them reach inferences and discover the concepts on their own. This is done by: (i) Ask questions to address each of the 5 aspects of education. (ii) Let them come up with answers and (iii) Give a form to what they should learn/realize, and
iii. Agama – Finally, give the necessary additional information.

2 SYLLABUS- CURRICULUM DETAILS

This section defines the next-level of details, using a "what-why-how" approach, i.e., the topics that should be taught, followed by the reasons for doing so, followed by a schedule and more details.

For each standard, a schedule is also given. Hence it is expected that a teacher would be able to comfortably complete the syllabus prescribed, by taking *one class per week for primary, one or two classes per week for middle school and two classes per week for secondary. The topics recommended, allow sufficient room for creativity in the form of activities, projects and the teacher has complete control of how to present a given topic.*

2.1 1ST STANDARD

Theme: Existence Awareness / Games and fun with computers

What: At the end of 1st STD, a child should be able to:

- Concepts: Understand the different uses of computer regard the computer as a machine with various parts and associated functions (that can be controlled/directed).
- Usage Skills: Identify all the parts of a computer; use keyboard (arrow enter/return keys) and mouse (single/double click) as input devices; open applications, such as Music, Paint, or Games and their rudimentary use; open, save and close an activity; change the wall paper.
- Social Aspects: Maintaining cleanliness; dust-free area; not spilling food etc; orderliness

in handling peripherals, sharing resources and working in teams for activities and projects.

Why: At the end of 1st Std, it is enough for a child to be able to relate to a computer as an interesting entity with various parts and functions (Existence Awareness). More topics are not required because the goal is to simply introduce the computer as a tool for doing other tasks. Since it can be a highly distracting toy, the content is deliberately low-key. However, fewer topics are not desirable because the child should not get left behind in terms of his/her peers or get overwhelmed at a later age. Emphasis on usage skill is required at this age for the students to get familiar.

How: There could be one class per week, roughly as per the following schedule:

Week	Topic
1st – 4th	**Use of Computers** *Simple and interesting uses of computers in daily life : Library, Railway station, listening to music, painting*
5th – 7th	**Parts of Computers** *CPU ,monitor, keyboard, mouse*
8th – 10th	**Do's and Don'ts with Computers** *using a computer safely and correctly, postures, sharing*
11th	Revision
12th – 14th	**Using a mouse** *Understanding double click, right click, single click*
15th – 17th	**Using a keyboard** *Entering alphabets, numbers using a keyboard, understanding function of special keys like backspace,*

	enter
18th, **19th**	Revision
20th – 22nd	**Paint using a computer** *Concepts of Icons, Tools, Toolbar, open, save options in Paint*
23rd – 24th	**More actions using paint** *New , quit, options , dialog box*
25th – 26th	**Using a music player** *Play music files, use control buttons like : Play, pause, stop, volume.*
27th - 29th	**Exploring the desktop** *change wallpaper, minimize and close an activity*
30th	Revision
31st -32nd	**Project – Evaluation and Assessment**

Comments: It is important to keep in mind that there may be significant variance in physical and mental development among the children. It is acceptable (and expected) if some children are not able to do all the activities completely. There is time for them to catch up in the 2nd Std.

A valuable insight of the implementation is that children learn faster in groups. This inculcates the habit of working in teams and sharing resources.

The number of weeks across each lesson is representative [The number of weeks taken during implementation at an urban school in Mumbai]. The schedule can be followed with some amount of flexibility to finish the topics in the academic year.

2.2 2ND STANDARD

Theme: Capability Awareness

What: At the end of 2nd Std, a child should know:

- Concepts: Input and output, organization ,concept of reuse through copy and paste, understanding start up and shut down , elementary step-wise thinking
- Usage Skills: Drag and drop, create a folder, get familiar with the keyboard, edit text on the computer, login/logoff; start up and shut down. Rename and delete files; search for files and applications associated with files [drop].
- Social Aspects: Care in handling of all computer accessories; sharing resources, practice proper posture, doing exercise, ergonomic aspects; respecting others' privacy; preliminary security awareness.

Why: At the end of 2nd STD, a child should be familiar with the versatile uses and applications of a computer (Capability Awareness). The learning of the previous STD should be reinforced and those lagging behind would catch up. The same topics should be advanced to the next level of features. Introduce at most one or two new topics.

How: There should be one class per week, roughly as per the following schedule:

Week	Topic
1st – 4th	**Revision of class I** *Simple and interesting uses of computers in daily life : Library, Railway station, listening to music, painting, open, save and close an activity, change wallpaper*
5th – 7th	**Input and Output Devices** *keyboard, mouse, CPU ,monitor, speakers*

8th – 10th	**Remain healthy while using computers** *using a computer safely and correctly, postures, sharing*
11th – 13th	**Activity with mouse** *Understanding double click, right click, single click*
14th-16th	**Commonly used keys**
17th-18th	**Revision**
19th	**Evaluation and Assessment**
20th – 22nd	**Activity using Paint** *Concepts of Icons, Tools, Toolbar, open, save options in Paint*
23rd – 26th	**Basic Features of Text Editor** *New , save, quit, cut-paste. Copy-paste, dialog box*
27th – 29th	**Computer Startup and Shutdown** *startup, username, password, login, logout, shut down* *Play music files, use control buttons like : Play, pause, stop, volume.*
30th	**Revision**

31st -32nd	**Project – Evaluation and Assessment**

Comments:

If a school is just introducing computers but already has a child in the 2nd STD, then it is advisable to have 2 classes per week instead of one, just for one year. The 1st STD portion can be done in the first half of the year while the 2nd STD portion can be done in the second half of the year, without putting undue pressure on the children. From the next year onwards, the children can follow the regular schedule as prescribed.

2.3 3RD STANDARD

Theme: Stepwise thinking and Scratch

What: At the end of 3rd STD, a child should know:

- *Concepts*: Instructions in a program, Sequence of steps while performing a task, Concept of editing, simple commands in Scratch.
- *Usage skills*: Basic step-wise reasoning; Breaking up a task into sub-tasks, Write a script using drag and drop, Notion of a computer language; Formatting text.
- *Social Aspects*: Ethics, respecting other's privacy; preliminary security awareness.

Why: At the end of 3rd Std, a child should be able to find programs in a computer (Navigational Awareness). After a quick revision of the previous Std, the child should move to new topics and applications. Emphasis should be on systematic functioning & thinking.

Week	Topic
1st – 4th	**Revision**
5th – 9th	**Step wise Thinking** *Different steps of an activity, importance of sequence of steps ,step wise instructions given to a computer*

10th – 14th	**Introduction to Scratch-A** *Instructions within a program, construction of a program, write and execute a script in scratch*
15th – 18th	**Asanas while using Computers** *Importance of exercises, exercises for wrists, neck, eye and spine*
19th – 20th	**Revision**
21st – 22nd	**Evaluation and Assessment**
23rd – 27th	**Simple animation with Scratch-B** *Construct a program using instructions of control block, changing background of a program.*
28th – 30th	**Fun with Text Processing** *Fun with colors, highlighting, formatting, fonts etc.*
31st -32nd	**Projects**

Comments:

If a school is just introducing computers but already has a child in the 3rd Std, then it is necessary to have 2 classes per week instead of one, for one year. The 1st Std portion can be done in the first quarter of the year while the 2nd Std portion can be done in the second quarter of the year, since the children would have the ability to quickly grasp these topics. The 3rd Std portion can be done in the third and fourth quarters of the year, at a normal pace by using 2 classes per week. From the next year onwards, the children can follow the regular schedule as prescribed.

2.4 4TH STANDARD

Theme: Logical thinking and problem solving

What: At the end of 4th Std, a child should know:

- *Concepts*: Reasoning, problem solving, control statements, storage and organization, classification of content.
- *Usage Skills*: Creating folders, and organizing files within folders, file extensions, writing scripts for games in scratch, parameter changing in scratch blocks.
- *Social Aspects*: Awareness of computer-usage posture, eye-care; Keeping the computer safe from malicious use.

Why: At the end of 4th Std, a child should be able to understand logical thinking, break up a task into subtasks, organize contents and find the necessary information to carry out simple tasks using the computer. The child should be able to configure, customize programs (Control Awareness). A child should be equipped to independently learn the preliminary use of common applications.

How: There should be one class per week, roughly as per the following schedule:

Week	Topic
1st – 3rd	**Revision**
4th – 8th	**Logical Thinking** *Reasoning, problem solving*
9th-13th	**Fun with Scratch** *Control statements, ,scripts using scratch controls, co-ordination between program parts*
14th – 16th	**Do's and Don'ts – Balancing Asanas** *Exercises for legs, ankles, foot muscles*
17th – 18th	**Revision**
19th – 23rd	**More activities using Scratch** *Animation of concepts in other subjects, writing scripts for games*

24th – 28th	**Naming and organizing files** *Storage and organization of files, folders, classification of content*
29th -32nd	**Project**

At the end of Primary, a child should be proficient in the following: Operating computers and peripherals; Using multimedia and applications such as word processing; Exposure to making presentations; Awareness of privacy and security; Ability to take precautions; logical thinking, stepwise thinking and elementary programming through GUI.

Internet applications such as email and search, are not introduced in primary since it is important that a child be able to first understand the safety aspects thoroughly.

2.5 5th STANDARD

Theme : Gathering and Organizing information

What: At the end of 5th Std, a child should know:

- *Concepts*: Gathering and organizing information, Tabulating data; simple programs; Network-related concepts such as message exchange between computers.
- *Usage Skills*: Networking; Connecting to Internet; browsers; e-mail; search engines; Office applications.
- *Social Aspects*: Careful use of Internet; Recognize and avoid potential dangerous actions, such as opening spam mail, downloading/installing arbitrary programs.

Why: At the end of 5th Std, a child should be able to competently use common programs. Emphasis should shift from just learning how to use a tool to the underlying concepts. For example, simple concepts of gathering information from various resources, should be introduced. *Introduction of Internet cannot be further deferred;* otherwise they may learn incorrect usage from elsewhere. There should be a major emphasis on security and safety aspects before they move to unsupervised use.

The recommended topics for grade 5 are given below.

Week	Topic
1st – 3rd	**Revision**

4th – 6th	**Gathering and organizing information** *Capture information from various sources and consolidate and organize the same*
7th-9th	**Scratch-Organisation** *Organisation concepts using Scratch programs*
10th – 12th	**Internet applications: Browsing** I*ntroduction to Internet as a network of computers, browsers as tools to access internet*
13th – 15th	**Internet applications: Search** *Searching for information on Internet, effective searching*
16th – 18th	**Revision**
19th – 22nd	**Internet applications: Email** *Communication through email, Creating accounts, receiving and sending messages*
23rd – 25th	**Dos and Don'ts: Internet Safety** *Safety and precautions while accessing internet, Parental guidance*
26th – 28th	**Organized Thinking: Tables: Sorting and Comparing data** *Representing data in the form of tables, filtering data as required*
29th -32nd	**Project**

2.6 6th STANDARD

Theme: Concept of Big 6 in education [Information gathering, organization, task break up, synthesis, analysis, evaluation]

What: At the end of 6th Std, a child should know:

- *Concepts*: Concept of use of Information, Synthesis and analysis of information and also evaluation. Exposure to flow charts and Introduction to Internet plagiarism Sequential program execution; Syntax and structured logic.
- *Usage Skills*: Transform information gathered to a form where it can be presented. Exposure to presentation skills, structuring presentations, creating web pages, creating and publishing content online. Increase efficiency in typing.
- *Social Aspects*: Increased awareness of security; sharing photos or personal information over email.

Why: At the end of 6th Std, a child should be able to not only collect information, but also be able to synthesize and analyze it. The processed information can be presented using standard presentation tools. Concept of creating flow charts is very essential as a precursor to programming languages. Emphasis on security and safety aspects of Internet usage should continue. With students of all ages creating online content, it is important to teach them basic skills like html programming and the process of publishing content.
The recommended topics for grade 6 are given below.

Week	Topic
1st – 3rd	**Revision**
4th – 6th	**Introduction to Big 6** *Concept of Big 6 as a process model to solve an information problem.[task definition, information seeking, location and access, use of Information, synthesis, evaluation]*
7th-9th	**Big 6** *Use of Information, synthesis, analysis and evaluation*
10th – 12th	**Concept of drawing flowcharts for non-programming tasks**. *Entry; Step; Branch; Loop; Exit*
13th – 15th	**Presentation skills** *Outline the structure of a presentation, focus on*

	functionality, using templates
16th – 18th	**Revision**
19th – 21st	**Dos and Don'ts: Internet** *Plagiarism, downloads, FOSS*
22nd – 24th	**Basic html, creating and publishing content** *Creating content, importing and exporting , multifinger typing, blogging, publishing content*
25th – 28th	**Programming 1** *Introduce simple programming language*
29th -32nd	**Project**

2.7 7TH STANDARD

Theme: Multiple data representations

What: At the end of 7th Std, a child should know:

- *Concepts*: Concept of syntax and structured logic, exposure to various thinking tools, data visualization, data representation. Concept of Boolean logic, pseudocode, simple algorithms. Elementary searching and sorting techniques.
- *Usage Skills*: Using spreadsheet application, Data sorting/filtering, generating graphs; Command line skills
- *Social Aspects*: Reinforce the importance of security and etiquette in online transactions, social networking sites; Copyright and piracy awareness.

Why: At the end of 7th Std, a child should be able to use some standard applications and

Internet with some competence. A child should also be able to write simple structured programs. Which programming language is used is not important as the concepts remain the same across multiple programming languages. It is important for the child to move from GUI based programming to syntax based one. Multiple data representation also helps them to clearly present information in various formats.

Week	Topic
1st – 3rd	**Revision**
4th – 6th	**Simple widely useful algorithms.** *Such as: Elementary sorting/searching techniques.*
7th-9th	**Spreadsheets as a database** *Sort, filter, mathematical calculations , graphs, Use of Information, synthesis, analysis and evaluation*
10th – 12th	**Spreadsheets as a calculator.** *Mathematical calculations, applying formula to find sum average of rows and columns*
13th – 15th	**Boolean Logic** *And/Or, True/False, applications of Boolean logic*
16th – 18th	**Revision**
19th – 21st	**Programming 2** *More programming concepts and writing of programs using various constructs.*
22nd – 24th	**Install and download free and open source software/games** *Search for Open source contents/software, install and use of such software.*

25th – 28th	**Programming 3** *Extension of programming tasks.*
29th -32nd	**Project**

2.8 8TH STANDARD

Theme: Computer architecture, operating systems and administration

What: At the end of 8th Std, a child should know:

- *Concepts*: Simple understanding of architecture, operating systems, algorithms, databases, networks, resource sharing, memory management, firewalls; How stuff works, mail, hyperlinks.
- *Usage Skills*: Elementary trouble shooting, control panel settings, Internet usage expertise
- *Social Aspects*: Understanding of online transactions and importance of security.

Why: At the end of 8th Std, a child should be able to use most applications and Internet with reasonable competence. A child should be able to write simple structured programs. He/she should also be familiar with application level understanding of databases and how widely they are used in day to day online applications. A glimpse of internal functions and working of CPU, Memory, and disk is also essential at this level. Simple control panel activities and settings will make them understand the power of administration activities. The advantage of using syntax based structured languages versus GUI based languages is better appreciated at this age.

Week	Topic
1st – 3rd	**Revision**
4th – 8th	**Hardware Architecture** *Binary system, Functions of CPU, Memory, Disk, networking.*

7th-10th	**Software Architecture** *Operating systems , resource sharing, memory management*
11th – 13th	**Basic trouble shooting.** *Task manager, Back up, configure firewalls, control panel settings*
14th – 17th	**Programming 4** *Exercises to cover all features of the language*
18th – 20th	**Revision**
21st – 24th	**Database Concepts** *Concept of back end and front end, query language, primary key, examples like ticket booking system.*
25th – 28th	**Internet online transactions** *Online shopping, buying of tickets, precautions*
29th -32nd	**Project**

2.9 9TH STANDARD to 12th STANDARD

The syllabus for the 9th Std to 12th Std is generally outlined by the school board. Some boards have the subject as an elective and some boards have it as a subject which is graded throughout the academic year, but not included in the board exam. Hence this curriculum document does not recommend topics for the high school level of Computer Science.

3 IMPLEMENTING THE CURRICULUM

The first version of this curriculum was released in March 2007, after a rigorous review by faculty and teachers from schools. Based on the curriculum, lessons/handbooks were developed initially for teachers. During the course of this development, worksheets and activities based on the lesson were also developed, which could be used in classrooms.

As the entire content for a lesson was available from a teacher's perspective, the next logical step was creating textbooks for children.

Based on the above curriculum, textbooks were authored for levels I to IV titled " Computer Masti". The entire textbook is available for free download on the website: http://www.cse.iitb.ac.in/sri/ssrvm. The textbooks have been used to teach computer science in Mumbai schools for the last two years.

Training workshops have also been conducted for schools teachers to enable them to teach computer science using our textbooks.

4 TEACHING LEARNING STRATEGY

Different teaching learning strategies can be implemented in the class while covering the topics recommended in the curriculum for different levels. These innovative strategies enhance the teaching learning process during the classroom transactions. Across levels from 1 to 5, we suggest a sample of suitable strategies that can be used. The details of each strategy recommended are given in Annex E.

S.No	Strategy/Level	Level 1	Level II	Level III	Level IV	Level V
1	Puppet Show	✓	✓	✓		
2	Role Play	✓	✓	✓	✓	✓

3	Story telling	✓	✓	✓		
4	Games	✓	✓	✓	✓	✓
5	Exploratory learning	✓	✓	✓	✓	✓
6	Illustrations	✓	✓	✓	✓	✓
7	Hands on experience	✓	✓	✓	✓	✓
8	Scenario Based learning: Inductive Deductive		✓	✓		
9	approach		✓	✓	✓	✓
10	Problem solving			✓	✓	✓
11	Think pair share				✓	✓
12	Number heads together				✓	✓
13	Think Pair solo:				✓	✓
14	Small group teaching technique:					✓
15	Filamentality strategy:					✓
15	Minimalist Approach				✓	✓
16	Brain storming sessions				✓	✓
17	Reciprocal				✓	✓

Examples for each strategy mapped to curriculum topics

Puppet show: Puppets may be created of different parts of computer to show how they work together when they are joined to the CPU.

Role Play: Two groups of children can be shown handling computer in very different ways, one group takes proper care of the computer; it not only works properly but also does not cause any harm to the children using it. Whereas the second group does not handle the computer properly and also the students do not maintain proper postures while using the computer. As a result the computer does not work properly on a regular basis. The bad postures also cause physical strain to the children.

Storytelling: Story involving the input and output devices can be narrated to the class to give them an idea about what they are and the difference between an input device and an output device. For eg: A story of farming can be used in which seeds are input and we get the harvest as output.

Games: Computer based educational games can be used to teach concepts like input/output device or skills like typing letters and using keyboard.

Exploratory: Students can be given the freedom to explore the effects of different tools and options within a particular application [Paint] to enhance their creativity.

Illustration: Posters depicting health hazard due to inappropriate postures and ways to avoid those hazards may be put up in classrooms. The teacher can explain with the help of the illustrations.

Hands on Experience: Activity may be given at the end of teaching session whereby the learners will create a greeting card using various tools of the paint. This hand on experience will make it easier for them to understand the usage of an application.

Scenario based learning: Real life scenario can be given to the students to identify the main and detailed steps of the activities. For example, for better understanding of the concept, the children can be asked about planning a birthday party. To relate the learning to the computers, the children can be asked about the steps of starting a computer or shutting down a computer.

Inductive/Deductive: Learners may be given certain examples when computer usage can create health problems followed by some time for students to think and deduce their own meaning. Then the teacher summarizes the ideas.

Problem solving: Students can be posed with a simple problem of dividing chocolates equally among students and giving the remaining ones to the teacher. If 50 chocolates are to be divided among 23 students, how do they go about solving the problem? In the process they also improve their thinking skills.

Think- Pair- Share: This strategy can be used to teach the concept 'Importance of gathering information'. Assume the goal is to understand “global warming” concept. Let students think independently and then, pair up with other students. Then they can share their thoughts with the entire class. This strategy will help students to understand the need to gather relevant information and will evoke several responses.

Team- Pair- Solo: Students in team can be asked to explore how they can showcase life cycle of a butterfly using scratch programming application. Let the students do the same in a pair. Once they have worked collaboratively on the same task they can now create the same work independently. This will help in reinforcing their concept of organization in scratch.

Small Group using projects: A collaborative project can be given to the students to create an animation. Ex: life cycle of butterfly. This will include using hands on and a project strategy. It will prove effective since the students themselves have created the product.

Filamentality strategy: Give the students some web based learning material on Internet. Give them an essay writing assignment on the topic of how Internet evolved over the years.

Minimalist approach: Students can be given small task to do on scratch with minimal amount of information. In such approach, students are then expected to explore independently and find out how they can achieve the given task.

Brainstorming: A teacher can pose a statement: ex- if a student named Anita wish to create a scrapbook for her friend, how should she go about doing it. The response from the students will evoke concepts of gathering information and organising the same

Reciprocal thinking: Teacher can provide little text on the need and how to organise information. Students should then be asked to form their own questions and ask the teacher where teacher will act as a student.

5 ANNEX A: CURRICULUM SURVEY

A brief survey of the curriculum followed in India and Abroad is given in this section.

5.1 NCERT (CBSE Board)

National Council of Educational Research and Training (NCERT) has released a national framework of Curriculum for IT in schools. The competencies, skill sets are divided into six heads namely Fundamental Operations and Concepts, Social and Ethical issues, IT Tools, Communication Tools, Technology Research Tools and Tools for Problem solving.

The curriculum also proposes the desirable competencies for teachers. The children are expected to attain the skills listed out in the syllabus during their schooling as part of their general education till class 10. The curriculum is categorized for three levels, Primary, Middle and Secondary schools. At each level, the six heads as listed above are again divided into competencies, activities through which these competencies can be attained and detailed specific skills.

At the end of each level: Primary, Middle and Secondary schools, a list of learning outcomes and evaluation techniques are also prescribed. The CBSE board follows the curriculum framework of NCERT.

5.2 ICSE Board

The ICSE Board system has Computer applications as a core subject from 1st to 8th standard. In 9th and 10th standard it is an elective subject and hence is not compulsory. The outline of the syllabus is given to the schools and they have the freedom to follow textbooks by any Publisher which they find suitable.

The syllabus for 9th standard covers the following topics: 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.

The syllabus for 10th standard covers the topics: Computer structure, Review of Programming, Advanced Programming, Documentation of Programming, and Practical sessions. A part of the syllabus document from the ICSE website is given below.

COMPUTER SCIENCE (71)

Aims:

1. To enable candidates to comprehend the concepts and practices of Computer science.
2. To develop an understanding of how computers store and process data.
3. To enable candidates to describe the major components of computer hardware, their functions and interaction.
4. To develop an understanding of the fundamental concepts of programming and the ability to apply the same.
5. To develop an appreciation of the implications of computer use in contemporary society.

CLASS IX

There will be one paper of two hours duration carrying 80 Marks and Internal Assessment of 20 Marks.

The paper will be divided into two Sections A and B.

Section A (20 marks): This section will consist of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.

Section B (60 marks): This section will consist of questions based on programming. There will be a choice of questions and candidates will be required to answer four questions from this section.

PART I – THEORY

1. **Computer hardware: parts of a computer and their functions**

   CPU, the clock, cache memory, primary memory, secondary memory, input and output devices, communication devices (the aim is not to describe/discuss an exhaustive list of devices but to understand what parts are present in a typical computer and what the function of each part is).

2. **Data representation and internal computer structure**

   (i) Number systems, base of a number system - decimal, binary, octal, hexadecimal representation, conversion between various representations, character representations (ASCII, ISCII, Unicode).

   (ii) Representations for integers, real numbers, limitations of finite representations.

   (iii) Internal structure of a computer, a simple decimal load and store computer and its machine language, instruction format, registers, program counter, instruction register; register addressing modes, instruction cycle, assembly language for the same computer, simple algorithms in assembly language.

3. **Computer software**

   The boot process, operating system (resource management and command processor), file system.

   (i) Boot process, operating systems - resource management, command processing.

   (ii) Directories, files and hierarchical file system.

   (iii) Programming languages (machine language, assembly language, high level language).

   (iv) Compilers and interpreters.

   (v) Application software.

4. **Social context of computing and ethical issues**

   (i) Intellectual property and corresponding laws and rights, software as intellectual property.

   (ii) Software patents, copyrights, and trademarks, software licensing and piracy.

   (iii) Free software foundation and its position on software, open source software.

   (iv) Privacy, email etiquette.

5.3 State Boards

Many State Boards have introduced the subject of Computer applications in schools but not many details are available online at present. Hence the computer science curriculum of State Boards has not been studied in detail.

5.4 IB curriculum

Common core 125 hrs

Topic 1—Systems life cycle and software development 35 hrs
The systems life cycle 8 hrs
Systems analysis 4 hrs
Systems design 4 hrs
Social significance and implications of computer systems 5 hrs
Software life cycle 2 hrs
Software design 8 hrs
Documentation 4 hrs

Topic 2—Program construction in Java 50 hrs

Topic 3—Computing system fundamentals 37 hrs
Language translators 2 hrs
Computer architecture 12 hrs
Computer systems 5 hrs
Networked computer systems 8 hrs
Data representation 6 hrs
Errors 2 hrs
Utility software 2 hrs
Case study 3 hrs

Topic 4—Computer mathematics and logic 11 hrs
Number systems and representations 6 hrs
Boolean logic 5 hrs

Topic 5—Abstract data structures and algorithms 41 hrs
Fundamentals 3 hrs
Static data structures 8 hrs
Dynamic data structures 14 hrs
Objects in problem solutions 6 hrs
Recursion 6 hrs
Algorithm evaluation 4 hrs

Topic 6—Further system fundamentals 15 hrs
Processor configuration 2 hrs
Magnetic disk storage 1 hr
Operating systems and utilities 2 hrs

Further network fundamentals 4 hrs
Computer/peripheral communication 6 hrs

Topic 7—File organization 10 hrs

5.5 AP Curriculum , USA

Computer Science I	Computer Science I AP
Week 1:	**Week 1:**
Introduction to Windows 95 Operating System.	Introduction to Windows95 and MSDOS operating systems / Computer fundamentals: historical background, computer architecture, internal representation, ethical use of the computer, internet resources.
Week 2:	**Week 2:**
Computer fundamentals: Historical background of computer development, ethical use of the computer, internet resources.	C++ (IDE) / Introduction to C++ Programs
Week 3:	**Week 3:**
Computer fundamentals: computer architecture, internal data representation	Variables and Constants using simple data types
Week 4:	**Week 4:**
Introduction to MS/DOS operating system	Operations and expressions using arithmetic operators
Week 5:	**Week 5:**
C++ (IDE); program development; good programming habits	Simple data type operations continued / Program Modularity and Simple Functions (no parameters)
Week 6:	**Week 6:**

Writing First C++ programs

Week 7:

Variables using simple data types

Week 8:

Operations and expressions using simple arithmetic operators

Week 9:

Arithmetic operators and expressions, continued

Week 10:

Introduction to library classes using pasturing

Week 11

Introduction to classes

Week 12:

Constants / Introduction to Modular programming using functions

Week 13:

Return Functions without parameters

Week 14:

Void Functions without parameters

Program Modularity and Simple Functions (no parameters)

Week 7:

Program Modularity and Simple Functions, continued / Introduction to Parameters and prewritten Classes

Week 8:

Parameters and Classes, continued Graphical Output

Week 9:

Control Structures: Conditional (if, if. else, switch)

Week 10:

Control Structures: Repetition for loops

Week 11:

Control Structures: Repetition (while,do..while)

Week 12:

Boolean Logic

Week 13:

Boolean Logic / Control Structures with nested and compound conditional

Week 14:

Control Structures with nested repetition

	for, while, do..while
Week 15:	**Week 15:**
Void Functions with Value Parameters	Control Structures with nested repetition / Program Design
Week 16:	**Week 16:**
Void Functions with Value and Reference Parameters	Program Design / Void Functions with Value Parameters
Week 17:	**Week 17:**
Control Structures: Conditional (if and if..else)	Void Functions with Value Parameters
Week 18:	**Week 18:**
Control Structures: Conditional (switch)	Void Functions with Value and/or Reference Parameters
Week 19:	**Week 19:**
Control Structures: Repetition (for)	Return Functions with Value and/or Reference Parameters; preconditions and postconditions
Week 20:	**Week 20:**
Control Structures: Repetition (while)	C++ Data Structures, the Record
Week 21:	**Week 21:**
Control Structures: Repetition(do.while)	C++ Data Structures, the Record / Introduction to Object Oriented Programming (OOP)
Week 22:	**Week 22:**
Control Structures: Nested Repetition	Introduction to Object Oriented Programming (OOP) continued
Week 23:	**Week 23:**

C++ Data Structure: the Text File	C++ Data Structure: 1D Array with apvector
Week 24:	**Week 24:**
C++ Data Structure: the Text File	C++ Data Structures, the 1D Array with Apvector / C++ Data Structures, the 1D Array with Apstring
Week 25:	**Week 25:**
C++ Data Structure: 1D Array with apvector	C++ Data Structures, the 1D Array with Apstring / C++ Data Structures, the Text File
Week 26:	**Week 26:**
C++ Data Structure: 1D Array with apvector	C++ Data Structures, the Text File
Week 27:	**Week 27**
C++ Data Stucture: 2D Array with apmatrix	C++ Data Structures, the 2 Array with apmatrix
Week 28:	**Week 28:**
Algorithms: Quadratic Sorting techniques	Algorithms: Quadratic Sorting techniques; More Efficient Sorting techniques (Quick, Shell, Merge, for example)
Week 29:	**Week 29:**
Algorithms: Quadratic Sorting techniques	Recursion
Week 30:	**Week 30:**
Algorithms: Linear and Binary Searching techniques	Recursion / Understanding Class functions
Week 31:	**Week 31:**
C++ Data Structure: the Record with *struct*	Understanding Class functions / AP Case

	Study
Week 32:	**Week 32:**
C++ Data Structure: the Record	AP Case Study
Week 33:	**Week 33:**
C++ Data Structure: the Record implemented with *class*	AP Case Study / AP Exam
Week 34:	**Week 34:**
Graphical Output	Post AP Exam Topics: Projects
Week 35:	**Week 35:**
Graphical Output	Post AP Exam Topics

5.6 ACM Curriculum

A Model Curriculum for K -12 Computer Science, Final Report of ACM Task Force.
This ACM (Association of Computing Machinery) report proposes a model curriculum to integrate computer science as a subject throughout primary and secondary schools, both in the United States and throughout the world. With the rapid growth of computing technology and it's relevance to the modern world in terms of real life applications, there is an urgent need to provide a framework for the schools to follow.

Computer science is already an established core discipline at the college level but the holistic integration of computer science concepts into the K–12 curriculum has not been happening. As a result, the general public is not as well-informed about computer science as it should be. This report provides a framework within which schools can revise their curricula and be ready to educate the youngsters.

This curriculum model provides a four-level framework for computer science. The first two levels suggest subject matter that ought to be mastered by all students, while the second two suggest topics that can be elected by students with special interest in computer science, whether they are college-bound or not.

5.7 Schools Abroad

5.7.1 Virginia Public Schools

The Standards of Learning for Computer/Technology is a reference document for Virginia Public Schools is a reference document. The Standards identify and define the progressive development of essential knowledge and skills necessary for students to access, evaluate, use and create information using technology. They provide a framework for technology literacy and demonstrate a progression from physical manipulation skills for the use of technology, to intellectual skills necessary for information use, to skills needed for working responsibly and productively in groups.

Computer/technology proficiency is not an end in itself, but lays the foundation for continuous learning. The focus is on learning using technology rather than learning about technology. To become technologically proficient, the student must develop the skills through integrated activities in all content areas K-12, rather than through one specific course. These skills should be introduced and refined collaboratively by all K-12 teachers as an integral part of the learning process. Teachers can use these standards as guidelines for planning technology-based activities in which students achieve success in learning, communication, and prepare them to meet the challenges of today's technology-rich world of work.

This document is divided into K-2, 3-5 ,6-9, 10-12 Grades and lists out Basic Operations and concepts, Social and Ethical issues, Technology and research tools, Problem solving and decision making tools ,Technology and Communication tools for every grade.

5.7.2 Pennsylvania School Curriculum [Avon Grove school]

The Pennsylvania Academic Standards for Science and Technology and the National Educational Technology Standards for Students from ISTE (International Society for Technology in Education) define the curriculum for Grades K-8. Grades 9-12 will have specific classes that students may choose related to technology.

The milestones for the curriculum describe what students should know and be able to do by the end of fourth, seventh, tenth and twelfth grade. In addition, the standards also reflect the progress that they expect their students to achieve. This curriculum assumes that the students can apply the skills learnt at the earlier levels and add new concepts every year. Previous learning is reinforced but not taught again.

5.7.3 New York Public School Curriculum

The New York State Standards for Computer Technology divides the curriculum into two levels: Elementary (1st to 5th grade) and Intermediate (6th to 8th grade).

The Elementary level has the following heads: Word processing, Computer skills, Networking and Telecommunication skills, Legal and Ethical issues, Information Management skills.

The Intermediate Level has the following heads : Word processing, Computer skills, Networking and Telecommunication skills, Legal and Ethical issues , Information Management skills, Database skills, Spreadsheet skills, Multimedia skills.

5.7.4 Ontario School Curriculum

The Computer Skills curriculum for 1st to 8th grade is organized into seven heads: Operating the Computer, Word Processing, Keyboarding, Graphics, Database, Spreadsheets, Internet, Multimedia and Authoring Software.

Every Grade starts with an Overall and Specific expectations. Achievement levels at the end of each grade are also classified as Understanding of concepts and terminology, Keyboarding and word processing skills, communication of required knowledge, Application of concepts and skills.

5.7.5 Pocantico School Curriculum

This curriculum recognizes the inevitable change in computer technology and as such should be viewed as an evolving, flexible guideline for study, rather than a fixed set of skills. The curriculum is divided into Primary level [1st to 5th] and Middle school level [6th to 8th] and elaborates on the exit goals at the end of each grade.

The major goals at the end of 8th grade are Computer operations and Terminology, Using electronic Information resources, Using Spreadsheets and Databases, Organizing and analyzing information, presenting information in variety of ways, Ethical behaviour in using Computer technology, Proficiency in using Word-processing tools.

6 ANNEX B: TEXTBOOKS SURVEY

This section gives a listing of the topics covered in various textbooks surveyed and will later provide an informal evaluation of these textbooks as per the criteria defined in the Lesson Review Form (Section 3.5).

Table 2:	**Summary of Textbooks Reviewed for School Computer Science.**				
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 Balasubramanian*
Year:	2005 (Second edition) ***Follows NCERT framework***	2006 (Fourth edition) ***Recommended for CBSE***	2005 (Revised edition)	2006? (Revised edition)	2002 (First edit
Standard					
1st	Parts of a computer Uses of computers Mouse Keyboard	Computer Parts of a computer Handle with care Uses of computers Keyboard Mouse handling Paint	Useful electronic Devices About Computer History of Computer Some other Parts Uses of Computer Importance of Computer Machines Don'ts with Computer Computer Alphabets	Computer Machines Electricity Information Computer and its parts Monitor Cursor Let's use the Keyboard Mouse and Printer CPU A to Z of Computer World	What is a computer Uses of computer Computers everywhere Parts of a computer Monitor Keyboard Input, Processing, Output CPU Compu Maths
2nd	Computers – A Machine.	What is a Computer?	Computer	Machines/Electricity	Applications of computer

	Parts of computers Application of Computers Start and Shut down Keyboard Mouse Fun with Paint	Parts of a computer Storage devices More about computers Things to do How does it work? Input-Process-Output Keyboard Mouse handling Paint Operating a computer Precautions	Components of a computer Keyboard and keys CPU and its usefulness Monitor and its uses Types of Computer Languages and LOGO March of a TURTLE How a computer works Uses of computer	Man and Machine Information Where to store Information? Why do we need Computers? What is a Computer? Computer System Let's Use Keyboard Input-Output Some Maths with Computer Uses of Computer Some Do's and Don'ts	How computers work Getting started with a PC Using the Keyboard Compu Maths
3rd	Introduction to Computers Keyboard Operating system Operating a Computer Starting Paint Drawing in Paint Introduction to LOGO LOGO Commands Writing with LOGO Arithmetic with LOGO Notepad Project work	Know your Computer Parts of Computer Input output devices Hardware and software First step to Lab Your windows Starting MS Paint Fun with LOGO Drawing, Moving cmds Introduction to MS Word Project work	Introduction and History Uses of main parts. Other basic devices. Operating a computer Other operations. Languages and LOGO Introduction to Windows 98 Introduction to WordPad Introduction to Multimedia	The Computer Parts of Computer LOGO **11 Chapters on LOGO commands and usage**	Man and Computer Structure of a computer Input devices Output devices Windows Paintbrush Compu Maths
4th	Computer Evolution Input an Output Devices More about Windows	Computer overview History of Computer Working with windows	Evolution of Computer Computer: Detailed Focus Computer Applications	Computer LOGO **15 Chapters on LOGO**	Learning step by step Introduction to LOGO **6 Chapters on LOGO commands and usage**

				commands and usage	
	More about Paint More LOGO commands REPEAT and PRINT Introduction to MS Word Multimedia Project work	Working with MS Paint Drawing with LOGO Procedures in LOGO Advanced LOGO Word Processing Document Formatting Project Work	Computer terminology Learning PC LOGO Windows98 – OS Working in Paintbrush Working with MS Word Multimedia and Internet Social Ethics	Some programs	
5th	Applications of Computers Data Storage Media More about Windows Working with Calculator LOGO Procedures Editing Text in MS Word Formatting in MS Word More features of MS Word Internet Flowcharting Project work	Computers Overview Input Units Output Units Computer Memory Computer Software MS-Windows98 Clip art and Word art Algorithm and Flowchart Introduction to BASIC BASIC statements Multimedia and Internet Project Work	Generation of Computers Fundamental Elements Output Devices Uses of Computer More about Windows98 More about Paintbrush More about MS Word Electronic Mail Introducing Networks Social Ethics	Computer Lets write a Program Language (BASIC) Print System Commands Constants and Variables LET Let's Try Print Again GOTO Graphics Project	Algorithms and flowcharts Windows ME Paintbrush Wordpad Multimedia, Internet and email Compu Maths Compu English
6th	Computer Peripherals More on MS Word Creating tables in MS Word Word Art and Draw Mail Merge MS Excel Internet	Review of a Computer Uses of a computer Characteristics Classification Input / output devices Hardware and software Windows98	Evolution of Computers Fundamentals of Computers Elements of Computers Working with Windows 98 Working with word processor Flow Chart Multimedia and Internet	Computer Architecture Computer Generation A Quick Revision (BASIC) Revision of Commands More System Commands INPUT Flow Chart	**Not Seen.**

	Email Basics of BASIC Project work	Windows: My computer Windows: Accessories Word processing Document Formatting Clip art and word art Excel and Powerpoint Multimedia and Internet Project work		For … Next LEN and Library Function Read – Data Condition and Decision Counters On GOTO Graphics	
7th	Computer peripherals More features of MS Word MS Excel Editing in MS Excel Formatting in MS Excel Formulas in MS Excel Intro to PowerPoint Internet as post office Computer Viruses QBASIC looping statements Project	Review of Computer Generations of Computer Computer memory Operating system MS DOS commands Files in MS-DOS Windows: Explorer Word processing Text formatting in Word Mail merge in Word MS Excel Basics PowerPoint basics Multimedia Working with Internet Project work	Fundamentals of Computer DOS and Windows Introduction to Word Multimedia and Internet Computer Virus Fundamentals of BASIC	Computer System MS DOS File, Batch file, Directory Format/Mode Date, Time, Prompt Version,Volume, Label, CLS Wildcards Directory (DIR) Path and Pathname **9 chapters on DOS commands** Common Error Message	**Not Seen.**
8th	Types of Computers Advanced MS Word Advanced MS Excel	Review of Computer Number system Computer languages	Fundamentals of Computer Introduction to Word Networking	Windows Window Elements Explorer	**Not Seen.**

	Charts in MS Excel MS PowerPoint Text in MS PowerPoint Organization in PPT Graphics,Charts in PPT Enlivening a PPT Intro to MS Access What's on the Internet E-Commerce Graphics in QBASIC Project	Path and Batch file External commands Windows98 Worksheet basics Editing in Excel Charts in Excel PowerPoint basics Slide formatting Computer Network Web browser HTML programming Project work	Multimedia and Internet	Control Panel My Computer, Recycle Bin Word pad and Notepad Paint Internet Explorer Calculator and Address Book Windows 2000	
9th	**Not Seen.**	**Not Seen.**	**Not Seen.**	MS Word : Introduction Document Navigating the Document Formatting of Text Paragraph Formatting Document Tools	**Not Seen.**
10th	**Not Seen.**	**Not Seen.**	**Not Seen.**	**Not Seen.**	**Not Seen.**

Publisher:	**IL&FS – ETS**
Authors:	-
Year:	2005 (First edition)
Standard	
Kid Clix – Module 1	Computer Awareness Simple Edu Software
Junior Clix – Module 1	Not seen
Junior Clix – Module 2	MS Paint Typing Skills Simple Edu Software Project Based Learning
Junior Clix – Module 3	Introduction to Word Pad Typing Tutor Project Based Learning
Junior Clix – Module 4	Simple Edu Software Wordpad and Paint Typing Tutor Project Based Learning
Intermed Clix – Mod 1	Computer fundamentals Windows Explorer Introduction to MS Word Project Based Learning
Intermed Clix – Mod 2	Introduction to PowerPoint Internet Project Based Learning
Intermed Clix – Mod 3	Not seen.
Senior Clix – Module 1	Not seen.
Senior Clix – Module 2	Not seen.
Senior Clix – Module 3	Introduction to HTML Programming Turbo C++

7 ANNEX C: CATEGORISING CM CONTENT USING BLOOM'S TAXONOMY

Bloom's revised taxonomy has 6 thinking order levels, viz. Remembering, Understanding, Applying, Analysing, Evaluating and Creating. Work is currently in progress for categorising the worksheet questions in Computer Masti (Books 1-4) under Bloom's revised taxonomy. Some questions were selected from these books and were extended to all the 6 levels. A pilot study is under way in two nearby schools to see whether students are able to solve these questions. Framing of extra questions (higher order thinking) for the existing books will help in improving thinking skills of students.
An extension of this work will be a well defined process using which, any Computer Science textbook content can be in evaluating and categorized according to Bloom's Taxonomy.

8 ANNEX D: ADULT LITERCAY PROGRAM

A team of research students, educationists, and faculty from IITB are in the process of defining the curriculum for adult literacy. The process also involves identifying which topics of the above Model Curriculum for schools can be adapted for an adult literacy program. The adults enrolling in such programs may be literate or semi-literate. Usually they come with clear learning objectives and specific aims like "we want to learn mailing, chatting, creating documents etc". Their existing capabilities and educational background also need to be considered and the curriculum has to be tailored accordingly. Unlike a school student for whom the conceptual understanding is very important, for an adult, directly teaching skills without major emphasis on concepts also works well.

9 ANNEX E : TEACHING LEARNING STRATEGY DETAILS

- **Puppet Show:** This strategy is a powerful way to attract student's attention. It has got visual appeal and along with effective delivery it can sustain interest of the learners.

- **Role play:** This strategy refers to the playing of roles generally in educational setting. It allows students participation which acts as a motivational factor in

learning. Role playing can be done by teachers for small children and can also keep students interested.

- **Story Telling:** This Technique works well with younger children. Story telling with effective voice modulation and powerful communication can enhance the students' motivational level. It can be done by using flash cards, Flip charts and other teaching aids.

- **Games:** It is a powerful strategy. Learning through games has proved effective in educational setting. Learning through games increases students' motivation and enhances their performance.
- **Exploratory Learning:** Exploratory learning approach is considered most appropriate for teaching generalized thinking and problem-solving skills which is a crucial factor for students across all levels.
- **Illustrations:** Illustrations or examples is the basic need in any knowledge building activity. It helps to get the clarity on the content area. It is subjective to the context and hence it works well with students across all levels.

- **Hands on experience**: Hands on also called "by doing" is a technique where learning occurs by performing the task. Mere, theory or content will not prove sufficient. Hands on proves an effective way to learn software or improve psychomotor skills.
- **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.
- **Inductive Deductive approach**: It is a step by step approach used in teaching learning process. For teaching a topic, a teacher first gives several examples of the topic. Then asks students to find similarities in all the examples. Teachers then ask students to state the rule to cite more examples for the rule.
- **Problem solving:** This approach can be used for grade 3 and above. Teacher poses a problem statement for which many solutions are expected. Learning through this approach critical thinking gets developed. Students think from various perspectives.

- **Think pair share:** It is a technique that encourages individual participation. Students think through questions using three distinct steps:

  Think: Students think independently about the question that has been posed, forming ideas of their own.

  Pair: Students are grouped in pairs to discuss their thoughts. This step allows students to articulate their ideas and to consider those of others.

  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.

- **Number heads together:** Students are placed in groups and each person is given a number (from one to the maximum number in each group). 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.
- **Think Pair solo:** In this strategy the students work together first as a team and then as pairs before solving similar problems on their own. It is usually given to those groups of students to perform those tasks which they will not be capable of doing on their own, but have a better chance of performance when working in a group.
- **Small group teaching technique:** It is a problem based teaching technique whereby the students are divided into groups and they work in groups to find a solution and then share among the other groups. It helps students to develop their understanding of concepts and to acquire or improve strategies and approaches to problems. It helps in higher-order thinking and learning activities promoted by small group teaching, it is helpful for the student to engage in meaningful communication directed towards a goal or set of goals. Eg. Jigsaw, Phillips 66, fish bowl, crossover, snowball etc.
- **Filamentality strategy:** It is a web-based interactive learning strategy, whereby the learners are provided various web-based learning materials. The types of filamentality are hot list, scrapbook, treasure hunt and web quest.

- **Minimalist Approach:** It is an approach of a teacher who will teach the students through number of small steps where the teacher gives a minimal introduction to the topic which will help them to explore further. The students learn the whole topic through a number of small steps.

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

-

10 ANNEX F: TEMPLATE FOR LESSON CREATION

Based on the curriculum, lessons can be authored by individuals or collaboratively by teams. The suggested lesson creation template and a sample lesson are shown below.

<table>
<tr><td>Title:</td><td colspan="3">Give the title of the topic here.</td></tr>
<tr><td rowspan="2">Contributors:</td><td rowspan="2">Names of those who created or contributed this lesson and their affiliation (if required).

IF content is downloaded from some site, give the link here. Ensure that there are no copyright violations.</td><td>Std:</td><td>Grade level</td></tr>
<tr><td>Reviewers:</td><td>Names of those who reviewed and/or modified this lesson.</td></tr>
<tr><td rowspan="2">Submission Date:</td><td rowspan="2">Date of sending the lesson</td><td>Approval Date:</td><td>Date of inclusion into the curriculum.</td></tr>
<tr><td>REF No:</td><td>Internal reference no.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Brief Description:</td><td colspan="3">What is this topic about? Give a 2-3 lines description.</td></tr>
<tr><td>Goal:</td><td colspan="3">What aspect of this topic do we want a child to learn?</td></tr>
<tr><td>Pre-requisites:</td><td colspan="3">What should the child know before starting to learn this topic?</td></tr>
<tr><td>Learning Outcome:</td><td colspan="3">What do we expect the child to gain by learning this topic?
This is similar to the Goal but may include more abstract concepts.</td></tr>
<tr><td>Duration:</td><td colspan="3">Number of hours (class periods).</td></tr>
<tr><td>References:</td><td colspan="3">Main sources referred for creating this content.</td></tr>
</table>

	This is important so that teachers can find additional material on this topic.
Detailed Description:	Give a detailed description of the topic. *Provide the detailed description on separate page(s).* *Use figures or pictures wherever appropriate. In case of handwritten or hand-drawn materials, please scan into a single document.* *Note: If using contents from the Internet or other sources, please ensure that there are no copyright violations.*
Lesson Plan:	Give a sample lesson plan for the teacher to follow in the class. Include any associated *Activities (or other innovative ideas)* here. *Provide the sample lesson plans on separate page(s).*
Worksheet:	Give some worksheets for use in class or homework. *Provide the sample worksheets on separate page(s).*
Evaluation:	Give some sample questions that a teacher can use to check whether a child has learnt this topic. *This part is optional.*
Other Notes:	Any other remarks or supplementary notes to the teacher. *(Optional)*

11 ANNEX G: CONTRIBUTORS

The first Draft of the curriculum was authored by:

Sridhar Iyer (IITB)
Malathy Baru (IITB)
Umesh Bellur (IITB)

Reviewed by:

Teacher Trainers

Swami Suryapad (Trustee)
Muralidhar Koteshwar (Trustee)
Shravan Bharatulwar (SSRVM Varthur)
Jayalaxmy Swamy (SSRVM Mulund)
Niharika Luthia (SSRVM Mulund)
Savita Bharadwaj (SSRVM Mulund)

Professors/Researchers

Abhiram Ranade (IIT Bombay)

Om Damani (IIT Bombay)

Varsha Apte (IIT Bombay)

Abhijit Deshpande (IIT Madras)

Mangala Sunder K. (IIT Madras)

Sasi Kumar (CDAC Mumbai)

G. Nagarjuna (HBCSE, Mumbai)

C. Mani (Kendriya Vidyalaya)

Anitha Kurien (Kendriya Vidyalaya)

Names of lesson material contributors, lesson reviewers for the first draft of curriculum are part of the earlier document at: http://www.it.iitb.ac.in/~sr/ssrvm

12 ANNEX H: REFERENCES

1. NCERT Framework website : http://www.ncert.nic.in
2. ICSE Syllabus website : http://www.cisce.org/
3. ACM Task Force report website. : http://www.acm.org
4. Creative Commons website. http://creativecommons.org
5. What is worth teaching? A book by Krishna Kumar http://*gyanpedia.in/tft/Resources/books/worthteaching.pdf*

