CEMCA

Technology Tools for Teachers

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Commonwealth Educational Media Centre for Asia
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Preface

Way back in the 1950's a story surfaced about a student's answer to the question: "Show how it is possible to determine the height of a tall building with the aid of a barometer." The bored, smart but mischievous student came up with about half a dozen answers, all correct, but refused to provide the expected answer. Obviously, the student had no patience for trick questions that belittled tools. Warned sufficiently by the story, our attempt here is to identify and discuss the use of appropriate tools for a given educational context encountered by a 21st century learner. Of such a learner, the only assumption being made is that the young century has given her some familiarity with the Web.

The Web is huge. Navigating it without a clear perception of how educational goals can dictate tool choices, can often result in futile meandering. A rapidly changing technological landscape only compounds this. Acknowledging therefore, that a given educational context demands certain specific types of tools, the monograph takes upon itself the task of searching, assessing and evaluating a sub set of easy and openly accessible tools which can extend learning and help immerse students in experimentation and problem solving.

The attempt is to re-examine technology in teaching-learning, particularly at the secondary level. In the present scenario of large classes, a technology tool's acid test is to regain the benefits of the one-to-one approach to teaching and at the same time allow for an increase in the teacher's productivity. Multiple tools are therefore, needed to address the multiple needs of learners. With tools becoming increasingly sophisticated but simpler to use, our selection of tools are neither prescriptive nor closed. We hope the pages ahead succeed in communicating this. Our purpose is to emphasize the need for tools and to equip the readers with a toolkit to examine and use tools for education.

1 Introduction

One direct fall out of technological advancements of recent years is the displacement of physical resources – equipment and books, as the primary teaching-learning material available to teachers and students alike. Instead, the newer digital learning space has come to stay, changing in its wake, the traditional methods of teaching which had remained more or less the same for centuries.

In any given educational context, the need is to communicate our knowledge to students and perhaps to even lead them towards independent pursuits when our own knowledge base is found wanting. As any teacher can vouch, this is easier said than done. For not only is each student endowed differently but the school system keeps making newer curricular demands in order to keep pace with the changing world.

When we need to achieve something and find it impossible to do so with purely our physical or mental abilities, we look for or develop a tool. It is interesting to note that digital technology made its entry first in higher education and research as a means of quick computation and data representation. Though the tasks were not impossible, technology's use was deemed imperative to save time while accomplishing complicated and involved calculations. This provides the first criterion for the usefulness of a tool – minimize the time and effort spent on a task.

It took more than a quarter century to design and develop microcomputers, later called personal computers, which made computing accessible to the school system too. Acceptance improved when a non-programing user interface, which came to be termed as the graphical user interface, was introduced to make computers usable by non-technical users. This points to the second requirement of the tool – ease of use; eliminating a lengthy or steep learning curve.

The early use of computers in education, before the invention of the graphical user interface, required programming. LOGO programming language (Papert, 1976, 1980) and later BASIC provided an opportunity to students to create their own learning environments. Technology thus supported the changing educational practice – to accommodate a learner led approach as the traditional teacher led class. It must be pointed out here that though the development of technology is mainly for industry and business, the constant effort to make it easy to use allows for its adaption in various other fields including education. Herein, lies a limitation that was soon recognized. The need to adapt a technology implies the tool was not developed primarily for the purpose. Over the years, this limitation has been addressed and tools for exclusive use in education developed.

Even a cursory look at the theories of learning or the vast diversity in educational practice across the world is sufficient to demonstrate that teaching and learning is highly contextual. There is no uniformity in learning, each child being unique. The context of teaching and learning vis-a-vis technology is thus very different from skill development. Using a tool for a single purpose requires skill, using it for multiple

purposes, as for instance meeting varying needs of children in a class, requires creativity that stems from an understanding of both the context of use and the tool's capabilities. Consequently, some situations require multiple tools. Technology scores on this count. With more than half a century of engagement with digital technology leading to the development of inexpensive computers, tablets and mobile phones as one class of hardware and the other class that includes handheld devices, digital probes, interactive whiteboards, digital video cameras; together with a mind boggling array of software to drive them; and the Internet as the backbone of the digital learning space, teachers have better opportunities today to individualize learning than ever before. Individualization is the primary goal of technology in education.

Affordability is the third criterion in tool selection. Educational contexts are very demanding in terms of resources. The most appropriate tool for a given educational need may not always meet these three criteria. The ease of use gets compromised first, especially when the educational need gets very specific. Along with this, the first criterion, that of saving time may not be fulfilled either. But the silver lining comes in the form of movements started about two decades ago to make software and educational resources free and open ("Free Open Source Software", n.d.; "OER Commons", n.d.). A movement that strives to fulfill the three criteriaes to provide a wide set of tools that can meet requirements of all teachers. The following chapters will be devoted exclusively to free and open tools, preferably cross-platform – software that can run on multiple types of computer systems, for example on Linux, Mac and Windows; that can facilitate individualization and fulfill the teachers' motto of Learn-teach-learn.

Before we get to the tools, we must present to ourselves a profile of our students at the secondary level. Our students are capable of critical thinking and deep understanding and can be expected to possess good communication abilities. They appreciate the need for rigor, perseverance and accuracy in their work and are gradually acquiring an eye for detail and perfection in all activities. If encouraged, they can set goals and evaluate themselves properly. More importantly, they are comfortable users of technology – keen on exploring new tools and applying them to new contexts both at school and their communities.

To nurture the above abilities, a teacher at the secondary level, aware that gradation in the curriculum, teaching methodologies and evaluation are continuous and logically connected across classes, organizes learning in multiple settings, coordinates learning and document achievements and progress to complete the feedback loop for curricular refinement.

Equipped thus, we proceed in the next chapter to discuss a few categories of tools. The specific tool is less important than the purpose for which it is introduced, for tools themselves are evolving and more appropriate ones can be expected. The categories chosen are those that can help in planning an entire academic year and organizing learning. Chapter 3 focuses on online tools and services, while Chapter 4 discusses a few subject specific tools.

Web-based tools and mobile phone apps are gaining popularity as anytime anywhere tools but our discussion will be restricted mainly to desktop and online tools with mobile apps being alluded to in a few cases. An entire set of tools necessary for maintaining a computer, like anti-virus or system checking tools will however not be discussed.

Learn-Teach-Learn 2

An academic year sees a teacher planning, teaching, monitoring, assessing and reporting. Students' transition from the elementary level to the secondary level is marked by an increase in analytical abilities. With greater focus on subject domains, multiple learning opportunities, including those that address backlogs and gaps, are needed for achieving curricular goals. Paying individual attention to students becomes that much more difficult.

Of all the tasks performed by a teacher, those devoted to teaching and facilitating learning must receive maximum time. Her choice of tools must help in minimizing the time spent on non-academic activities. Not only would she need tools to teach better but also to learn continuously and keep track of both her teaching and learning. Her toolkit must include tools for planning and organizing learning, collecting and creating learning resources, data mining and representation and finally, backup tools. We proceed to introduce tools for these purposes.

2.1 Mind Tools

Calendars, mind maps, and notes are essential tools for planning and organizing ones thoughts. Good planning includes time management and strategic plans, and is a prerequisite for any time bound project. Strategizing requires a drawing board to put together available information and common practices of the trade to zero in on a workable plan. While such planning can be done in one's mind, experience tells us that tools, functioning as memory and organizing aids, can vastly improve our efficiency.

2.1.1 Calendars

Scheduling mandatory tasks and programmes of the academic year helps the teacher and her students jointly to decide priorities and time frames. Calendars not only help in time management but it can be used to set tasks to students and track their completion by getting periodic reminders. Individual calendars can also be set for each student. Investing a little time at the beginning of the academic year and periodically updating the calendar jointly helps each student retain focus. Procrastinating and underestimating the time required for tasks are the usual shortcomings that can only be overcome with constant vigil.

Rainlendar is a simple desktop calendar. Events and to do lists can be created at the planning phase and reminders set for each event and task. The advantage of this tool has over a mobile phone which has a calendar as a regular feature, is its presence on the desktop and the various icons that can be used to give a quick visual summary of the month's activities. The tool is however useful only if teachers have personal computers. A more sophisticated calendar that can be synchronized with phones and emails, Google Calendar will be discussed in Chapter 3.

2.1.2 Journals

For a teacher, a journal, as an everyday

documentation of her activities and observations, is a tool for reflection. A commitment to journal writing is a commitment to examine and re-examine ones growth in the profession. In addition, it helps in planning and reviewing plans and goals. Like time management, when writing is regularly done, another habit of mind – introspection, gets cultivated. It is only when we value something that we encourage our students to likewise value it.

One of the simplest tools that combines a journal, a notepad and a calendar is the **RedNotebook** (see Fig. 2.1). It can be configured to load on start up and can be accessed anytime from the task bar. The tool has an automatic save – any input is saved instantaneously. This feature ensures that no entry is lost. Journal entries can be tagged and searched either using the word cloud or the search box (see section 2.2.2).

RedNotebook can also be a notes-taking application but **Basket Note Pads** or **Tomboy Notes** are better as they are single-utility tools. Both these tools have the added feature of organizing notes and share the feature of instantaneous auto save, which makes this class of tools valuable to an over-worked teacher. Tomboy Notes can also be synchronized to an online storage.

2.1.3 Mind and Concept Maps

Notes emerge from ideas. Linked notes like those created in Tomboy Notes are an elaboration of linked ideas. When we summarize ideas with words or phrases and link them together, we create a visual representation called a mind map. For example Fig. 2.2 is an example of a mind map created from notes about Earth. A mind map thus has the potential of visually representing snap-shots of our mind, which could be curricular design for an academic year or the sequence of a teaching session or a class presentation to take students through a lesson or brainstorm an issue. When students use mind maps, they discover the

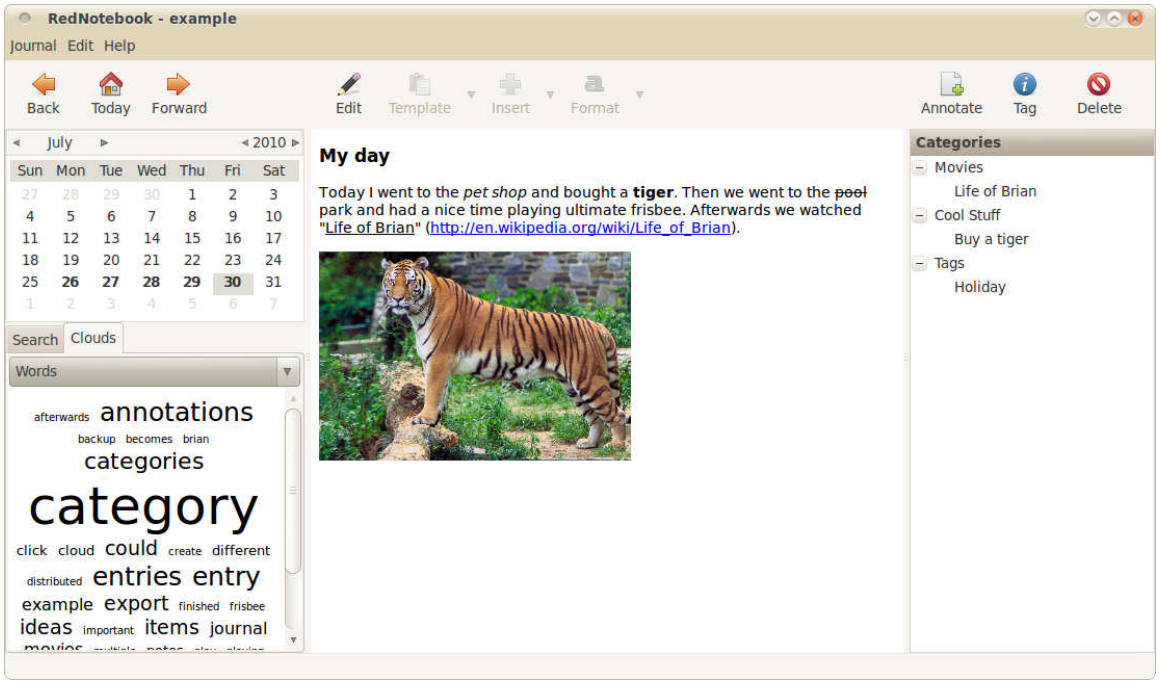

Figure 2.1: Search and statistics in RedNotebook

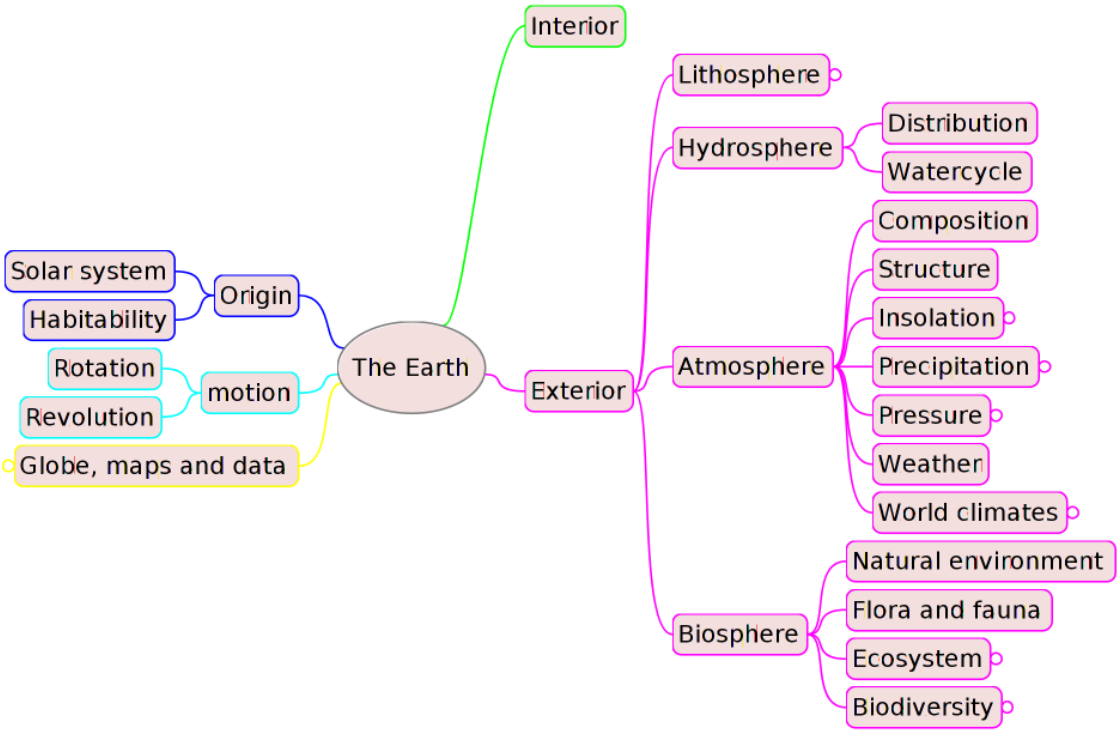

Figure 2.2: A Mind Map of related topics

ease with which thoughts and ideas can be organized. They also discover that it is easy to collectively pool their ideas to design and execute a collaborative project.

Text 2 Mindmap is perhaps the easiest mind mapping tool. Text is input in a text area. Each text line is a node. With respect to a text line, those that are indented are branches of that node. However, a tool that can mimic our mind needs to achieve more. **FreeMind, Freeplane, Xmind** and **Visual Understanding Environment** are some examples of more sophisticated mind map tools. A few important features are included in description of tools in the List of tools. As a rule, maps created in such tools can fold or unfold to gradually build the presentation while keeping the main idea in focus.

Maps can be exported in multiple formats including image, PDF or HTML, making it easy to prepare organized text as handouts. It is also possible to attach or link text, images and documents to nodes. This extends the mind map to include teaching resources.

The best use of a mind map in the school context is to create concept maps. By showing relationships between concepts, a bird's eye view of a topic can be presented. Concept maps help a teacher decide on the order in which concepts are to be introduced. It functions as a summarizing tool for learners to represent what they have learnt.

A carefully constructed hierarchical concept map can be used to design assessment and evaluation items that can point out whether or not lower order concepts, necessary for the introduction of new concepts, have been learnt.

Text 2 Mindmap can be used to construct concept maps as well – by inserting relationships within brackets before subsidiary concepts. Another easy to use tool is Gliffy Diagrams, a multipurpose app that can be installed on Google Chrome browser. It is essentially a very intuitive drag-and-drop drawing tool ideal for flow charts (a concept map can be considered to be a variant of a flow chart), organizational charts and much more.

2.2 Resource Management Tools

Many free and open repositories on the web can help a teacher enrich her lessons. A teacher also creates digital content and generates digital data that gets stored on her computer. A frequent user should soon expect to be flooded with files of all varieties stored on her hard disk or other storage devices. With time in short supply, an efficient way of managing digital content including regular backups to mitigate to some extent the eventuality of files getting accidentally deleted becomes necessary.

2.2.1 Resource Mapping

Native to all computers is a file manager with a folder structure to hold every variety of files. More folders can be created within these, as per requirement, to organize files and resources in a convenient way. Every user develops a file and folder naming style. Through simple and advanced searches, any file on the computer can be accessed. However, this is not a very efficient way of accessing files especially when memory fails to provide suitable search words. Mind map

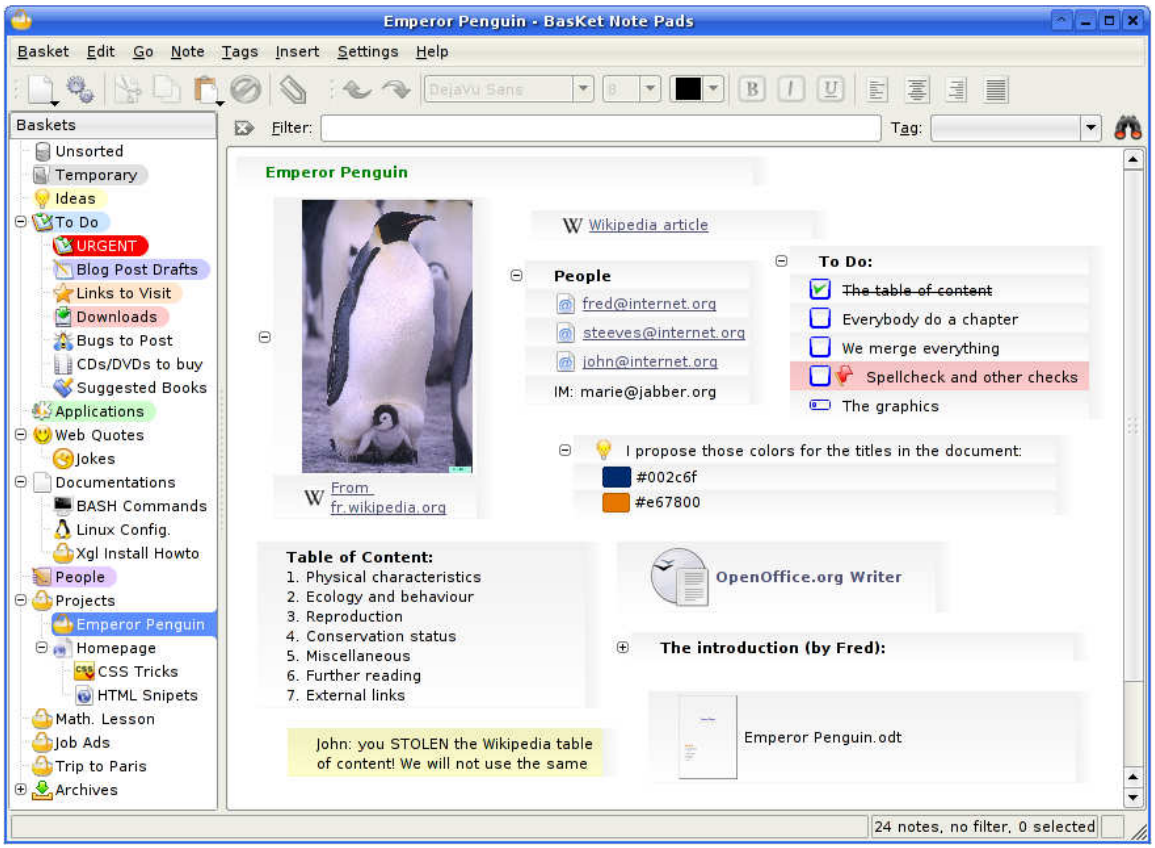

Figure 2.3: Inserting files in Basket Note Pads

tools like Freeplane or the notes tool, Basket Note Pads can be used with advantage to link files and extend mind mapping to resource mapping. In Fig. 2.3, along with notes, weblinks, images, an open document file is inserted. Video and Audio files or for that matter any other file including archives (zip files) or executables can be inserted. If the computer has suitable applications to open them, Basket Note Pads launches the applications and displays the file. Notice that this facility not only helps in accessing files on the computer within the context of a lesson or learning activity but can also function as a presentation tool.

2.2.2 Resource Tagging

Resource mapping cannot be the best way of managing resources when a resource belongs to several themes or topics. Recall that RedNotebook uses tags to label notes and journal entries. The same logic can be extended to files. Tags are keywords or labels. Any number of tags can be assigned to a file. For example, a documentary can be tagged using the genre, director, country of origin, subjects areas covered, duration and so on. It can then be searched and retrieved for any occasion or learning context. Cross-platform tools specifically suited to file tagging are available.

TagSpaces (see Fig. 2.4) is one such tool with lots of added features. While capable of all the conventional file management tasks – rename, create, move and delete files, TagSpaces makes it easy to tag files by simple drag and drop actions. It allows for colour coding tags and organizing them thematically in groups. Batch tagging – adding and removing many tags to many files at a single go is also possible.

2.2.3 Extending File Management

Tools such as **TagSpaces** are designed to enhance productivity. Once a file is

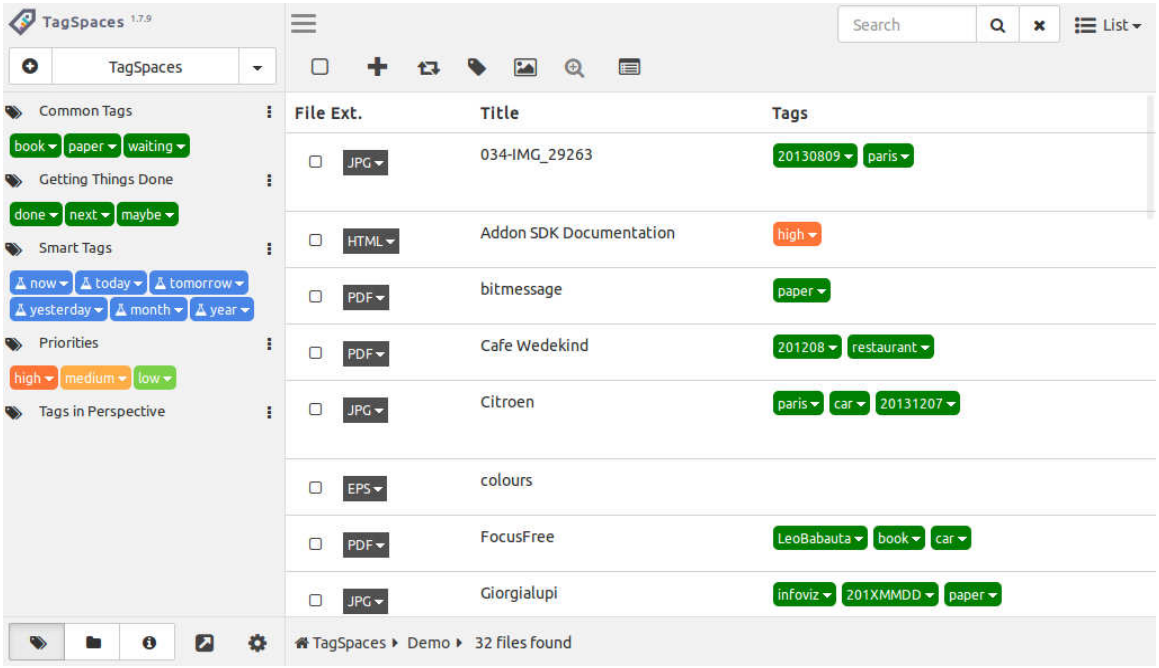

Figure 2.4: TagSpaces interface

searched, it can be previewed as well. The full file preview improves upon the thumbnail or icon views presented in native file managers. In addition to file preview, media managers allow basic editing of files and uploading to media sharing websites like Flickr or YouTube.

An important source of images and videos are digital cameras. Most cameras come with their own proprietary software to download, edit and manage media files but these are not adequate. As more and more ûles get accumulated, searching and retrieving a particular image or video can get tedious. **Shotwell** and its Windows equivalent, **Picasa** are tools dedicated to the management of images and videos. They can capture information from the camera like the date and time of exposure, GPS latitude and longitude, exposure details and so on and also provide for user defined details which include tags, titles, ratings and descriptions. Larger the information set, technically termed as metadata which is a set of data that describes and gives information about other data, better can searches become.

Mention must be made of another useful tool – **Docear,** which integrates with Freeplane to manage pdf files. Besides a lot of functionalities, Docear allows for annotations of pdf files and including them in the mind map.

2.2.4 Backups

With accumulation of files comes the constant fear of losing them. Files can accidentally get deleted, the operating system can crash or the computer can simply stop working. It is possible to copy important files manually to pen drives or removable hard disks for safe keeping but over a period of time, we tend to forget where we have copied what. In our anxiety, we also make multiple copies of the same set of files. A backup tool that remembers what we want to keep can come handy at such times.

Some of the tools we have discussed, like the notes tools have a backup feature in addition to exporting as text or html files. All operating systems have an inbuilt backup tool in which preferences can be set about what to backup and where. Backup locations can be on the hard disk or on removable hard disks. Regular backups can be scheduled.

2.3 Creativity Tools

Once an educational context is established, a teacher needs to create the environment for learning. She can initiate this with a teaching session, where she imparts instruction, or a facilitating session, where students can self-learn under her guidance. Whatever a teacher does, she creates a conducive environment for students to create meaning (learn) for themselves. We must recall here that as the learning style of each student is unique, a teacher has to create as many learning environments as students. And this she must, to keep alive the joy of learning for herself and for her students. For this, she has at her disposal, a wide variety of tools and both technologies and otherwise, that can help students observe better, remember and connect thoughts, think deeply to analyze and solve problems – in short, launch off on the path of life-long learning.

2.3.1 Digital Storytelling

Storytelling is all about packaging an idea and communicating it so as to impact the audience, more specifically ensuring that

the story, along with its message is transmitted and re-transmitted either faithfully or with embellishments or personal experiences, to conserve the idea as well as to extend it. And this is what teachers do all the time, except that their focus is seldom on fictitious matters. By adding a digital component to storytelling, we have the liberty of using multiple media in our narration, including the ability to make the narrative interactive. The educational use of digital storytelling centres around a learning objective and communicating, both the process of its achievement and the result itself. It can be a learn-together tool with inputs from the teacher and her students.

The familiar computer based presentation (commonly but erroneously referred to as PowerPoint presentation) also qualifies as a digital storyteller. **S5** is a simple time saving tool for a straight forward slideshow of text and images. A better option for creating quick presentations would be any convenient word processor. No matter what page size is chosen, text and images can be centered on it and a page break used for the next slide. When exported as a PDF, it can be used on any computer. The standard 'Fit Page' option should be used to display the whole page. Arrows or PageDown keys on the keyboard can be used for navigation.

With a little bit of initial effort, a document creator like **LaTeX** with special packages suited exclusively for presentations such as **Beamer** is ideally suited for quick presentations that can also be re-structured or made part of another presentation easily. The output from Beamer is again a PDF. Missing however in these PDF presentations are the fancy transitions and rudimentary animations or sound effects which anyway contribute little to the content of the presentation, especially at the secondary level. Moreover, a highly structured tool as in the case of commonly used Microsoft PowerPoint or **LibreOffice Impress** (with placeholders for content and presentation outlines) is less suited for creative work.

In a teacher centric presentation, the teacher is the active communicator and students are active listeners/observers/thinkers/processors of information. Presentations enhance listening skills and encourage thinking. They strengthen conceptual understanding and through the use of multi media, enhance teaching. However, the time spent on making them must be commensurate with the learning that is achieved. Presentations must be in conformity with the flow of instructional activity of the class and enhance the learning environment. The minimum requirement for achieving all these is to ensure that a content based presentation has multiple examples to illustrate. For example, a presentation on inflorescence would require photographs of different flowers and plants. When the purpose is to show photographs in sequence, any image viewer (native to all operating systems) is adequate. Images can be sequentially numbered if necessary. The next-previous navigation and the zoom and rotate features are more than adequate to achieve the objective of the lesson.

Photographs and videos are perhaps the most extensively used media for storytelling and presentations. The necessary audio narration can be recorded either using simple recorders that come bundled with the operating system or use offline tools such as **Audacity** to record and edit sound. Text-to-speech tool like **NaturalReader** or **Text2Speech** is quicker and more convenient especially when our voice

quality or modulation is poor. Audacity may appear intimidating at first but its many features allow for experimenting with sound and mixing them, making it a good learning tool to understand sound quality and effects as well. Text-to-speech tools are also productivity tools. Listening to a textual creation instead of reading, it saves time and helps in proof-reading and/or editing.

There are many easy to use online tools for digital storytelling and presentations (for example **Animoto, Cartoonist** – online comics tool) but mind map tools are far more effective and interactive. The pathway feature in Visual Understanding Environment helps in creating paths through nodes and the paths can be used to highlight desired node in a large map. The folding and unfolding feature of most mind maps are likewise beneficial in focusing attention on certain nodes while keeping the bigger picture in front.

2.3.2 Data Visualization

Simply put forward, data visualization is all about describing data visually. Data, as the definition goes, refers to facts and statistics collected together for reference or analysis. As a creativity tool, visualization is a graphical representation or explanation of information. It is a way of looking for patterns in enormous quantities of data, as in the case of demographic data or as Fig. 2.5 shows, the global flow of people during 2005-10.

Returning to Fig. 2.1, notice the word cloud at the bottom left corner. Picking up commonly used words from journal entries, **RedNotebook** generates a word cloud; bigger a word in the cloud, more frequent is its use in the entries. RedNotebook uses word cloud as a search tool but it can also be used to glean the context of the entries from prominent words. Wordle is an online

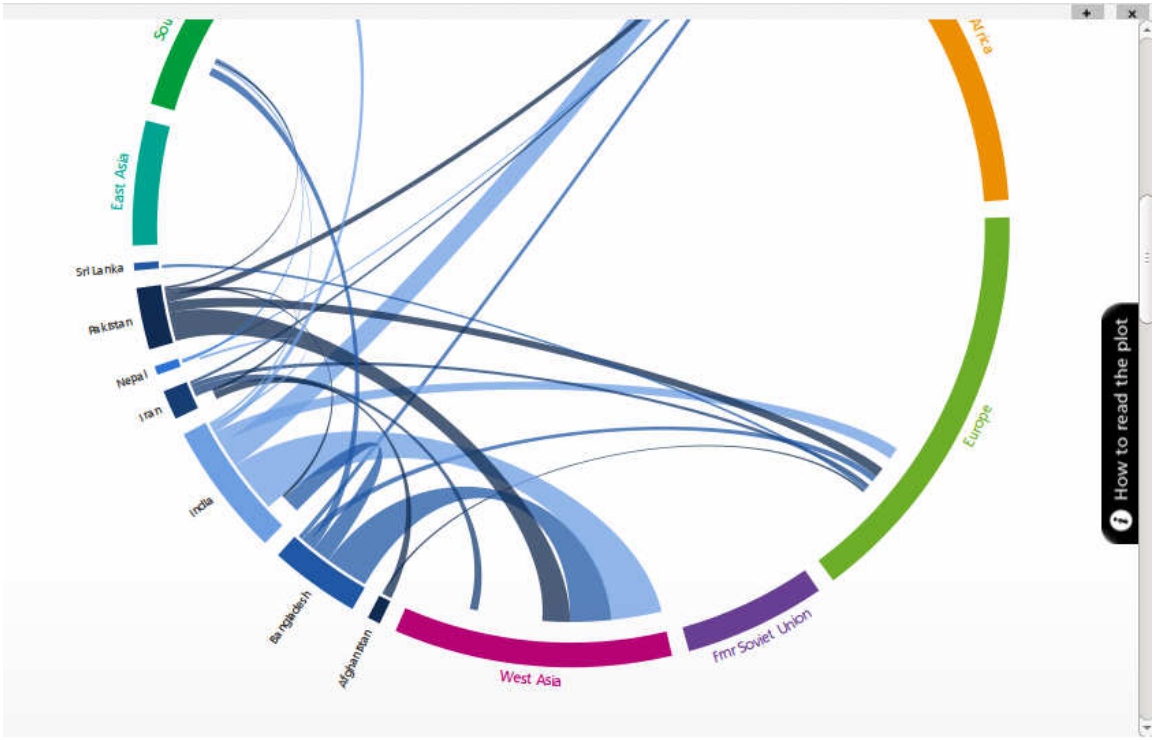

Fig. 2.5: Data visualization, the global flow of people

tool to generate word clouds, which can be considered as a visualization of words in a text piece. Consider the potential of this tool it can be used in analysing essays or textbooks.

2.3.3 Infographics

Data visualization with just the bare minimum textual support that conveys data patterns and analyses is an example of an infographic. This is a slight variant of storytelling. A good infographic is one that sets the viewer thinking about the data, its relevance to the context and its implications for doing something with the data. An interesting application of word cloud to create an infographic can be seen at ("Inaugural Words", 2011) which presents American Presidents on a timeline and analyzes their presidential inaugural addresses. Another example ("World Cup", n.d.) is presented in Fig. 2.6.

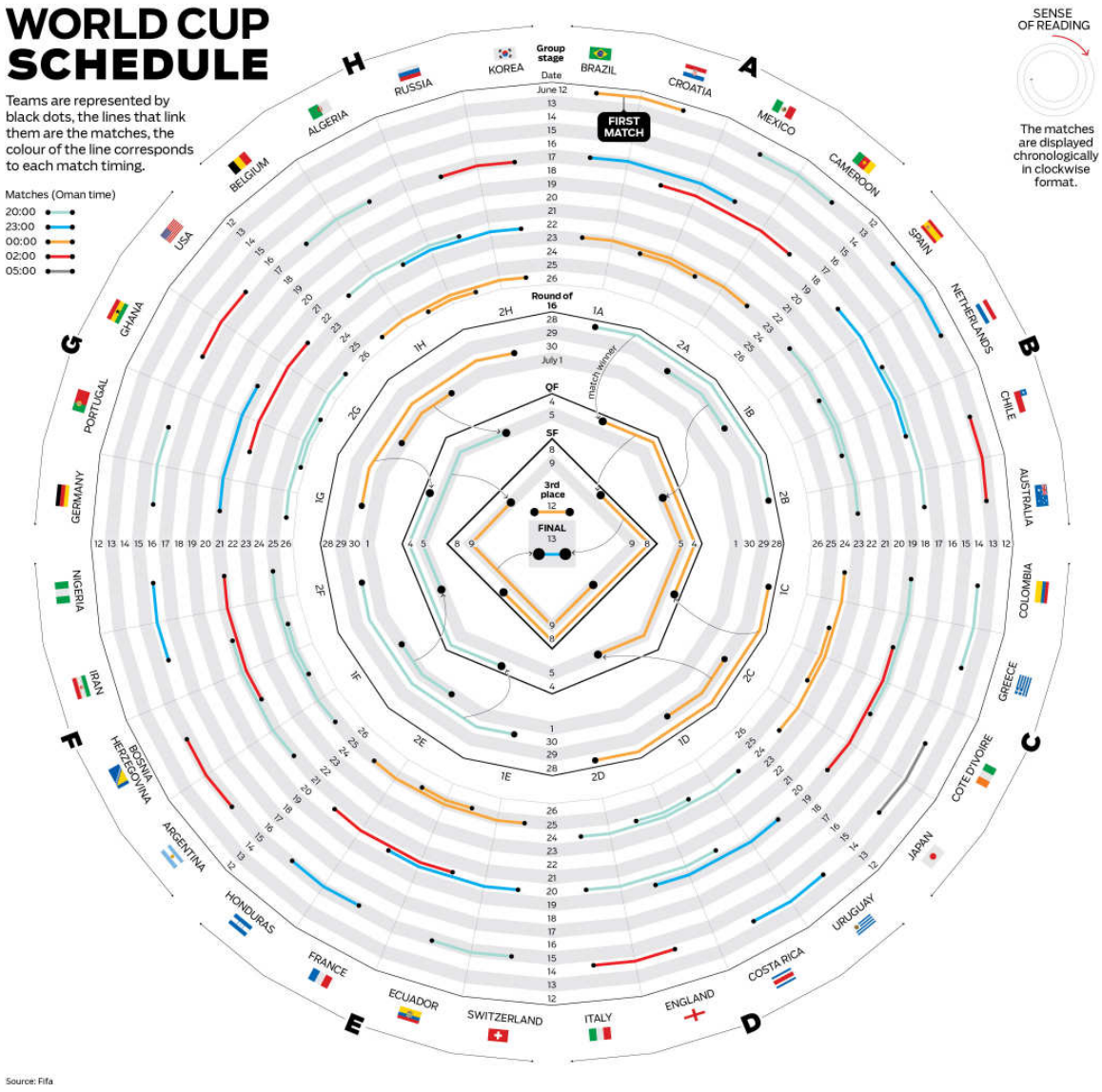

Figure 2.6: Example of an infographic

Maps and charts can also qualify as infographics and so also brochures. But the real power of an infographic is when the purpose of communication is quick and clear – a communication characterized by messaging and great visual impact.

A free online tool to create and share infographics is - **easelly**. Using templates available on the website and a simple drag and drop of content bits, infographics can be created easily. If the data is chronological, timelines are an appropriate form of visualization. An interesting example can be found at ("Revolutionary User Interfaces", n.d.), a timeline constructed using an online timeline creator Timeline JS, that pulls data and media details from a spreadsheet.

Good data is central in creation of good infographics or any other learning resource. Spreadsheets and databases are best suited for collecting, organizing and processing data.

Data can be collected or can be accessed from various sources. Extracting data from documents is however not easy. **Tabula** makes it easy to extract data from PDF files into Comma Separated Variable (CSV) or Tab Separated Variable (TSV) file, which can then be imported into any spreadsheet or database or web application for further processing.

2.3.4 Content Centric Creation Tools

All creations are content centric. By terming a tool content centric, we refer to tools like S5 in opposition to tools like Microsoft PowerPoint. The difference is that the latter tool has a WYSIWYG (What you see is what you get) interface and the tool offers a certain amount of interactivity – dragging and dropping elements, selecting the font type and colour, playing with effects, etc., while the former is similar to a programming environment where instructions are compiled or processed by the tool to generate the creation.

Another example is Text 2 Mindmap while its WYSIWIG counterpart is Freeplane. The need to point out this difference is to bring home two aspects of content centric creation tools:

1. Content centric tools allow the user to focus on the content and leave designing to the tool.
2. The production, be it a document or a presentation, is of high quality generally meeting professional standards.

The first aspect is of importance in the educational context, where the engagement necessarily is with the quality of content and the style of presentation, both of which hardly require a WYSIWIG environment. Learning to use the tool is often time consuming, but once a certain amount of familiarity is acquired, time required for new projects drastically reduces. In addition, as the tool takes care of designing, it is absurdly easy to accomplish complex and demanding creations like books. For example this monograph has been created using **LaTeX,** which has automated the generation of contents page, figure numbers, cross-referencing, bibliography and glossary of tools. **LaTeX** is ideally suited for creation of scientific documents but it can also be effectively used to create any document.

2.4 Conclusion

A teacher's constant concern is to encourage creativity. Experiences, observations, memory and imagination

contribute to the development of original thought. The best route she can take is to demonstrate creativity. Every action of hers is under scrutiny and every positive attitude imbibed.

All the preparation, planning and creating is of no consequence if the learning outcome is not up to the mark. Her keen observation is sometimes inadequate to gauge her students progress. And nobody knows better than her that grades and marks are not adequate proofs of learning. The simple tools of yesterday have matured considerably to enable her to constantly track each student's progress. The design and development of learning management systems with integrated learning analysis tools that collect analyse and report data about learners and their learning has vastly encouraged her to explore different teaching techniques. This takes us to an entire new dimension of technology tools. While such systems can be installed on the school's hardware, online deployment of learning systems either as free or paid services rid the teacher of managing complex software and hardware but instead allows for setting up a highly interactive learning environment that she had always dreamt about. In the next Chapter, we discuss a few online tools and complete learning management systems.

Online Learning 3

When a teacher plans a learning session, she is always aware of time constraints that prevent longer classes or greater detailing or more question answer time and discussion. Worse, she is aware that her sessions address everybody in general and nobody in particular. Teachers everywhere have continuously worked towards overcoming the limitation of a switch-on switch-off class which interrupts thought and forces compliance with a single method of learning. Possibilities of technology solutions to such issues emerged only after the Internet became ubiquitous. However, as graph 3.1 shows, successes and larger acceptance of e-learning took time.

Online learning liberates both teachers and students. The teacher is not restricted to just resources that she can deploy in her class but can invite her students to access a larger variety of resources. She can also extend her interactions beyond the class. Device liberation has also come about with easy synchronization of computers, hand-held devices and mobile phones. This brings in many new possibilities, each attempting to eliminate one or the other constraint she conventionally faced. Students can choose when to learn and what to learn and from whom. Teachers can employ multiple teaching-learning methodologies for the same curricular goals and offer learning style choices to students. Teachers can

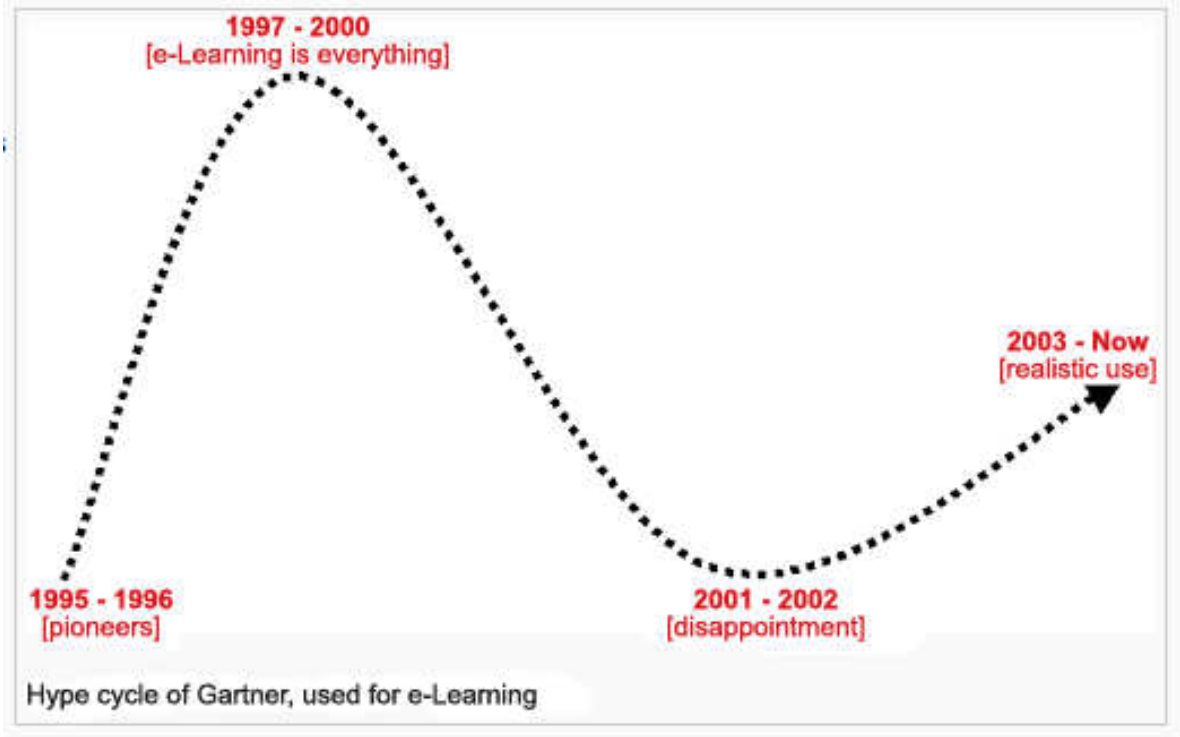

Figure 3.1: e-Learning Hype cycle ("eLearning Fundamentals", n.d.)

create, share, modify and re-use digital learning resources.

We have already encountered a few online tools in the previous Chapter. Almost all of them allow for sharing of content, collaboration and linking services, as we will see later on in this Chapter. This introduces a connectedness in the workspace, extending beyond the school boundary. A collection of tools can create a complete solution for a given educational context.

We examine a few such solutions in this Chapter. Incorporating such solutions requires a higher level of technical comfort, especially for installing and maintaining them, than the simple tools we have encountered so far. To overcome this difficulty, Software as a Service (SaaS) is increasingly becoming popular. A SaaS is an online hosted software or application and users subscribe to the service to use it. The service provider takes on the responsibility of installing, maintaining and providing tutorials. While most of them are priced solutions, some are offered free.

3.1 Learning Management Tools

The name says it all. When the learning environment has been designed and learning resources created, attention is turned to their management to ensure that learning goals are met. Management consists of defining the rules of the learning environment, deploying learning resources, opening enrollment, facilitating learning, setting up assessment and evaluation, and finally concluding the learning session – exactly the same process as in a face-to-face learning situation. A Learning Management System (LMS) can be deployed on the school's server to extend the school work or can be a complete virtual school where teachers and students meet online.

3.1.1 Characteristics of LMS

Except for increasing the ease and efficiency, administrative tools of LMSs are similar to those encountered in schools. They make it convenient to announce courses, enroll students and collect payments, set up the learning environment (equivalents of classrooms and labs), assign teachers, collect statistics (termed as logs), establish communication between teachers and students and maintain records. The distinguishing features are those pertaining to delivery of the course and tracking students' progress and performance. Thus, LMSs score are in their ability in personalizing the learning environment for each student. Multiple tools are available for customizing them to every teacher or student's style. Taking the example of **Moodle,** we examine a few general features of LMSs with the focus being on personalizing learning.

3.1.2 Resources and Activities

Learning is centered on content. The advantage of digital technology is the facility of packaging content in multiple formats – text, multimedia, video; and including as many of them as necessary in a course. Contrast this with just the textbook or a few reference books that a typical classroom affords. A file manager facilitates uploading files, searching and including selected resources in courses. With the proliferation of online repositories like Flickr and YouTube and the ease of integrating them with the LMS, the choice of learning resources has increased. This is less of a challenge than building activities

around them. LMSs have picked up this challenge as Fig. 3.2 shows, and built various interactive elements that include discussion forums, collaborative workspaces, peer assessments, continuous teacher grading, surveys and lessons with multiple learning paths where the choice of path is decided on by tracking previous learning etc. The list keeps increasing with every passing day. Available in a modular manner, the course creator has the option to include only those that suit the pedagogy of her course.

3.1.3 Course Structure and Learning Paths

A course structure in an LMS is visible to students like a contents page but clearly shows the path to be taken – resources to be studied, activities to be accomplished and assignments to be submitted. The format of the course can be varied. It can be a time bound course with specific learning expected in a certain time frame or thematically structured with no time frame specified or can be totally discussion based.

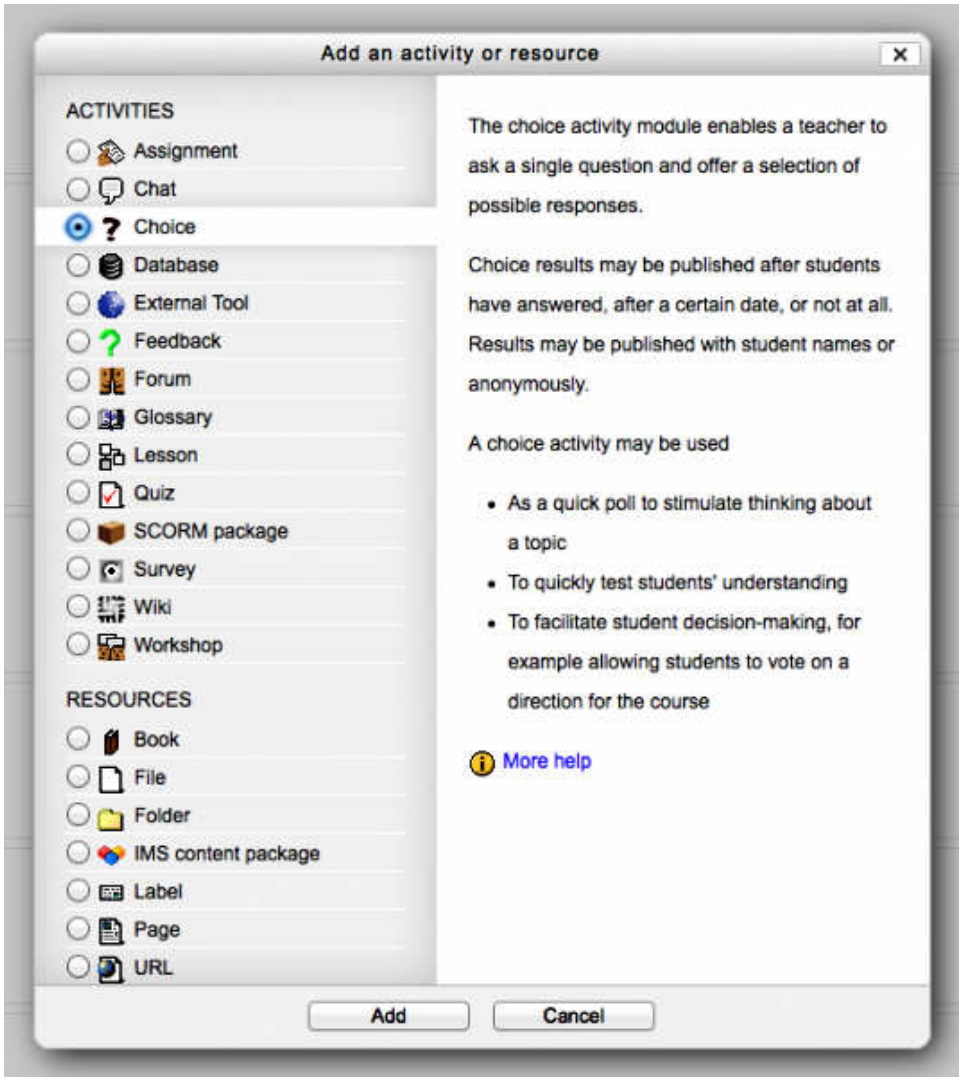

Figure 3.2: Types of resources and activities in a course

While any style can be chosen, a teacher has the option of offering the same course in multiple formats as resources and activities can be re-used or ordered difierently. The course can be structured tightly or made flexible, building new learning sessions as and when students are ready to get to the next level.

The online nature of the LMS not only provides for instant messaging together with synchronous and asynchronous communication between the teacher and student but also between the whole class or a sub-class. The hallmark of a good LMS is plenty of opportunities to address the minutest of learning needs of each student as quickly as possible.

3.1.4 Tracking Learning

The learning path to be taken can be decided either by the teacher or by the student. The path includes accessing learning resources, creating products of learning or demonstrable evidences of learning, assessment of learning and the inevitable final evaluation for certification. On an LMS, there is ample scope for experimenting with each of these aspects and establishing appropriate learning environments. When most of the transaction is digital, we have a greater scope for showcasing and tracking learning over a period of time, comparing individual showcases to ascertain the effectiveness of the designed learning environment – in short, archiving proofs of learning as a good feedback loop for the iterative process of learning. This is facilitated to a large extent by digital portfolio tools. A portfolio is a collection of creations including, if desired, a documentation of the process of creation. Allowing all students to present their achievements in the form of portfolios and preserving them to analyze learning or convert them into learning resources is easily achieved in LMSs. **Mahara** is a popular and versatile electronic portfolio that integrates with LMSs like Moodle. A single page of a portfolio with varied artefacts (content creations) is shown in Fig. 3.3.

Mahara is available as a SaaS or for free download and installation. Apart from portfolios, LMSs have many other tools to track learning. A teacher can set conditional activities that restrict students from completing the course if certain tasks are

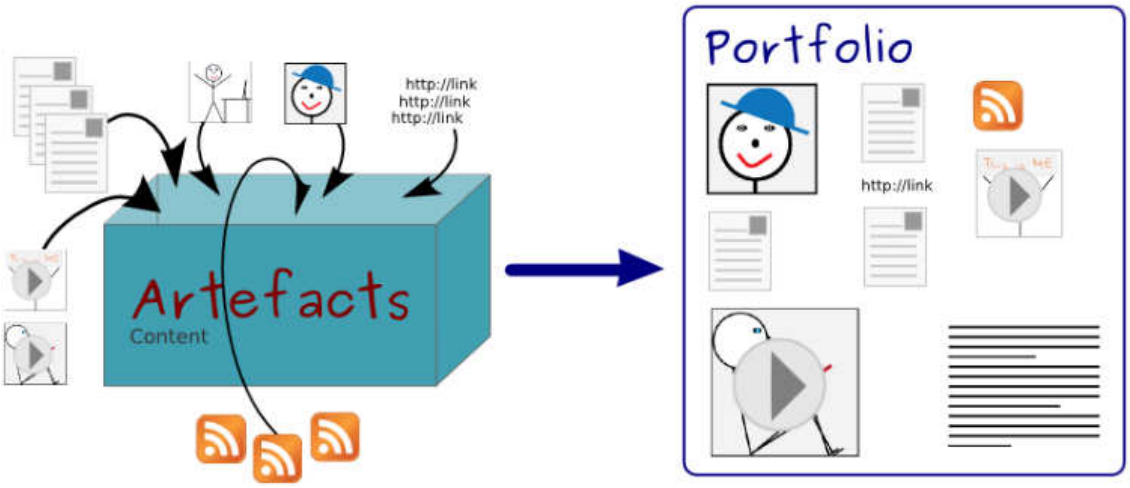

Figure 3.3: A portfolio work with Mahara

not completed. She can set a final evaluation to rank the student and based on the performance in all activities, allows for the completion of the course. She can choose to keep the student informed of the progress at each stage or consolidate all performances to declare the final score. Likewise, a student can track his or her progress by participating in self-assessing activities and decide whether to get to the next level or not depending on the performances. Opportunity for multiple attempts can easily be configured. Complete flexibility can be built to ensure students have the maximum exposure to learning activities which include self, peer or teacher assessment and review.

A model implemented in **Moodle**, shown in Fig. 3.4, is an example of the elaborateness in assessment that can easily be achieved in a digital course delivery. Multiple choice questions, short answers, surveys and polls and more such possibilities that are available in almost all LMSs; some of them allow for combining tools to develop complex assessments. The designed assessments can be used independently for evaluation or in the context of a learning session. Advanced options like rubrics or portfolios are also available. Rubrics are descriptive tools that convey the quality of work or learning. Criteria of assessment or performance is clearly communicated and a rubric score gives adequate pointers to students for improvement.

Pre-made rubrics for almost all school subjects and activities (Rubrics4Teachers, n.d.) as well as online tools (Rubistar, n.d.;

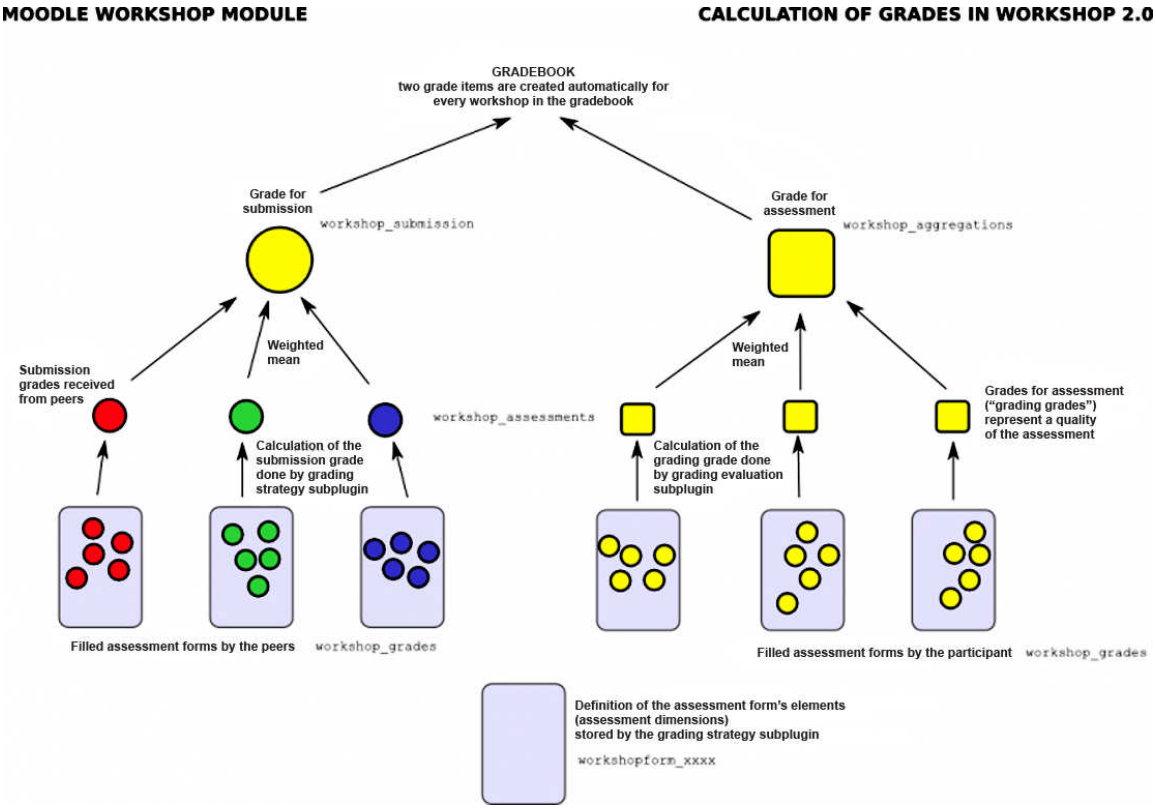

Figure 3.4: Assessment model in Moodle-Workshop module

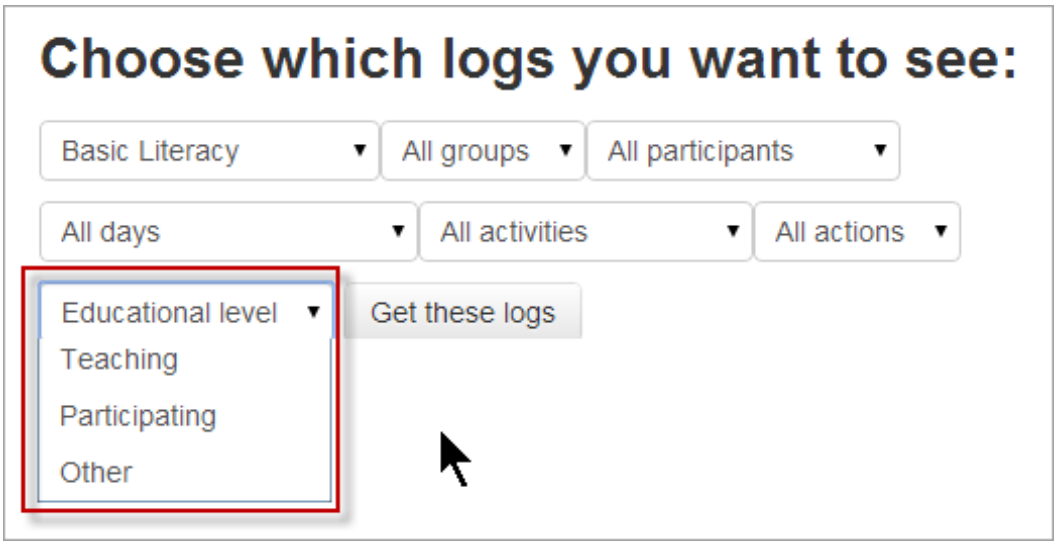

Figure 3.5: Accessing logs in Moodle

iRubric, n.d.) where rubrics can be created, shared and downloaded are available.

The advantage of using these tools as a part of an LMS is the ease of performing the complicated and memory intensive task of tracking each student's progress. LMSs provide for very elaborate and explicit logs of students' activities on the learning platform (see Fig. 3.6). Data on number of resources accessed, time spent on studying course materials or participating in activities, details of student-teacher interactions and other such information is readily available to teachers either in the raw form for her to interpret them or via inbuilt data analyses tools. LMSs are continuously improved to meet the demanding needs of educators.

3.2 Google Apps for Education

Google began as a search engine and is currently one of the most popular web services for searching the web and for the ever increasing array of applications (apps) that can be deployed for many purposes, including education. Qualifying as anytime anywhere tools these applications need just a web browser, more specifically Google's Chrome browser. Eliminating elaborate installations or separate user licenses, Google provides almost all digital experiences in an intuitively accessible manner, especially for non-technical users of the web. All services and applications can be accessed with a single account. In addition, many networking and service websites allow access with a Google login.

Google has bundled apps for education that includes Gmail, Calendar, Sites, Documents and browser. And all applications have the well known Google's powerful search facility inbuilt, so also the facility of sharing. Google Calendar has all the advantages of a desktop calendar and the ability to sync with other applications including desktop calendars, email and mobile devices. Calendars created in other tools can be imported into it. A high utility feature is the ability to create multiple calendars including addition of information like sunrise-sunset times, moon phase, etc. and can also share them. Calendars can be added for all academic scheduling – projects, activities, resources, tests, etc.

Google Drive is an online storage. Any file can be uploaded to the drive. Files can be stored in folders and shared. The powerful search helps in quick retrieval of files. Files can be synced and accessed from anywhere.

Google Docs, Sheets, and Slides are applications that allow for online creation of documents, spreadsheets and presentations with the additional option of sharing them or inviting others to collaborate on them.

Perhaps the best starting point to access all Google applications is the Google Chrome browser. Applications can be accessed from the browser, making it an alternate desktop. One can also access the Chrome Web Store where apps can be searched and installed. Chrome also facilitates online access of many applications including the Calendar, Gliffy, Gmail and Drive.

3.3 Conclusion

Actual learning is fostered better when students are directly involved in a learning experience rather than just listening to teachers' presentations or lessons. We have mentioned earlier that each student has a particular learning style. Fortunately, technology provides both time and tools to cater to each student's needs. This may appear unmanageable at first but a little effort at deploying LMSs will yield rich dividends.

With the days of desktop computing quickly giving way to online and mobile computing the focus of technological developments today is increasingly seen in these areas. Connectivity is demanded but the ensuing ease of use, especially with regard to technology maintenance worries, more than compensates for the cost of connectivity. More enamouring are the new possibilities of learning that have emerged, some of which we have hinted at in this Chapter, to meets the cherished goals of teachers alluded to in the Introduction.

Online learning calls for some adaptation and a change of mindset. Designing online learning is also not an easy task. Time deployment for designing the learning environment and creating digital content can be enormous and should be justified only if learning that accrues is superior to that from conventional methods.

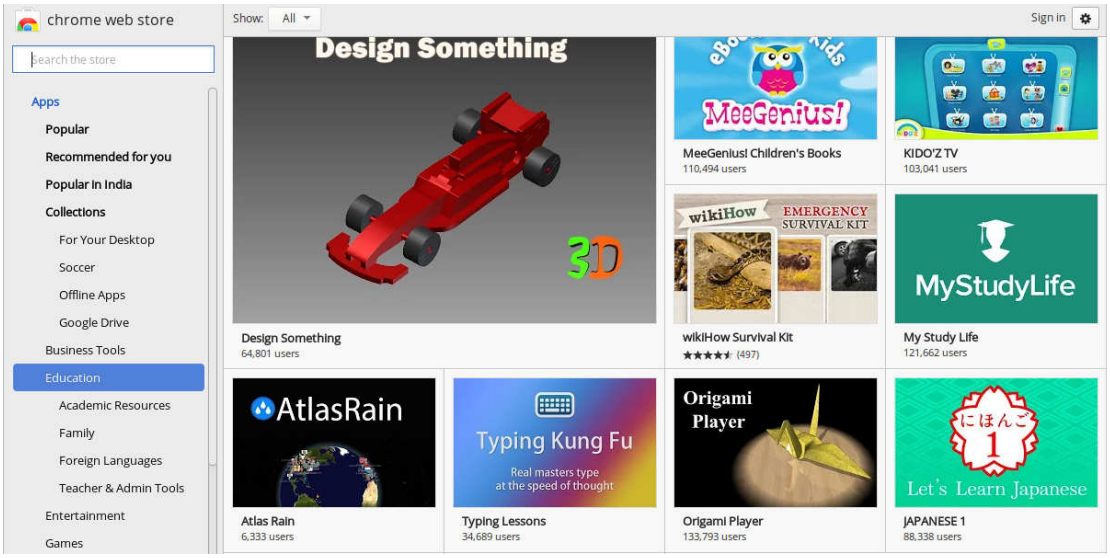

Figure 3.6: A few educational apps in Chrome web store

Subject Specific Tools 4

We have encountered many interesting tools in previous chapters that help in organizing activities, tasks and creating or using resources. However, when it comes to introducing students to specific subjects, the focus is on enlarging their knowledge base by systematically familiarizing them with the techniques of study, instruments and measures specific to a subject domain. Students need to acquire the discipline of the particular discipline, be it science or the arts or technology. Conceptual understanding comes with long hours of engagement with the subject and students at the secondary level need to make a beginning of getting into the rigors of systematic study that can enhance their analytical abilities.

Subject specific tools therefore, are not simple tools to achieve a given task but elaborately designed software that take into consideration both the requirements of subject learning and the need for open ended pursuits to explore and internalize concepts. We propose to discuss the characteristics of a few subject specific tools in this chapter. Learning the tool and exploiting all its functionality however, requires some effort.

The availability of innumerable tools for every subject, with newer ones getting added almost on a daily basis, makes it diûcult to provide a comprehensive list of subject specific tools. Highlighting tool categories that are best suited to subject explorations and self-learning, our discussion is limited to only a few tools in each category to serve as illustrations.

4.1 Expanding the Knowledge Base

The web is an alternative to printed books and a vast collection of all varieties of digital resources. The OER movement has resulted in the establishment of many online repositories. Resources can be searched, used and adapted. An example is **OER Commons,** is an aggregator of open educational resources. Search results can be filtered on a number of criteria as shown in Fig. 4.1. Belonging to the same class are many others, notably Wikipedia, Curriki and institutional repositories like that of NASA.

Maps and globes are inevitable to the social science class. Roll up maps and globes can be used to explore not only places and physical features but also geographical information such as latitudes and longitudes. A major limitation of physical aids is that their details are fixed. Virtual globes and maps score over them. Based on very high resolution satellite maps, they afford a much greater detailing. They allow zooming in and out, enabling the selection of an altitude at which a place is viewed. Based on data, they are completely searchable. They switch-on and switch-off features, making the interface as clutter free as one wishes. These maps and globes make excellent teaching aids. At the same time, they lend themselves to independent exploration by students and problem solving, enabling setting of projects, assignments and assessment of performance.

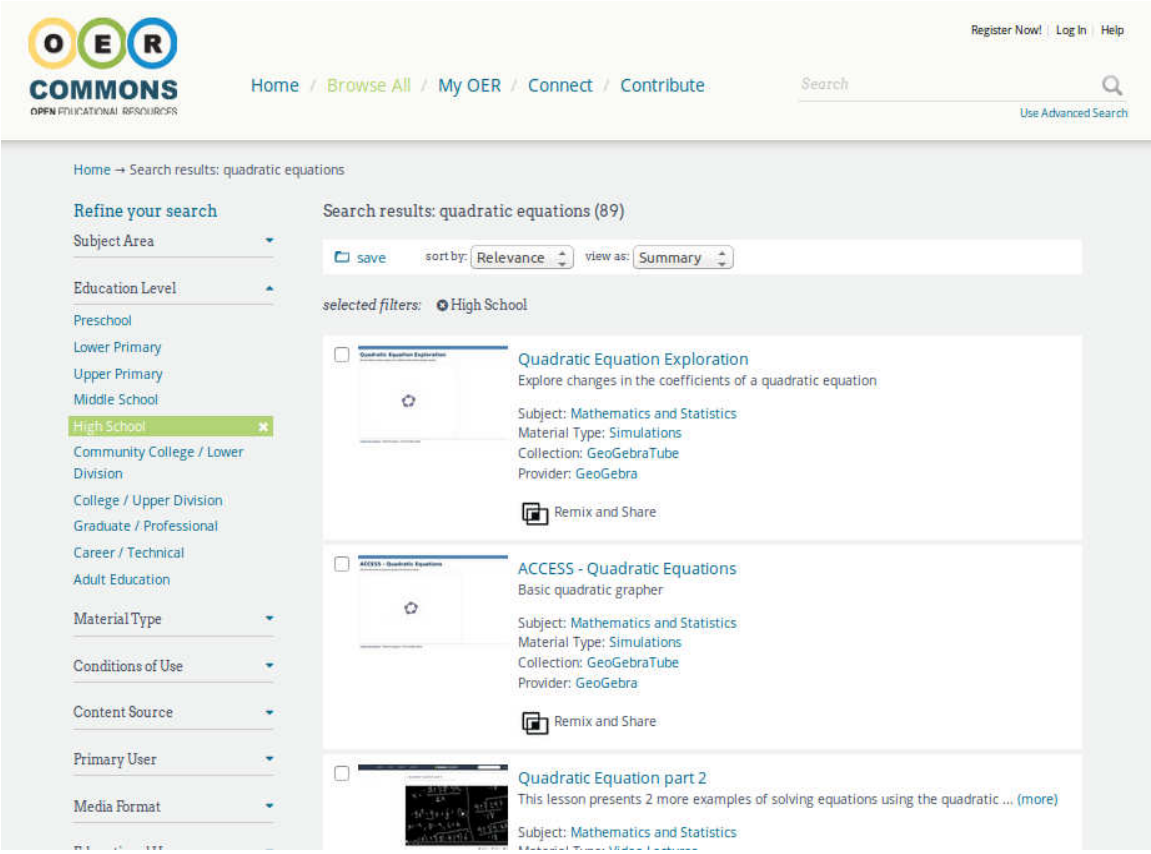

Figure 4.1: Filtered search at OER Commons

Google Earth is one of the most popular virtual globes. Combined with Google maps, they enable a variety of teaching-learning activities. They also have features where locations can be added, descriptions and photographs inserted to customize the globe for lessons or activities. **Bhuvan** and **Open Street Map** also provide similar features. **Field Papers** is a software that overlays on Open Street Map and constructs a ready to print map. Activities like history walks or identifying trees in the neighbourhood become easy.

Combining data and an urge to fight devastating ignorance, tools like **Gapminder** are applications for generating interesting data visualization that provides fact-based worldviews. Gapminder compiles data on various indicators from different sources to build views that everyone can easily understand. The tools and other teaching resources can be downloaded from the website and used offline for such visualization and data analyses.

4.2 Experiential Learning

A hands-on approach to learning must follow teacher's instruction for a thorough conceptual understanding and/or adequate practice with techniques and procedures. More a student engages with the subject, deeper will the understanding be. Tools that provide for extended engagement with the subject to examine and explore many 'what if' situations are ideally suited to trigger interest for and deep thinking about the subject domain. Such tools often succeed in

providing a greater conceptual understanding of the subject.

Mathematics generally requires more practice – to overcome the phobia and to apply it to other domains. **GeoGebra** (it takes the name from geometry and algebra) is a very convenient and useful tool that can save a lot on paper! It can construct almost every conceivable geometrical object (latest version can do 3D too). Object drawing is interactive – can be moved around, modified, measured. It has an algebra pane which provides algebraic representation. Data can be plotted from a spread sheet (see Fig. 4.2). By putting a tracer on it is possible to observe how the plot of a function changes. Attaching a slider to any variable allows a simulation to be created. This function can be used for standalone assignments. Questions can be framed and students encouraged to interact with the GeoGebra diagram. Better still, this tool can be easily plugged in into most LMSs and is also available as an app in Google Chrome.

Spreadsheet software are used to tabulate data and also represent them as graphs. The cells of a spreadsheet store data as well as functions enabling us to make calculations on the rows and columns of numbers. Datasets can thus be developed. These can then be represented as Bar charts, pie charts, x-y plots, etc. Spreadsheets are particularly useful in statistical, financial and other similar data applications.

There are many software, including GeoGebra, that are especially used to visualize mathematical functions. The algebraic and geometric pane of GeoGebra demonstrates how it can be used to plot and view different functions.

An electronics class would benefit from a circuit drawing program. While any drawing

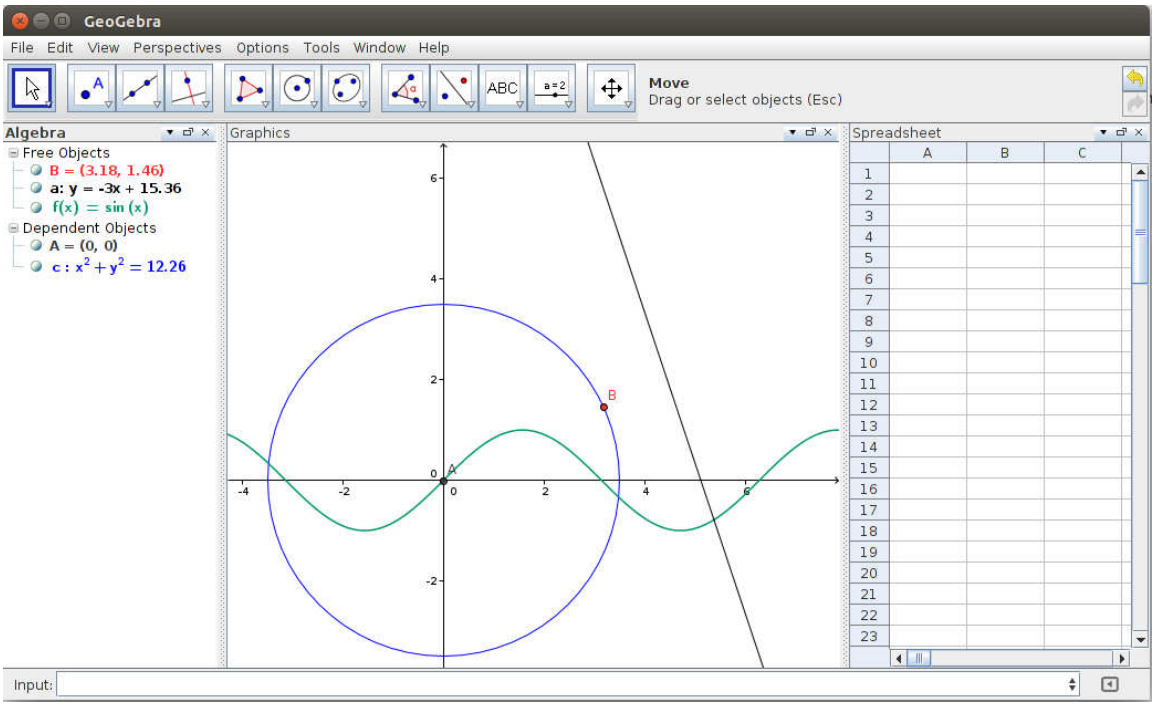

Figure 4.2: Workspace in GeoGebra

program would be able to draw circuits, having a set of ready made icons and tools, which is built around electronics would be a great time saver. **XCircuit** is one such generic drawing program tailored for making circuit diagrams. **KiCad** is a more involved tool while **CircuitLab** is an easier tool available as a Google Chrome app.

An introduction to chemical structures such as crystal lattices or organic molecules would need appropriate visualization which can help communicate the geometry of these molecules. An ability to rotate these in space would be an added feature. Many software have been developed ranging from simple to use 2D chemical structure viewers to those that draw complex DNA structures and even enable computations. **Avagadro** is a very simple and intuitive software, which helps in building molecular models, rotate them in space, measure bond angles, bond distances, etc.

Kalzium extends Avogadro to include a Periodic Table of Elements, chemical reference, chemical equation solver, and a data plotting application.

4.3 Simulations

Equipped with the right knowledge base and tools to analyze available information to experiment with ideas and apply them to real situations, students can be trained or train themselves to synthesize and integrate what they know to simulate scenarios and processes. Simulations are interactive computer programs which allow a user to change variables and see the effect of the

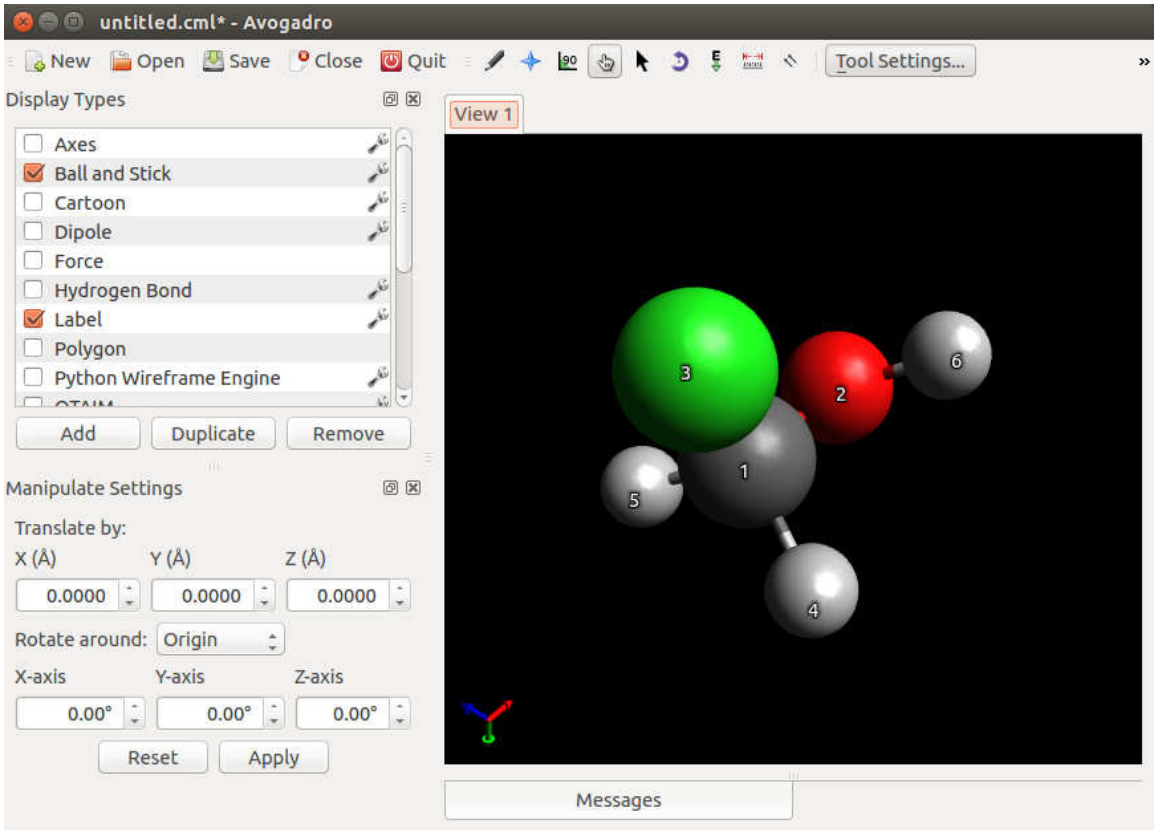

Figure 4.3: Workspace in Avogadro

changes on the system. These are very useful in helping students explore the subject, solve problems and can also become a useful self-assessment tool. GeoGebra can be used in this mode. Defining appropriate sliders or radio buttons, it allows the user to vary values and see the effect of such changes. GeoGebra Tube is a collaborative library of applets created with GeoGebra.

A variety of science simulations are available, some of them downloadable and some others as online tools. Online Labs, **PhET** and **NetLogo** are good examples. A number of javascript libraries have been developed to simulate and allow students an opportunity to explore scientific phenomena. The **Easy Java Simulations** is one such authoring tool that can help anyone create interactive simulations.

4.4 Conclusion

Using a tool or creating a tool calls for a clear view of the end result – the exact task to be accomplished. Working back from this, the ability to understand the process or procedure of accomplishing the task together with the skill to wield the tool is to be gained. Therein lies the challenge. Therein lies the fascination.

List of Tools

Animoto http://animoto.com

Creates videos and presentations by incorporating images, video clips, audio and text. A limited free version is also available.

Audacity http://audacity.sourceforge.net/

An audio recorder and editor. It handles almost all popular types of sound files.

Avagadro http://avogadro.cc/wiki/Main_Page

An advanced molecule editor and visualizer designed to be used in computational chemistry, molecular modeling, bioinformatics and related areas.

Basket Note Pads http://basket.kde.org/

A notes taking application that allows for grouping notes and data. Can also make to do lists. Notes can be exported as html.

Beamer http://sourceforge.net/projects/latex-beamer/

A LaTeX package for creating presentations. A Beamer presentation is created like any other LaTeX document. A few extra commands need to be mastered. Many templates are available on the Internet to lessen this task.

Bhuvan http://bhuvan.nrsc.gov.in/bhuvan_links.php

A gateway to Indian Earth observation. Offers visualization of multi resolution satellite images, is a platform for Government data, can enriching maps with people's inputs, provides disaster support services and more.

Cartoonist – online comics tool http://animoto.com

Creates cartoons or multimedia stories using backgrounds, characters, props, images and text. A limited free version is also available.

CircuitLab https://www.circuitlab.com

An electrical circuits designing tool available as a Google Chrome app.

Docear http://www.docear.org/

Maps PDF files which can be annotated. Includes many more features for searching, organizing and abstracting. Annotations can also be imported.

easelly http://www.easel.ly/

An online tool to create infographics that can either be built from scratch or assembled using templates available on the website.

Easy Java Simulations http://fem.um.es/Ejs/

A free authoring tool written in Java that helps non-programmers create interactive simulations in Java or Javascript, mainly for teaching or learning purposes.

Field Papers http://fieldpapers.org/

A tool to create a multi-page atlas of anywhere in the world. Once printed it can taken into the field to record notes and observations about the area, or can be used as a personal tour guide in a new city.

Flickr https://www.flickr.com/

An online photo and video management and sharing website.

FreeMind http://freemind.sourceforge.net/wiki/index.php/Main_Page

A mindmapping tool that can also organize hierarchies. Has an emphasis on folding nodes and is a knowledge and content management tool.

Freeplane http://freeplane.sourceforge.net/wiki/index.php/Main_Page

A mindmapping tool that organizes ideas in nodes. Nodes can be freely positioned or connected. Has different export options. Files can be linked to nodes and add-ons can extend its features.

Gapminder http://www.gapminder.org

A tool to build fact-based world views to learn about global patterns and trends.

GeoGebra http://www.geogebra.org/

A free mathematics software for all levels of education that joins geometry, algebra, tables, graphing, statistics and calculus in one easy-to-use package.

GeoGebra Tube http://geogebratube.org

Is a collaborative library of applets created with GeoGebra.

Gliffy Diagrams https://www.google.com/chrome/browser/

A Chrome app that also works offine and can create diagrams and flowcharts quickly and easily for presentations, wikis or web pages. Requires Google Chrome browser to be installed.

Google http://www.google.com

An ever increasing collection of web applications including a very popular search website and email service. All services and applications can be accessed by creating a free user account.

Google Earth http://www.google.com/earth/

A virtual globe, map and geographical information tool.

Kalzium hhttp://edu.kde.org/kalzium/

An information rich application on the periodic system of elements.

KiCad http://opencircuitdesign.com/xcircuit/

A program for drawing electrical circuits, design of printed circuits and more.

LaTeX http://latex-project.org/

A general purpose document creator for high quality complex documents and presentations that can easily conform to a pre-decided consistent design.

Mahara https://mahara.org/

An electronic portfolio for recording evidences of learning. Students and teachers can display their creations.

Moodle https://moodle.org/

A learning platform for personalizing learning. Can be installed locally on the school server or hosted on the Web.

NaturalReader http://audacity.sourceforge.net/

A Text to Speech software with natural sounding voices. Can convert any written text including PDF files into spoken words.

NetLogo http://ccl.northwestern.edu/netlogo/

A programmable modeling environment.

OER Commons https://www.oercommons.org

A ggregates open educational resources.

Online Labs http://www.olabs.co.in/

Offers subject-wise content, simulations, animations and lab videos. Access to Online Labs is free for schools upon registration.

Open Street Map http://www.google.com/earth/

Is built by a community of mappers that contribute and maintain data about roads, trails, caf´es, railway stations, and much more, all over the world.

PhET http://phet.colorado.edu/

Provides interactive, research-based simulations of physical phenomena.

Picasa http://picasa.google.co.in/

An image organizer and image viewer for organizing and editing digital photos, plus an integrated photo-sharing website. Available for Windows and Mac systems.

Rainlendar http://www.rainlendar.net/cms/index.php

A customizable calendar application which stays out of the way but keeps all important events and tasks always visible on the desktop.

RedNotebook http://rednotebook.sourceforge.net/

A diary and journal. It includes a calendar navigation, customizable templates, export functionality and word cloud. Entries can be formatted, tagged and searched.

S5 http://meyerweb.com/eric/tools/s5/

A simple slide show system that generates presentation slides and printed handouts from the same file.

Shotwell https://wiki.gnome.org/Apps/Shotwell

A personal photo management tool on the Linux platform. Also imports from camera and edits images.

Tabula http://tabula.nerdpower.org/

A text mining and data extraction tool. Data can be extracted from PDF and imported into spreadsheet or database applications for further processing and analyzing.

TagSpaces http://www.tagspaces.org/

A data manager to organize files by tagging them.

Text 2 Mindmap https://www.text2mindmap.com/

A simple mindmapping tool that takes tabbed text as input to generate mind maps. Maps can be downloaded as images.

Text2Speech http://www.text2speech.org/

An online tool. After entering text, a voice can be selected to convert text to audio. The resulting mp3 file can be downloaded.

Timeline JS http://timeline.knightlab.com

A tool for building visually rich timelines using a simple spreadsheet. It can pull media – images, video and more from a variety of sources and has in-built support for Google Maps, YouTube, etc.

Tomboy Notes https://wiki.gnome.org/Apps/Tomboy

Simple and easy to use notes taking application. Has the potential to help in organizing ideas and information. Can be synchronized with Dropbox (https://www.dropbox.com/ an online free storage, sharing and a synchronizing service).

Visual Understanding Environment http://vue.tufts.edu/

Provides a flexible visual environment for structuring, presenting, and sharing digital information.

Wordle http://www.wordle.net/

An online tool that generates a word cloud for a text piece composed in it or pasted in the text box available under ‘Create’ menu.

XCircuit http://opencircuitdesign.com/xcircuit/

A program for drawing publishable-quality electrical circuit schematic diagrams and related figures.

Xmind http://www.xmind.net/

A mindmapping tool to clarify thinking, manage information, brainstorm and organize work.

YouTube https://www.youtube.com/

A website to share originally-created videos.

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