

ISSN 0036-679X (print)
0972-5061 (online)

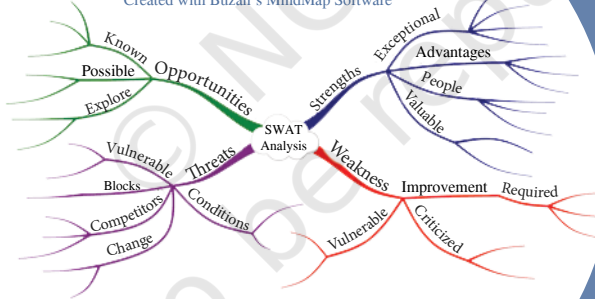
School Science

A QUARTERLY JOURNAL OF **SCIENCE EDUCATION**

Vol. 54 No. 2 and 3 June–September 2016

SWAT Analysis Example (Starter)

Created with Buzan's MindMap Software



Constructing a Concept Map provides a way to explore, reflect upon, deepen and share people's understanding

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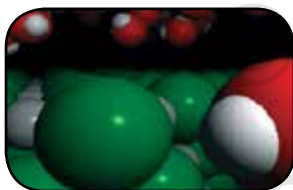
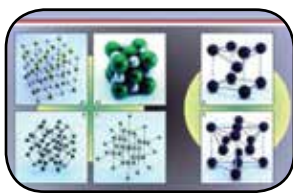
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ISSN 0036-679X (print)
0972-5061 (online)

Vol. 54 No. 2 and 3 June-September 2016



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EDITORIAL

Information Communication Technology (ICT) has now become an integral part of regular teaching and learning process. Looking into the situations like pandemics etc., the scope of ICT in school curriculum should be intensified as regular teaching learning process and due space may be given to it in the syllabus for science education in the school system.

This is a joint issue of two quarters containing nine articles for readers from different areas focussing on ICT in Science education in schools.

The article 'Techno-pedagogical Modelling Through Web 2.0 Tools in Science Classrooms' elaborates on key elements of Web 2.0. technology which helps in reading, sharing, collaborating and communication between people. Also, the article highlights types of Web 2.0 tools, such as, Wiki, blogs, podcasts, social networks, social bookmarking, RSS and mash-ups using in science classrooms to revolutionise new pedagogical strategies in teaching learning.

In the article 'Immersive ICT Tools for Teaching and Learning Science' authors highlight the ICT tools for individual learners at any time or place and discuss integration of ICT in science education whereby highlighting the use of VR technologies in teaching-learning process to make the concepts more easy and understandable.

In the research paper, 'E-Learning Strategy to Enhance the Achievements of Elementary School Students in Science' the researcher highlights transformation of learning from

physical to digital mode. The paper presents the findings of their study that e-content have the potential of proving an alternate and really effective teaching and learning tool. It discusses how e-learning creates interest among the students and the utilisation of e-content within the classrooms enhance educational achievement significantly.

The article 'Application of Information and Communication Technology (ICT) in Assessment of Learning Levels of Students', highlights technology contribution in improving learning through assessment. It says that it is not just about a linear progression mode and the counts reached, rather it is in defining and describing the levels of learning outcomes achieved.

In the article 'Integration of Information and Communication Technology with Physics Education for Effective Learning', the author states why ICT should be integrated with the concepts of physics for effective learning.

The article 'Some Aspects of the use of ICT in Chemistry Teaching', discusses how ICT plays an important role in chemistry teaching and how students may make the use of ICT tools while interacting with the community awareness in solving problems related to chemistry. The article also highlights how ICT is used in teaching the concepts of Chemistry.

'Using Information and Communication Technology for Quality Mathematics Teaching', talks about how learning outcomes in mathematics may be achieved using ICT in mathematics teaching.

In the article 'Continuous Professional Development of Teachers with Web Portal and Mobile Application' the author describes the professional development of teachers with ICT. Also, many online course platforms have been discussed, such as, MOOC, NISHTHA, DIKSHA, etc.

The article, 'Computational Physics with Spreadsheet – I', highlight the use of excel

spreadsheet program to deal with simple problems in basic physics and discuss the plotting of simple graphs as a relation between physical quantities.

Our regular features 'Science News' and 'Web Watch' bring interesting knowledge for readers.

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TECHNO-PEDAGOGICAL MODELLING THROUGH WEB 2.0 TOOLS IN SCIENCE CLASSROOMS

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The emergence of many new technologies, has created the nexus between technology and pedagogy espoused in education is sometimes very tenuous. Technological pedagogical content knowledge integrates content, pedagogy, and technology knowledge that strengthens the teaching-learning process and enables teachers to use educational technology in constructive ways to teach content. Web 2.0 is a powerful tool that allows users to interact and collaborate with one another as content creators in a virtual community. It also facilitates a way for students to apply their knowledge by using diversified tools like wikis, blogs, social networking sites such as Facebook and Instagram, RSS reader, video sharing sites, like YouTube. The study focuses on the integration of Web 2.0 technologies into the teaching of science that rejuvenates techno-pedagogical practices. It documents features of various Web 2.0 tools and how they can be utilised in the context of science classrooms to support teaching and learning and also explores the benefits, strategies and approaches to effectively integrate Web 2.0 tools into science classroom instruction regardless of different content areas in science or age of learners. The study concludes that teachers should provide opportunities for students to use Web 2.0 tools in their science learning process.

Key Words: *Web 2.0, Technological Pedagogical Content Knowledge, Techno-pedagogical Modelling*

Introduction

World Wide Web (www) is a platform interconnected with hypertext documents acknowledged by URL (Uniform Resource Locator) accessed through the internet. The first generation of the Web is denoted by Web 1.0. It is a read-only Web that includes static pages and searching for information. User interaction and content contributions are very low. On the other hand, Web 2.0 is a read-write Web that appeared as a follow-up of the transition from Web 1.0. The concept of

Web 2.0 was flourished by Tim O'Reilly. Web 2.0 stands for the second generation of Web resulted in making a new pattern in the use of the internet and collaboration. Web 2.0 is the term used to describe a variety of Websites and applications that allow anyone to create and share online information or material they have created. A key element of Web 2.0 technology is that it allows people to create, share, collaborate and communicate.

Web 1.0 & Web 2.0 — A Comparison

The following table oversees the differences between Web 1.0 and Web 2.0.

Table 1

Web 1.0	Web 2.0
1990's	2000's
Read-only Web	Read and write Web
Tim Berners-Lee	Tim O'Reilly
Content creators were few	Anyone can be a content creator
Millions of users	Billions of users
Static content	Dynamic content
Information sharing	Interaction

What is Web 2.0?

Web 2.0 is the second generation of the World Wide Web which is a transition from static HTML pages to more interactive and dynamic Web pages. Web 2.0 focuses on the skill for people to collaborate and share information online through blogging, social media, and other Web-based channels.

Web 2.0 tools are internet tools that allow the user to go ahead of a mere gathering of information through the Web. The user has an interface for creating and collaborating content with others. Web tools can be used to boost up teaching and collaboration among teachers and students, as well as, increased professional collaboration between educators. Social media sites such as Facebook, Twitter, Edmodo, Voicethread, and Skype are some examples of Web 2.0 tools.

Features of Web 2.0 tools

Web 2.0 tools facilitate the creation of blogs, uploading of media content, and social network sites. The main features of Web 2.0 are given below:

- **Folksonomy** – Folksonomy is related to tagging Web 2.0 tools that facilitate users to classify and find information together (e.g., tagging enables users to label images, Websites, videos, links).
- **Rich User Experience** – Users can get rich experiences with dynamic content responsive to user input.
- **User Participation** – Information flows two ways between the site owner and site user by means of evaluation, review, and comments. It enables users to organise and find information collectively. Users can add content for others to see and comment on.
- **Software as a service** – Web 2.0 sites developed APIs (Application Programming Interface) to allow automated usages by an app or mashup.
- **Mass Participation** – Many users can participate simultaneously via universal Web access.
- **Like buttons** – Like buttons allow users to indicate their likes or dislikes to the content.
- **Free distribution of information** – Information is disseminated liberally to all.

Types of Web 2.0 Tools

The major Web 2.0 tools focused in the present study are wikis, blogs, podcasts, social networks, social bookmarking, RSS and mashups.

1. **Wikis:** Wiki is a Hawaiian word that means 'fast'. Wiki is a server programme in which modification of its

content and structure is done directly from the Web browser collaboratively. The text is written using a simplified mark-up language in a typical wiki and can be edited with the help of a rich-text editor. Wikipedia is an online encyclopedia that is an example for the wiki which is edited by different persons. (0% plagiarism)

Features of Wiki

- Each page in a wiki Website is known as 'wiki page' and the whole collection of Web pages is known as the 'wiki'.
 - Easy Editing
 - Multimodal
 - Collaborative encyclopaedia
 - Allows every member to continuously check the changes done by other members on the wiki.
 - Openness
 - Evolving —the content is dynamic
2. **Blog:** The term blog originated from Web-log as web+log—weblog—blog, which is a term used to express Websites that keep up an ongoing record of information. A blog features opinion, information, personal diary entries, or links arranged in chronological order.

Features of Blogs

- The content is published in a reverse chronological fashion
- Visitors can add comments
- Other blog authors can interact
- The blogs can be created easily in less time

- Entries usually include the source of information which validates the data
- Free public access to content
- Hyperlinked post structure
- The post is involuntarily achieved

3. **Podcasts:** Podcasts are audio recordings that consist of episodic series of audio files in the form of talks, interview, and lectures viewed and downloaded through the Website or computer or mobile device. Video podcasting is called vodcasting.

4. **Social Networks:** Social network is connectivity among individuals or organisations through social media to share ideas and information. Connections between the members can be voluntarily made. Some of the social networking sites are Facebook, Twitter and MySpace, etc.

Features of Social Networks

- Collaboration
- Connections are made based on interdependency and need.
- Allow live chats
- Sharing of ideas and information
- Provide tagging alerts
- Complete freedom for users

5. **Social Bookmarking:** The concept of shared online bookmarks is a unique service allowing its members to save, review and share Websites, articles, photos and music that they discover on the internet. Collaborative tagging is used to connect people.

6. **RSS:** RSS stands for Really Simple Syndication. It is a type of Web feed that allows users to access updates to online content in a standardised, computer-readable format. These feeds can allow a user to keep track of many different Websites in a single news aggregator.
7. **Mash-ups:** A mash-up is a term used to refer to a Website or Web page that combines data and services from various sources on the Web. Mashups can be divided into seven categories: mapping, search, mobile, messaging, sports, shopping, and movies. Google Maps is an example of mashups.

Techno-pedagogical Modelling

Techno-pedagogical modelling is teaching with technology. They are needed for quality teaching in the 21st century classroom. Web generation had played a prominent role in highlighting techno-pedagogical modelling. Anderson (2007) used Web 2.0 tools, such as, social networking, blogs, wikis, and other dynamic, internet-based applications for the study and that allow an ongoing, collaborative and investigative digital experience for the learners.

In view of Hew and Cheung (2013), instructional modelling should be developed and practiced in conjunction with the use of Web 2.0 tools to support students' achievement. Web 2.0 instructional practices involve the combination of technological, pedagogical, and content knowledge.

Technological Pedagogical Content Knowledge

The Technological Pedagogical Content Knowledge (TPCK or TPACK) framework

highlights the integration of effective technologies for teaching specific content which requires a thorough conceptualisation of the relationships between Technology, Pedagogy and Content. TPCK became very popular in the year 2006 after Mishra and Koehler (2006) introduced their framework. The seven knowledge components of TPCK framework are Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPCK).

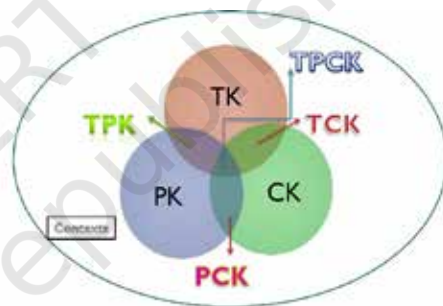


Fig. 1: TPCK Framework by Koehler and Mishra, 2008

Content Knowledge (CK) is the knowledge about the content to teach, Pedagogical Knowledge (PK) is the knowledge about approaches or methods of teaching, and Technological Knowledge (TK) is the knowledge about technology to be used. Pedagogical Content Knowledge (PCK) is knowledge about how to integrate suitable pedagogy to a content, Technological Content Knowledge (TCK) is knowledge about how to integrate appropriate technology to teach content, and Technological Pedagogical Knowledge (TPK) is knowledge about

technology as a facilitator of different teaching methods. Technological Pedagogical Content Knowledge (TPCK) is an integrated form of knowledge about how appropriate technologies and pedagogical methods can be incorporated to facilitate the learning of content.

Science Classrooms and Technological Pedagogical Content Knowledge

Earlier our notions of science were in comprehending scientific concepts and making it applicable in unknown situations. The over-richness of concepts in the form of content was the usual condition of our classrooms. But now comprehending more and more knowledge is not very difficult because the technology has penetrated to odd nooks and corners of our lives which provide all sorts of knowledge at our fingertips. Then it was the research on pedagogical understanding which gave better solutions to the classroom transactions in science. Twenty first century science classrooms are not mainly focussing on pedagogy rather they focus on techno-pedagogy. The concept of techno-pedagogy has been a technological transition of the earlier concept of pedagogical content knowledge proposed by Shulman (1986). Now Kohler and Mishra came up with TPACK, which utilises all the different Web 2.0 tools for its delivery, especially in the science classrooms. Today's learners, motivated with the new technological gadgets and the creativity bestowed on using these technical tools, are more interested in TPACK oriented learning than the conventional activity-based learning. Activity-based learning many a time creates a feeling that activities are artificial and not natural or related to their living conditions.

Web 2.0 Tools as a Tool for Techno-Pedagogical Modelling in Science Classrooms

Web 2.0 tools can be applied in the teaching of science using technology. Web 2.0 tools can be used to produce, publish and update individual or shared writing products. In that way, technology's capacity to link to other information and to display information flexibly and dynamically is well-performed in practice. The applications of different Web 2.0 tools in Techno-pedagogical Modelling in science classrooms are described as follows:

(i) Techno-pedagogical Modelling Using Wikis

In science classrooms, wikis can be used to post assignments and group projects. This allows students to critically analyse a topic. Group discussions on a topic sharing own viewpoints can open a way to enhance science content. Brainstorming can be done by editing a given wiki topic. Writing skills on a science idea and editing in accordance with the suggestions and evaluations put forth are facilitated by using wikis. Techno-pedagogical Modelling using the technology wikis and pedagogical approaches like brainstorming, reflective writing, think-pair-share, interactive lecture and collaborative work can be done for teaching a science topic.

(ii) Techno-pedagogical Modelling Using Blogs

Blogs can be used as a techno-pedagogical tool that allows classroom communication by putting all information in one place for everyone to see. Teachers can publish instructional materials and the students can comment on it. Online reading and writing of articles on a science topic are made more

advanced using blogs. Informal learning by sharing experiences from others on their field visits like a science museum, planetarium, etc., are facilitated. Creating an online e-portfolio of their science experiment on a regular basis, collaborative discussions and works can be done. Assessment of students is done by posting assignments and asking others to give feedback for improvement. Teachers can inform about daily science events to students. Using the technology blogs and pedagogical approach like collaboration on learning more about a scientist can be modelled techno-pedagogically.

(iii) Techno-pedagogical Modelling Using Podcasts

For reviewing a complicated topic in science, recorded lectures and discussions are distributed with the use of podcasts. Vodcast or Video podcasts can be used for teaching concepts involving visuals. Students can create their own podcasts on researching the science behind a project assigned by the teacher. Supplementary educational material related to the content to teach can be delivered. Techno-pedagogical Modelling using the technology podcasts or vodcasts and pedagogical approaches like lecture method, discussion and individualised instruction can be done for learning a topic in science.

(iv) Techno-pedagogical Modelling Using Social Networks

Recent information related to science and technology can be updated by linkages in social networks. Discussion and critical analysis of the scientific problem can be fruitful through sharing of information. Creativity on a scientific idea can be nurtured more easily. Option for one's own interest

and disinterest in different science topics can be marked. Additionally, there is a prospect of creating new Web pages specialised in specific fields like astrophysics, pharmacy, organic chemistry, biodiversity, etc., to meet students who are interested in one field of science and give them the opportunity to participate and manage their own page. Moreover, the social network pages involving students' collaboration about science-related topics outside the class may enhance their learning resources. Pedagogical approaches like discussion, collaboration and brainstorming can be integrated into different content areas in science suitably to incorporate social networking.

(v) Techno-pedagogical Modelling Using Social Bookmarking

Social bookmarking enables creating lists of bookmarks or favourites of a particular science Webpage for quick access. Tagging of particular science content and photo tagging are possible Teachers can highlight important and relevant information on a Web page. Diigo and Delicious are the two most commonly used social bookmarking sites in education. Collaborative group work or research can be assigned to students for particular topics of research and send out bookmarked Websites for their use.

(vi) Techno-pedagogical Modelling Using RSS

Updates on recent developments in science and technology without visiting their sites can be made possible via RSS feeds. RSS feeds for assignment topics and areas of research interest are available. RSS reader marks the read content as read. "Science Buzz" and "Why Files" are RSS feeds on science. Pedagogical approaches like discovery

learning or heuristic method can be employed to research a science topic using RSS and thus techno-pedagogical modelling can be done.

(vii) Techno-pedagogical Modelling Using Mashups

Mashups facilitate inquiry-based learning. It assesses and reinforces the student's visual literacy. Mapmaking like 'Sky Map' exploring the sky with YouTube videos, images, and Google maps is facilitated. Inquiry-based learning methods to solve a scientific problem using mashups can be modelled techno-pedagogically.

Impacts of Web 2.0 as Tools for Techno-pedagogical Modelling in Science Classrooms

The major impacts of Web 2.0 as tools for techno-pedagogical modelling in science classrooms are the following.

- Supports twenty first century skills like collaboration, communication and creativity among students and teachers
- Integration of different technologies, pedagogies in accordance with the content to teach
- Better access to science notions
- Disseminates and updates scientific information
- Higher quality of science instruction
- Usability of each and every branch of science subject
- Easy learner reception of scientific concepts

- Effective transmission of reality and simulation
- Motivates learners to know scientific principles more deeply
- Provision for student feedback about their science learning
- Ubiquitous nature of Web 2.0 tools makes learning possible at any time and anywhere
- Learner-focused
- Cost-effective

Suggestions

Teachers

- Need to be trained on how to use Web 2.0 tools in teaching science to realise their learning objectives.
- Should understand how to structure a lesson in science involving techno-pedagogical activities.
- Need up to date Web 2.0 tools to understand how they fit into the science curriculum and locating resources to meet its standards.
- Should use Web 2.0 technologies to improve and support scientific skills and to keep your learners motivated and on-track.
- Should participate in teacher training programmes on courses or workshops on techno-pedagogical aspects for science classrooms.

Conclusion

Web 2.0 tools result in making considerable changes in the use of internet and interactivity which thus opens a new life for science learning by techno-pedagogical Modelling. The rejuvenation of this Techno-pedagogic Modelling should be nurtured by the teachers with updating of new emerging Web 2.0 tools. The study provides information on how to use Web 2.0 tools as learning tools in the science

classroom. The needs of the twenty first century learner are satisfied through the use of Web 2.0 tools like wikis, blogs, podcasts, RSS, social networking, social bookmarking and mashups. The most appropriate Web 2.0 tools for teaching a particular science content using the aptest pedagogy are to be well-designed by the teachers. Hence, Web 2.0 act as a powerful mechanism for science teaching with technology.

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IMMERSIVE ICT TOOLS FOR TEACHING AND LEARNING SCIENCE

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The importance of hands-on experimentation in understanding concepts of science is well established. However, due to various constraints, every student does not get enough hands-on opportunity, and this limits their creativity and cognitive development. The Information and Communication Technology (ICT) offers various tools helpful to visualise and explain science in an effective manner. This article lists some of the available avenues for such interactive learning. It further discusses some of the possible ways of adopting emerging technologies for the purpose of science education, particularly in the context of school education.

Key words: *Science education, ICT, Augmented Reality (AR), Virtual Reality (VR), Simulation, Hands-on activity.*

Introduction

The emergence of Massive Open Online Courses (MOOCs) as well as availability of high quality educational text, video and other e-contents are in a way furthering the globalisation of education. This trend is helping address the challenge of access in education. Education is becoming available to every individual learner, regardless of the place, time and pace at which one is accessing or the culture, background and other socio-economic status one belongs to. Many world class institutions are offering credit based courses in fully online mode which are being recognised by other institutions. For example, the University Grant Commission (UGC) of India has come out with the regulation "Credit Framework for Online Learning Courses through SWAYAM" for learners who complete online courses through the SWAYAM MOOC portal.

Online course contents are constrained by the fact that concepts of science inevitably require laboratory activities as part of the

skill acquisition process. The ideal solution may be having remote access to physical laboratories. But, a remote-access physical laboratory is complex to build and operate, especially with regard to the communication and sensory-control hardware and software required, and the equipment and their maintenance expenses. A fully software-based virtual laboratory and simulated experiments therefore appear to be good alternatives. Therefore, virtual laboratories should be a necessary component of science teaching-learning in online or virtual modes. Such virtual facilities although cannot replace the hands-on experience with real equipment or apparatus in a physical science laboratory. However, with the advancement in computer graphics and computing powers, and the emergence of technologies like Augmented Reality (AR) and Virtual Reality (VR), the boundary between the real and virtual world are reducing [1].

This article is an introductory overview of some of the ICT based tools that help in creating interactive environments required

for understanding concepts of science. The next section discusses the need of ICT tools in teaching and learning of Science, followed by the listing of some of the emerging ICT tools and their use cases. This is followed by the section on integration of ICT in science teaching.

Need of ICT Tools in Teaching and Learning of Science

Science teaching must happen in the laboratory, for experimentation is the most effective tool [2, 3]. This holds true for explaining scientific concepts to school children as well. That is why science at the higher secondary classes of the 10+2 school system has a mandatory component of laboratory work [4]. In the laboratory, students get the opportunity for cooperative learning using a limited number of experimental kits, and this improves their overall quality and efficiency as well [5].

But there are many concepts of science which appear to be abstract for learners due to the absence of direct or hands on experiences. As an example, behaviour of atoms and molecules in a chemical reaction, dynamic equilibrium, the mechanism of evolution, study of nuclear fusion and fission, behaviour of alternating current in a circuit, etc. This limitation of experiencing the phenomena directly is a constraint in comprehending and understanding of the abstract concepts. This can be overcome to a certain extent with the help of ICT tools. It has been observed that systematically designed multimedia material correctly depicting a scientific phenomenon has a greater potential than a printed textbook especially in learning abstract concepts in science [6].

Science students sometimes encounter phenomena which appear to be static when viewed macroscopically whereas it is dynamic in nature when studied microscopically, such as, dynamic equilibrium in reversible reactions. It has been found that using animations to show the dynamics involved at microscopic level simplifies the complicated static illustrations used to represent the dynamics in the books [7].

ICT tools also help students in visualising objects that are either very difficult or almost impossible to be seen even with the finest equipment, such as interaction between molecules, internal structure of atoms, molecules, cells, bacteria and viruses.

In some parts of the world killing animals for experimental purposes has been banned which became a constraint in the learning of life science related things. In vivo experiments can be replaced by in silico experiments performed on computers via computer generated simulations. Virtual Reality (VR), Augmented Reality (AR), simulation, or simply an animation sometimes has the capacity to remove this barrier to a great extent.

According to the *National Curriculum Framework* (NCF) 2005 of India, one of the important aims of science education is to nurture the natural curiosity of children [8]. While it is suggested that children should become independent learners, in actual laboratory practices they are given very little space to do the things independently. They are given prescription for each and every step and are not allowed to deviate from the predefined path. This kills the innate curiosity of the child, instead of nurturing it. The associated risks of accidents due to chemical explosion or mishandling of equipment are there when

children are allowed to try out things on their own. This may cause irreparable damage to the instruments as well. But use of ICT tools, such as, virtual laboratories may give children the required space to explore more and understand about the chemical reactions or instruments without any fear of damage either to the apparatus or to themselves. In this way, ICT can provide more scope to children to work independently and quench their thirst of enquiry. It encourages and engages students in the process of learning science and making their experiences in science a fun [9].

Immersive Technologies

Information and Communication Technology (ICT) includes both hardware and software that can be used for teaching-learning purposes, including science education [10]. It allows us to create and share a variety of e-contents such as text, image, audio, video, animation, etc. These contents were usually used to be delivered through offline modes like Radio, Television, CD/DVD, Pen Drive, Portable Hard Disc Drive, etc. But, the evolution of faster and affordable Internet facilities (3G, 4G and upcoming 5G) has made it easy to create, share and access a rich variety of e-contents available across the globe.

The continuous improvement in hardware and software technologies are resulting in emergence of experiences, such as, Simulation, Augmented Reality (AR), three Dimensional (3D) Virtual Reality (VR) and various other interactive e-contents.

The Augmented Reality (AR) basically enhances the objects in the real physical world by integrating digital content, such as, visuals, sound, or other sensory stimuli created using technology. AR basically

superimposes the computer generated contents onto a user's view of the real world, thereby creating a seamless experience for the user. Popular examples of application of AR are devices like Microsoft's HoloLens, Magic Leap, and Pokémon Go game. Some of the educational use of AR can be educational tours of museums, historical places, etc. For example, during a physical visit to a museum, the visitor can turn on a mobile camera and point to an object. The AR App can help by providing additional useful historical facts and information about the object. AR applications are considered to support preschool children's cognitive development as well.

Virtual Reality (VR) is a computer generated virtual environment, mimicking the real world. Unlike AR, VR creates a fully virtual environment by simulating the real world. VR technology is being applied in the area of 3D cinema, video games, entertainment, and education, particularly in military and medical training. It too generates an immersive feeling by placing the user inside an experience. VR uses head-mounted display equipment with a small screen in front of the eyes, hand-controllers, and various sensors. Popular among them are Oculus Rift and HTC Vive. Using such equipment, a user is able to look around the artificial world, move around in it, and interact with virtual features or objects.

Integration of ICT in Science Education

The AR and VR are two promising areas that have the potential to disrupt the pedagogies of science teaching. Studies have shown that AR technology can enhance the development of students' laboratory skills, and generate interest and curiosity to carry out actual hands-on activities in a physical setting [11]. AR has been used in chemistry teaching,

particularly to explain non-perceptible notions such as atoms, molecules, chemical bonds, etc. It helps students develop spatial thinking, ability to visualise and interpret three-dimensional structures of molecules and crystals, and understand the bonds between the structures of molecules [12].

VR technologies are immensely useful in medical education, particularly surgery. The three-dimensional (3D) virtual reality (VR) based technologies create peripheral view of objects such that students get a feeling of virtually touching, interacting and examining objects. Students can practice surgeries on virtual patients, before performing surgeries on real patients.

Virtual reality allows teachers to teach science in a lot more effective and interesting manner. In order to provide remote-access to labs in various disciplines of science and engineering, the Ministry of Education, Govt, under the initiative National Mission on Education through ICT has come up with the Virtual Labs (<https://www.vlab.co.in/>). Interactive simulations help in attainment

of student's scientific literacy, which is an indicator of inquiry behaviour.

All these interactive technologies allow us to create an immersive experience for users to better understand and visualise certain concepts which are otherwise difficult to visualise or experience.

Conclusion

Although it has been established by several studies that nothing can actually replace the real hands-on experiences in learning of science but it is also true that in depth understanding of many of the scientific concepts is not possible without the intervention of ICT tools, such as, the interaction at microscopic levels, or abstract concepts like intermolecular bonds, atomic structures, etc. Due to the recent advancement in the field of hardware and software technologies it has become possible to integrate different ICT tools in teaching and learning of Science for making the concepts of science more understandable, more easy and more enjoyable.

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E-LEARNING STRATEGY TO ENHANCE THE ACHIEVEMENTS OF ELEMENTARY SCHOOL STUDENTS IN SCIENCE

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In the present technological and scientific era, since the traditional teaching strategies are not enough to stimulate the interest among the scholars and do not meet to the emotional, psychological and intellectual requirements of the scholars within the new millennium, therefore the strategies of teaching science need to be changed. This study was conducted to assess the effect of e-content strategy as compared with conventional strategy on Science achievement of grade school students. The procedure was executed by employing pre-test-post-test control group design. A sample of 80 pupils of Class VII was taken from a government school in Patiala district of Punjab through cluster sampling technique. One experimental and one control group was formed. Experimental group was taught with the supplement of e-content, the control group was taught Science through conventional method. The info were analysed with the assistance of correlated t-test, one-way and two-way ANCOVA. The results of the study revealed that e-content significantly enhances science achievement of Class school students as compared to those taught with conventional method. A big main effect of treatment on achievement in science was found. However, no significant effect of gender was found on achievement of grade school students in science when pre-achievement in science was taken as a covariate. Thus, within the field of education, e-content have the potential of proving an alternate and really effective teaching and learning tool. The utilisation of e-content within the classrooms attended make the training enjoyable and long-lasting in numerous ways resulting into the enhancement of educational achievement significantly.

Key Words: *e-learning, e-Content strategy, Science Achievement, Conventional Strategy, Gender.*

Introduction

Technological development and therefore the internet have changed people's lives on different scales including as an example teaching and learning. The internet has become one among the channels of learning that opens the door for people round the world to access education free of charge, or for lesser costs. A number of the foremost important developments in education have happened since the launch of the Web. These days learners are well versed with the use of smartphones, text messaging and using the Web— so participating in and running a Web course has become an easy affair.

Message boards, social media and various other means of online communication allow learners to stay abreast and discuss course related matters. Within the fast-paced world of e-learning the available technologies to form a new and exciting course are always changing, and course content can and will be updated quickly to offer students the very latest information.

In the age of cyberspace in the twenty-first century, calculation, composition and communication on paper alone may be a fractional, impoverished and increasingly outdated concept and practice for thinking and communication. To create on the accomplishments of paper technology, a

digital infrastructure must be in situ. At present, e-Content is being included in most subjects within the field of education. It has been proposed to be used as a tool where and when considered useful. By integrating e-Content into standard learning material, by offering e-Content module cases and by integrating the utilisation of e-Content within the different subject areas, different types of actions are taken or planned, to make sure that e-Content is going to be a real part of the curriculum by supporting software development. If we are to deal with the varied challenges of the swiftly changing society or environment and make use of latest opportunities offered by e-Content, plans need to be realised giving learners, teachers and educators access to necessary equipments. The foremost competence to be built is the development of pedagogical methods, which will happen only when long-standing competence programmes can work along side real-life experience, where educators, teachers and learners use e-Content in their day-to-day life and learning experiences. Use of e-Content encourages self-expression and discovery by means of its interactive non-linear access of data. Students are going to be more motivated to find out since a multimedia lesson can provide near-real information through its sort of available media elements (text, audio, video and animation). The learners may learn by using their multiple senses, which provide innovative, new and enriched experiences. The training process is going to be a lively one, leaving the learners to find out by their own. From the review of related literature associated with the effectiveness of e-Content, it had been concluded that e-Content strategy has improved the tutorial

achievement of the scholars significantly more than compared to standard strategy (Rose and Stella, 1992; Proctor and Richardson, 1995; Kumar, 1998; Yadav, 2000; Nimavathi and Gnanadevan, 2008; Hughes, 2009; Kavitha and Sundharavadivel, 2012; Rohendi, 2012; Pio, 2017; Jasmin, 2017).

This study was conducted to assess the effectiveness of e-Content strategy as compared with conventional strategy of teaching science to the grade school students. The aim of the study was twofold, firstly the event of e-Content and secondly to assess the effectiveness of such e-Content. Comparison of e-Content strategy and traditional strategy of teaching is not only a comparison of two modes of instruction but of two theoretical paradigms. Conventional strategy represents a paradigm whereby knowledge is transmitted from teacher to student. The teacher plays a lively part during this mode of instruction. E content represents a paradigm where the knowledge is constructed by the learner. The learner plays a lively role within the learning process. Learning is individualised, self-paced and hands on. During the past 12 to 15 years, the utilisation of computers in education has increased dramatically and a good range of educational computer programs are now widely available for individual and classroom use. However, there has been little or no research reported on the effectiveness of such use. At elementary level, it was difficult for the scholars to know the concepts in science, because the abstract content matters are boring to the learners and induce disinterest. Abstract learning needs more sensory integration to repair up within the future memory. So attention must be focussed on the integrative efforts of data

processing approach, transformation between short term memory and future memory and accelerating cognitive strategies. The utilisation of e-Content in teaching of science produces more integrated sensory output in learning science subject.

Objectives of the Study

Following were the objectives of the study:

1. To study the achievement of grade school students in Science at pre- and post-test stages of the e-Content group.
2. To compare the adjusted mean scores on achievement in science of the grade school students within the e-Content group and traditional strategy group by considering pre science achievement as covariate.
3. To study the effect of treatment, gender and their interaction on achievement in science of grade school students by considering pre science achievement as covariate.

Hypotheses of the Study

1. There is not any significant difference between mean science achievement score of grade school students at pre and post stages of the experimental group.
2. There is not any significant difference between adjusted mean science achievement score of grade school students within the e-Content group and traditional method group by considering pre-test science achievement score as covariate.
3. There is not any significant effect of treatment, gender and their interaction

on achievement in science of grade school students by considering pre-test science achievement score as covariate.

Delimitations of the Study

1. The study was delimited to the topic of science only.
2. The content of Sophistication VII Science are going to be taken from the text book of NCERT only.

Operational Definition of Terms Used

(a) e-Content Strategy

e-Content Strategy of teaching is the strategy during which the digital contents are presented to the learners within the integrated sort of text, graphics, animation, audio, video and also provide interactivity with the learner.

(b) Achievement in Science

Achievement in Science refers to accomplishment of proficiency of performance within the subject of Science. It signifies successfully administered performance by a private or a gaggle assessed after the completion of a task. Here during this study, achievement in Science was considered in terms of marks obtained by the scholars in Science achievement test at pre and post test stages of experiment.

(c) Elementary School Students

Elementary school students refer to the scholars studying in Classes I to VII. Here during this study, Class VII students were considered as grade school students.

Research Design

This study was experimental in nature. The

investigator has employed pre-test post-test Control Group design. This is often also called the Classic Controlled Experimental design because it: Controls the assignment of subjects to experimental and control group through the utilisation of table of random numbers; Controls all other conditions under which the experiment takes place.

Sample of the Study

A small representative portion of population is named sample. For choosing samples, the investigator has employed sampling technique. This study was conducted on a sample of 80 pupils studying in Class VII of state grade school from Patiala district of Punjab. One section formed experimental group and one section formed the controlled group.

Research Tools Used

For every research problem, the investigator uses some devices to collect new facts. The devices which the investigator uses for data collection are referred to as research tools. In the present study, Science Achievement Test developed by the investigator was used to measure the achievement of seventh grade students in science at the pre-test and post-test stage.

Conducting the Study

The procedure was executed. One experimental and one control group was formed. The experimental e-Content group was taught science with the supplement of e-Content, the control group was taught science through conventional method. The planning had comprised three stages: the primary stage involved pre-testing of all the scholars of two groups on the Science Achievement Test. The second stage involved

treatment of two months. The experimental treatment consisted of teaching Science to Class VII with e-Content to experimental and through conventional method to regulate group. During the third stage, i.e., post-test stage, the scholars were post-tested on achievement in Science just after the treatment in order to determine the effect of treatment.

Pre-Test

Before the commencement of the experiment, the groups were administered a science achievement test. Before administering the test, instructions were explained verbally to the themes by the investigator. Both the groups of subjects were administered their test. The administration of the test was administered as per the norms and directions. After administering the above test, they were scored as per the scoring procedure. Thus, pre-test score were obtained on achievement in Science for both groups.

The Treatment

To seek out the efficacy of the independent variables, the experimental variables were manipulated within the sort of teaching supported e-Content and traditional method. The experimental group was taught through e-Content and control group was taught through conventional method. The method was administered for two months. Same topics were taught to both the groups. The treatment was conducted by the investigator himself in both groups to avoid teacher variable and maximum precision.

Post-test

Immediately after the treatment was over, the themes were administered the post-test.

An equivalent criterion test as in pre-test was taken. Both the groups of sampled students were subjected to the post-test. In this way, post-test scores were obtained on achievement test in science of both the groups.

Results of the Study

The aim of the study was to match the effect of conventional strategy versus those of e-Content strategy on achievement in science of grade school students across gender. Mean, variance, correlated t-test and One-way ANCOVA was employed to seek out the effectiveness of e-Content strategy on achievement in Science of grade school students. The results of study of knowledge are presented below:

Effectiveness of e-Content on the Idea of Accomplishment in Science

The first objective of the study was to match achievement in science of grade school students within the experimental group at the pre-test and post-test stages. The results of correlated t-test are presented within the Table 1.

Table 1

Comparison of Achievement in Science of Elementary School Students in the Experimental Group at the Pre-test and Post-test Stages

Testing	N	Mean	SD	Correlated t-value
Pre-test	40	47.20	8.47	21.31**
Post-test	40	60.43	6.74	

* $p < 0.01$

From Table 1, it is evident that the correlated t-value is 21.31 which is significant at 0.01 level. It reflects that the mean scores of

achievement in science at pre-test and post-test stages of e-Content group differ significantly. Thus, the null hypothesis— that there is no significant difference between mean scores of achievement in science at pre-test and post-test stages of e-Content group— is rejected. Further, the mean score of achievement in science at post-test stage is 60.43 which is significantly higher than the mean score of achievement in Science at pre-test stage which is 47.20. It may, therefore, be concluded that teaching science through e-content significantly enhanced achievement of students in science.

Comparison of Adjusted Mean Scores of Achievement in Science of e-Content Group and Conventional method Group by Considering Pre-Science Achievement as Covariate

The second objective of the study was to compare adjusted mean score of achievement in Science of e-Content group and conventional method group by considering Pre-Science achievement as covariate. The data were analysed with the help of one-way ANCOVA. The results are given in Table 2.

Table 2

Summary of the Results of Analysis of Covariance for the Effect of Treatment on Achievement in Science

Source	SS	df	MS	F-value
Pre-test	3322.243	1	3322.243	345.17**
Treatment	1338.607	1	1338.607	139.08**
Error	741.132	77	9.625	
Total	6195.487	79		

** $p < 0.01$

From Table 2, it is evident that the adjusted F-value for the effect of treatment on the achievement in science is 139.08 which is significant at 0.01 level. It shows that the adjusted mean score of achievement in science of students taught science through e-Content and those taught the same topics through conventional method differ significantly when pre-science achievement was taken as a covariate. Thus, the null hypothesis that there is no significant difference in adjusted mean scores of achievement in Science of e-content group and Conventional group when pre-science achievement is taken as covariate is rejected. The adjusted means of achievement in Science of experimental and control groups along with pre-test and post-test mean scores are presented in the Table 3.

Table 3
Mean Achievement in Science Scores of Elementary School Students of Experimental and Control Groups and t-value

Source	SS	df	MS	F-value
Pre-test	3322.243	1	3322.243	345.17**
Treatment	1338.607	1	1338.607	139.08**
Error	741.132	77	9.625	
Total	6195.487	79		

** $p < 0.01$

It may be observed from the Table 3 that the adjusted mean achievement in Science scores for the e-Content group and conventional method group are 59.40 and 51.12 respectively. Further, the t-value testing the significance of mean difference in the adjusted mean scores of the experimental and control group came out to be 5.13 which

is significant at .01 level. It may, therefore, be said that the teaching Science through e-Content strategy was found to significantly enhance Science achievement in comparison to conventional method when groups were matched on Pre-Science achievement.

It was found that the mean score of achievement in Science at post-test stage was significantly higher than the mean score of achievement in Science at Pre- test stage of experimental group. Therefore, the e-Content strategy was found to significantly enhance Science achievement of students of e-Content group.

Effect of Treatment, Gender and their Interaction on Achievement in Science by considering Pre-Science Achievement as Covariate

The third objective was to study the effect of treatment, gender and their interaction on achievement in Science by considering pre-science achievement as covariate. There were two levels of treatment, namely, e-Content and conventional method. The data were analysed with the help of 2x2 Factorial Design ANCOVA. The results are given in Table 4.

Table 4
Summary of Analysis of Covariance of Interaction Effect of Treatment x Gender for Achievement in Science

Source	SS	df	MS	F-value
Pre-test	3322.243	1	3322.243	345.17**
Treatment	1338.607	1	1338.607	139.08**
Error	741.132	77	9.625	
Total	6195.487	79		

** $p < 0.01$

Effect of Treatment on Achievement in Science

From Table 4, it is evident that the adjusted F-value for the main effect of treatment on the achievement in science came out to be 136.93 which is significant at 0.01 level. It shows that the adjusted mean score of achievement of students in science taught Science through e-Content and those taught the same topics through conventional method differ significantly when groups were matched with respect to pre-science achievement. It may, therefore, be said that the e-Content was found to improve achievement in science significantly higher in comparison to conventional method when groups were matched on pre-science achievement.

Effect of Gender on Achievement in Science

From Table 4, it is evident that the adjusted F-value for the main effect of gender on achievement in Science turned out to be 0.15 which is not significant even at .05 level. It indicates that both male and female students do not differ significantly on achievement in Science when groups were matched in respect of pre-science achievement.

Effect of Interaction between Treatment and Gender on Achievement in Science

It may be seen from the Table 4, that the adjusted F-value for interaction between treatment and gender turned out to be 0.55 which is not significant even at .05 level when pre-science achievement was taken as covariate. It indicates that there was no significant interaction effect of treatment and gender on achievement in science when pre-science achievement was taken as covariate. It may, therefore, be said that gender may not

be kept in mind while selecting the strategy of teaching science when groups were matched with respect to pre- achievement in science as both male and female students were found to have achievement in science to the same extent when groups were matched in respect of pre-science achievement.

Table 5 shows the adjusted mean achievement in science scores of male and female elementary school students in the experimental and control groups.

Table 5
Adjusted Mean Achievement in Science Scores of Elementary School Students

Source	SS	df	MS	F-value
Pre-test	3322.243	1	3322.243	345.17**
Treatment	1338.607	1	1338.607	139.08**
Error	741.132	77	9.625	
Total	6195.487	79		

** $p < 0.01$

It may be observed from Table 5, that the adjusted mean achievement in science scores of the male students of the experimental and control groups are 59.08 and 51.25 with SD of 6.50 and 7.64 respectively. The t-value testing the significance of mean difference came out to be 3.71 which is significant at .01 level. It indicates that there is a significant difference in adjusted mean science achievement scores of male students of experimental and control groups. Further, the perusal of Table 5 indicates that the adjusted mean Science achievement scores of female students of the experimental and control group are 59.88 and 51.00 with SD of 6.92 and 7.70 respectively. The t-value testing the significance of mean

difference turned out to be 3.56 which is significant at .01 level indicating that there is a significant difference in the adjusted mean Science achievement scores female students of the experimental and control groups of students. It may be concluded that there is significant difference in the adjusted mean scores of achievement in science of experimental and control groups across gender.

Discussion of Results

The present study showed that the e-Content improve achievement in Science significantly higher in comparison to Conventional strategy when groups were matched on pre-achievement in Science. The findings of the study supported by the previous studies in which students learned academic material/subjects using multimedia program performed significantly better than those taught using conventional strategy. Panda and Chaudhary (2000) observed that computer assisted learning was very effective in achieving higher cognitive skills among students. Also, Sharma and Sansanwal (2002) found that video based instructional strategies for teaching science were effective on achievement in science of Class IX students. In addition, these findings are consistent with Jayaraman (2006) and Nimavathi and Gnanadevan (2008) who found that the computer based multimedia learning packages were effective on performance, behavioural outcomes and understanding of academic material for students at different age groups. Also, Jyothi (2007) claimed that computer based learning had a significantly better effect than traditional instruction on learning. The findings from the present study are also in agreement with the research by

Kavitha and Sundharavadivel (2012) indicated that e-learning students performed better than the traditional learning students in their post-test total mean scores and there is a significant difference between e-learning and traditional learning methods. Rohendi (2012) found that e-learning which was based on animation content not only had significant effect on mathematical connection abilities but also been able to improve students' mathematical connection abilities far better than that of conventional approach.

Also, Owino (2013) and Robert (2013) found e-Content learning package in science education for the prospective teachers to be more effective than traditional method of teaching. In addition, these findings are consistent with Jaleel (2015), who showed that the e-Content in Science is effective over activity oriented method on developing Mathematical Thinking of Students at secondary level. The research by Awasya and Singh (2015) suggested that e-Content can be used to teach Environmental Management to undergraduate students as it is helpful in enhancing the knowledge as well as making the attitude favorable. Similarly, Amutha (2016) also found that e-Content strategy enhances the achievement of the students at tertiary level. In addition, the results of the present study are also in consistent with the results of the research by Jasmin (2017) who established the effectiveness of the e-Content learning package in learning Tamil subject for students who are studying in English medium schools. The researcher gives the fact that the e-Content strategy has promoted learning because it encourages students to take an active role in the learning process and have a better control over their education. Muthukumari and Ramakrishnan

(2017) concluded that use of e-Content way of teaching has significant impact on enhancing the achievement in history among the Class IX elementary school students. Further, Mishra et al. (2017) also concluded that e-Content proves to be is very useful tool for teaching green consumerism at secondary level. On the contrary, Lin et al. (2014) reported that e-learning strategy is not different from the traditional learning method in terms of achievement in accounting for freshman students in college.

The findings of present study showed no significant effect of gender and their interaction on achievement in Science when groups were matched with respect to their pre-achievement in Science which is in agreement with the findings of the research by Rose and Stella (1992) found that there was no significant relationship between the post treatment scores of gender and achievement. Similarly, Rajaswaminathan (1998) also found no interaction between treatment and gender in his study on the impact of multi-media package on the teaching of commerce with reference to select variables.

Implications

1. The results of the study revealed that the e-Content significantly enhance science achievement of students, so it is

suggested that with the implementation of e-Content in the schools, the students will develop keen interest in their course of study and will be able to explore their abilities and hidden talents

2. The results of the study revealed that there is no significant effect of Interaction between treatment and gender on achievement in science, therefore, it is suggested that gender may not be kept in mind while selecting the strategy of teaching science.
3. The achievement level of the students can be significantly enhanced especially in the subject of Science if the conventional strategy of teaching is supplemented with the e-Content.
4. The more use of e-Content in the educational institutions leads to further positive attitude towards computers, by the virtue of which when the students are taught with the help of computers or e-Content, the achievement of the students significantly enhanced as the students feel much more involved in their studies.
5. The e-Content strategy needs to be introduced for teaching Science as it will significantly enhance academic achievement of the students.

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APPLICATION OF INFORMATION AND COMMUNICATION TECHNOLOGY IN ASSESSMENT OF LEARNING LEVELS OF STUDENTS

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The obsessive-compulsive behaviour of checking email or social media updates is distracting and is conditioning the human mind to accept interruptions. Researches have proved that to focus back on whatever was being done before the interruption, usually takes 23 minutes. Also, studies have shown that the designing of the technologies is such that it is training the human mind to be self-disruptive every 3 and a half minutes. This design in the technology has an adverse influence on learning. So, what should the future of technology look like when it takes in its design effect the goals of learning. Application of Information and Communication technology in assessment of learning levels of students is all about understanding one's success in terms of achieving the outcomes of learning rather than the 'likes' received, and the connections made. So, technology's contribution in improving learning through assessment is not just about a linear progressions made and the counts reached, rather it is in defining and describing the levels of learning outcomes achieved.

Learning process starts with defining the Outcomes related to three domains-cognitive,

psychomotor, affective, to be achieved, (not necessarily in water tight compartments), through Learning Experiences, i.e., creating opportunities provided to learners to achieve the learning Outcomes. And it must be ascertained by Assessment of Learning the levels to which the outcomes have been achieved. Where both the constructs, i.e., the Learning Experiences and the Assessment are happening in tandem to each other. A Blueprint of the above process integrates the three-dimensional rubrics for capturing and describing the matrix involved in defining the Outcomes, facilitating the opportunities, i.e. Learning Experiences and describing the levels of Outcomes achieved, in other words, the Assessment of Learning.

The above permutation and combinations of Outcomes, Learning Experiences and Assessment is done differently in different pedagogies. Behaviourist pedagogy gives importance to imparting knowledge for behavioural change, whereas, in Constructivist pedagogy, using knowledge to create new knowledge and reflection on the learning process and performance is of paramount importance. Accordingly, the Outcomes differ. These abilities and

competencies which are developed in students, described as the learning outcomes achieved can be assessed with the help of Information Communication Technology (ICT).

Changing Perspectives of Assessment

Information Communication Technology (ICT) has influenced all aspects of our life— even our day-to-day routine life activities. The world is changing fast. Connectivity is ever increasing. In last couple of decades, more than half of Indian population is connected by mobile phones and internet and this number is increasing exponentially, day-by-day. Information is available to you at your finger tips on the computer. A new connected knowledge society is emerging. Educational needs of this society are also changing. Learners today, have to now live in this more and more technology driven world. Therefore, education has to develop new capacities, capabilities and skills as learning outcomes which will be useful and relevant for living in a world wherein the process of change is the 'ruling mantra'. It is essential for us to ensure that the process of assessment in any learning situation is comprehensive and is able to capture the different levels of dynamic adaptability of the learners to proactively equip oneself with the skills and competencies required.

In the recent past, traditional ways of assessment are being changed to more sophisticated Assessment strategies. Our single method strategies are replaced by multiple methods, and paper-and-pencil tests are being replaced by computerised tests. The normal pass/fail decisions are shifted to assessment standards, and the assessment

of knowledge has been replaced by the assessment of competence. Efforts have been also made to standardise subjective judgments, to develop sets of performance appraisal standards, to generate assessment evidence from multiple sources, and to replace the search for knowledge with the search for "reflection in action" in a new learning environment.

Assessment for learning rather than assessment of learning, support the learner rather than punish for failure, prefer formative rather than summative assessment and use criterion referenced rather than norm referenced testing for assessment of the learners' performance. This trend leads us to School Based Assessment (SBA).

Using Computers in Assessment

Computer based assessment implies the use of computers as an aid in the development, administration, scoring and interpretation of psychological or achievement tests. Use of computers in testing has become a dynamic tool for student assessment. One of the major benefits of computer assisted assessments is that one can individually select students and provide customised help as per requirement. This saves more time to spend on designing learning experiences to be provided. This also improves the involvement and chances of success of students who often are ignorant about the domains in which extra time needs to be spent.

While using multiple choice tests, computerised Question Banks are the best suited device for selecting items of required types, content and difficulty and discriminating power. It is useful for setting papers, creating equivalent but different forms (random item

mix), designing seating arrangement so that no two students sitting next to each other get the same form of test, eliminating the possibility of copying, dispatch of forms to examination center electronically just a few minutes before the scheduled time, involving no examination security hazards, etc.

This approach to assessment is similar to the conventional paper-pencil tests. The only difference is that when the software like Moodle is used for testing, the items are accessible on screen and one can answer by marking the choices on screen or writing answers on computers, instead of using a printed test paper. This way, one can test a very large number of examinees, simultaneously, without much difficulty.

Even in conventional examinations where essay type test items are mostly used, computers can be used for dispatch of question papers by examining body to examination center through e-mail, suitably monitoring the access using the mechanical safety measures, getting the adequate number of copies photocopied locally, just a few minutes before the actual examination, eliminating the problems related to storing, security, pilferaging, copying, postal delays or mix up of papers; with standby arrangements ready for power supply like generators in case of exigency. Though scoring of these essay type questions need to be done manually, but again computers may be used for preparing results, creating necessary records like mark lists, certificates, etc.

Further, the main advantage of computers in evaluation process is that one can conduct a test on a very large number of examinees, simultaneously, in the same testing conditions, without any bias, assessing the

answer sheets speedily. The Optical Mark reader (OMR) can read the marked answer sheets, check the answers against the pre fed scoring key for different forms, generate the score, rank them and prepare the list of qualified examinees on a certain cut off score with the speed of 5,000 to 10,000 sheets per hour, minimising the time spent on evaluation. The students can also get the score cards instantly, the moment they finish the test.

It is usually perceived that computer assisted assessment is costly to implement. The hardware like computers, servers and printers, as well as, the networking, maintenance and technology transition can also be hurdles for limited resources. Using standard software packages may prove to be too generic and may not be effective for specific purpose as expected and customisation may also prove to be expensive.

However, the cost is lowering down due to continued improvement in computer-based assessment techniques like using Web based programs rather than static software that often need to be customised. The benefits of computer assisted assessment will further expand as technology improves and becomes more accessible for teachers and learners. Advantage of scale also goes in its favor. The computer based assessment can save time and money. Some assessment software provides direct feedback to students regarding development of study skills and mastery over curriculum topics.

As computer networking is increasing fast, it would be possible for students to log on at any time to do formative or diagnostic testing, adding flexibility in testing and additional support for learners. It will lead ultimately to On-demand Exam.

In assessment technology, one can create their own content like open-ended free-response questions, 2-D and 3-D plots, built-in mathematics and randomisation tools, etc., for any subject like Maths, Science, Engineering for easy and reliable online testing and comprehensive assessment of anyone, anytime, anywhere-A3 situation. The academic market offers a collection of testing solutions which can free schools from the cost, effort, and limitations of paper-pencil assessment. Drawing on the strengths of ICT, Web-based solutions make it easy to deliver meaningful tests on any subject and content and cost-effective options designed to meet the needs of an individual teacher, department, or entire institution. They may include selection testing, drill and practice, assignments, quizzes and tests, or entrance examinations. Some of them enable to use the tests directly from inside the LMS like Blackboard classes.

ICT Based Tools and Techniques of Assessment

Anecdotal Records

Anecdotal records are the systematic and occasional notes of the teacher regarding development of the child, based on her observations of students in the classroom or outside for assessment. These observations provides the database for understanding the learning path of student, their interactions and collaboration with peers and general observations on their learning styles, attitudes and behaviours. Several areas not assessable by conventional exams or the paper pencil tests, with the help of computers, one can create, maintain and use a record of development in such areas for understanding the learning growth of the child. The anecdotal records are most useful and valuable tool for use in School Based Assessment (SBA). A simple form to keep such record may look like this:

Anecdotal Records Form

Name		Name	
Date of assessment		Date of assessment	
Observation period		Observation period	
Observation period		Observation period	
Comments		Comments	

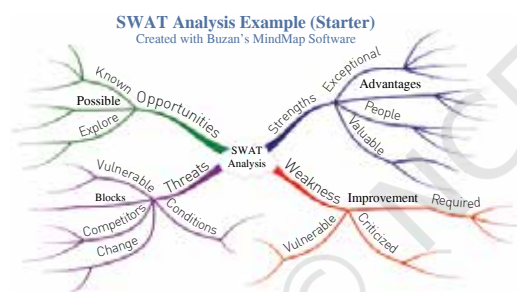
Graphic Organisers

Two types of graphic organisers viz. Mind Maps and Concept Maps, are instructional tools but can serve the purpose of assessment. By definition, Mind Map is a graphical method of taking notes. It is a

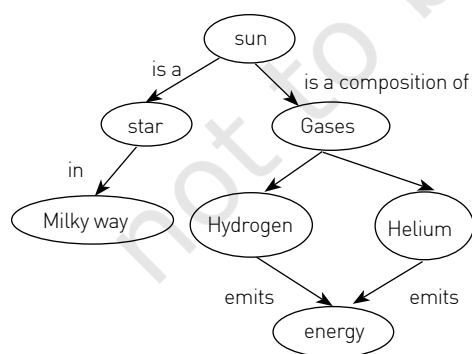
diagram to represent words, ideas, tasks, or other items linked to and arranged around a central key word or idea. It can be used to generate, visualise, structure, and classify ideas, and as an aid to studying and organising information, solving problems, making decisions, and writing.

A Concept Map presents the relationships among connected concepts and ideas. It is a tangible way to display how the mind "sees" a particular topic. In a Concept Map, the concepts, usually represented by single words enclosed in a rectangle (box), are connected to other concept boxes by arrows. A word or brief phrase, written by the arrow, defines the relationship between the connected concepts. Major concept boxes will have lines to and from several other concept boxes generating a network. Constructing a Concept Map provides a way to explore, reflect on, deepen, and share your understanding.

Mind Map of SWAT Analysis



Concept Map-Sun



Reflective Journals

Writing Journals can be used to assess the process of learning and student growth. They can be open-ended or can provide guiding, reflective questions for the students to respond to. The journals can provide insight and reflections on the learning processes of the students, if they are recorded and maintained on the computer.

Reflection is a process for looking back and integrating new knowledge. It is a meta-cognitive process that creates greater understanding of self and situations to inform future action. It is a process in which thoughts are 'turned back' so that they can be interpreted or analysed. Reflection may be accomplished individually and collectively. Interaction with peers, mentors, tutors, coordinators, experts provide opportunities to reflect on own experiences as well as others.

e Portfolio assessment

A portfolio is a purposeful representative collection of individual students' work- the art effects and reflections that demonstrate how a student has reached the current standards of performance. This is one of the best tools for performance appraisal particularly when used in digital form. E-portfolio is a digital creation of the student, which helps to portray the knowledge, skills and abilities in a variety of different ways that cannot be assessed by conventional tools like paper pencil exams and essays.

Rubrics

A rubric is "a road map, telling students and teachers where to begin, where they're going, and how to get there." (Dr. Kay Burke). Rubrics are scoring guides for teachers which describes the expectations used to

assess students' level of understanding and allow students to know what they need to do in order to be learning at a higher level. Students take time to self-assess and peer-assess using the rubric created. By doing this, students understand the areas of their strength and identify areas that needs improvement.

Rubrics lists the dimensions (tasks) of the learnings to be assessed, and the specific criteria used to evaluate each dimension. It is different than a simple checklist since it also describes the gradations of quality (levels) for each dimension of the learning being assessed, and assigns a point value to each gradation of quality.

Simulation

Simulation is the imitation of some real situation, experience, state of affairs, or process. The act of simulation generally entails representing certain key characteristics or behaviours of a selected physical or abstract system. It can be used to show the eventual effects of the real conditions and courses of action. You can safely use simulation when the real system cannot be engaged or real experience cannot be provided because it may not be accessible, or it may be dangerous or unacceptable to engage. Simulations can be used as:
(a) live simulation - where actual players use genuine systems in a real environment, or
(b) virtual simulation - where actual players use simulated systems in a synthetic environment. The virtual simulation involves application of computers and technology.

Simulation permits mistakes during learning. Simulations in education focus on specific tasks. They model a real world environment in a simplistic way so as to help a learner

develop an understanding of the key concepts. The learners assume roles in a simulated environment and perform tasks assigned to the roles. They are observed and assessed for their performance on the tasks allotted. Hence the assessment in a simulated situation is process oriented.

Question Bank

A question banking provides a well-organised collection of pedagogically sound, scientifically field-tested questions, bearing suitable psychometric properties like difficulty level, discriminatory power, etc., leading to reliable and valid evaluation. It minimises the time and energy required to construct a good test. Question Bank is developed for facilitation of teaching-learning process and also for assessment of learner in terms of learning outcomes. Question Bank becomes important when one assess a large number of students, or when continuity of assessment and record keeping over a time span is involved, frequency of testing is more, assessment is broad based and involves more parameters.

Question Bank can be a part of Assessment Management System (AMS), which often is part of Learning Management System (LMS). For example, Moodle is the most popular and user friendly software available to be used for inserting questions in the Question Bank and selecting them for testing. Moodle helps to store the questions under different subjects, topics and subtopics. Each topic can maintain its own pool of questions, which can be used to create a test or a quiz. Also, the questions can be uploaded from file, downloaded, used, answered, checked, imported and exported across the courses available in Moodle and can be inserted into the test directly.

e-Platform

The cyber infrastructure required for effective use of technology in education including assessment, mainly involves the e learning platform for the use of the learners and the teachers. Now the technology is poised to create such e platform on the cloud, making PCs obsolete. The components of the e-platform include the systems and procedures to be used for different purposes at different stages of education process. Different information and communication techniques, frameworks and tools like Web 2 technologies, can be included and used to create suitable e-Platform for evaluation system. Development and use of Evaluation Rubrics, selection of suitable Tools, Techniques and Frameworks, Search engines, OMR, Distributed Class, e-Platform like the one of IGNOU, network of Study Centers and counselors, etc., help in developing effective technology platform for assessment.

The e-platform may include—

- Learning Management System (LMS) – for delivery of online programs and conducting learning activities like Educational Revolution for All (ERA) of MKCL, Moodle (moodle.org), WebEx, Sakai (sakai.org), Ruby star, etc.
- Course Design and Integration Frameworks (CDIF) useful for development and updating the courses by the course teams. Even the students can provide feedback on the courses using this software.
- Assignment Management Systems (AMS) to manage the assignments right from their announcement, submission, follow up, evaluation, assessment, feedback, declaration of results, reminding the defaulters and keeping track of the progress of this activity.
- Distributed class (DC) with audio graphic and video conferencing facilities on broadband and on narrow band, using dial up connectivity, like SABA CENTRA for Mass interaction and mass personalisation, for an expert to deliver course content from central facility to learners at their places, to conduct learning activities, provide feedback, monitor group work, etc.
- Meta-database with SCORM compatibility.
- Tri-Band Technology, Mobile Telephony and Internet for network, communication and for working together.
- New tools and devices and social networks like Blogs, Orkut, YouTube, Facebook, Twitter, etc., for Virtual Conferencing/Working.
- Open Educational Resources (<http://ocw.mit.edu/index.html>), Open learn (<http://openlearn.open.ac.uk>), OER4S of Homi Bhabha Centre for Science Education (HBCSE) (www.mkcl.org/mahadnyan) and mechanisms for online mobilisation and training of functionaries and learners.
- Supplementary learning resources in multiple formats, print and non-print: like Power point and multi-media presentations, virtual lectures, Webinars, panel discussions, the digital resources like, eBooks, CDs, VCDs,

audio-video cassettes, journals and textbooks, readings on net / Websites, etc.

- Very strong and continuous, virtual, and real time student support system.

e-Platform can be used for conducting examinations in different modes like Online and On demand examinations, preparation and conduct of large scale competitive examinations; conducting viva voce test, preliminary interview for selection, for providing Feedback and counseling; using computers for development and operating Question Bank (Online), etc. But successful operation of such a system depends on the capacity building of teachers and students in ICT applications and development of required competencies and skills for using social networking for learning, working and developing together and using statistical packages such as SPSS, and computers, for data analysis and feedback for better learning and assessment.

Conclusion

The role of ICT in the teaching-learning process and assessment from different perspectives have been studied and compiled to give an insight to the use of ICT in assessing

students leaning levels. Since learning and assessment cannot be compartmentalised, the use of ICT in both these constructs have been elaborated upon. The different tools, techniques and procedures of assessment using ICT such as anecdotal records, mind maps, self and peer evaluation, e-portfolio assessment, reflection, project evaluation, rubric, Question Bank and simulated exercises, etc., have been expounded for the implications in their uses. The concept of e-Platform and its components like LMS, CDIF, and AMS, etc., and uses of e-Platform are also discussed.

The processes of assessment are critically important to check whether relevant learning is taking place to achieve the targeted outcomes and impact of education on the social system. Appropriate assessment can help us in determining whether useful life skills, competencies, and capabilities are being developed to equip the learners today, to live in the knowledge based society tomorrow and the support of technologies available for this task. The thing required to build is the knowledge base and capabilities of our teachers to enable them to use it productively for enhancing the skills and competencies of the learners to develop them as socially useful citizens for the society of Next Now.

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U.S. DEPARTMENT OF EDUCATION, 2016. Office of Educational Technology, Future Ready Learning.
Reimagining the Role of Technology in Education. Washington, D.C.

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INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGY WITH PHYSICS EDUCATION FOR EFFECTIVE LEARNING

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Introduction

It is well known that technology has affected all walks of our life in a big way. One such technology is Information and Communication Technology (ICT). Gone are the days when we used to struggle for getting timely information and for communicating from one place to another. Today, vast sea of information appears before us and we can communicate instantly to anyone anywhere in the world at one click. ICT has changed everything, be it commerce or rituals or political boundaries or even our way of thinking and education sector is not an exception. With the advent of ICT, changes which were never imagined before have happened in the field of education. Physics is a particular branch of science that deals with the matter, energy and their interactions. In a sense, it is one of the most fundamental branches which affect all the facets of our lives and hence, it is imperative for us to explore the nature through physical phenomena. Most of the time, in Physics, we have to deal with the unseen microscopic world which is beyond our sensory organs and it becomes really difficult to connect with the concepts underlying in those phenomena. Here comes ICT to our rescue,

which can take us to an exotic world of Physics. For proper understanding of physical phenomena, interactions and processes, it is highly important to integrate ICT with the concepts of Physics. In this paper, we would like to explore some of the possible ways of integration with few suggestive examples.

Goals of Science (Physics) Education

Education can be best described as a societal activity which requires proper collaboration, cooperation and interaction to explore the already existing knowledge and at the same time, to create something new. Hereby teaching and learning in education are the two facets of the same coin. For effective teaching-learning processes, technology comes as an aid. Science in general and physics in particular require the element of critical thinking. According to a belief, learning best happens when it is individualised because every learner learns at its own pace and own readiness. In spite of their best pedagogical approaches, big size of classrooms poses a hurdle to teachers in implementing individualised learning. Here the shortcoming on the teacher's part may be overcome by the strength of ICT.

No one can deny the importance of science education in the present world for the development of scientific attitude among the people and for overcoming the problems of the world. It can really lead to a more just, more peaceful and more equitable society. Easy access to science education for the masses is only possible through ICT. This has been reflected in *National Curriculum Framework (NCF) 2005*, which advocates that “Information and Communication Technology (ICT) is an important tool for bridging social divides. ICT should be used in such a way that it becomes an opportunity equaliser by providing information, communication and computing resources in remote areas. ICT if used for connecting children and teachers with scientists working in universities and research institutions would also help in demystifying scientists and their work” (NCERT, 2005). Position paper on Science Education by NCERT also categorically says that ICT should be used in such a way that it becomes an opportunity equaliser, by providing information, communication and computing resources in remote areas (NCERT, 2006). It further adds that providing children more direct access to multimedia equipment and ICT, and allowing them to mix and make their own productions and to present their own experiences, could provide them with new opportunities to explore their own creative imagination. The paper stresses in the context of classroom that it should be such that it provokes questioning, discussions and debates and enhances students’ metacognitive skills. It is clear from these documents that it is high time to take advantage of ICT in Science Education and we should think for the amalgamation of the two. Now let us know what ICT is and what it can do for us.

Information and Communication Technology (ICT)

ICT contains three words— information, communication and technology. In a way, it is the process of communicating information through technology. When we think of communication, it is a complex process which includes the source, the medium, the receiver and their interaction. Better communication can happen with the help of technology. ICT is generally defined as a diverse set of technological tools and resources used to transmit, store, retrieve, create, share or exchange information. ICT may include computers, Websites, social sites, live and recorded broadcasting media, multimedia, simulations, smart phones, etc. Proper selection of ICT tools for educational purpose is a very important and thoughtful activity which requires critical thinking and one has to keep in mind many factors like content, objectives of content, level of learners, their physiology, learners’ demography, etc. Injudicious use of ICT may lead to overburden and frustration among the learners.

ICT in Teaching and Learning

Teaching and learning is a dynamic process which continuously evolves with time. Earlier, a teacher was the only source of information, but now there are multiple sources of information. Transfer of knowledge was thought to be one way process having giver-taker relationship. It is established now that the teacher’s role is only as a manager and facilitator of learning and learner constructs their own knowledge and in the dynamic process of learning, continuously learns, unlearns and relearns. Teacher

and ICT have in common the elements of information and communication. There is slight difference among the two— ICT as such cannot take care of pedagogy and teacher has some limitations in terms of individual and fast communication. The shortcomings of the two can be tackled if these are integrated properly. Thereby, teacher and ICT complement and supplement each other. It is worth mentioning that using technology and making use of technology are two completely different things. Using technology means nondirected use of technology. Making use of technology leads to desired results and requires proper planning and proper training on the user's part. Tremendous amount of information and resources are available on Web and other ICT tools, which can stray the users from their desired objectives and can entrap them in eddies of uncertain and spurious facts or processes. A lot has happened in the field of ICT. In fact, it has revolutionised the whole process of teaching and learning. ICT can now be viewed as a virtual or surrogate teacher, who has far surpassed the conventional role of a teacher. Multifold aspects of teaching-learning process (including assessment) are being taken care by ICT in terms of e-learning, online learning and virtual learning. It has really paved a way for democratising the society with equal access of knowledge to everyone and helped in making an information based society.

Why use ICT?

ICT has many things to offer to education. Its evolution is phenomenal. Think of the situation when the teaching-learning process was confined within the school premises. Teachers, library and textbooks were the only

sources of information. Compare this with today's scenario where plenty of knowledge is readily available just in the palm of your hand. It has altogether changed the way education was perceived. The list is very long, but following are a few key features of ICT which prompts us to make use of it:

- Accessibility
- Adaptability
- Flexibility
- Augmented learning
- Cost effective
- Variety of information
- Reduction of communication gap
- Collaborative learning
- Higher cognitive processes
- Individualised education and global outlook
- Creation of new knowledge
- Promotes equity
- Real time (updated knowledge)
- Learner centred approach

NCERT's Initiatives in ICT

The National Council of Educational Research and Training (NCERT), being an apex advisory body to the government for school education has taken many steps to tap the potential of ICT in education. All the textbooks and other printed material developed by NCERT can be accessed online on e-Pathshala and other platforms. The National Repository of Open Educational Resources (NROER) is another

such initiative, where users can find e-content in abundance in the form of documents, audios, images, videos and interactive learning. Knowledge can be brought to the next level of cognition using such platforms. NCERT also telecasts high-quality educational programmes using the GSAT-15 satellite on SWAYAM PRABHA channel. In order to realise the goals of NCF 2005 and Digital India Campaign 2015, NCERT has also developed curricula for ICT in education for school system which aims for preparing the teaching-learning community to participate creatively in the establishment, sustenance and growth of knowledge (<https://digitalindia.gov.in/>, NCERT, 2017). This curricula is designed to promote creativity and problem solving.

Engaging in Physics Learning through ICT

Now we come to the central theme of the article, i.e., learning physics with the help of ICT. Professor Ootuka of Japan once said that the process of teaching physics will never be as efficient as it might be until good aids are generally available throughout the world (UNESCO, 1972). The time has now come when we are realising this through ICT. Physics is the study of processes related to the non-living world and deals with fundamental interactions and its manifestation in matter and energy. The interactions happening in the regime of microscopic scale are beyond our sensory perceptions and we have to understand them in an abstract manner. This abstractness often poses a great challenge for the learner. Experimentation and verification of the theory or postulate thereby becomes a challenge for the learners in the wake of lack of laboratory

facility. Thus, the correlation of the concepts of physics with daily life is really a challenge, which pushes the learners back from physics. This situation can be tackled with the help of ICT.

Tremendous efforts have been put around the globe to make physics learning an engaging, joyful, interesting and productive activity. The world of Web is full of the versatile physics material available in text, audio, video, animation, simulation, and multimedia format. Some of the available ICT resources useful for physics learning can be categorised as follows.

Social media

Social media refers to those virtual platforms where one can connect with the people around the globe to communicate, share and create their ideas. To mention a few, we can refer to Facebook, WhatsApp, Telegram, Twitter, LinkedIn, Quora, Pinterest, Google Hangout, Zoom, etc. On these platforms, you can connect to the people of your choice and interest. Suppose we are interested in the learning of electricity and magnetism, then we need to connect with such existing group(s). Synchronous and asynchronous interaction can take place on these groups and we can be updated on the subject. Not only that, we can clear our doubts from the experts in the group. All these platforms are becoming very popular as useful resources for the improvement in learning. Competitive examination related groups can also be found in abundance. Social media is acting like virtual facilitator of learning.

Websites

Computer or mobile with internet connection is a window to the world. Latest and up to date

information related to any field of physics is accessible instantly through the World Wide Web. Many Websites are dedicated to physics education. Few of them are listed below.

- <https://arxiv.org/archive/physics>
- <http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html>
- <http://planetphysics.org/>
- <https://www.feynmanlectures.caltech.edu/>
- <https://phys.org/>
- <https://ocw.mit.edu/courses/physics/>
- <https://www.physicsforums.com/>
- <https://www.nasa.gov/education/materials/>

The list given is suggestive. We can explore many more of our choice.

YouTube

YouTube is an online video-sharing platform of Google. It is one of the most explored ICT tool with billions of users. If we type any topic related to physics here we will get a huge number of videos, audios and animations which can be chosen as per our requirement and interest. Use of multimedia in these YouTube videos makes them very interesting and ever-engaging.

Simulations

Simulation is emulating the things in such a way that it represents the real process. Many a times it is very difficult to perform the real experiments due to the constraint of time, money or security. In such cases, simulations are very important to get insight of the real experiment. For a subject like physics,

where experimentation is the key aspect of learning, simulation is a boon. Interactive simulations are even more important, where the learner can feel the result of experiment with the variation of one or more independent variables. This feel is otherwise very uncommon with scarcity of resources and time. Excellent efforts have been done by many for developing physics simulations. Phet is one such initiative developed by Colorado University.

Interactive simulations of Physics on phet (<https://phet.colorado.edu/en/simulations/Category/physics>) deals with the sub branches of Motion, Sound and Waves, Work, Energy and Power, Heat and Thermodynamics, Quantum Phenomena, Light and Radiation, and Electricity, Magnets and Circuits. Thoughtful and easy to perform simulations are provided here. We would like to discuss (give an oversight of) two representative examples. Firstly, we discuss a simulation on Hooke's law for two spring system. A snapshot of this simulation is given in Fig. 1. It can be visualised here that we have two springs of spring constant 400 and 300 N/m, respectively with common applied force of 50 N. The common extension in both the springs is 0.071 m. Individual restoring forces developed in two springs are 28.6 and 21.4 N, respectively. Here, you can vary the stiffness of two springs and get a dynamic feel of individual restoring forces. You can also vary the applied force on the spring system. In a way, this dynamic play of a physical process is of great educational value.

In another example, we consider the simulation shown in Fig. 2, which is a snapshot of the simulated Young's two slit experiment. Here we can choose the frequency (wavelength) and amplitude of light

source. We can also vary the slit width and the separation between two slits. Resultant wave interference pattern is shown on the screen with intensity distribution curve also along the vertical locations on the screen. Also we can note that all maxima are not of same intensity. In fact, a central maximum is followed by secondary maxima. Such a control of parameters in terms of different light sources and different slit width and slit separation is otherwise very difficult to realise in actual experiment of Young's double slit interference. Coloured wave pattern is additional benefit here. These simulations not only are performable, but they also contain the concerned theory, related text, discussion forum and evaluation strategies of learning.

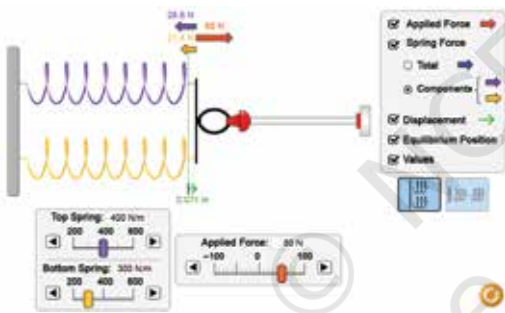


Fig. 1. Hooke's Law for Two Spring System

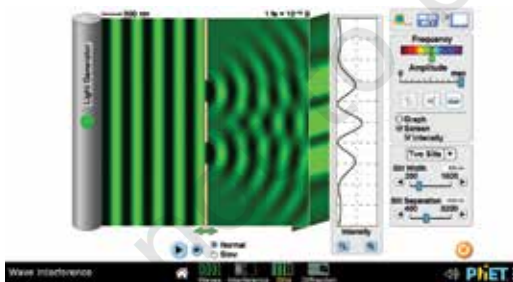


Fig. 2. Young's Two Slit Experiment

These types of physics simulations are now expanding rapidly with the availability of Free

Open Source Softwares (FOSS). Few more physics simulations can be explored at My Physics Lab (<https://www.mypysicslab.com/>). Many more examples of physics simulations available are Advanced Simulation Library, Algodoo, Open Source Physics, Physics Abstraction Layer, Step, etc. Many of them are open-source software, which gives full control to the users free of cost.

Open education

Access to the physics education has now become very easy with no need to attend the lectures in the educational institutes. Concepts or courses of your choice are available online and that too with very good quality. National Repository of Open Educational Resources (NROER) (<https://nroer.gov.in/>) is one such platform where one can learn at any pace at her/his will. Plenty of diverse learning resources are available here. DIKSHA (<https://diksha.gov.in/explore>) is another such platform where a variety of learning material can be accessed for school level physics.

Online Education

Online education has crossed the spatial and temporal barriers. Interested learners of any age and any region from around the globe can enroll for online courses and enhance or update their learning. This has become possible with MOOC courses available on SWAYAM (<https://swayam.gov.in/>) portal developed by Ministry of Human Resource Development, Government of India. These courses contain video lectures, reference material, discussion forums and assessment items developed by the experts in their field. These courses are open to those people also, who just want to attend for self-learning and are not interested to be credited.

Virtual Laboratories

Experimental facilities are not available to many because of financial or other constraints. Here comes a concept of virtual laboratory where a variety of experiments can be performed anytime anywhere on virtual online platforms. Components of experiments are present in these laboratories in the same way as they are in the real experiments. For a country like India, where 70.64 per cent of secondary schools and 57.14 per cent of higher secondary schools only have the adequate science laboratories (NCERT, 2016), virtual laboratories are great supplements for a reasonably good feel of experiments. One such initiative of the Government of India is through the vlab (<http://www.vlab.co.in/broad-area-physical-sciences>), where many physics experiments can be performed. For school level physics experiments, you can visit <https://www.olabs.edu.in/?pg=topMenu&id=40&>, where varieties of experiments are available. To mention a few—Vernier calipers, screw gauge, spherometer, simple pendulum, surface tension, inclined plane, Young's modulus, Newton's law of cooling, internal resistance of a cell by potentiometer, focal length of convex and concave mirrors, focal length of concave lens, refractive index of a liquid, conversion of galvanometer to ammeter, AC sonometer, transistor characteristics, etc. These experiments consist of theory, procedure, simulator, video, viva-voce, resources and feedback sections making these labs engaging and useful.

Mobile and Mobile Apps

Integration of ICT in the learning was thought to be a big challenge until now, when internet connectivity was limited to desktops, laptops

and notebooks with meagre accessibility to the general public, but after the launching of smart phones the scenario has changed completely. Users of smartphones have increased phenomenally approaching 500 Million in India and the number is still increasing. These smartphones are really smart. Operating systems usually Android, iOS or Windows, give them a variety of features which allow them advance computing speed, touch screen, increased audio-video quality, installable apps, etc. These smartphones are just like laptops and in some cases even more than that. You can access any learning resource with them as in internet linked computer. Moreover, plenty of learning apps can be installed very easily. These apps are very interactive and allow you to control your learning to explore the unexplored things.



Fig. 3: Orion Constellation through Skysafari App

As a representative example, we can think of Celestia or Skysafari App, where we can take a virtual tour of the sky. Variety of astronomical objects, such as, Sun, its planets, moons of planets, stars, asteroids, constellation of stars, etc., can be explored in real time. It can give us a thrilling experience of virtual tour of the sky without any telescope. Orion, one of the prominent constellation can be seen here in Fig. 3, which is a screenshot of the virtual tour from Skysafari. Many such physics learning apps can be explored as per your requirement. We can now say with more faith that ICT is ready to assist in democratising the learning of physics.

Augmented Virtual Reality

These are novel technologies which project the reality in virtual world and enhance the reality. They can also be seen as a continuum between real and virtual environment. Concept based visuals and activities can be developed using Augmented Reality. These activities are interactive in nature where students have enough opportunities to participate and control the proceedings of the activity. They can be viewed using a mobile phone or an iPad with a camera. You need to just direct the mobile camera to a surface with high contrast. Now you can go to such a scenario created in virtual space as if a laboratory is before you and you are performing original Rutherford experiment of alpha particle scattering and controlling various parameters such as foil to screen distance and moving detector at various angular locations. Events like launching of an artificial satellite can also be experienced and understood using this technology. The virtual

world generated by augmented reality thrills the user with elevated sensory experiences which become more interesting when a person can control and manipulate also the presented scenario.

Conclusions

Inclusion of ICT in physics education in schools at secondary and higher secondary stage is not a choice now. Use of ICT in teaching-learning process of physics has gone to an unprecedented level in the recent years. Variety of ICT media and ICT tools are helping our understanding to grow with enhanced possibilities of interaction and individualised learning to happen. However, it should be borne in mind that ICT is a tool to empower the instructional processes and it should not be allowed to become a master. Proper integration of content and pedagogy with ICT can lead to the desired learning of physics as per set learning objectives. On teachers' part, it is imperative that they are mentally prepared to integrate the ICT for facilitating the learning of physics in a better way. This can only happen when they are equipped with the ICT tools and are in consonance with the fast changes happening in the ICT technology. Judicious use of ICT can lead to the achievement of higher order cognitive abilities in physics with increased interest and creativity. Lastly, it should be reemphasised that ICT is not a substitute for the teaching-learning process of physics but a helping hand and one should not undermine the experiences gained by performing actual experiments.

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SOME ASPECTS OF THE USE OF ICT IN CHEMISTRY TEACHING

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Information and Communication Technologies (ICT) have become one of the fundamental building blocks of modern society. Many countries now regard the mastering of the basic skills and concepts of ICT as an inevitable part of the core of education. To this end, various new models of education are evolving in response to the new opportunities that are becoming available by integrating ICT and in particular web-based technologies, into the teaching and learning environment more particularly in Chemistry teaching as many students have difficulty in learning abstract and complex lessons of chemistry. This paper investigates how students can develop their understandings of abstract and complex lessons in chemistry with the aid of visualising tools: Animation, Simulation, Video, Films, Images, etc., that allow them to build clear concepts. These tools enable learning by doing and provide opportunity to explore the abstract and complex lessons of chemistry. They also enable to present information in a more dynamic, compelling and interactive way with engaging environment. The effective integration of such applications however, depends to a large extent on teacher's familiarity and ability with the IT learning environment. Keeping this in mind, in this paper various aspects of ICT for chemistry teaching are discussed and listed in the form of Compulsory Reading material. Useful links on the Websites for chemistry teaching, Learning Activity by using ICT in chemistry and resource material are given outlining thus a programme of objectives and related activities for an ICT-enhanced learning environment in chemistry teaching and learning.

"It is through formal and/or informal education that an individual can be equipped with the knowledge, skills and attitude needed to be a successful citizen, which helps him or her to adapt to the ever changing political, social and economic environment"—(UNESCO, 2003).

Introduction

Let us start this topic with an example— a senior secondary level student in China got information from the Internet that the research which won the 2005 Nobel Prize in Chemistry revealed the mechanism and process of olefin metathesis. At this point, this student was learning about olefins. He asked his chemistry teacher two questions on this information—firstly, the olefins we learned could make addition reaction and substitution reaction. But metathesis reaction was not mentioned in the book. What's more, the types of organic reaction did not include metathesis reaction; secondly, it was said on the Internet that 2005 Nobel Prize in Chemistry realised "the return of chemistry."

How to understand it?

This example illustrates that information technology has created a vivid and trans-time-and-space digital learning environment for students. It is quietly affecting the way students study. Our teachers must not turn a blind eye to it. Instead, they should use a clear mind to face the arrival of this change and consciously and actively play a positive role in use of information technology to achieve teaching objectives.

Significance of information technology in changing chemistry learning style

(Retrieved from <http://Proceedings.InformingScience.org/InSITE2014/InSITE14p121-127Huang0602.pdf>)

Understanding the Problems in Teaching Chemistry

Many chemistry concepts and phenomena are abstract and complex, which can be understood and communicated only through the use of chemical representations. Along with this, understanding of chemical processes and phenomena, such as, dissolving substances, transfer of electrons, conduction of ion, inter molecular and intra molecular bonding as well as the dynamic nature of phenomena is fundamental to learning the chemistry. But the students have difficulties to understand this chemist's conceptual representation of the microscopic particles. On the other hand, when misconceptions or alternative misconception occur they hinder further chemistry learning. It is also important to identify factors affecting students understanding of the abstract and complex concepts of chemistry in their effort to construct their own meaning. This is the key to quality chemistry learning. This suggests that teachers should have to prepare an appropriate, clear and an interesting learning environment engaging their students in the participatory learning process that increases their positive attitude towards chemistry learning.

Introducing ICT in Teaching Chemistry

This can be achieved by introducing some very basic tools made available to

us by technological innovations. We can understand it with an example. A teacher has taught the states of matter in the previous classes and now it is time to teach (as per the Chemistry curriculum) the structures of simple organic molecules like methane, ethane, propane, etc. The usual way is to present the nomenclature and their structures on the chalk board (which is a two dimensional object—2D). It is, however, learnt through chemistry education research that most students could not understand the three dimensional (3D) nature of the structure of the molecules. Furthermore, it is time consuming for the Chemistry teacher to draw the structures every time he or she wants to teach or review the structures for different sections of a grade level. The teacher wants to know to what extent the students understood the content taught to them on the states of matter. One way is to prepare a PPT involving pictures of actual objects and ask them to write down their responses on a sheet of paper when each slide is shown to the whole class. Note that such an approach can accommodate a large number of students in one class as long as the PPT is visible to every student.

In addition the teacher can use transparencies prepared by others. One example is the UNESCO & IUPAC chemistry teaching material entitled DIDAC. See the following examples extracted from that material. These slides can be copied or printed onto overhead transparencies and used for teaching in the Chemistry classroom.

Example 1: The link between the differences in electronegativity and the type of bonding

$\Delta EN = 0$	$0 < \Delta EN < \sim 1.7$	$\Delta EN > \sim 1.7$
ΔEN	$\Delta EN \mu / 10^{30} \text{ c.m}$	ΔEN
F ₂ 0	H ₂ O 1.4 6.1	CsCl 2.3
N ₂ 0	CO ₂ 1.0 0.0	NaCl 2.1
S ₈ 0	NH ₃ 0.9 4.9	CaCl 2.0
H ₂ 0	CH ₄ 0.4 0.0	MgF ₂ 2.8

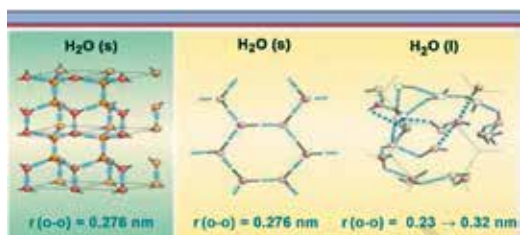
AJCE, 2014, 4(3), Special Issue (Part II) ISSN 2227-583511)

Substances built up of molecules which have clear polar bonds, e.g., H₂O, NH₃, CO₂, CH₄ do not necessarily behave as polar substances.

- It is possible that the various polar bonds in a molecule cancel each other out, or "neutralise" each other.
- The direction and charge of the dipole moments generated by the polar bonds has to be taken into consideration, as does the resulting dipole moment for the whole molecule.

CO₂, for example, is an apolar molecule with two polar bonds between the C and O atoms, each having opposite dipole moments. H₂O and NH₃ are polar molecules, CH₄ is apolar. Nonetheless, all of these compounds contain polar chemical bonds.

Example 2: Structure of water as an example of hydrogen bonding



On the left side, the three-dimensional representation of the structure of ice: the lattice contains a hexagonal structure. Each water molecule has four neighbours in a tetrahedral configuration. A very open structure that has a very low density. When it is warmed (to 4°C) the hydrogen bonds are partially broken resulting in a denser structure. On further warming the thermal agitation of the water molecules increases and the density again decreases. The right side compares the structure of ice with the structure of water at a given instant in time (computer simulation): [*AJCE*, 2014, 4(3), Special Issue (Part II) ISSN 2227-5835-12]

The hexagonal pattern of ice is shown by a light green dotted line. The blue dotted line represents the hydrogen bonds. The shorter the distance between the dots the shorter the hydrogen bond. The colour of the oxygen atom indicates to what extent it is out of the plane: white atoms are in the plane whilst dark brown atoms are between 0.7 and 1.0 nm in front of the plane. The light pink and red atoms are at an intermediate distance; the darker the colour the further the atom

is in front of the plane. Hydrogen bonds are essential for the spatial configuration of biologically important molecules, such as, proteins.

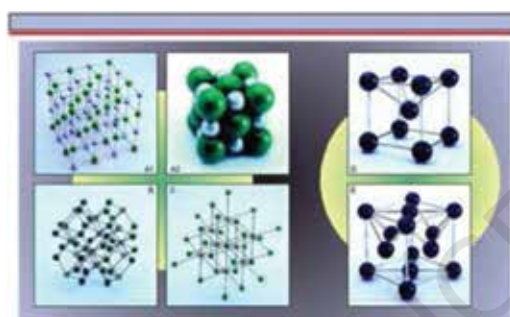
Example 3: Lattice Structures Ionic Lattices

A1 = NaCl (open structure),

A2 = NaCl (close-packed structure),

B = CaF₂,

C = CsCl₂

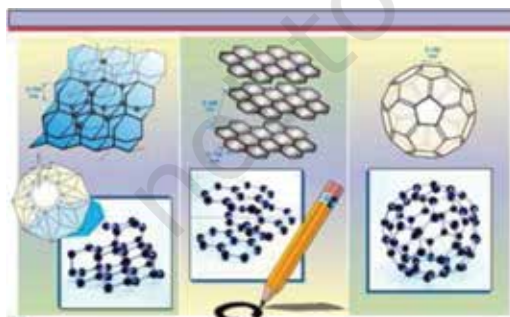


(AJCE, 2014, 4(3), Special Issue (Part II) ISSN 2227-5835-13) Metal Lattices

D = Fe (bcc unit cell)

E = Cu (fcc unit cell)

Example 4: Allotropes of Carbon: Diamond, Graphite and Fullerenes



Diamond (left)

Each atom is bonded via sp³-hybrid orbital to four atoms in a tetrahedron. All four valence electrons are paired in bonding orbitals.

Diamond is stable, being an insulator with a high melting point and the hardest substance on earth. It is transparent and has a high refractive index.

Graphite (middle)

Each atom is bonded to another three atoms by sp²-hybrid orbitals and consists of layers of flat, hexagonal rings of carbon atoms. The layers are held together by London force. They slide easily over each other. Graphite is a soft, black material and is used as a lubricant. Each atom contributes three valence electrons to the three s-bonds. The fourth electron forms a π-bond with a neighbouring atom. This is not a localised bond but it moves freely throughout the π-system. The electrical conductivity parallel to the layers is high, but is low perpendicular to the layers. (AJCE, 2014, 4(3), Special Issue (Part II) ISSN 2227-5835-14)

Fullerene, C60 (right)

This molecule consists of 60 carbon atoms divided into 20 six-rings and 12 five rings, like a football.

(In 1996 Robert F. Curl, Sir Harold W. Kwoto and Richard E. Smalley received the Nobel Prize in chemistry for this discovery.) (AJCE, 2014, 4(3), Special Issue (Part II) ISSN 2227-5835-15)

Animations and Simulations for Teaching and Learning Chemistry

Animated visualisations that show both structures and processes help teachers

convey important scientific concepts in chemistry. Designers of these animations benefit from knowing how students perceive and comprehend such visualisations. Specifically, instructional developers seek to design visualisations that allow students to learn critical concepts and relationships between these concepts. For example students learn molecular chemistry concepts and relations by attending to, seeing, and understanding all the associated elements and the ways that they change and evolve during the process. Because often animations are too complex to be quickly understood, learners need to establish accurate mental models to assist in their comprehensions.

One example can be described when students watch an animation of moving molecules. The molecules are symbolised by tumbling balls of different colours coming apart and coming together. Students see these balls as pushing others so they will join or adhere. Studies have suggested that students who receive instruction including computer animations of chemical processes at the molecular level are better able to answer conceptual questions about particulate phenomena.

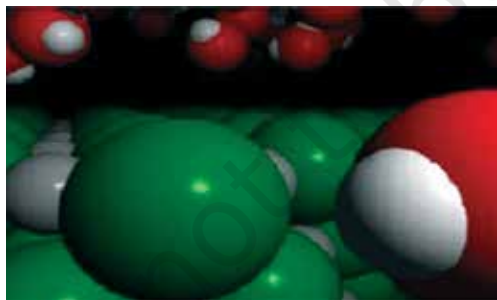


Fig. 1: Molecules from Salt Dissolving in Water Animation

(Ref.: Tasker, Dalton, Sleet, Bucat, Chia, and Corrigan, 2002).

Besides animations help students better understand dynamic molecular processes. Animations and simulations visually help students understand difficult concepts related to the dynamics of complex chemical systems including molecules and reactions. Students' mental models are positively and negatively affected by viewing animations of basic chemical processes. Combining animations with microcomputer based laboratory experiments support student integration of multiple representations of chemistry concepts. Many lab experiments are complemented by multimedia simulations and animations that represent the phenomenon being explored by students. Often, instructors help students use animations and technology to stay on task and to solve a complex scientific problem where guidance is provided as needed to sustain educational progress among the learners. Laboratory instruction helps students understand the connections between their macroscopic observations of chemical phenomena and the underlying molecular processes. Visual representations help students develop multiple representations for the same chemical phenomenon during laboratory work. Molecular animations are an external representation that corresponds to the mental images that chemists use to solve authentic research problems.

Teachers' Formation and role in ICT integration in Chemistry

Chemistry teachers can infuse ICT in all aspects of professional life to improve

student learning and the management of learning processes. ICT enables teachers to become active and creative in stimulating and managing the learning process, by infusing a range of preferred learning styles and uses of ICT in achieving educational goals. Chemistry teachers can master authoring tools, animation tools and multimedia tools to develop instructional software in Chemistry in accordance with the ICT-enhanced teacher standards. For instance, a Chemistry teacher can start designing their own lessons by using free software available for educational purposes. One such software is the Advanced Chemistry Development (ACD/ChemSketch). ACD/ChemSketch is a chemical drawing software package from ACD/Labs designed to be used alone or integrated with other applications. ChemSketch is used to draw chemical structures, reactions, and schematic diagrams. It can also be used to design chemistry-related reports and presentations. ACD/ChemSketch has the following major capabilities: **Structure mode** for drawing chemical structures and calculating their properties, **Draw mode** for text and graphics processing, and **Molecular Properties** calculations for automatic estimation of Formula weight, Percentage composition, Molar refractivity, Molar volume, Parachor, Index of refraction, Surface tension, Density, Dielectric constant, Polarisability, Monoisotopic, nominal, and average mass.

ACD/ChemSketch can stand alone as a drawing package or act as the "front end" to other ACD/Labs software such as the NMR Predictor engines. Once ACD is installed in the computer. (TK), the Chemistry teacher can follow the instructions or user manual for drawing and animating (PK), for instance, the structures of organic molecules (CK). (AJCE,

2014, 4(3), Special Issue (Part II) ISSN 2227-5835-18)

The animated structures with different models such as, wire frame, sticks, ball and sticks, space filling, dots only, and discs can be used to challenge students' misconceptions about the structures of the molecules through the teacher's application of this particular activity.

Students' Participation in the use of ICT in Chemistry

ICT becomes an integral part of daily personal productivity and professional practice. The focus of the Chemistry curriculum should be now much more learner-centered and should integrate the subject in real-world applications, both in real and virtual environments. For example, students may work with community leaders to solve local problems related to water by accessing, analysing, reporting, and presenting information with ICT tools. Learners' access to technology is broad and unrestricted. They take even more responsibility for their own learning and assessment. ICT is taught as a subject area at an applied level and is incorporated into all vocational areas. The institution has become a centre of learning for the community. (AJCE, 2014, 4(3), Special Issue (Part II) ISSN 2227-5835-19)

Teachers need to master special software, learning management system, simulation and modelling tools, networking and various Web tools, in order to innovatively transform the teaching and learning system. At this stage, the teacher is a creative and innovative person. They can design, implement and evaluate a range of technological tools

in teaching Chemistry and across the curriculum. At this stage the teacher should be able to design Chemistry Website at least using open source software like Joomla. They should also be able to use the content management software like Moodle for wider and online learning.

Some Aspects of the use of ICT in Chemistry Teaching

We will now discuss some aspects of ICT use in Chemistry in form of Compulsory Reading, Useful Links, Learning Activities, Project Based Learning, etc.

Compulsory Readings

1. UNESCO (2002). *Information and Communication Technology in Education: A Curriculum for Schools and Programme of Teacher Development (2002)*.

The chemistry student, teacher or instructor can use the manual for developing subject-specific approaches to the use of ICT as a tool for designing new IT learning environments and helping their future students to use ICT. Many teachers are keen to develop professional expertise on ICT use in education. This book is designed to raise the knowledge for ICT applicability to subject-matter content in science, mathematics, languages to a minimum level, and to provide a foundation for further professional development.

2. Tuvin-Arad I; and Gorsky P. (2007). *New Visualisation Tools for Learning Molecular Symmetry—a Preliminary Evaluation* Department of Natural Sciences, The Open University of

Israel, Israel. Published online: *Journal of Chemistry Education Research and Practice*, 2007, 8 (1) 61–72

This research article is about molecular visualisation in chemistry learning using new IT visualisation tools. It describes how a Website that helps students visualise and locate symmetry elements on three-dimensional (3D) molecular structure was developed. The article includes textual explanations and a tool kit -an open tool-that enables students to draw symmetry elements for any molecule in 3D. The paper focuses on how students learned while using the symmetry tool. The study provides empirical support for the use of visualisation tools in molecular symmetry and other areas of chemistry such as inorganic spectroscopy, quantum chemistry grounded in visualisation.

3. Burewicz A. and Miranowicz, N. (2006). *Effectiveness of Multimedia Laboratory Instruction*. Department of Chemistry Education, Faculty of Chemistry, Adam Mickiewicz University Poland. Published. *Journal of Chemical Education Research and Practice* 2006, 7, (1) 1–12

The article outlines the process of ICT integration in traditional chemistry laboratory teaching. It describes the development of a computer based programme for testing the effectiveness of using interactive laboratory instructions in chemistry teaching. Overall the study shows that the use of interactive laboratory instruction increases performance in the resulting laboratory skills and shortens time spent on completing laboratory exercises and tasks. A number of transition steps were found to characterise the integration of ICT-laboratory learning environments.

- Kennedy, D. and Finn, Sean. (2000) The Use of Data logging in Teaching Physics and Chemistry in Second-level Schools in Ireland: A Report submitted to the National Centre for Technology in Education and The Department of Education and Science. Ireland.

Teacher will find the report a very useful source of information and ideas, with regard to the theory and practice of computer-assisted data logging to enhance practical work in chemistry and physics. The report also addresses other valuable teacher professional development issues in the use of computer technology in teaching chemistry in the classroom or laboratory.

Useful Links

In this section, links useful for ICT use in chemistry are given. The links placed here

introduce teachers and learners to the resources available to them. As a teacher, one should encourage learners to read the descriptions provided before moving on to the learning activities. Education research shows that this will help learners be more prepared and help them articulate previous knowledge

Description

ICT Resources for Teachers, the CD-ROM contains a set of ICT-based resources for teaching and learning of science, mathematics, etc., for secondary-level students, including simulations, video clips, interactive learning objects for quizzes, animation, and other kinds of multimedia learning activities. The materials and lesson plans provided here are organised and relevant to subjects. A separate directory is provided to give an overall view of the types of resources available.



UNESCO Bangkok: ICT Resources for Teachers CD-ROM
<http://www.unescobkk.org/index.php?id=3871>

- <http://www.crocodile-clips.com>



Description

This Website provides a number of free sets of simulations which are available to download. It lets you open, run and interact a set of chemistry simulations that have been enabled for use. Incorporating graphic software into chemistry courses has been found to foster understanding of molecular 3D structure, and spatial ability and to promote meaningful learning. Difficulties in learning chemistry are attributed mainly to its abstract, unobservable, particulate basis and to the need for quick movement or transfer across the three identified levels of chemistry understanding—the macroscopic, the microscopic and the symbolic world of chemistry. With the advent of computer graphics software, Computerised Molecular Modelling (CMM), and simulated chemistry laboratories have become tenable. This is a very useful site that provides a simulated chemistry laboratory where you can model experiments and reactions, plot graphs, view mechanisms using 3D animations, view lesson kits designed for various topics in chemistry, and which can then be adapted for preparing your own ICT learning activities in chemistry teaching.

- http://www.thinkquest.org/library/cat_show.html?cat_id=49



Description

This site features a state-of-the-art technology for a fully interactive chemistry learning experience. The Think Quest library boasts of a number of chemistry textbooks on line for under graduate studies, a list of chemistry education-related topics that are designed for student interactive hands-on experience. It is a Website designed by and for chemistry students themselves. An interactive, hands on experience is one way of learning that is effective and great fun. This Website provides a veritable source of information of useful topic sites, for chemistry teaching and learning in an IT-rich environment. It provides among others an exhaustive guide to chemistry on the Internet, which include chemistry textbooks online, Chem Web online, Digital Chemistry textbook, etc. For example, Chem Web 2000, whether for a beginner or an advanced chemistry student, is an excellent site for studying and understanding various topics in chemistry in an interactive manner.

Description

This Website is designed to help the chemistry teacher find useful and detailed

information on various chemistry teaching and learning activities. These activities are displayed under the instructional categories of demonstrations; laboratory investigations; teaching tips, and miscellaneous. Under miscellaneous activities are included involving preparing and using worksheets, internet research exercises; power point assignment; chemical calculations, etc. For the chemistry teacher, familiarity with a range of learning and teaching activities in chemistry is a foremost pre-condition among others, for successful ICT integration into the chemistry curriculum. In addition to providing demonstrations, labs and other information which teachers and users can access in chemistry, this Website also provides useful information on ICT integration and teaching tips.

- <http://chem.lapeer.org/Chem1Docs/Index.php>



Demonstrations

1. Acid Base Demonstration

- <http://lapeer.org/ChemCom/Index.html> and <http://chem.lapeer.org>



Description

This website is for science/chemistry teachers to share ideas and exchange information. Permission is given to use and reproduce all materials at the site as long as the activities are not sold. This chemistry teachers' resource Website is an easy-access source for a variety of chemistry teaching and learning activities on the internet. There is much more information available, it is just a matter of finding what is relevant to your needs.

Description

This Website is a collection of chemistry applets simulating various chemical systems and experimental systems. It exposes the user to virtual chemistry experiments and exercises. These configurable applets are available for use, and to create new Web pages containing customised simulations and representations of chemical experiments. The chemistry-specific learning activities of this module require of the student knowledge of subject matter content (i.e., chemistry), and a measure of competence in chemistry-ICT integration skills. This website provides the user or student with the invaluable opportunity to review a variety of resource based ICT-chemistry integration activities, for possible adaptation in a given classroom situation. This collection of applets includes a series of tutorials and simulated experiments available for a variety of chemistry topics; 3D visualisation of molecular structure, and generated computational chemistry exercises.

- <http://www.chm.davidson.edu/resources.html>



Learning Activities and Project Based Learning (PBL)

1. Working with a database

Summary : Application of databases in chemistry

In this activity students are required to create and use databases for storing information or variables in chemistry and then carefully examine these databases to find relationships and commonalities, in terms of, say, structure and the corresponding properties and functions.

Assignment

As a first step, try to prepare an appropriate structure of a database for any chemistry example, into which data can be added.

Variables, such as—

- the characteristics of chemical elements in the periodic table;
- the characteristic structures and properties of the functional groups in organic compounds

But before preparing an appropriate database you need to understand some of the relevant

steps in problem solving, which include such stages as, design, data entry and modification, etc., and then identify a problem in chemistry that can be solved by a database.

Design and create a database to enter and store chemical information into which you can add data.

Formative Evaluation

- the identification of the chemistry topic(s) suitable for the application of database
- the demonstration of an understanding of the relevant phases of problem solving
- the ability to create or use prepared database to store information and variables, (for example, the characteristics of chemical elements in the periodic table)
- the ability to draw and interpret these databases to find relationships and commonalities in a structured and rational manner.

Other important links for lesson ideas

1- Periodic table 2- Genetic Variation (modelling)

2. Title: Data logging

Summary : The use of ICT tool for the measurement, collection and processing of chemical data.

Experimentation and measurement in chemistry is one of the principal means for guided discovery learning, and for knowledge construction based on experience. Computer aided data logging has given rise to new approaches in chemistry practical work.

The basic parts of a computer aided data logging system or an ICT measurement system are shown here. The system includes: the input (sensors), processor (computer), output (software— graphs, tables, data handling).

A sensor is a device that is able to respond to the physical property of the environment. Sensors detect variables or changes in the physical properties of: sound, conductivity, force, oxygen, heat flow, voltage, pH, light and light gates, temperature, differential gas pressure, barometric pressure, electrical current, angular displacement, humidity, magnetic flux density, blood flow, radioactive decay, acceleration.

A wide variety of sensors exist and they are used for recording data automatically. A list of some of the sensors required for teaching secondary school chemistry are— Temperature Sensor, pH sensor, Colorimeter sensor, High range Temperature sensor, Voltage sensor, Light Sensor, Conductivity sensor, Absolute sensor pressure.

The sensors, interface unit computer and appropriate computer software comprise what is commonly called data logging system.

Assignment

1. A teacher has to find out from a survey of the educational literature available on the Internet, the chief advantages of data logging in chemistry education.
2. Identify and list 20 areas or topics of the school chemistry syllabus in which data-logging equipment has been and can be used.
3. Write two experiments in school chemistry for which a particular brand

of data-logging equipment could be used. Conduct an Internet search for a template (or develop one) to illustrate the format to be applied for writing up the details of the experiments. Include lesson plan and assessment scheme and lesson evaluation.

Formative Evaluation

The assessment will be two fold: the first will be based on your knowledge of the elements of an ICT measurement system and what research says about the effectiveness of data-logging in teaching chemistry at secondary level; and secondly, the ability (during contact session) to perform simple computerised measurements on a wide range of experiments in chemistry laboratory work, process the experimental data and draw conclusions from them using the most suitable data-logging system.

Title: Use of ICT in project-based learning in chemistry (Information and Communication in Chemistry)

In an IT environment, students can use ICT-based tools, such as, a word processor or presentation software to report on the results of experiments, present a research project or communicate with other students. Also, for research projects and specific assignments, the Internet can be used as a source of scientific data and theoretical information.

This learning activity is about the integration of project-based learning in an IT environment into chemistry teaching, using the Internet as the learning environment.

Assignment

The two assignments given as examples here are to be carried out individually. The

resources needed are— computer and access to Internet.

The two are titled 'Elements in the periodic table' and 'Scientific theories'.

The first assignment, Elements in the periodic table takes the investigative form of asking the student to identify a chemical element in a riddle by investigating the periodic table and seeking information using the Web.

The riddle for such an inquiry is— *"I can be found in batteries and coloured old glasses, but not in pencils anymore, I am known for my high density and I am poisonous who am I?"* (the answer is lead Pb)

The students are asked to identify the element and present information regarding the date, place, and the way the element was discovered. They are also required to present an image or visualisation of the element, its chemical and physical properties and its daily use and applications. Furthermore they may be required to make use of online data including readily available easy-to-use applets to identify and perhaps simulate all kinds of processes and phenomena relevant to the investigation. Individuals or groups of students may be asked to investigate different chemical substances.

The second assignment, Scientific theories is concerned with the complex process of accepting or rejecting a scientific theory. The students may be required to investigate the principles of a given theory in chemistry and to explain why it was accepted or rejected by the scientific community.

In this assignment each or a group of students will receive a different theory. Some theories, such as, cold-fusion and poly-water fell by the wayside, i.e., rejected, while others,

such as molecular orbitals, quantum theory, acid-base by Lewis, and Schrodinger's atom model are accepted.

At the end, the teacher may want the students to share the knowledge they had acquired by asking them to upload their projects to the course website for the benefit of all classmates.

Formative Evaluation

The PBL in chemistry may be evaluated both quantitatively and qualitatively. The quantitative component may take the form of a pre- and post-test of students' prior knowledge in the areas to be covered.

The qualitative evaluation may focus on content analysis of the students' projects in which qualitative interpretations will be constructed gradually from the presentation. First, the students' answers to the inquiry based questions will be processed and analysed listing concepts, words and arguments they used. Second, conceptual categories of chemistry understanding will of necessity be generated from the write-ups (to be supplemented by interviews perhaps) to determine meanings and relationships of concepts. Third, the issue of how critical the students were in terms of evaluating the quality and relevance of all information retrieved and the ability to cite and reference sources correctly when reporting will be factored in. Finally, a summary of the teacher's insights into the investigated project will be produced.

Conclusion

Information and communication technologies facilitate worldwide contacts between teachers and students. The Internet is

now a veritable source of scientific data and theoretical information and offers a viable means to support authentic learning in chemistry. Discovering the scope of information available over the Web and in other ICT based cognitive tools and how to use it should be part of the undergraduate education of every chemistry student and teacher. In this paper, we have engaged in learning activities that focus, among others, on the integration of the Internet and the World Wide Web as an additional medium

for enhancing the teaching and learning of chemistry. For example, simulations can be used to develop understanding of chemical concepts in different contexts, computers can be used as research tools for inquiry-based chemistry projects. The possibilities are endless and can be stretched to limits and depend on a teacher's efforts and imaging powers and also on the collaboration and cooperation among teachers and students. We hope this paper will provide enough material to meet these demands.

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AJCE, 2014, 4(3), Special Issue (Part II) ISSN 2227-5835

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USING INFORMATION AND COMMUNICATION TECHNOLOGY FOR QUALITY MATHEMATICS TEACHING

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The technological pedagogical content knowledge framework in Mathematics (originally TPCK, now known as TPACK, or technology, pedagogy, and content Knowledge in Mathematics) for teacher knowledge is described in detail, as a quality interaction among Content, pedagogy, and technology, the three components of knowledge. To successfully integrate technology use into quality teaching-learning, we require the types of flexible knowledge which could emerge by theoretical as well as practical interaction of these components of knowledge. This article explores from a theoretical perspective the importance of ICTs in education. Furthermore, it describes the concept of key competences and ICT competences that learners should achieve in order to enable them to successfully participate in quality learning.

Key words: *ICT in Education, Education, TPCK, Mathematics Education, ICT Integration in Mathematics, Professional Development in Mathematics*

Introduction

ICT, Digital Media and especially Web 2.0 tools are important levels to support quality learning and improve the learning outcomes of the participants. We observe that in a normal classroom situation there are several ways for applying ICT. In a substitution method an educator replaces a number of the old technologies with ICT. For example: the teacher may use PowerPoint, may allow students to send their homework via e-mail, even could present the tests electronically. Such ICT-scenario wouldn't require much change or training. This may be called a cosmetic change. There is a need to have a paradigm shift in teaching-learning situations through a transformational approach through which the following recommendations of broad process perspectives of *National Curriculum Framework 2005*, for teaching and learning of Mathematics could be met

- Student Activity
- Multiple Representations
- Experimental and Guided Discovery Learning

In the transformational scenario, digital media like Mathematics specific software for example, GeoGebra, Cabri, winplot, etc., can provide these opportunities to enhance learning by

- visualising—learners can see abstract concepts
- representations—learners can make connections
- experiments—learners can discover mathematics

Background and Need

We believe that the use of ICT foregrounds the ways in which teachers can match in school

the opportunities for learning with child friendly environment. In fact, there is enough evidence that young people who have been surrounded by and interacted with ICT on continuous basis develop a different approach to learning and knowledge management from those who have not had such opportunity. Therefore, the integration of ICT is believed to be crucial for the welfare and well being of our future generations.

In educational reforms the teacher is the last but crucial chain in the process of educational change. However, when considering ICT related innovations in education we cannot consider teachers as isolated performers. In their schedule, Teachers follow routines, according to their pre-service training and on the work , they're required to implement curricular objectives and contents that very often are formally established, they work within the constraints of the school organisation having fixed time tables, etc. Innovations that need teachers to vary many aspects of their daily routines are very demanding for them. Complex innovations can only achieve success if variety of interacting conditions are met.

It is believed that when students learn with technology, they'll use it as a cognitive tool that helps them to construct meaning supported their prior knowledge and conceptual framework. The growth rate of Web users and developers has increased at large. Publishers, curriculum specialists, mathematicians, teachers, and students have placed an excellent deal of mathematics and mathematics-related information and activities online. There is a requirement to consolidate these applications in order that students can access a greater range of

learning opportunities and teachers can have a stronger sense of the technology's utility and connection to learning outcomes. Also technology enhances learning opportunities because it can efficiently support graphing, visualising, and computing. Moreover, the technology is used as a medium to provide resources and learning situations that would otherwise be unrealistic or impossible to create.

Digital Technologies and Mathematics Education

The mathematics education community is engaged with the question to find out how children best learn mathematics. Due to coherence property, Mathematics is a huge and constantly expanding network of interrelated facts and concepts just like the fields of cognitive development as well as the psychology of learning. A large proportion of teachers lately attempt to base much of their teaching practice on constructivist ideas— i.e., on the assumption that the teacher's role is to create opportunities for children to build their own understandings of concepts. However, if only we could discover precisely how the child best learns mathematics then we could work out exactly how to teach the child the subject in the most effective way.

Even though technology can influence what is taught, teachers need to be mindful of designing instruction and environments that promote content and learning framework. In fact, technology supports learning requirements when it is used "as a tool for processing the concepts with investigations and problem solving". Digital technologies are often seen as catalysts for a paradigm shift. Keeping in view of readily availability of

printed material and books, education has experienced a gradual shift away from the idea that its success relies on the student's capacity to memorise and accurately recall large amounts of information. Instead, developing research and problem-solving skills are on the wider targets. With emerging information and communication technologies (ICTs), in recent times, the main objective has rapidly mounted to shift our views on effective teaching and learning even further. Emphasis is now placed on equipping students with effective inquiry skills, including the power to seek out and process new information using digital technologies. Many educators are now seeing digital technologies, with their interconnectedness, as environments, instead of just tools, for learning and teaching. The difference between these two perspectives is significant, the former requiring a fundamental change in teaching practice for many teachers.

Challenges of Teaching with Technology

Considering the challenges with newer technologies present to teachers, for many teaching with basic technology may be complicated itself. Computers, handheld devices, and software applications like digital technologies, by contrast, are protean (usable in many different ways; Papert, 1980); unstable (rapidly changing); and opaque (the background workings are hidden from users; Turkle, 1995). Newer digital technologies, which are usable in many different ways, updating regularly, and opaque, present a great deal of challenges to teachers who are struggling for technology integrated teaching. Also facing complications while teaching with

technology gives an impact that technologies are neither neutral nor unbiased. Rather, particular technologies have their own propensities, potentials, affordances, and constraints that make them more suitable surely tasks than others. Understanding, how these affordances and constraints of available technologies are impacting teachers' classroom activities, is not straightforward and may require restructuring teacher education and teacher professional development by giving new thoughts.

Social and contextual factors also impacting the connections between teaching and technology. Teachers may not be getting adequate supports to integrate technology use into their work under social and institutional contexts. They often have inappropriate experience with using digital technologies for teaching and learning activities. Many teachers earned degrees at a time when educational technology was at a really different stage of development than it's today. It is, thus, not surprising that they are not consider themselves sufficiently prepared to use technology within the classroom and sometimes don't appreciate its value or relevance to teaching and learning. Acquiring a replacement knowledge domain and skill set are often challenging, particularly if it's a time-intensive activity that has got to fit into a busy schedule. Moreover, this data is unlikely to be used unless teachers can imagine technology uses that are according to their existing pedagogical beliefs (Ertmer, 2005). Furthermore, teachers have often been given inadequate training for this task. This is another dilemma, that even teachers operate in diverse contexts of teaching and learning, while technology integration

many approaches to teachers' professional development offer a one size-fits-all.

An Approach to Thinking About Technology Integration

Faced with these challenges, how can Mathematics teachers integrate technology into their teaching? An approach is required that treats teaching as an interaction between what teachers know and the way they apply what they know within the unique circumstances or contexts within their classrooms. To integrate technology into curriculum, the "one best way" is still unavailable. Rather, integration efforts should be creatively designed or structured for particular material ideas in specific classroom contexts. At the guts of excellent teaching with technology, there are three core components: content, pedagogy, and technology, plus the relationships among and between them. Since, these three components playing out differently across diverse contexts, the interactions between and among these components, account for the wide variations seen within the extent and quality of educational technology integration. Thus, these three knowledge components (content, pedagogy, and technology) form the core of the technology, pedagogy, and content knowledge (TPACK) framework.

Continuous Professional Development—Digital Integration

The TPCK framework in Mathematics through digital integration will be about supporting quality teaching in Mathematics. Our intent with the TPCK framework in Mathematics is to provide designing a way for teachers

as they seek to improve their effectiveness in delivering high-quality, productive mathematics learning experiences for all students.

We define tools and techniques in the TPCK framework in Mathematics for practical and user-friendly support for effective teaching. Regardless of how effective anybody could be in their teaching, we may still grow and improve. The TPCK framework in Mathematics will be aimed at continual improvement and sustaining quality teaching as well as for the beginners it will be designed to help identify areas to improve the performance, and to focus support for the important and continuous development. With TPCK framework in Mathematics, our ultimate goal is to improve the educational experiences and achievement of the students we serve in our schools by focusing directly on teacher effectiveness. The focus is for Pedagogical enhancement, Technological empowerment and effective content delivery.

In Order to enhance the quality resources and its availability to a Teacher of Mathematics, following points should be met by effective use of ICT.

- It should integrate easily into the teacher's daily work.
- By providing innovative presentations of content, increase interest for learning and making it a fun for those who find the concepts tough.

Designing TPCK Framework

- (i) Towards Pedagogical enhancement NCF-2005 recommends that Teachers are now facilitators for

students' learning by creating a learning environment intertwined with inquiry approach. Accordingly the teachers need to upgrade and reorient themselves. Though every teacher has her own style, here comprehensive technology exposures side by side, the way to design digital content resources with pedagogical approaches are going to be discussed. If ICT is to be successfully incorporated into any lesson then there are some fundamental issues that require to be tackled at a really early stage. The next success of the lesson depends upon that. Employing ICT tools as a part of a mathematics lesson isn't difficult, but it adds another dimension and therefore the place and purpose of it needs careful consideration.

Planning the ICT lesson

So what does ICT based mathematics lesson appear with in TPCK Framework? Much of it will be familiar, containing because it does all of the key features that one would expect during a plan for a mathematics lesson.

These features consider the following

- Selecting an appropriate topic: Why this, i.e., the particular topic been chosen?
 - Key learning objectives: What are the intended learning outcomes as a results of the lesson?
 - The content of the lesson: Teaching points.
 - Details of any prior learning: The start line may often be the children's previous experiences.
- Teaching methodology to be used: Focusing on ICT integration.
 - Key teaching points: What exactly you are going to transact? What will you communicate? What will be your query to make sure that they learn what you would like them to learn?
 - The foci for assessment: How to assess to ensure that students have learned? What are the intended learning outcomes?
 - Cross-curricular links: Are there any clear and relevant connections to other areas of the curriculum?
 - Follow-up work: Where does this lesson fit during entire teaching-learning episodes?

Based on above exhaustive features, the subsequent design for our template has been selected to develop a mathematics lesson:

1. Learning Objectives
2. Introduction of the subject
3. Flow of chapter (Step by Step containing GeoGebra and other Applets, etc.)
4. Examples
5. Hands on activities
 - (a) Self exploratory experiments (if any)
 - (b) Day to day application
 - (c) Application (Problem Solving)
 - (d) Interdisciplinary Applications / Problems
 - (e) HOTS questions

6. Extension activities
- (a) External Web resources for the content
 - (b) Suggested Readings
 - (c) Thought-provoking questions that lead students to do more exploration
- (ii) Towards Technological Empowerment
- Many ICT tools are available to support and enhance teaching and learning with digital media. Different software tools offer widely varied experiences and access to different aspects of a subject. Simply to consider the range of number of applications which users are learning to use in generally not a good way to monitor the value of new technologies. One user who only uses a single application may achieve far more in the same time than another user who uses several. Software applications are resources and it is more important to think about the nature of the user's experiences. Use of software can be invoked in two distinct ways. Sometimes it's appropriate to offer the user a ready-made document or file which has been already created and invite them to explore it. At other times, it may be better for users to create their own from scratch, as they express themselves with contentment by means of a more open application or resource. While using tools like Geo-Gebra, etc., users give shape to their own ideas in "expressive mode," as well as in pre-planned "exploratory mode." Geogebra or other applets can be pre-built for users to explore or they can build their own reflecting their particular way of looking at a situation.

One may use these open source software to develop a module based with TPCK framework in mathematics:

1. GeoGebra Applets (www.geogebra.org): For dynamic and interactive representations of mathematics content.
2. LA TEX (<http://www.latex-project.org/>): A document preparation system
3. PS tricks (<http://tug.org/PSTricks/>): A set of macros that allow the inclusion of PostScript drawings directly inside LA TEX code
4. Camstudio (<http://camstudio.org>): Software that can record all screen and audio activity on your computer and create video files (i.e., screencasts)
5. Wink (<http://www.debugmode.com/wink/>): Screencasting software
6. Screencast-o-matic (<http://www.screencast-o-matic.com>): Screencasting software
7. UnFreez (<http://www.whitsoftdev.com/unfreez/>): An application that will take any number of images, saved as separate GIF files, and create a single animated GIF from those images.
8. eXe (<http://exelearning.org/wiki>): Application for snapping (capturing) images from selected parts of one's computer screen (i.e., screen capture)
9. MWSnap (<http://www.mirekw.com/winfreeware/>): Screen capture software
10. Eclipse (<http://www.eclipsecrossword.com>): Software that generates crossword puzzles from lists of words and clues

11. Tarsia Formulator (<http://www.mmlsoft.com>): Software to create, print out, save and exchange customised jigsaws, domino activities and a variety of rectangular card sort activities
12. Graph (<http://www.padowan.dk/graph/>): Graph is an open source application used to draw mathematical graphs in a coordinate system
13. Libre Office (<http://www.libreoffice.org/>): LibreOffice is an open source personal productivity suite for Windows, Macintosh and GNU/Linux, that includes 6 document production applications (e.g., spreadsheet, word processor, presentation software)
14. Scratch (<http://scratch.mit.edu/>): It is a programming language to create user's own interactive stories, animations, games, music, and art- and share their creations on the Webpage.
15. DIA (<http://live.gnome.org/dia/>): Dia is a GTK+ based diagram creation program for GNU/Linux, MacOS X, Unix, and Windows
16. Freemind (<http://freemind.sourceforge.net>): It is a free mind-mapping software written in Java. Basically, Mind maps are tools to visualise, generate, structure, and classify ideas. This is also very useful in studying and organising information, solving problems, making decisions, and writing.
17. Geonext (<http://www.tdmaths.com/en/geonext.htm>): Geonext is an interactive and dynamical geometry program for making geometric constructions.
18. WinPlot (<http://math.exeter.edu/rparris/winplot.html>): Winplot is a general-purpose interactive plotting utility use to draw (and animate) curves and surfaces presented in a several formats.

General Approaches

During learning, meaningful interaction depends upon students individually constructing their own figures from a blank screen (the expressive option). One way to develop meaningful interaction is to run a teacher centred lesson using a single laptop with a data projector and an interactive whiteboard. A second possibility is to supply students with pre-constructed sketches. With such files, students can manipulate the figures that appear before them: many of the initial access problems are bypassed.

Thinking Geometrically — Dynamics through Software (Pedagogical Implications)

As teachers, we know that "Geometry" is a skill of the eyes and hands as well as of the mind. The word "Theorem" comes from a Greek words meaning "vision" and 'theatre': both are concerned with display; both have a touch of revelatory magic about them. The power of software like GeoGebra lies within the way its users interact directly with geometric figures they need constructed (or that are pre-constructed for them). This interaction occurs in a continuous and dynamic way, by means of the direct control of one's hand on the mouse. It is also possible to 'animate' a construction, so that the screen images move 'on their own.' But, for us, the foremost striking and powerful impact comes when, in pursuit of a mathematical question or goal, students directly explore a

geometrical realm informed by hand and eye, focused by their minds. One of the problems in trying to explain motion and its effects in text is that one necessarily has got to miss out on all of the essential ingredients. In fact, animating mathematical diagrams and illustrations can bring, externalising and setting back in motion images that are held static within the pages of textbooks provide a sense of surprise and wonder. Towards this pedagogical requirement we need to separate out exploratory versus expressive approaches to using GeoGebra. In other words, we must confront the decision of offering users preconstructed files to explore versus providing students with tasks that require the construction of their own figures. And, as always, there's the overall pedagogic question of what sorts of questions and tasks can help students to focus their attention on the mathematically important aspects of the situations presented to them by others or generated by them. There's a learning curve involved in acquiring a particular function within software itself. (Murdock, Kamischke, and Kamischke, 2002). A task that appears simple when demonstrated by an informed individual might involve steps that aren't so easily discovered by a beginner. Interactive geometry software, like GeoGebra, etc., offers teachers and their students a wide variety of tools and facilities to explore mathematics. Some users thrive in such an open-search setting, exploring at length and at will. Others can become somewhat overwhelmed initially by the variety of options in the menus and by the fact that each tool does something mathematical to the image on the screen and is related to a geometrical concept. However, with a structured introduction to certain available tools, and with perhaps some introduction to the experience of dragging

dynamic constructions, users can acquire confidence and build valuable insights. There are two different but related kinds of learning involved in using software, which we call instrumental and conceptual. Instrumental learning is about the way to do things within the specific software: the way to create points or lines or circles, the way to operate with menu items (like 'rotate' or 'construct perpendicular bisector'), the way to perform calculations (like measuring lengths, areas or angles). Instrumental learning reflects decisions made by the software designer. For example, so as to be an efficient user of the software, the scholar may have to seek out and use the tool to construct a midpoint. Such learning isn't intrinsically mathematical and may be developed during a context during which students aren't deliberately extending their mathematical understanding. Tasks that develop instrumental understanding may involve the creation of images or the utilisation of features like reflection or animation. One striking thing about interactive geometry software is that instrumental learning is also frequently conceptual. Mathematical language of the interface both provides and seeds the well-liked vocabulary for subsequent mathematical discussion. An understanding of some or many of these terms is gained in the software environment and the words act as both labels for that experience as well as the commands to make that action occur. Thus, the words can serve as both verbs and nouns. This is a common process in mathematics, where verbs are turned into nouns. However, effective use of the software also requires conceptual learning. Conceptual learning develops gradually, through deepening experience with both geometry and therefore the software, both on and off the PC. It is often difficult for

users to form a sense of the visual complexity of a filled, changeable display screen. A more experienced user learns to 'hide' objects used in a construction and to construct visible line segments where they need to be visible. The pedagogy regarding working with pre-constructed sketches or students constructing their own sketches may be refereed in 16.

Focusing Attention when Exploring Geometry

Whether constructing from a blank screen (expressing) or exploring a pre-constructed file (exploring), many users will benefit from having some fundamental questions to ask themselves as they investigate. Some fundamental questions need to address while working geometrically, both with and without pre-constructed files. It might be involved in helping users deal meaningfully with these questions.

What's happening ...? – It is not always a straightforward question to answer, as it is not always easy to make sense of a confusion of changing geometric figures. One way of beginning to make sense of what's happening is to start with the question of what stays the same and what changes? This question focuses attention on the hunt for invariance, a fundamental issue in geometrical thinking.

What if?– What if? questions provide a variation on the theme of trying to find invariance. The process is now one of asking 'if I change this, what else changes?' and, by implication, 'what stays the same?' 'What if . . .?' questions are particularly important in whole-class discussion around one screen? At every stage, students can be asked to predict what will happen if the

teacher changes something. It is also a crucial question in independent exploration, where the question can cause changing initial aspects of things to increase a task.

Can I make . . . happen? – The question could be quite simple ('can I create a triangle of a particular area?') or it might involve complex problem-solving ('can I create a file to prove the Pythagoras theorem?'). The solution to the question may end up to be 'no,' but the method of exploration still could be valuable. For example, an attempt to create a triangle with two right angles may lead to an understanding of why this is not possible.

Summary

Thus, we've looked at ICT integrated pedagogical approaches in quality mathematics learning for sustainable development. Although interactive geometry is often used anywhere within the mathematics curriculum where a visible approach is acceptable, it's geometry and geometric thinking that underlie all such models. GeoGebra and other software-based interactive content materials will form a resource pool and motivate users from exploratory mode towards expressive mode.

Thus a primary goal is to know the relationships between two key domains: (a) teacher thought processes and knowledge and (b) teachers' actions and their observable effects. The TPACK framework seeks to increase tradition of research and scholarship by bringing technology integration into the sorts of knowledge that teachers got to consider when teaching towards ESD. The TPACK framework enforces development of better techniques for discovering and describing how technology-related

professional knowledge is implemented and instantiated in practice and ultimately influence ESD. By better describing the kinds of data teachers need (in the shape of content, pedagogy, technology, contexts and their interactions), educators are during a better position to know the variance in levels of technology integration occurring. Additionally, the TPACK framework offers several possibilities for promoting research in teacher education, teacher professional development, and teachers' use of technology. It offers

options for watching a posh phenomenon like technology integration in ways in which are now amenable to analysis and development. In summary, TPACK allows teachers, researchers, and teacher educators to think beyond oversimplified approaches that treat technology as an "add-on" instead to focus and redesign entire teaching-learning scenario, and during a more ecological way, upon the connections among technology, content, and pedagogy towards Education for Sustainable Development.

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CONTINUOUS PROFESSIONAL DEVELOPMENT OF TEACHERS WITH WEB PORTAL AND MOBILE APPLICATION

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It is generally observed that a teacher needs quality pre-service and in-service education to become more mature and confident to perform their task more efficiently and effectively. The cascade model of In-service Teacher training has a problem of information loss and speed of scaling to reach the mass. ICT plays a significant role in the continuous professional development of In-service teachers. The Curricula for ICT in Education (2012) broadly attempts to equip teachers with ICT competencies to strengthen their own professional capacities and to effectively use ICT tools and devices in their teaching-learning. The online courses teachers in the subject areas, pedagogical concerns and ICT hosted on various Web portals like ICT curriculum Website (<http://ictcurriculum.gov.in/>), NCERT Web portal for In-service Teacher Professional Development (ITPD) courses (<http://itpd.ncert.gov.in/>), SWAYAM portal (swayam.gov.in) for Massive Open Online Courses (MOOCs), DIKSHA Web portal (<https://diksha.gov.in/>) etc., and several Mobile Applications like ChalkL it, specially designed for teacher education and training, are solving the purpose of Teachers' continuous professional development. Recently, National Initiative for School Head's and Teachers' Holistic Advancements (NISHTHA), an integrated teacher training of nearly 42 lakh teachers in the country is almost completed. ICT supported the training by providing educational resources to teachers through a dedicated Web portal (nishtha.ncert.gov.in) and mobile app anytime anywhere and handhold the learning of teachers during training as well as monitored the complete training programme.

Key words: *Continuous Professional Development, ITPD, ICT, MOOC, SWAYAM, DIKSHA, NISHTHA*

Introduction

The quality of citizens' life in a country is significantly determined by the quality of education they receive. The quality of their education depends on their teachers. It is generally observed that a teacher needs quality teacher education before joining the service as well as quality In-service Teacher Professional Development to become more mature and confident to perform his/her task more efficiently and effectively. The traditional method of In-service teacher training is based on cascade model. This model of training has observed problem of information loss and it is very difficult to reach each and every teacher with in a short period of time.

Further new development in Information and Communication Technology (ICT) and its increasing availability put high demand on teachers to integrate ICT into their teaching and learning. Teachers entered the workforce need not only to be equipped with the skills to use those new technologies, but also to be flexible, adaptable, and multi-skilled.

Continuous Professional Development of Teachers with ICT

It is widely accepted that ICT has potential to introduce and sustain education reform efforts towards making a world class citizen. Further, ICT is becoming integral part of the society; most of our young population is

using ICT in one way or another and we dare to predict that the use of ICTs will increase very fast in future. Similarly majority of our youth learners are learning through ICTs like learning through online learning platforms, social networking platforms and mobile applications, etc. Such kind of uses of ICT in the society is creating the demands for on-going professional development of teachers. ICTs can be important tools to support meet such increased needs, by helping to provide access to more and better educational content, aid in routine administrative tasks, provide models of effective teaching practices, and create learner support system, both in face to face and distance learning situations. Planning for teaching-learning through digital tools, presenting content in digital forms, communicating with learners and peer learners with ICTs and assessing learner's performance digitally are some examples of ICT integration in teaching and learning.

Several initiatives related to professional development of teachers through ICT have been taken. Some of the major initiatives are as follows:

Online Course Platforms

Internet may provide a large number of online learning opportunities as one can access educational content, interact with teachers or experts, discuss with peers and can learn in online courses, etc. The online learning platform may supply the reading materials as well as opportunity to post your learning. Following are some examples of online learning platforms:

- NCERT ICT curriculum portal (www.ictcurriculum.gov.in)
- NCERT ITPD portal (itpd.ncert.nic.in)

- SWAYAM (swayam.gov.in)
- NISHTHA (nishtha.ncert.gov.in)
- DIKSHA (diksha.gov.in)

and some others as follows:

- The Open University, London
- Commonwealth of Learning - <http://cctonline.org/>
- Khan Academy - <https://www.khanacademy.org/>
- Sailor - <https://learn.saylor.org/>
- EdTech Leaders Online - <http://www.edtechleaders.org/>
- iEARN - <http://www.iearn.org> and so on.

NCERT Online In-service Teacher Professional Development Courses

Teachers need continuous content and pedagogic enrichment to address the diverse needs of children in their classrooms so that their learning outcomes will be improved. NCERT is developing and offering various online Teacher Professional Development courses that provide teachers an opportunity to get online training as per their need and time with continuous mentoring support from the experts in the field. These courses may help teachers in developing their reflective skills and improve teaching in the classroom. The course integrates concerns regarding gender, adolescent learners, ICT, etc., along with subject specific content. This course was offered for science teachers at the upper primary and secondary stages and for Environmental Studies for teachers at the primary stage. Each module of the course contains video about the module, text, assessment questions and links for extended

learning. Besides, an online course on action research for teachers is being conducted at regular intervals in the MOODLE platform (<http://ictcurriculum.gov.in/course/index.php?categoryid=125>). Post Graduate Diploma in Guidance and Counseling for in-service teachers is also offered through the same course portal.



Fig. 1: NCERT ITPD Web portal

Courses based on Curricula for ICT in Education

For the teacher, it is an initiation into—exploring educational possibilities of technology, learning to make right choices

of hardware, software and ICT interactions and Growing to become a critical user of ICT. The curriculum is rolled out as a series of short courses. Three induction and 20 refresher courses leading to a diploma in ICT in Education is proposed.

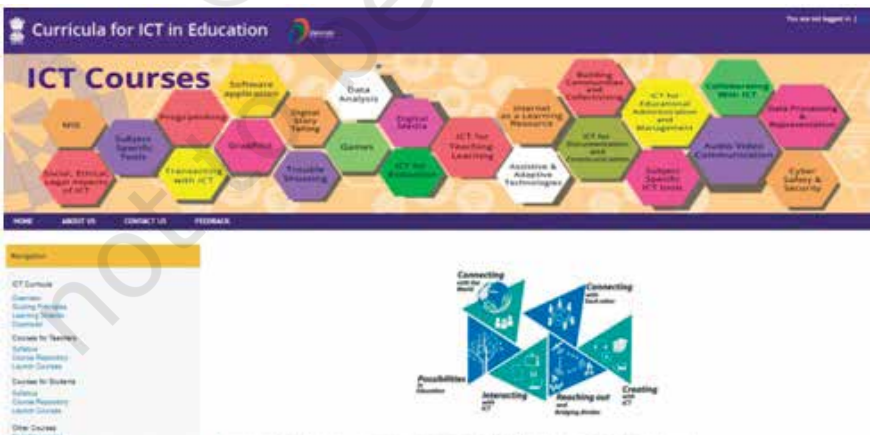


Fig. 2: ICT Curriculum Web portal

MOOCs on SWAYAM

Online education has been around for a long time. But Massive Open Online Courses (MOOCs) have made online learning more significant and meaningful. The term MOOC was used for the first time by Dave Cormier in 2008. Conceptually, MOOCs refer to massive, open and free courses. There are several platforms across the world such as edX, Coursera, Khan Academy, Udemy, Canvas, Futurelearn, Udacity and NPTEL and SWAYAM from India that offer online courses for the mass. There are several benefits of MOOCs for professional teacher development. Firstly, MOOCs offer increased exposure for teachers to OER resources. Secondly, these courses use blended learning and flipped classroom approach to improve the teachers' academic understanding and that they can then bring into their classrooms. Thirdly, the professional network of teachers increased drastically with the use of such courses that can include participants from all over the world. Professional development of teachers through MOOCs is creating a community for learning with like-minded peers across the globe. This trend of community building and exchange of ideas, best practices, and lessons learned is also increasing significantly.

Ministry of Human Resource Development (MHRD), renamed as Ministry of Education, Government of India has launched a MOOCs platform popularly known as SWAYAM (Study Webs of Active learning for Young Aspiring Minds) on 9 July, 2017. The portal offers online courses for students, teachers and teacher educators from school education and higher education to promote quality education and lifelong learning. SWAYAM is intended to achieve the three important

principles of Education Policy viz., access, equity and quality. It is aimed to provide the best teaching learning resources and academic support by the best minds across the country to all learners including the most disadvantaged. SWAYAM is hosting more than thousands courses, starting from Class XI till post-graduation courses that can be accessed by anyone, anywhere at any time. These courses are interactive in nature and available, free of cost to all. The best teachers across the country are engaged in creating these courses to provide the quality learning. SWAYAM adopted four quadrants approach in these courses considering the essential components in face to face classroom teaching-learning.

- The first quadrant is video lecture along with transcription that is similar to the teachers' presentation in face-to-face classroom situation.
- The second quadrant is e-content that is specially prepared reading material that may include PDF, Text, e-Books, Illustrations, documents and interactive simulations including Web links, Wikipedia, open content, etc.
- The third quadrant is self-assessment through tests and quizzes and
- The last quadrant is an online discussion forum for clearing the doubts.

In order to ensure best quality in these courses, a detailed guideline to create and run MOOCs are developed. Further, national coordinators have been appointed to ensure and sustain the quality of these courses on SWAYAM. As one of the national coordinators, NCERT is developing and running courses for students and teachers in school education.

In order to ensure that best quality content are produced and delivered, seven national coordinators have been appointed: They are NPTEL for engineering, UGC for post-

graduation education, CEC for under-graduate education, NCERT and NIOS for school education, IGNOU for out of the school students and IIMB for management studies.



Fig. 3: SWAYAM portal

NISHTHA

NISHTHA - National Initiative for School Heads' and Teachers' Holistic Advancement is an initiative to build capacities of teachers and school principals at the elementary stage. The programme aimed to build the capacities of around 42 lakh participants covering all teachers and heads of schools at the elementary level in all Government schools, faculty members of State Councils of Educational Research and Training (SCERTs), District Institutes of Education and Training (DIETs) as well as Block Resource Coordinators and Cluster Resource Coordinators in all States and UTs. This

programme is organised by constituting National Resource Groups (NRGs) and State Resource Groups (SRGs) at the National and the State level who are training 42 lakhs teachers subsequently. A robust portal— Management Information System (MIS) for delivery of the training, monitoring and support mechanism will also be infused with this capacity building initiative.

Highlights of NISHTHA Web portal and Mobile App

The web portal made the course modules accessible anytime, anywhere free to everyone. The course materials include modules in pdf format, panel discussion

on the module theme in video format and presentation in ppt format. The Web portal has also other Web resources in different formats like documents, images, audio, videos and interactive hosted on various Web portals such as NROER, ePathshala and DIKSHA, etc. The NISHTHA Web portal facilitated teachers' learning during training by providing course modules as well as other supplementary e-resources followed by the opportunity to discuss with resource

persons using discussion forum on the Website. The training is also monitored using the Web portal and the details of the training programme including training date, place, teachers and resource persons, etc., shared in the dashboard on the Web portal. The portal also has the features of sharing the photos and videos of the training, news clips and best practices of teachers during training and after training.

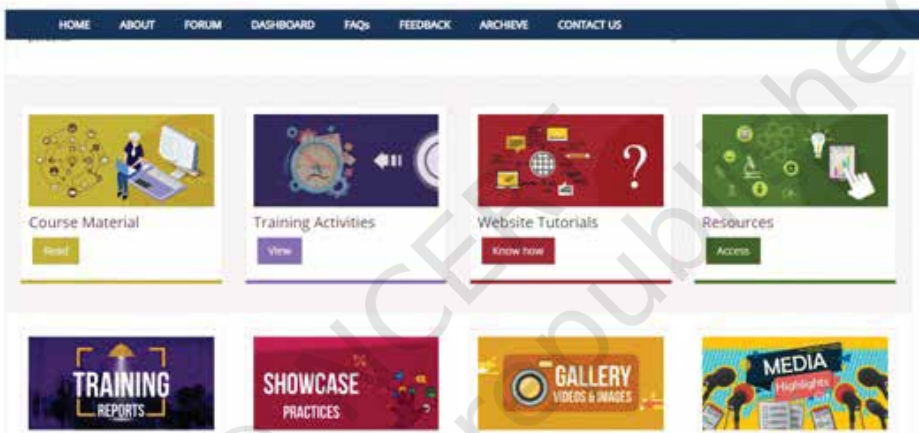


Fig. 4: Main highlights of NISHTHA Website

NISHTHA mobile app is designed and developed to share the educational

resources including course modules, and supplementary resources offline.



Fig. 5: NISHTHA mobile app

DIKSHA

MHRD has launched DIKSHA portal for providing digital platform to teachers giving them an opportunity to learn and train themselves and connect with teacher community. The portal envisages helping teachers boost their teaching skills and create their own separate profile with their skills and knowledge, and help in improving quality of education with use of latest technologies in education sector. DIKSHA as National Digital Infrastructure for Teachers will enable, accelerate and amplify solutions in realm of teacher education. All teachers across nation will be equipped with advanced digital

technology. It is helping teachers to create training content, profile, in-class resources, assessment aids, news and announcement and connect with teacher community. The DIKSHA platform and mobile app offers teachers, students and parents engaging learning material relevant to the prescribed school curriculum. Teachers have access to aids like lesson plans, worksheets and activities, to create enjoyable classroom experiences. Students understand concepts, revise lessons and do practice exercises. One of the verticals of DIKSHA, Teacher professional development provides contextualised digital courses that support teachers in their professional development.



Fig. 6: NISHTHA mobile app

Mobile Apps for Teacher Training

There are several mobile applications that are designed and developed by various agencies to provide training to teachers. All the major initiatives for teacher professional development discussed in this article like SWAYAM, DIKSHA, NISHTHA are also

available in mobile applications. But there are some mobile applications that are designed specifically for teacher training. ChalkLit is one of such mobile applications for teacher education and training. ChalkLit provides tools, resources, and trainings to teachers to help them teach better in their classrooms. It also offers a personalised peer to peer social

micro learning network where teachers can learn from the best practices and experience of other teachers.

Conclusion

In this paper, we have discussed various opportunities that are provided by ICTs for teachers for their professional development. We have explored several online learning platforms for providing teachers' professional development. There are several MOOC platforms, such as, edX from Harvard and MIT and even private portals that offers various courses. The potential benefit for using MOOCs for professional teacher development is that

they offer increased exposure for teachers to OER resources, which make blended learning and flipped classroom type efforts more accessible. Also, online learning through MOOCs advances the teachers' academic understanding and that they can then bring into the classroom. Further, MOOC providers should sustain the quality of learning and at the same time, teachers should value and accept these courses as opportunity for their professional development. The combination of MOOCs and professional teacher development warrants more empirical and analytical research in the future in order to better study the potential successes and hazards.

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COMPUTATIONAL PHYSICS WITH SPREADSHEET – I

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Introduction

Physics deals with two different approaches, namely experimental and theoretical. During last couple of decades the computational physics has emerged as a very powerful tool to do physics.

In this series of articles, we discuss the use of spreadsheet programme to deal with simple problems in basic Physics. We use Microsoft Excel as a spreadsheet programme as it is most commonly accessible. Other spreadsheets function almost in the same manner.

In this article we discuss plotting of simple graphs as relation between physical quantities.

How to use EXCEL (Skip this section if you are already familiar with EXCEL)

When we open a new EXCEL file, it displays worksheet which has rows and columns. In each cell, we may either enter a data or a formula. When formula is entered, it calculates the result and displays it in the cell. Whether a given cell contains a formula or just data can be seen by looking at formula bar.

Each cell has a name. When we select a cell by taking the cursor on it and clicking, its

name appears in the name box. The default name of the cell is its address written by column and row, e.g., A3 means column A and 3rd row or BFA36789 means column BFA and row 36789. We may change the name of the cell by typing it in its name box.

MS Excel worksheet (with office 7 version) has 16384 columns, i.e., A, B,... Z, AA, ..., AZ, BA, ..., ZZ, AAA, AAB, ..., XFD and 1048576 rows.

We can do mathematical or logical operations on data. For this we write a formula in a cell where we want the result to appear. The formula contains name of the cells containing data in place of variables. For example, if data is stored in cell A3 and B3 and we want its product in the cell G3, then in the cell G3 we write formula: `'=A3*B3'` (with no quotation symbols). All formulae start with '=' sign. So when the excel sees that the content of a cell starts with '=' sign, it interprets it as a formula, otherwise the contents of the cell are treated as data.

Example: if cell A3 contains 35 and cell B3 contains 2, then cell G3 will contain the answer of product of 35 and 2 in the above example.

It is possible to copy a formula from one cell and apply it to other cells. However, when a formula is copied, excel modifies the formula

that refer the data by relatively changing the cell addresses.

Example: from the above example if the formula in cell G3 is copied to G4, the formula will automatically change to '=A4*B4'. Since, the formula is shifted one row below, all the addresses are also shifted down by one row. This most of the times turns out to be a very useful feature.

Now if the formula from G3 is copied to J3 (i.e., 3 columns to right) then it automatically changes to '=D3*E3'. So we have to be careful when we copy the formula from one cell to another.

Applying formula to multiple cells

When we want to apply the same formula to multiple cells, we may use any of the following methods:

1. Drag the formula
2. Copy and paste the formula

Enter the formula in one of the cells and press Enter key. This will make Excel to evaluate the formula and store the result. Now take the cursor to the bottom right corner of the cell containing formula so that the cursor changes from white + sign to the dark + sign. Now click the mouse left button and drag the cursor to all the cells where formula is to be applied. This method is useful when the formula is to be applied to an entire row or column.

Alternately, after evaluating the formula where it was entered first, keep the cursor on that cell, and copy the cell. For copying the cell, we can right click on mouse and select copy in the appeared menu or use the short-cut key CTRL+C (i.e., press CTRL button on keyboard, and while this button is kept pressed, also press button C). This will copy

the formula from the cell to internal memory clipboard of Excel. When contents of cell are copied, the cell gets a dotted blinking border. Now wherever we want to apply the formula, select those cells and paste it by pressing CTRL+V on the keyboard or right click the mouse on the selected cell and click on paste. Even after pasting the contents, the original cell contents are still in the memory. To remove that, press Esc key. This will remove the contents from memory clipboard and the blinking border will also disappear.

Locking the cells

Many times we may want to use the same constant in formulae for the entire data set. For example, if we want to calculate the function. We may put x values in column A and the calculated function in column B. So, x values may be from cells A5 to A15. Now the constant A we may write in cells say A2. To evaluate the function for the first data point, we may write formula '=A2*EXP(-A5)' in cell B5. However, when we copy the formula from B5 to B6, it will not only change the variable x from A5 to A6, it will also change the cell reference A2 to A3. This will cause an error as the constant is written only in cell A2 and not in A3. So we need to lock the cell A2 in the formula. This is done by using \$ sign before the row number in A2, i.e., instead of referring it as A2 we shall write this as A\$2. The formula in B5 then will be '=A\$2*EXP(-A5)'. This when copied to cell B6 will read as '=A\$2*EXP(-A6)'.

Plotting data

For plotting data we may use a chart. For plotting the points of data, select the data cells and then click on Insert tab → Scatter button in Charts group. There are five different options of scatter plot: 1) only

points, 2) consecutive points are joined by straight lines, 3) consecutive points are joined by smooth curves, 4) and 5) points are joined like in 2nd and 3rd option respectively, but the points themselves are not displayed.

The charts are not graphs, in a sense that no best fit curve is drawn for the given data points. For best fit curves there is an option of adding trend lines, but we shall not discuss that here.

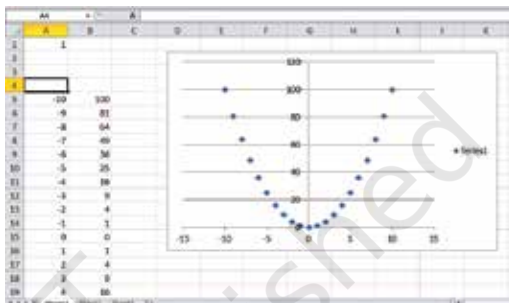
Example

Suppose we want to plot the x^2 function.

We decide to take x values from -10 to 10 in the step of 1 .

1. We enter -10 in the cell A5.
2. We enter incremental step value of 1 in cell A1.
3. We write formula in A6 as $'=A5+A\$1'$ (A\$1 implies the cell A1 is locked in the formula). When we press enter, it shows the value -9 .
4. Now we drag this formula up to cell A25. Cell A25 will display value 10 whereas the formula bar shows that it actually contains the formula $'=A24+A\$1'$
5. This has given us x data points from $-10, -9, \dots, 0, \dots, 9, 10$.
6. Now in cell B5, write the formula $'=A5^2'$. (^ symbol indicates the raised to operation. So here it is content of A5 cells are raised to 2.) and press Enter.
7. The cell will show the result 100 .
8. Drag the formula till B25.
9. So we finally get the numbers in B5 to B25 as $100, 81, 64, \dots, 0, \dots, 81, 100$

10. Select the cells A5 to B25.
11. Click on Insert tab \rightarrow Scatter (in charts tab) \rightarrow first option of only points.
12. You will see the points in parabolic pattern.



Consider another example.

Example: Suppose we want to plot the following relation.

We decide to simulate real life data: let the constant be 22.4 atm-litre . Now let's see how pressure varies as volume is changed from 10 litres to 65 litres. (Excel only handles the numbers, we interpret and assign the units.)

1. Put incremental volume of 1 in A1, constant 22.4 in cell B1.
2. Enter 10 in cell A5.
3. Write the formula $'=A5+A\$1'$ in cell A6 and press Enter. Drag the formula in cell A6 to A60. We get the volume values from 10 to 65 in the steps of 1 .
4. Enter the formula $'=B\$1/A5'$ in cell B5 and drag it upto cell B60. These are then the values of pressures (in atm) as predicted by Boyle's law.

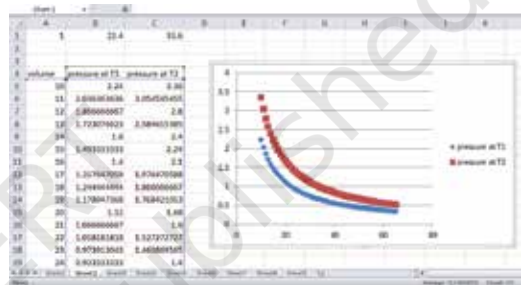
5. Select the cells from A5 to B60. Click on Insert tab → Scatter button (in charts tab) → select first option of Scatter with Only Markers.
6. We see the hyperbolic curve of Boyle's law.

Now we may add another set of data in the same worksheet and chart for a different constant. Say for the same gas if the temperature is increased and for this increased temperature the constant is say 33.6 atm-litre.

1. Write this new constant 33.6 in cell C1.
2. In cell C5 write the formula '=C\$1/A5' and enter. Drag the formula upto cell C60.
3. Write the labels for the columns in 4th row, Volume in A4, pressure at T1 in B4 and pressure at T2 in C4.
4. So we get the new values of pressure corresponding to higher temperature.
5. Now right click on the chart's plot area.
6. Click on Select Data. A dialogue box opens.
7. Click on 'Add' under Legend entries (series).
8. A box for edit series opens.
9. Click on the icon given in Series X values. The box reduces only to show X values. Click on A5 and drag till A60. The series X value will automatically update to '=Sheet1!\$A\$4:\$A\$60'. Again click on the icon in the box. The original dialogue box will appear.
10. Now in Series Y values click on the icons. In the reduced Y values box, click

on C5 and drag till C60. The series Y values will automatically update to '=Sheet1!\$C\$4:\$C\$60'. Again click on the icon in the box. The original dialogue box will appear. Now click on Ok and then again Ok on Select Data Source dialogue box.

11. The original chart has now two curves in two colours. They are represented as pressure at T1 and pressure at T2.



Just to feel comfortable, one may try following exercise and build familiarity with spreadsheet.

Exercise

1. The displacement of an object under uniform acceleration is given by $S = ut + \frac{1}{2}at^2$. Consider a car accelerating from zero initial velocity with an acceleration of 1.00m/s². Plot the displacement as a function of t from 0s to 60s.
2. Consider a ball thrown up with a speed of 30.0 m/s. Calculate and plot the displacement of the ball taking acceleration as -9.8m/s for time t = 0.0s to 6.0s in the incremental step of 0.1s.

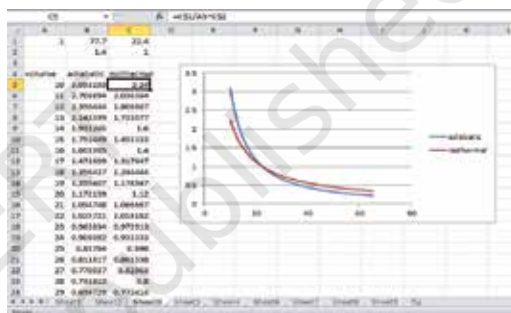
Adiabatic curve $pV^\gamma = \text{Constant}$

Let γ be 1.4 and the constant be 22.4atm-litre. Now let's see how pressure varies as volume is changed from 10 lit to 65 lit. (Excel only handles the numbers, we interpret and assign the units.)

1. Put incremental volume of 1 in A1, constant 22.4 in cell B1.
2. Enter 10 in cell A5.
3. Write the formula '=A5+A\$1' in cell A6 and press Enter. Drag the formula in cell A6 to A60. We get the volume values from 10 to 65 in the steps of 1.
4. Enter the formula '=B\$1/A5^B\$2' in cell B5 and drag it up to cell B60. These are then the values of pressure (in atm) for adiabatic change.

5. Plot the curve for pressure versus volume data using 'scatter with smooth lines' option. We see the adiabatic curve.
6. For comparison we may also plot the isothermal curve (Boyle's law curve) and compare the two curves.

We observe that the adiabatic curve falls faster than the isothermal curve as volume increases, i.e., the pressure falls faster in adiabatic expansion than the thermal expansion.



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SCIENCE NEWS



Smartphones may decrease sedentary time, increase activity, study finds

Report calls use of prompts 'a promising strategy'

Using smartphone reminders to prompt people to get moving may help reduce sedentary behaviour, report investigators. Evidence has linked sedentary time to increased risk of breast, colorectal, ovarian, endometrial, and prostate cancers as well as weight gain, higher BMI, and obesity. Nevertheless, adults in the US spend an average of about 8 waking hours per day being sedentary.

Evidence has linked sedentary time to increased risk of breast, colorectal, ovarian, endometrial, and prostate cancers as well as weight gain, higher BMI, and obesity. Nevertheless, adults in the U.S. spend an average of about 8 waking hours per day being sedentary. Few interventions have specifically focused on decreasing and interrupting sedentary time and even less

is known about the role of mobile phone technology.

Researchers Darla E. Kendzor, PhD of the University of Oklahoma Health Sciences Center and Kerem Shuval, PhD of the American Cancer Society explored whether smartphone interventions have the potential to influence sedentary behaviour. Nearly two in three U.S. adults owned smartphones in 2015.

Participants wore accelerometers, to measure movement, and carried smartphones for seven consecutive days. Participants who reported more than two hours of sitting during the previous day or replied that they were sitting during any random smartphone assessment received a message emphasising that long uninterrupted sitting is bad for health, and encouraging them to stand up and move around more, and to sit less.

Over the seven-day study period, participants had significantly fewer minutes of daily sedentary time and more daily minutes of active time than controls. Accelerometers

recorded three percent less sedentary time than control participants, equaling about 25 minutes of time spent engaged in activity rather than in sedentary behavior on any given day.

Due to the pilot nature of the study it had inherent limitations that should be noted: it was not randomised and the duration was brief. Nonetheless, the authors say: "Overall, simple smartphone prompts appear to be a promising strategy for reducing sedentary behavior and increasing activity, though adequately-powered and well-designed studies will be needed to confirm these preliminary findings."

Small talk: Electronic media keeping kids from communicating with parents

It happens in many households. Kids are tapping on their cell phones or are preoccupied by their favorite TV show as their parents ask them a question or want them to do a chore. Unlike previous research that has relied on self-reports by parents tracking their children's media usage, a new study used enhanced audio equipment to track the home environment of preschoolers as they interacted with parents in 2010 and 2011.

It's not just teens caught up in electronic media, but also preschoolers. In fact, there is little mother-child dialogue or conversation while children ages 3 to 5 are using media, such as TV, video games and mobile devices, according to a new University of Michigan study.

Unlike previous research that has relied on self-reports by parents tracking their children's media usage, the U-M study used

enhanced audio equipment to track the home environment of preschoolers as they interacted with parents in 2010 and 2011.

For the study's 44 families, the recordings averaged nearly 10 hours daily. The recordings documented the format of media used, duration and communication between the mother and child.

The audio recording output indicated when the recording device "picked up" a media signal, which allowed researchers to code media use and transcribe media-related talk at home. Researchers also examined demographic differences in media use and mother-child communication about media.

Children of mothers with graduate degrees had less electronic media exposure than kids of mothers with high school degrees and/or some college courses, the study showed.

The kids whose moms had advanced degrees often watched educational programs. In addition, these highly educated mothers were more likely than other mothers to discuss media with their children, said Nicholas Waters, the study's lead author and survey specialist at the U-M Institute for Social Research.

"Importantly, children of mothers with less than a graduate degree were exposed to media without any dialogue related to the media content for the vast majority of the time," said co-author Sarah Domoff, a research fellow with the U-M Center for Human Growth and Development.

This is important, she said, because parents' "active mediation" of television and other types of media may mitigate risks associated with media exposure.

Waters and Domoff also collaborated on the study with Sandra Tang, a researcher in the Department of Psychology and Institute for Social Research. Future studies might include father-child interactions, they said.

Domoff will present the findings May 29 at the annual Association for Psychological Science conference in Chicago.

Restoring chemotherapy sensitivity by boosting microRNA levels

By increasing the level of a specific microRNA (miRNA) molecule, researchers have for the first time restored chemotherapy sensitivity in vitro to a line of human pancreatic cancer cells that had developed resistance to a common treatment drug.

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If the miRNA molecules can be delivered to cells in the human body — potentially with nanoparticles — the technique might one day be used to battle the chemotherapy resistance that often develops during cancer treatment. A research team at the Georgia Institute of Technology identified the miRNA used in the research with a computer algorithm that compared the ability of different miRNAs to control the more than 500 genes that were up-regulated in drug-resistant cancer cells.

The study was scheduled to be reported May 27 in the Nature Publishing Group journal *Cancer Gene Therapy*.

"We were specifically interested in what role miRNAs might play in developing drug resistance in these cancer cells," said John McDonald, a professor in Georgia Tech's School of Biology and director of its Integrated Cancer Research Center. "By increasing the levels of the miRNA governing the suite of genes we identified, we increased the cells' drug sensitivity back to what the baseline had been, essentially undoing the resistance. This would suggest that for patients developing chemotherapy resistance, we might one day be able to use miRNAs to restore the sensitivity of the cancer cells to the drugs."

MicroRNAs are small non-coding molecules that function in RNA silencing and post-transcriptional regulation of gene expression. The miRNAs operate via base-pairing with complementary sequences within messenger RNA (mRNA) molecules, silencing the mRNA molecules that control the expression of certain proteins.

Roman Mezencev, a senior research scientist in the McDonald lab, began by exposing a line of pancreatic cancer cells (BxPC3) to increasing levels of the chemotherapy drug cisplatin. After each in vitro treatment, surviving cells were allowed to proliferate before being exposed to a higher level of the drug. After approximately a year and 20 treatment cycles, the resulting cell line had a resistance to cisplatin that was 15 times greater than that of the original cancer cells.

The next step was to study the genetic changes associated with the resistance, comparing levels of more than 2,000 miRNAs in the cisplatin-resistant line to the original cell line that had not been exposed to the drug. Using a hidden Markov model (HMM)

algorithm, they found 57 miRNAs that were either up-regulated or down-regulated, and identified miR-374b as the molecule most likely to be controlling the genes that govern chemotherapy resistance.

While previous work by other researchers has shown that miRNAs can provide a mechanism for the development of drug resistance, the Georgia Tech team took the findings a step farther by increasing the expression of miR-374b. When they did, they found that the cells previously resistant to the cisplatin were again sensitive to the drug — almost back to their original levels.

Techniques to control protein expression are already being used in cancer therapy, but McDonald believes there may be benefits in targeting the activity higher up in the process — at the RNA level. Studies by the Georgia Tech team and by other researchers clearly show an association between chemotherapy resistance and changes in levels of certain miRNAs.

"Molecular evolution is a highly efficient process," McDonald said. "Our evidence suggests that many of the genes regulated by a single microRNA are involved in coordinated cellular functions — in this case, drug resistance. We believe that microRNAs might be particularly good cancer therapeutic agents because when we manipulate them, we are manipulating suites of functionally coordinated genes."

A next step will be to study the effects of manipulating miRNA levels in animal cancer models. The McDonald research team is currently pursuing this possibility by inserting the microRNAs into tumors using nanoscale

hydrogels developed by Andrew Lyon, former chair of Georgia Tech's School of Chemistry and Biochemistry.

McDonald says the study confirms the role of miR-374b in creating resistance, though he says there could be other microRNA molecules involved, as well.

"These cells have acquired resistance to the drug, and we have found a microRNA that seems to be playing a major role," he said. "We have shown that we can bring sensitivity to drugs back by restoring levels of miR374b, but there may be other miRNAs that will work equally as well. Just as there are multiple pathways to establish cancer and chemoresistance, there may be multiple pathways to restore chemosensitivity, as well."

If cancer could one day be treated using miRNAs, it's likely to be a continuing battle rather than a decisive victory, McDonald said. Cancer cells are very resourceful, and will likely find a new genetic route to resistance if one pathway is destroyed. That could require use of a different miRNA to reverse resistance.

While the miRNA research isn't likely to provide a "magic bullet" for cancer, it does show the possible role of these tiny RNA molecules in controlling a broad class of bodily processes.

"There is growing evidence that this class of small regulatory RNAs may be involved in many processes ranging from evolution to heart disease," he said. "MiRNAs are emerging as important players in cancer in general. Here, we are focusing on just one particular aspect of it."

New 'genetic barcode' technique reveals details of cell lineage

By using the gene editing tool CRISPR to create unique genetic 'barcodes,' it's possible to track the lineage of cells in a living organism, a new study reveals

By using the gene editing tool CRISPR to create unique genetic "barcodes," it's possible to track the lineage of cells in a living organism, a new study reveals.

The development could accelerate our understanding of an array of cellular processes. While several different methods exist for tracking cell lineages, each has limitations.

For example, dyes may be used to track the creation of daughter cells, but do not provide insights into the relationships between the descendant cells.

Here, Aaron McKenna and colleagues developed a lineage tracing method called Genome Editing of Synthetic Target Arrays for Lineage Tracing (GESTALT). The method introduces unique patterns of mutations into a distinct, short genetic sequence called a genomic barcode. The DNA sequence of mutated barcodes in daughter cells is then used to reconstruct cell lineage relationships.

McKenna *et al.*, demonstrate the efficacy of this technique in cell culture and live zebrafish. Upon introducing bar codes at the embryonic stage of zebrafish and analysing various tissues at the adult stage, the researchers found that just a few embryonic progenitor cells give rise to the majority of cells that make up adult organs.

For example, only 5 of the 1,138 gene variants observed in a four-month-old zebrafish gave rise to more than 98 per cent of blood cells.

The authors note that this new technique can be used in future analyses to track more complex, multicellular processes in normal development, and that it can also be used to identify the cellular origin of tumors and metastases.

New 3-D hydrogel biochips prove to be superior in detecting bowel cancer at early stages

A new method of diagnosing colorectal cancer has been developed by researchers. The scientists have created a hydrogel-based biochip to help detect bowel cancer (colorectal cancer).

Researchers from the Moscow Institute of Physics and Technology (MIPT), the Engelhardt Institute of Molecular Biology (EIMB RAS), the Institute of Bioorganic Chemistry (IBCh) and a number of other Russian research centers have developed a new method of diagnosing colorectal cancer. The results of the study have been published in Cancer Medicine.

The scientists have created a hydrogel-based biochip to help detect bowel cancer, i.e., colorectal cancer (CRC). CRC is the third most common type of cancer and it develops with minimal clinical symptoms in the early stages. Despite doctors' efforts, the 5-year survival rate does not exceed 36 per cent. Treatment is only effective, and patients only have a good chance of recovery, if the cancer is detected early.

Diagnostic methods that are currently in use are not sufficient. Analyses carried out in

vitro have low specificity and invasive studies such as colonoscopy are not only traumatic, but they are also not always suitable for an early diagnosis, as they do not give a complete picture of the development and distribution of colorectal cancer.

The method proposed by scientists from EIMB RAS, MIPT, the Russian Scientific Center of Surgery, Sechenov First Moscow State Medical University, the Institute of Bioorganic Chemistry, and Buyanov City Clinical Hospital is based on the simultaneous detection of various substances in patients' blood. These substances are autoantibodies against tumor-associated glycans, which can be found in serum at the early stages of cancer, immunoglobulins of different classes, and oncomarkers (molecules produced by tumor cells).

What?

Oncomarkers are already widely used to detect cancer. However, the combination which is used to detect CRC (carcinoembryonic antigen (CEA) with carbohydrate antigen (CA) 19-9) is not sensitive enough and is only able to detect 1 in 2 cases of the disease. To increase diagnostic sensitivity, researchers turned to glycobiology, a rapidly developing science that is focused on the most important biological molecules — glycans.

The best known glycans are amyllum, chitin and cellulose. In terms of chemistry, glycans are biopolymers consisting of a large number of monosaccharides (glucose and fructose are commonly known examples) linked glycosidically (by oxygen atoms). Besides acting as nutrients and building materials for cells, glycans are important for the contact between cells, appropriate organ growth and

much more. Tumor cells have special glycans enabling scientists to differentiate them from healthy cells, and this is the key aspect of the new study.

To detect tumor-associated glycans, scientists use autoantibodies. Antibodies are molecules produced by the immune system to attack enemy cells with high precision. They are "fine-tuned" to interact with a particular target. Antibodies against the influenza virus, for example, interact only with the protein contained in the viral particles of a certain strain, and autoantibodies against tumor-associated glycans react exclusively with glycans that are only found in CRC cells.

Antibodies are able to define target cells and initiate the process of destroying them. Any cells may become a target if they have transformed to cancer cells or become infected with a virus. Many laboratory diagnostic methods and scientific experiments are based on the unique capacity of antibodies to selectively detect other molecules.

How?

The researchers proposed looking for autoantibodies against tumor-associated glycans in serum. The method has already demonstrated its potential in the diagnosis of ovarian cancer (Swiss scientists published the corresponding paper in 2012) with biological microchips used as the primary diagnostic tools.

The idea of using microchips was first suggested in the 1980s by Andrei Mirzabekov, who was the head of the Institute of Molecular Biology and MIPT's Department of Molecular Biophysics. Today, this idea is said to be the technical basis for the biology of the 21st century. A microchip is normally a flat plate

containing samples of particular biological molecules, however in their new paper the researchers examined a new development — a three-dimensional hydrogel-based biochip.

These chips were developed at EIMB RAS. They are 3D cells made of a special gel which contains the required reagents — molecular probes. The structure of the gel provides an optimal environment for conducting tests, and the scientists were able to solve a number of problems to ensure more accurate diagnoses — e.g., they achieved equal distribution of molecular probes with a far greater sensitivity than regular "flat" systems (or "planar" systems, as specialists call them).

What were the results?

The researchers developed a model of the test-system which is able to simultaneously measure the concentration of protein-based oncomarkers, the autoantibodies-to-glycans ratio, and immunoglobulins IgG, IgA, and IgM in a patient's blood. Taking into account the fact that most protein-based markers are not specific in terms of the location and type of the tumor, scientists divided them into groups — diagnostic and prognostic signatures (combinations of protein-based oncomarkers and antibodies to glycans, etc.)

Using the model, the scientists analysed the sera of 33 patients with colorectal cancer, 69 healthy donors and 27 patients with inflammatory bowel disease. Cases like Crohn's disease and diverticulitis may in the long term lead to colorectal cancer, however, they should not be confused with one another when diagnosing the disease — the laboratory analysis system needs to not only be sensitive, but also precise.

This method surpasses all other existing methods. The model of the test-system based on diagnostic signatures was able to diagnose CRC in 95 per cent of cases, compared to 79 per cent detected by traditional methods. The sensitivity of CRC detection (in patients with Stage II-IV CRC) was 87 per cent versus 21 per cent. This increase is clearly a significant achievement. The specificity of the method is 97 per cent.

The sensitivity of a diagnostic method is its capacity to detect a disease. The higher the sensitivity, the better the results, but sensitivity on its own is not enough to make a diagnosis. The tests must also be correct in cases of another diagnosis, i.e., if there is no cancer, the results should not say that there is cancer.

The first figure of 95 per cent is the ability to accurately predict the diagnosis, which means that the disease will be diagnosed correctly for 95 patients out of 100. The sensitivity of 87 per cent tells us that the method will detect CRC in 87 out of 100 cases of patients with the disease. The traditional method of detecting CRC has a sensitivity of 21 per cent, which means that a number of patients with CRC will be declared healthy. In patients with inflammatory bowel disease, cancer will be correctly diagnosed in 97 per cent of cases.

"The method developed at EIMB RAS has great potential to be used in diagnosing gastrointestinal diseases. We hope that testing systems based on the method will soon appear in clinical laboratories in Russia," says Zhanna Zubtsova, one of the authors of the new method, Ph.D. in Physics and Mathematics, assistant professor at MIPT.

Standards to Improve Sustainable Manufacturing

A public-private team led by the National Institute of Standards and Technology (NIST) has created a new international standard that can 'map' the critically important environmental aspects of manufacturing processes, leading to significant improvements in sustainability while keeping a product's life cycle low cost and efficient.

Anyone who's ever covered a wall with sticky notes to clearly map all of the steps in a process knows how valuable that exercise can be. It can streamline workflow, increase efficiency and improve the overall quality of the end result. Now, a public-private team led by the National Institute of Standards and Technology (NIST) has created a new international standard that can "map" the critically important environmental aspects of manufacturing processes, leading to significant improvements in sustainability while keeping a product's life cycle low cost and efficient.

According to the U.S. Energy Information Administration, manufacturing accounts for one-fifth of the annual energy consumption in the United States—approximately 21 quintillion joules (20 quadrillion BTU) or equivalent to 3.6 billion barrels of crude oil. To reduce this staggering amount and improve sustainability, manufacturers need to accurately measure and evaluate consumption of energy and materials, as well as environmental impacts, at each step in the life cycles of their products.

However, making these assessments can be difficult, costly and time consuming, as many manufactured items are created in multiple and/or complex processes, and the environmental impacts of these processes

can vary widely depending on how and where the manufacturing occurs. Additionally, the data collected are often unreliable, frequently not derived through scientific methods, and do not compare well with those from other types of manufacturing processes or from processes at different locations.

These issues are beginning to be addressed through a recently approved ASTM International standard for characterising the environmental aspects of manufacturing processes (ASTM E3012-16). The guide provides manufacturers with a science based, systematic approach to capture and describe information about the environmental aspects for any production process or group of processes, and then use that data to make informed decisions on improvements. The standard is easily individualised for a company's specific needs.

"It's similar to using personal finance software at home where you have to gather income and expenditure data, 'run the numbers' and then use the results to make smart process changes—savings, cutbacks, streamlining, etc.—that will optimise your monthly budget," said NIST systems engineer Kevin Lyons, who chaired the ASTM committee that developed the manufacturing sustainability standard.

"We designed ASTM E3012-16 to let manufacturers virtually characterise their production processes as computer models, and then, using a standardised method, 'plug and play' the environmental data for each process step to visualise impacts and identify areas for improving overall sustainability of the system," Lyons said.

For their next step, Lyons and his colleagues on the ASTM sustainability committee plan

to define key performance indicators (KPIs)—metrics of success—for manufacturing sustainability that can be fed back into the E3012-16 standard to make it even more effective.

"In the long term, we'd also like to establish a repository of process models and case studies from different manufacturing sectors so that users of the standard can compare and contrast against their production methods," Lyons said.

Through a collaboration with Oregon State University, NIST held regional industry roundtables in Boston, Chicago and Seattle to learn how best to introduce the benefits of the sustainability standard to U.S. manufacturers, especially small- and medium-size firms. A report about those meetings will be published later this year.

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Global Nitrogen Footprint Mapped for First Time

Four countries cause almost half the world's emissions, pollution from foreign demand

The first-ever global nitrogen footprint, encompassing 188 countries, has found the United States, China, India and Brazil are responsible for 46 per cent of the world's nitrogen emissions. The economic modelling, which grouped the nitrogen footprint into top-ranking bilateral trade relationships, noted a trend for increased nitrogen production and found developed nations largely responsible for emissions abroad for their own consumption. The first-ever global nitrogen footprint, encompassing 188 countries, has found the United States, China, India and Brazil are responsible for 46 per cent of the world's nitrogen emissions.

The international collaboration, led by the University of Sydney's Integrated Sustainability Analysis team in the Faculty of Science, found developing countries tend to embody large amounts of nitrogen emissions from their exports of food, textiles and clothing. Australia is one of the few wealthy nations that is a net exporter of nitrogen, because of the substantial agriculture industry.

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Ph.D. candidate Ms Arunima Malik, who co-authored the paper with University of Sydney colleagues Professor Manfred Lenzen and Dr Arne Geschke, as well as two researchers

from Yokohama National University and one from Kyushu University in Japan, said significant nitrogen net importers were almost exclusively developed economies.

"High-income nations are responsible for more than 10 times the emissions of the poorest nations," Ms Malik said. "This reflects greater consumption of animal products, highly processed foods and energy-intensive goods and services".

The vast bulk of emissions came from industries such as agriculture, transport and energy generation. Emissions from consumers-end use were mostly from sewage.

A paper on the research is published by the international journal Nature Geoscience.

Nitrogen pollution was becoming an increasingly significant problem, as countries not only consumed the naturally occurring element but were also producing greater quantities of synthetic nitrogen, Professor Lenzen said. New work by the University of Sydney looking at trends was expected to be completed soon.

"Policies are needed to integrate nitrogen supply-chains globally in order to reduce pollution, Professor Lenzen said. "We know nitrogen emissions are increasing — just as carbon emissions are increasing as populations expand.

"We are now analysing the trends, such as increased affluence and consumption, and looking at the various industries responsible for nitrogen pollution."

Findings of the research of 2010 data includes:

- Consumption in the United States, China, India and Brazil is responsible for 46 per cent of global nitrogen emissions.
- Japan and other developed nations import reactive nitrogen embodied in Chinese-made clothing as well as US and Australian meat.
- The United Kingdom, Germany, Italy, and France exchange significant amounts of nitrogen emissions embodied in food products.
- Hong Kong's nitrogen imports are primary agricultural and raw food products because it lacks land to produce its own livestock and crops.
- Developing countries such as China, India, Pakistan, and Thailand embody large amounts of nitrogen emissions into their exports of textiles and clothing.
- High-income exceptions are Australia, New Zealand, and Argentina, which export significant nitrogen embodied in livestock products.
- Per-capita nitrogen emission ranged from more than 100 kg annually for wealthy nations such as Hong Kong and Luxembourg, to less than 7 kg for developing nations such as Papua New Guinea, Côte d'Ivoire, and Liberia.
- Of the 189 teragrams of nitrogen emitted worldwide in 2010, 161 Tg was emitted from industries and agriculture and only 28 Tg was emitted by consumers.

Texting at Night affects Teens' Sleep, Academic Performance

Researcher finds that instant messaging in the dark makes a difference compared to having the lights on

The study, published in the *Journal of Child Neurology*, is the first of its kind to link nighttime instant messaging habits of American teenagers to sleep health and school performance.

"We need to be aware that teenagers are using electronic devices excessively and have a unique physiology," says study author Xue Ming, professor of neuroscience and neurology at Rutgers New Jersey Medical School. "They tend to go to sleep late and get up late. When we go against that natural rhythm, students become less efficient."

The American Academy of Pediatrics reports that media use among children of all ages is increasing exponentially; studies have found that children ages 8 to 18 use electronic devices approximately seven-and-a-half hours daily.

Ming's research is part of a small but growing body of evidence on the negative effects of electronics on sleep and school performance. But few studies, Ming says, have focused specifically on instant messaging.

"During the last few years I have noticed an increased use of smartphones by my patients with sleep problems," Ming says. "I wanted to isolate how messaging alone — especially after the lights are out — contributes to sleep-related problems and academic performance."

To conduct her study, Ming distributed surveys to three New Jersey high schools — a suburban and an urban public school and a private school — and evaluated the 1,537 responses contrasting grades, sexes, messaging duration and whether the texting occurred before or after lights out.

She found that students who turned off their devices or who messaged for less than 30 minutes after lights out performed significantly better in school than those who messaged for more than 30 minutes after lights out.

Students who texted longer in the dark also slept fewer hours and were sleepier during the day than those who stopped messaging when they went to bed. Texting before lights out did not affect academic performance, the study found.

Although females reported more messaging overall and more daytime sleepiness, they had better academic performance than males. "I attribute this to the fact that the girls texted primarily before turning off the light," Ming says.

The effects of "blue light" emitted from smartphones and tablets are intensified when viewed in a dark room, Ming says. This short wavelength light can have a strong impact on daytime sleepiness symptoms since it can delay melatonin release, making it more difficult to fall asleep — even when seen through closed eyelids.

"When we turn the lights off, it should be to make a gradual transition from wakefulness to sleep," Ming says. "If a person keeps getting text messages with alerts and light emission, that also can disrupt his circadian rhythm. Rapid Eye Movement sleep is the

period during sleep most important to learning, memory consolidation and social adjustment in adolescents. When falling asleep is delayed but rising time is not, REM sleep will be cut short, which can affect learning and memory."

Ming notes some benefits to early-evening media use, such as facilitating collaboration for school projects, providing resources for tutoring, increasing school readiness and possibly offering emotional support systems.

She suggests that educators recognise the sleep needs of teenagers and incorporate sleep education in their curriculum. "Sleep is not a luxury; it's a biological necessity. Adolescents are not receiving the optimal amount of sleep; they should be getting 8-and-a-half hours a night," says Ming. "Sleep deprivation is a strong argument in favor of later start times for high schools - like 9 a.m."

Optogenetic Technology Uses Light to Trigger Immunotherapy

"This is the first time anybody has used optogenetic techniques to stimulate the immune system, much less to fight cancer cells," said study author Gang Han, Ph.D., Assistant Professor of biochemistry and molecular pharmacology at UMass Medical School. "The advantage an optogenetic approach has over other immunotherapies, which typically activate global immune responses, is that we now have the tools to closely monitor the dose and location of the treatment to mitigate potential side effects to healthy tissues."

Neuroscientists have been using optogenetics, which combine breakthroughs in both optical technology and genetics, to

stimulate the activity of individual neurons in animals using light. Nerve cells are engineered with light-sensitive proteins that allow researchers to send or stop sending nerve impulses when they are exposed to a particular color of light. This has allowed researchers to map and decode neural circuitry in live animals.

Adapting this technology for use in other cells has proved challenging. Optogenetic technologies targeting neurons rely on the electrical impulses these cells use to quickly transmit messages. Other cells use different, and more diverse, methods of communicating, making them more difficult to turn on and off. These cells are also typically found deeper in the body where it is difficult for light to penetrate.

Dr. Han, in collaboration with Yubin Zhou, Ph.D., Assistant Professor at the Center for Translational Cancer Research at the Texas A&M Health Science Center Institute of Biosciences and Technology, approached these problems by focusing on the flow of calcium ions into cells as a potential on/off switch and using specially designed up-conversion nanoparticles to activate them. Details of the technology were published in eLife.

Dr. Zhou and his team genetically engineered dendritic cells with a light-sensitive calcium gate-controlling protein. When exposed to blue light, the calcium ion gates on the dendritic cell open and it is activated. (Once activated, the dendritic cells are responsible for programming T-cells that then attack infected or cancerous cells.) When the light is turned off, the gates close and the dendritic cells turn off.

To reach immune cells in a live animal, Han attached to the cells a nanoparticle he developed that converts near-infrared light into visible blue light. Unlike blue light, near-infrared light can penetrate tissue to a depth of two centimeters. When the near-infrared light hits the nanoparticle inside the animal it converts it to blue light. This, in turn, activates the light sensitive protein controlling the flow of calcium to the cell.

The light-sensitive cells and nanoparticles, called opto-CRAC, were then delivered with the tumor antigen surrogate ovalbumin to mice with melanoma tumors in their lymph nodes to see if an immune response could be activated to target cancer cells. A tumor antigen, such as ovalbumin, is needed to program newly activated T-cells with their intended target.

"When we exposed a near-infrared laser beam to these animal models injected with both the nanoparticle and the genetically engineered immune cells, this caused calcium channels on the dendritic cells to open and we saw a corresponding increase in the number of T-cells that were activated," said Han.

"More importantly," said Han, "we saw significantly suppressed tumor growth and reduced tumor volume in these animals. This suggests that the activated dendritic cells were successfully programming T-cells to attack the tumor."

One advantage of this method is that researchers can finely tune which cells are activated and in what part of the body. This specificity could potentially reduce system-wide side effects often seen with other targeted cancer immunotherapies.

It's also likely that this technique can be adapted to study other immune, heart, endocrine or hematopoietic cells. "Any cell that used calcium to perform its task could potentially be activated using this newly developed technology," said Han. "The flexibility of this system means it can be adapted to explore other cellular processes while minimally interfering with other physiological or biological functions."

How Mobile Ads Leak Personal Data

The personal information of millions of smartphone users is at risk due to in-app advertising that can leak potentially sensitive user information between ad networks and mobile app developers, according to a new study by the School of Computer Science at the Georgia Institute of Technology.

Results presented Tuesday, February 23 at the 2016 Network and Distributed System Security Symposium (NDSS '16) in San Diego, Calif, by researchers Wei Meng, Ren Ding, Simon Chung, and Steven Han under the direction of Professor Wenke Lee.

The study examined more than 200 participants who used a custom-built app for Android-based smartphones, which account for 52 per cent of the U.S. smartphone market according to comScore's April 2015 report. Georgia Tech researchers reviewed the accuracy of personalised ads that were served to test subjects from the Google AdNetwork based upon their personal interests and demographic profiles; and secondly, examined how much a mobile app creator could uncover about users because of the personalised ads served to them.

Researchers found that 73 per cent of ad impressions for 92 per cent of users are correctly aligned with their demographic profiles. Researchers also found that, based on ads shown, a mobile app developer could learn a user's:

- gender with 75 per cent accuracy,
- parental status with 66 per cent accuracy,
- age group with 54 per cent accuracy, and
- could also predict income, political affiliation, marital status, with higher accuracy than random guesses.

Some personal information is deemed so sensitive that Google explicitly states those factors are not used for personalisation, yet the study found that app developers still can discover this information due to leakage between ad networks and app developers.

"Free smart phone apps are not really free," says Wei Meng, Lead Researcher and a graduate student studying computer science. "Apps — especially malicious apps — can be used to collect potentially sensitive information about someone simply by hosting ads in the app and observing what is received by a user. Mobile, personalised in-app ads absolutely present a new privacy threat."

How it Works

- Mobile app developers choose to accept in-app ads inside their app.
- Ad networks pay a fee to app developers in order to show ads and monitor user activity — collecting app lists, device models, geo-locations, etc.

This aggregate information is made available to help advertisers choose where to place ads.

- Advertisers instruct an ad network to show their ads based on topic targeting (such as "Autos and Vehicles"), interest targeting (such as user usage patterns and previous click thrus), and demographic targeting (such as estimated age range).
- The ad network displays ads to appropriate mobile app users and receives payment from advertisers for successful views or click thrus by the recipient of the ad.
- In-app ads are displayed unencrypted as part of the app's graphical user interface. Therefore, mobile app developers can access the targeted ad content delivered to its own app users and then reverse engineer that data to construct a profile of their app customer.

Unlike advertising on a Website page, where personalised ad content is protected from publishers and other third parties by the Same Origin Policy, there is no isolation of personalised ad content from the mobile app developer.

For the smartphone dependent population — the 7 per cent of largely low-income Americans, defined by Pew Internet ("U.S. Smartphone Use in 2015"), who have neither traditional broadband at home nor any other online alternative — their personal information may be particularly at risk.

"People use their smartphones now for online dating, banking, and social media every day,"

said Wenke Lee, professor of computer science and co-director of the Institute for Information Security and Privacy at Georgia Tech. "Mobile devices are intimate to users, so safeguarding personal information from malicious parties is more important than ever."

The study acknowledges that the online advertising industry is taking steps to protect users' information by improving the HTTPS protocol, but researchers believe the threat to user privacy is greater than HTTPS protection can provide under a mobile scenario.

The researchers contacted Google Ad Networks about their finding.

Eternal 5D Data Storage could Record the History of Humankind

Scientists at the University of Southampton have made a major step forward in the development of digital data storage that is capable of surviving for billions of years.

Using nanostructured glass, scientists from the University's Optoelectronics Research Centre (ORC) have developed the recording and retrieval processes of five dimensional (5D) digital data by femtosecond laser writing.

The storage allows unprecedented properties including 360 TB/disc data capacity, thermal stability up to 1,000°C and virtually unlimited lifetime at room temperature (13.8 billion years at 190°C) opening a new era of eternal data archiving. As a very stable and safe form of portable memory, the technology could be highly useful for organisations with big archives, such as national archives, museums and libraries, to preserve their information and records.

The technology was first experimentally demonstrated in 2013 when a 300 kb digital copy of a text file was successfully recorded in 5D.

Now, major documents from human history such as Universal Declaration of Human Rights (UDHR), Newton's Opticks, Magna Carta and Kings James Bible, have been saved as digital copies that could survive the human race. A copy of the UDHR encoded to 5D data storage was presented to UNESCO by the ORC at the International Year of Light (IYL) closing ceremony in Mexico.

The documents were recorded using ultrafast laser, producing extremely short and intense pulses of light. The file is written in three layers of nanostructured dots separated by five micrometres (one millionth of a metre).

The self-assembled nanostructures change the way light travels through glass, modifying polarisation of light that can then be read by combination of optical microscope and a polariser, similar to that found in Polaroid sunglasses.

Coined as the 'Superman memory crystal', as the glass memory has been compared to the "memory crystals" used in the Superman films, the data is recorded via self-assembled nanostructures created in fused quartz. The information encoding is realised in five dimensions: the size and orientation in addition to the three dimensional position of these nanostructures.

Professor Peter Kazansky, from the ORC, says: "It is thrilling to think that we have created the technology to preserve documents and information and store it in space for future generations. This technology

can secure the last evidence of our civilisation: all we've learnt will not be forgotten."

New Glass Technology Discovered: Window Doubling as a Huge TV?

Imagine if the picture window in your living room could double as a giant thermostat or big screen TV. A discovery by researchers at the University of British Columbia has brought us one step closer to this becoming a reality.

Researchers at UBC's Okanagan campus in Kelowna found that coating small pieces of glass with extremely thin layers of metal like silver makes it possible to enhance the amount of light coming through the glass. This, coupled with the fact that metals naturally conduct electricity, may make it possible to add advanced technologies to windowpanes and other glass objects.

"Engineers are constantly trying to expand the scope of materials that they can use for display technologies, and having thin, inexpensive, see-through components that conduct electricity will be huge," said UBC Associate Professor and lead investigator Kenneth Chau. "I think one of the most important implications of this research is the potential to integrate electronic capabilities into windows and make them smart."

The next phase of this research, added Chau, will be to incorporate their invention onto windows with an aim to selectively filter light and heat waves depending on the season or time of day.

The theory underlying the research was developed by Chau and collaborator Loïc Markley, an assistant professor of engineering

at UBC. Chau and Markley questioned what would happen if they reversed the practice of applying glass over metal—a typical method used in the creation of energy efficient window coatings.

"It's been known for quite a while that you could put glass on metal to make metal more transparent, but people have never put metal on top of glass to make glass more transparent," said Markley. "It's counter-intuitive to think that metal could be used to enhance light transmission, but we saw that this was actually possible, and our experiments are the first to prove it."

Mapping the Maya: Laser Technology Reveals Secrets of Ancient Civilization

The steamy jungles of northern Guatemala don't reveal secrets easily. For centuries, the overgrown landscape has protected most of the remains of the Maya who once tamed it — yielding slowly to modern scientists seeking to learn more about the ancient civilisation known for its sophisticated hieroglyphic script, art, architecture and mathematics.

The Maya civilization began to emerge about 3,000 years ago, and reached its peak during the Classic Period, from about A.D. 250-900. Now, technology that allows for digital deforestation has uncovered thousands of new Maya structures previously undetected beneath smothering vegetation. For archaeologists like Thomas Garrison, Assistant Professor of anthropology at Ithaca College, the findings have done far more than recast notions of the size and density of the Central American society.

"Frankly, it's turning our discipline on its head," he said.

Garrison helped orchestrate the 2016 aerial survey these revelations stem from. The findings and the technology behind them — LiDAR (light detection and ranging) — will be the focus of a new National Geographic documentary to premiere on February 6 at 9 p.m. EST titled "Lost Treasures of the Maya Snake King." The documentary will follow a NatGeo explorer as he treks deep in the jungle to seek out a pyramid detected in the survey.

Garrison appears in the documentary commenting on the LiDAR mapping and its results. The program will also feature custom-designed images of many of the newly revealed structures, as translated from the data.

Laser Show in the Jungle

LiDAR is a method of mapping from the sky: An airplane-mounted device sends a constant pulse of laser light across a swath of terrain; precise measurements of how long it takes the emitted beams to bounce off surfaces are taken and translated into topographic data.

The laser pierces through the smallest gaps in the vegetation to record the lay of the land below with remarkable accuracy. The resulting data can be tweaked to filter out the trees, thus offering an unencumbered view of everything else on the surface.

The technology is a boon for surveys in jungles like those in lowland Guatemala, where dense canopy hinders other methods of aerial survey and thick undergrowth can conceal the relationship even between known structures.

"In that kind of environment where you can't see [a few feet in front of yourself], it's very hard to piece that all together," Garrison said. In a swampy area of rolling hillocks rising from the muck, for example: "You have this idea that there's some little stuff on the hills, but the LiDAR lets you see it in its totality."

The survey of 2,100-square kilometers encompassed several major Maya sites, including the largest at Tikal, and El Zotz, where Garrison focuses his research. The LiDAR mapping revealed over 60,000 previously unknown structures in total, from unknown pyramids, palace structures, terraced fields, roadways, defensive walls and towers, and houses. Archaeologists are realizing that the ancient population centers they've spent decades studying are much bigger than they speculated.

"Everyone is seeing larger, denser sites. Everyone," Garrison said. "There's a spectrum to it, for sure, but that's a universal: everyone has missed settlement in their [previous] mapping."

Especially telling to Garrison are newly revealed agricultural features that would be necessary to support the lowland Maya population during their centuries of civilization — population estimates have now expanded from a few million to 10–20 million — and defensive structures that suggest warfare was far more prevalent than previously known.

Only the Beginning

The LiDAR survey is a collaboration between archaeologists from the U.S., Europe and Guatemala, and the Fundación PACUNAM (Patrimonio Cultural y Natural Maya), a Guatemalan philanthropic and cultural heritage preservation organisation.

Garrison serves as one of the archaeology advisors to the project, and was fundamental in lobbying for the survey, which is now the single largest ever conducted in the field of Mesoamerican archaeology. Fundraising is already taking place for a second LiDAR survey of similar size, he said.

The LiDAR findings are only the beginning. There is still much to discover about the rise, peak and fall of the Maya civilisation. The LiDAR data points to new areas where those answers may be found through fieldwork and excavation.

"That's the challenge now. Now we have so much data," Garrison said. "How do we handle it and how do we move forward with it? We've still got to get to those places, we've still got to check them out.

"It's difficult to convey how exciting this time is for us."

Mobile Device Addiction Linked to Depression, Anxiety

Is cellphone use detrimental to mental health? A new study from the University of Illinois finds that addiction to, and not simply use of, mobile technology is linked to anxiety and depression in college-age students.

The study was published in the journal *Computers in Human Behaviour*.

"There's a long history of the public fearing new technologies as they are deployed in society," said U. of I. psychology Professor Alejandro Lleras, who conducted this study with undergraduate honors student Tayana Panova. This fear of new technology happened with televisions, video games and most recently, smartphones, he said.

Lleras and Panova surveyed over 300 university students with questionnaires that addressed the students' mental health, amount of cellphone and Internet use, and motivations for turning to their electronic devices. Questions included: "Do you think that your academic or work performance has been negatively affected by your cellphone use?" and "Do you think that life without the Internet is boring, empty and sad?"

The goal was to see if addictive and self-destructive behaviours with phones and the Internet related to mental health.

"People who self-described as having really addictive style behaviours toward the Internet and cellphones scored much higher on depression and anxiety scales," Lleras said. However, the researchers found no relationship between cellphone or Internet use and negative mental health outcomes among participants who used these technologies to escape from boredom. Thus, the motivation for going online is an important factor in relating technology usage to depression and anxiety, Lleras said.

In a follow-up study, Lleras tested the role of having, but not using, a cellphone during a stressful situation. Individuals who were allowed to keep their cellphones during an experimental, stressful situation were less likely to be negatively affected by stress compared with those without their phones.

"Having access to a phone seemed to allow that group to resist or to be less sensitive to the stress manipulation," Lleras said. This benefit was both small and short-lived, but suggests the phone might serve as a comfort item in stressful or anxiety-inducing situations.

While the role of phones as comfort items is somewhat tenuous, the relationship between motivation for cellphone or Internet use and mental health warrants further exploration, Lleras said. Breaking addictive technology habits may provide an important supplemental treatment for addressing mental health issues such as general anxiety disorder or depression, he said.

"We shouldn't be scared of people connecting online or talking on their phones," he said. "The interaction with the device is not going to make you depressed if you are just using it when you are bored. This should go toward soothing some of that public anxiety over new technology."

Researchers use New Technology to Sequence Mosquito Sex Chromosome

Researchers sequenced the Y chromosome — the genetic driver of sex-determination and male fertility — in a family of malaria spreading mosquitoes

A team of researchers with the Fralin Life Science Institute at Virginia Tech, working with a large international consortium, has sequenced the Y chromosome—the genetic driver of sex-determination and male fertility—in a family of malaria spreading mosquitoes.

The findings, published in the Proceedings of the National Academy of Sciences will inform a variety of genetically based mosquito control strategies that focus on creating more males than females.

Male mosquitoes do not bite and are harmless to humans, while female

mosquitoes bite humans to get the blood they need for egg production.

"Thirteen years after the publication of a draft genome of the *Anopheles gambiae* mosquito, we've finally characterised its Y chromosome," said co-author Zhijian Jake Tu, a Professor of Biochemistry in the College of Agriculture and Life Sciences and a Fralin Life Science Institute affiliate. "This is one of the last pieces of the puzzle. Having the Y will help us figure out the genetic basis of male biology in future studies."

The new information about the Y chromosome will facilitate efforts to reduce female mosquitoes or create sterile males—strategies of interest to research teams across the world.

"The Y chromosome had previously not been characterised because it mostly consists of repetitive DNA sequences that stump the algorithms used by computers to assemble the mosquito's entire genetic make-up," said co-author Brantley Hall of Christiansburg, Va., a doctoral student in the Genetics, Bioinformatics and Computational Biology program.

"We were able to get around this obstacle (at least partially) by using a new long single-molecule sequencing technology, a new bioinformatics algorithm specifically designed to identify Y sequences, and physical mapping of DNA directly to the Y chromosome," said co-author Igor Sharakhov, an Associate Professor of entomology in the College of Agriculture and Life Sciences and a Fralin Life Science Institute affiliate. "Our study provides a long-awaited foundation for studying mosquito Y chromosome biology and evolution."

"Our combined efforts have resulted in the most extensive characterisation of Y chromosome to date in additional malaria vectors as well, which will help identify targeted vector control approaches for different species," said co-author Atashi Sharma, a doctoral student in the Department of Entomology in the College of Agriculture and Life Sciences.

The research was in collaboration with Nora Besansky, the Rev. John Cardinal O'Hara C.S.C. Professor of Biological Sciences at the University of Notre Dame. Three graduate students at Virginia Tech were involved in the study, with Brantley Hall and Atashi Sharma being co-first authors on the paper. Xiaofang Jiang, a graduate student in the Genetics, Bioinformatics, and Computational Biology and Biochemistry, Vladimir Timoshevskiy, Research Associate, and Maria Sharakhova, an Assistant Professor of Entomology in the College of Agriculture and Life Sciences, from Virginia Tech also participated in the study. Philippos-Aris Papatathanos of the University of Perugia and Changde Cheng of the University of Norte Dame are also co-first authors.

Malaria causes as many as 907,000 deaths each year, mostly among children in sub-Saharan Africa. Anopheles mosquitoes, which bite mainly between dusk and dawn, transmit human malaria by spreading Plasmodium parasites that multiply in the human liver and infect red blood cells.

Big Data for Text: Next-generation Text Understanding and Analysis

News portals and social media are rich information sources, for example for predicting stock market trends. Numerous

service providers allow for searching large text collections by feeding their search engines with descriptive keywords. Keywords tend to be highly ambiguous, though, and quickly show the limits of search technologies. Computer scientists from Saarbrücken developed a novel text analysis technology that considerably improves searching very large text collections by means of artificial intelligence. Beyond search, this technology also assists authors in researching and even in writing texts by automatically providing background information and suggesting links to relevant Web sites.

Ambiverse, a spin-off company from the Max Planck Institute for Informatics in Saarbrücken, will be presenting this novel technology during Cebit 2016 in Hannover from 14 to 18 March at Saarland's research booth.

Living in the age of business smartphones and enterprise chatrooms, most information in companies is not distributed via spoken words but rather through e-mails, databases, and internal news portals. "According to a survey by the market analyst Gartner, a mere quarter of all companies are using automatic methods to analyse their textual information. By 2021, Gartner predicts 65 per cent will do so. This is because the amount of data inside companies is continuously growing and hence, it becomes more and more costly to have it structured and to search it successfully," says Johannes Hoffart, a researcher at the Max Planck Institute for Informatics and founder of Ambiverse. His team developed a novel text analysis technology for analysing huge amounts of text where massive computing power and artificial

intelligence (AI) are continuously "thinking along" in the background.

"For analysing texts, we rely on extremely large knowledge graphs which are built upon freely available sources such as Wikipedia or large media portals on the Web. These graphs can be augmented with domain- or company-specific knowledge, such as product catalogs or customer correspondences," says Hoffart. By applying complex algorithms, these texts are screened further and analysed with linguistic tools. "Our software then assigns companies and areas of business to their corresponding categories, which allows us to gather valuable insights on how well one's own products are positioned in the market in comparison to those of the competitors," he explains. Particularly challenging hereby is the fact that product or company names are anything but unique and tend to have completely different meanings in different contexts, making them highly ambiguous.

"Our technology helps to map words and phrases to their correct objects of the real-world, that way resolving ambiguities automatically," explains the computer scientist. "Paris" for example stands for the city of light and the French capital, but also for a figure from Greek mythology or a millionfold-mentioned party girl with German ancestors — always depending on context. "Efficiently searching huge text collections is only possible if the different meanings of a name or a concept are correctly resolved," says Hoffart. The smart search engine developed by his team continuously learns and improves over time, and also automatically associates new text entries to matching categories. "These algorithms are hence attractive for companies that analyse

online media or social networks to measure the degree of brand awareness for a product or the success of a marketing campaign," says Hoffart further.

At Cebit, Ambiverse will further present a smart authoring platform that assists authors in researching and writing texts. Users who enter texts are automatically provided with background information, for example company-internal guidelines and manuals or Web links. "Relevant concepts are linked automatically and links for further research are shown" says the computer scientist.

Visitors to the Ambiverse Cebit booth (hall 6, booth 28) will also have the opportunity to compete with their novel AI technology by playing a question-answering game. Ambiverse is funded by the German Federal Ministry for Economic Affairs through an EXIST Transfer of Research grant.

Vention makes 3D Mapping more Accurate

A new 3D mapping model integrates multi-platform satellite/aerial imagery and laser scanning data to achieve a higher accuracy in mapping products by 26–66 per cent to centimetre level compared to the conventional mapping technologies.

The two major traditional 3D mapping techniques are photogrammetry using satellite/aerial imagery and laser scanning. The former offers higher accuracy in the horizontal direction while the latter shows higher accuracy in vertical direction. They may produce errors at different levels and there are usually inconsistencies between the mapping products derived from them.

To eliminate data errors and integrate the advantages of the existing technologies, Professor Wu Bo at The Hong Kong Polytechnic University (PolyU)'s Department of Land Surveying and Geo-Informatics developed a "Novel Integrated 3D Mapping Model." Integrating multi-platform satellite/aerial imagery and laser scanning data, the technology greatly improved the accuracy in mapping products by 26–66 per cent to centimetre level.

The cost of the mapping products produced by this model is more or less the same as the satellite imagery. This new technology

allows monthly updates and handling of massive data and can cater for the needs in the big data era. It can be used in topographic mapping and 3D modelling of cities for smart city development. For example, it is particularly useful in analysing ventilation, visibility and sunlight distribution between buildings.

The invention won a Gold Medal and Special Merit Award from the Nizhny Novgorod State Technical University, Russia, at the 44th International Exhibition of Inventions of Geneva.

Source: Science Daily Online

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WEB WATCH

In this Section, we present Websites and a brief introduction about them. Inclusion of a site does not imply that School Science endorses the content of the site. Sites have been suggested on the basis of their possible utility to school systems.



- <https://epathshala.nic.in/>

Epathshala is a Web-site in which students access digital textbooks and e-resources for effective learning. It is also beneficial for teacher and educators for effective teaching-learning process.

- <https://nroer.gov.in/home/e-library>
- <https://nroer.gov.in/welcome>

NROER hosts large number educational resources in many subjects and in different Indian languages for primary, secondary and senior secondary classes. Resources are available in different formats such as videos, images, audios, documents, interactives, etc.

- <https://www.swayamprabha.gov.in/>

The SWAYAM PRABHA is a group of 32 DTH channels devoted to telecasting of high-quality educational programmes on 24X7 basis using the GSAT-15 satellite.

- <https://diksha.gov.in/ncert/>

This is a National platform of Government of India for dissemination of e-content and digital textbooks of National Council of Educational Research and Training

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To Our Contributors

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