

## Introduction

Some eye openers and alarming facts: India has world's largest population of illiterates – about 380 million. Nearly every child in the 6-11 years age group is enrolled at schools, but by Class V, one-third drop out, by Class VIII, half; and by Class X, nearly two-thirds are out of school. Only 10% go for higher education. In all, over 170 million children and youth in the age group of 6-24 years are out of the education system. And here are some more numbers - 65% of Indians are below the age of 35 and a staggering 600 million are under the age of 25. This is almost thrice the population of Britain, France and Germany put together. It is also predicted that by 2020, the average age of Indians will be 29 years. The capacities in Industrial Training Institutes (ITIs) and Polytechnics are grossly insufficient. Moreover, it is widely accepted that the curricula are outdated and the delivery modes are not user friendly. Thus, 88% of the population entering the workforce remains largely unskilled and hence, unemployable. In such a scenario, how is it even possible for the government to provide jobs to these growing populations! The problem of unemployment looms large on the people as well as the government. A possible way of finding a solution to above is to develop innovative ways of imparting employability skills backed up by duly prescribed norms of evaluation and certification. Establishment of community based small educational institutions called community colleges which are supposed to be institutions meant *For the community, By the community and Of the community* can help to address the educational needs of the underprivileged.

## Significance of Innovation in Education

According to Leucke and Katz (2003), *“Innovation is generally understood as the successful introduction of a new thing or method. Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes or services”*. To understand this, we must first realize why innovation is important. We know that there is a diverse population, marginalised and disadvantaged residing in unauthorised and resettlement colonies in semi-urban and rural areas with a wide spectrum of community based needs. This population has limited access to quality education and there are inconsistencies in whatever form of classroom teaching-learning transaction they undergo. On the other hand, the market needs skilled workforce. According to The Global Competitiveness Report of World Economic Forum, India will face huge skill gaps due to low employability. It has also proclaimed quite emphatically that the nation needs access to quality education for skilled manpower. The Radhakrishnan Commission on University Education had set up goals for development of higher education. While articulating these goals, the Commission put it in the following words: *“The most important and urgent reform needed in education is to transform it, to endeavour to relate it to the life, needs and aspirations of the people and thereby make it the powerful instrument of social, economic and cultural transformation necessary for the realization of the national goals. For this purpose, education should be developed so as to increase productivity, achieve social and national integration, accelerate the process of modernization and cultivate social, moral and spiritual values.”*

A community level educational institution is a community owned institution, which can be based on locality, region, trade or occupation. It serves the objective of empowering

community individuals by providing them skill-based training leading to gainful employment through collaboration between local industry and community. The programmes are customised as per the local needs and region based requirements with the help of approaches most suitable to the local community.

Any organisation with a strong background of involvement in community development may be considered for getting itself registered under the Community College Scheme of a nationally recognized body like a university. The only condition is that the community development activities of the organisation are adjusted in keeping with the academic requirements of the national body. A community college can be an organisation, well-known for its community development work. It should be working very closely with the community assessing their needs, aspirations and finding solutions for their day to day problems. As the organisation matures, the programmes can be expanded based on the demands of the community. It can also be registered under a centralised body, authorised to certify skills with an aim to widen the opportunities for empowering lives. The initiative is a strong mode to disseminate education to all segments of the society and would offer opportunities to all segments of the disadvantaged people.

### **Innovative Steps to Reach the Unreached**

Going back to the definition of innovation, the key words to note are a) Original, b) Relevant, c) Valued new products, d) Processes, e) Services. To address these factors, a community based educational institution has established a **unique and original** 4C model. It serves as a B School for the underserved and marginalised which focuses not only to produce competent students, but also make them compassionate, conscientious and the change makers. The teaching-learning transaction at the institution is carried out through the 4C Model of Competence, Compassion Conscientiousness and Change making. The mission is to provide transformative, personal, skill-based education to the marginalized and disadvantaged thereby enhancing employability and self-reliance. Students are empowered to excel in life in this institute while being taught skills in IT, Spoken English, Beauty Care, Stitching, Graphic Designing, Classroom Learning and Management courses for in-service and pre-service teachers and many others. The whole focus revolves around overall development of learners. The values of transparency, commitment to continuous learning, missionary zeal and co-option are inculcated in students through three day orientation programmes when a student joins the institute. Classes on moral education, general knowledge, environmental science, personality development and spiritual sessions are an integral part of the curriculum. Initially training programmes were restricted to informal courses, provided almost free of cost without any certification. Thus, they are not ensured career placement, but they get something more, that is facilitation towards self-employment. With the registered educational institution all academic programmes are standardised with proper credits for theory, practical, etc. All the festivals are celebrated with enthusiasm and zeal without any discrimination thus sensitising students on the values and teachings of all the religions and cultures. They are encouraged to be more outspoken and confidence is generated in them by way of participation in group discussions, presentations, interviews and other such learning techniques. Such an approach perhaps ensures the horizontal mobility as well as vertical mobility in terms of getting employment.

The community level educational institution can be an endeavour towards transforming a large section of the marginalised and disadvantaged society towards self reliance and empowerment by:

- enhancing beneficiaries' satisfaction,
- complying with the requirements of international standards,
- achieving continual improvements in effectiveness of our management system through systematic analysis and review of results, and
- training, participation and involvement of all our employees.

It is a fact that any school or college may impart knowledge but nothing can beat experiential learning. When the students get exposed to practice, it becomes the greatest learning experience. The project work and internships help the learners to discover themselves and seize opportunities for their brighter tomorrow. The resources in the community can be mapped, mobilising existing social capital and working actively to provide education to smaller children and adult literacy classes for women in the community. Not only this, the learners can be the ambassadors of education doing surveys, organising rallies and performing *Nukkad Natak* (street plays), spreading the message in their own locality. This leads to the children themselves coming to get their uncles enrolled in various programmes. And it is grandmothers who seem worried about the progress of their granddaughters. There are examples of husbands' sending 'thank you emails' saying it is not only their wives (enrolled in adult literacy programme) who are learning but they and their kids also.

To make the programme '**Relevant**', need analysis should be done regularly to ascertain the preferences of the defined community and to gather the education needs from them. Five exploratory questions can be developed to identify the academic programmes at the time of inception of the community level educational institute:

- 1) Is there any change in the preference of academic programmes in the community based on the location or geographical area?
- 2) What is the perception of male and female as far as the academic programmes are concerned?
- 3) In order to make the community employable, at what age do we need to initiate the academic programmes in the institute?
- 4) Does the demand of the community match the needs of the "labour market"?
- 5) Are there any barriers that prevent the community from taking up the academic programmes?

The community level educational institution is an institution with a difference, thus the programmes need to be adapted to the needs of the community so that it is a natural outcome of their social needs. The driving force behind the training institute should be that it strives to provide and widen opportunities for all. After assessing needs of the community through school visits, meeting with key persons, focus group meetings with youth, women, Panchayat, and home visits, various academic programmes can be developed to enable students to acquire necessary skills for livelihood and formal qualification for social status and societal recognition. Thus the required types of courses can be identified as per the needs of the people at grassroots. Moreover, the curriculum and content can be developed in accordance with the market demand. The educational institute can conduct community meetings. And if during these meetings great diversity is found in the demand for academic programmes across varied age groups, programmes can be designed accordingly. The demand can vary from programmes which are career based to those

aimed at enhancing the self esteem of the learners across different age groups. In one instance, there was a huge demand for English Speaking course and more professional courses in computers such as Animation, Tally and Desk Top Publishing. In addition to these courses on hardware, electrician, beauty care, hairstyling, and fashion designing were also in great demand.

A mechanism of base line assessment can be utilized as a part of the evaluation process. For courses such as Spoken English, Computers', etc, a base line assessment can be done. This helps to monitor the progress as well as assess impact of the curriculum on the learner. The baseline assessment and evaluation can be developed simultaneously with the curriculum and the course content. This also helps in coping up with different related topics which are required in the same area. For example, in one community college a course in Spoken English (Basic Level) was started, but after baseline assessment it was found that there was a need for another foundation level course before that course. Thus the mechanism of baseline assessment also helps to upgrade or evolve the curriculum of the courses being offered. Moreover, in the beginning of the course a community level institute also made a recording, with the learner introducing himself/herself, and after three months, that is after completion of the course, the student was shown the same to analyze the difference.

Technology can also be incorporated as an innovative aspect of the entire teaching methodology. For instance, in a course on Spoken English, the learners can use computers and speakers to learn the pronunciation. The learners can have separate practice sessions. Similarly, in a course on mechanics in the automobile sector. The institute partnered with subject matter experts from a knowledge organisation. They came up with 'enhanced pads' which is a small gadget like an ipad, but not expensive. The students were given a chance to learn using this enhanced pad.

In order to "**Value New Products**", it is extremely essential to understand the skill gaps in various industry verticals. One of the educational institutes studied the list of twenty high growth sectors enlisted by National Skills Development Programme, identified the role in the value chain and then developed academic programmes. The framework of the governance structure defined by the University with which it was registered was utilised and followed to facilitate smooth functioning of the various academic and administrative activities of the college. The college had constituted an Academic Committee and an Examination Committee and on the top of them a Board to validate all the processes undertaken in respect of conduct of academic operations and examinations. The members of these regulatory bodies can be from diverse fields; from industry, to local community, teachers from the college itself, local government representatives, etc.

The various outreach programmes help in analysing the needs of the community for various courses. These programmes also play a crucial role in connecting with the potential learners from the community. These programmes help in imparting awareness on education and overall well-being. Within the community awareness can be generated about the relationship between education, employability and economic development. Through various awareness programmes the benefits of lifelong education can be advocated at various levels. It helps in understanding the different barriers and challenges which hinder the educational and employment requirements of the community.

A community level educational institution must be committed to quality in every aspect of the process of imparting education, up-to-date and should be offering the most practical curriculum, administered by a sensitive professional teaching faculty, using innovative teaching methods, and modern infrastructure to make learning a pleasurable experience. The emphasis should be on ensuring that lack of financial resources does not hinder the aspirations and growth of a more secure future for those motivated to come forward. The shared vision and values can be imbibed in the culture of the organisation and used as a guidepost in decision making. The educational institute should develop “standardised processes” and endeavour to comply with the requirements of international standards achieving continual improvements in effectiveness of the management system thus enhancing beneficiaries’ satisfaction. The quality service system of the institute needs to be inbuilt in the design of the programme, execution, monitoring and feedback. The processes emanate from the community outreach programmes to curriculum development, classroom teaching, extracurricular activities, and placements.

One of the NGOs, that has registered as a community level educational institution, has witnessed the progress from being a learning and evolving organisation to the one that has reached a stage of maturity, both in terms of visibility as well as activity. It has enhanced visibility in the community using ICT such as sms services and other promotional activities, especially the outreach programmes. Our greatest role should be to empower the community, at every level, to be their voice at the time of distress. This can be done by addressing their various issues with the hope through time, and empowering them to address their own issues with social responsibility. Thus a community level educational institute can be truly a rising flame for a better life. Focus should be on ‘providing value added services’ to promote holistic growth. The students should be taught to be courageous to overcome the impediments and barriers, with integrity and rising above the challenges. The weak students should be helped by their friends to bring their learning levels at par with them through a concept of ‘buddy system’. Regular exposure visits to historical places and museums should be conducted to generate awareness among students about our rich heritage, culture and great leaders of our country. At times it is surprisingly found that their knowledge on these aspects is really bleak which only leaves one to ponder that whose responsibility is it when generations are deprived of their national history and the sacrifices made by the nation builders.

## **Innovative 4C model**

One of the community level educational institution follows an innovative 4C Model for providing a lifelong learning to the diverse community it serves for overall well-being. The 4Cs stand for Competent, Compassionate, Conscientious, Changemakers. This model also highlights the teaching learning process of the community level educational institution which is learner-centric and focuses on well-being and quality of life.

### **i) Competent**

One of the constant endeavours of the community level educational institution should be to enhance competency amongst its learners through opportunities in various academic programmes designed as per their needs. All the programmes should have well defined credit system. Technology can also be used as a tool to facilitate learning. To promote the climate fit to meet the competitive needs, state-of-the-art laboratory facilities and equipments, and class sizes tailored to learning needs can also be provided.

**ii) Compassionate**

The students should be taught to respect all religions and thus all the festivals irrespective of any religious conviction should be observed. Moral values should be inculcated as a part of classroom teaching. Special spiritual sessions can also be conducted on a regular basis. The students can be asked to document their feedback on their learnings and reflections. In one of the community level educational institute the students start their day with a prayer and by writing 'thought of the day' on the white board in the hallway.

**iii) Conscientious**

Students should be taught to appreciate the hygienic practices and contribute to cleanliness drives in their campus in order to enhance their sense of ownership of the college. In addition to their learning in classrooms regular sessions should be held on personality development and awareness of their rights and duties. Monthly analysis of attendance of the students should be done and displayed on the notice board so that the students stay alert on their regularity.

**iv) Changemakers**

It is important to make the youth responsible and proactive in community development in their local area and for this the students can be organised into voluntary groups. The concept can help to build leadership capabilities among them. In one such institute, the students identified the top ten needs of their area and worked together to seek solutions to the issues identified. They are involved in the process of developing a community library and with the help of cycle rallies and street plays they spread the awareness on the importance of education as ambassadors of change. The students identify a theme each month and their activities are centered on the selected social and environmental issues. These service learning programmes help in developing a sense of civic responsibility among the students. These programmes not only enhance their academic skills but also make them committed to their own community, thus finally mobilizing change in the society.

The 4C model and its four parameters provide the standards according to which the students can be acknowledged and recognised. All students should be provided equal opportunity to excel in various facets of life. The guiding belief should be that since the main purpose of education is to develop skills and knowledge, the emphasis should be on producing the kind of learners who have the capability to bring a positive change in the society.

The main emphasis should be to create an ambience that motivates students to grow as an enlightened human. In order to achieve this, there should be full time counsellors to cater to the needs of the students and aspirants at all levels and at all times. The parents can be motivated to send their children to institute through regular parent teachers' meetings and home visits. The talent of students can be identified through competitions, sports day and then linked with expert agencies. The students can be encouraged to participate in various club activities such as dance, music, arts, theatre for all round personality development. Seminars and workshops on rights and duties, premarital counselling, career counselling, health and nutrition should be made a regular feature. All these efforts inspire the learners to seek learning and not merely pass exams. The community voluntary group programme can be used to inculcate the

spirit of leadership and volunteerism amongst the students. Job fairs with corporate partners can be organised to provide placement opportunities to the learners. Additionally, the linkages can be done with bank for loan facilities and tie-ups directly with market industry for providing jobs.

Thus, a community level educational institute ensures to promote job oriented, work related, skill-based and life coping education to the deserving. It can play a significant role in meeting the needs of unemployed, underemployed, underrepresented, and disadvantaged sections across all age groups, culture and gender through various academic programmes. In addition, it can rise to hold a unique position in this juxtaposition of secondary and post secondary education for those who are able but disadvantaged in terms of receiving adequate learning levels and quality education for them to succeed in higher studies or career. It can also expand the demographic profile of the students who cannot afford the minimal fees by providing loan opportunities through bank linkages with special schemes and scholarships.

## **Conclusion**

The community level educational institution in a humble manner can strive to customise the educational programmes as per the needs of its students, and give the perfect platform to one and all. It can be an endeavour to provide a lifetime experience of learning to the diverse community it serves. Such community colleges can move towards a revolution from evolution bringing about modest changes but surely effective ones which can lead to innovative ways towards being change agents.

## Introduction

The Indira Gandhi National Open University has established a new emerging discipline, *Sustainability Science* under the guidance of eminent agricultural scientist Prof. M. S. Swaminathan in the backdrop of UN Decade for Education of Sustainable Development (2005-2014). IGNOU is the first University in India and one of the few Institutions across the globe that introduced *Sustainability Science* as a discipline. The foundation was laid with the sponsoring of the plenary session on Sustainability Science at the 95<sup>th</sup> Indian Science Congress on 6<sup>th</sup> January 2008 by the University. It is our great opportunity to share the basic concept of this new discipline, its innovativeness in terms of developing the programme and delivery mechanism through this article. The information has been structured into three major components:

- Sustainability Science: Concept and Genesis in India
- IGNOU's initiatives in developing and nurturing the new discipline
- Online delivery of programmes

## Sustainability Science: Concept and Genesis in India

The concept of the sustainability science has been well articulated and acknowledged in the definition given by Brundtland Commission, "The development to meet the needs of the present generation without compromising the ability of future generations to meet their own needs". It focuses on two components - the needs of the present and the future generation. The basic needs are food and shelter for everyone, and the same are provided by nature. So, everyone in this generation and the generations to come needs to have basic food and amenities. We should have a model of progress where proper food and livelihood security opportunities exist for the present and future generations. The nature plays an important role in providing food and livelihood security and this puts the onus on all of us to conserve nature. And this is a fact also that human beings and nature are distinct but inseparable.

Thus, Sustainability Science is the discipline that deals with the interaction between Nature and Society. In the words of Prof. Swaminathan, '*Sustainability Science is the study of arts and science of Sustainable Development*'.

Since *livelihood security* is the basic pillar to sustainable development, let us then delve into the livelihood issues and available livelihood system in the country.

## Livelihood Issues and Sustainability Science in India

Some of the major issues facing India in the 21<sup>st</sup> Century are population, poverty, nutrition, gender, climate change (multiple impact), development vs. environment, and unemployment. In addition there are most pressing challenges of today's era, i.e., climate change and resource depletion.

India is a society of large population and is the second most populated country in the world. These large populations are fed by the natural resources around them which are

degrading day by day. This finally leads to a state of poverty due to lack of traditional livelihood option. Again, nation like India is highly vulnerable to the global phenomenon of climate change. This is true especially in case of the poor sections of the society in particular, where the rate of poverty is very high and agriculture is one of the key drivers to GDP.

Livelihood system in India, mostly agriculture based, is built around – mountain, wetland, river and biodiversity. Rural livelihood is dependent on agriculture, livestock, forest produce, and produce from other resources like fish, labour etc. Livelihoods are dynamic in nature and are influenced by various external and internal conditions making the interdependent influencing factors more complex in nature. India is a country with huge diversity in physical landforms, with different agro-climatic zones, high biological diversity that finally leads to the diversity in culture and tradition. If one looks at the diversity in landform, it shows a sort of inter-connectedness in different parts of the country. For example, the Great Himalayas, the Ganges, the Indo-Gangetic plain, and the Western Ghats are the cases where each of the components cannot be studied in isolation. So, the need of the hour is to understand the existing conditions of the cyclic relations among the different landforms and livelihood options.

Degradation of local natural resources, viability issues with traditional sectors like agriculture, increase in climate vulnerability and changed aspirations are forcing people to shift to other livelihood opportunity. Low productivity, environmental impact on land and water resources, lack of access to formal financial system, poor forward and backward linkages, institutional setup, technical knowledge and assistance, lack of storage and transport infrastructure, poor-ineffective corrupt delivery mechanisms etc. are some other challenges. From the farmers to the decision makers, all need a discipline that cares for the holistic understanding of these aspects where the age old ethic centric principles are revisited and are spread across the country. The mass participation for the growth of sustainable development in India can be achieved through three major approaches, i.e. research, sustainable development models and education.

Research enables us to understand the issues and approaches for solving the various problems related to sustainable development. But the major obstacle is that *research* is restricted to a limited number of people and the mass involvement calls for successful implementation of the approaches and their extension. Education plays an important role in enhancing awareness among people on these issues. The mode of education (in terms of approaches and delivery mechanisms) also plays an important role when we have varied groups of stakeholders. It has been well-tested that the open and distance learning (ODL) system of education is the best and cost-effective option for mass education.

In brief, one can recommend that bringing sustainable livelihood needs a chain of approaches where research and education are the basic components. Let us discuss the role of education and specially the interventions made by ODL system in this direction.

## **IGNOU's Initiatives in Developing and Nurturing Sustainability Science**

It is essential to appreciate that educating the various strata of the society is much required to inculcate the culture of sustainability among the citizens in every aspect of life. Certain programmes have been designed and developed at IGNOU to address these needs. The programmes have been developed at different levels based on the target groups and levels of knowledge required for achieving the desired outcomes at the performer level. The

courses are structured at post graduate level. The programmes have been so designed to keep the performer actively involved in identification of issues and development of sustainable models for implementation. The following programmes have been introduced at IGNOU for different stakeholders.

- Appreciation or leadership programme  
Here, the main focus is on sector(s)/compartment(s) of livelihood and the course is designed at an advance awareness level.
- Post graduate certificates/diplomas

The University introduced the first appreciation programme – Appreciation Programme on Sustainability Science on 19 November 2008. We would like to share the basic approach in developing advance awareness courses under this discipline. The programme is developed with the development of a course of 4 credits and each credit is given for broad understanding of the issues, the core issues and its linkages, management approaches or principles and available case study as models (Fig. 23.1).

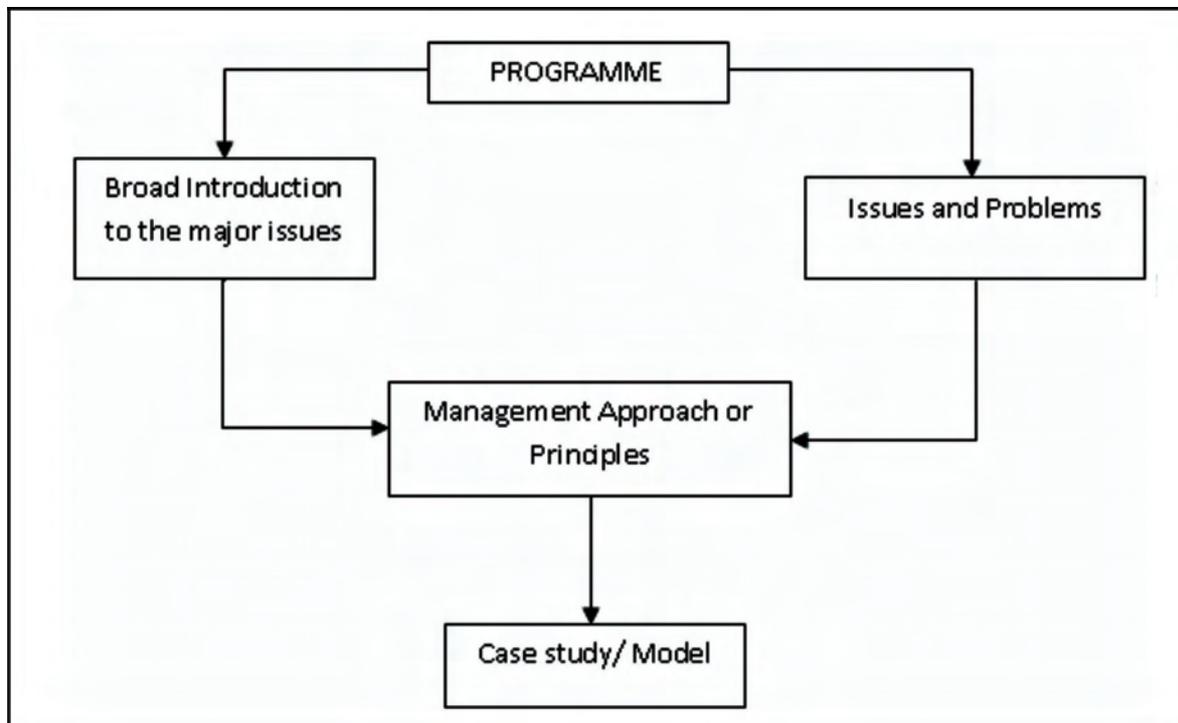


Fig. 23.1: Structure of Appreciation/leadership Programme

The programmes being offered under the discipline of Sustainability Science include credit programmes such as Post Graduate Diploma in Sustainability Science (PGDSS) and Post Graduate Certificate in Climate Change and Sustainable Development (PGCCSD). Non-credit programmes being offered are:

- 1) Appreciation Programme on Sustainability Science (APSS)
- 2) Leadership Programme on Nutrition Security & Sustainable Development (LPNSSD)
- 3) Appreciation Programme on Sustainable Management of Wetlands (APSMW)
- 4) Leadership Programme on Himalayan Ecosystems (LPHECO)

- 5) Appreciation Programme on Sustainable Management of Ganga (APSMG)
- 6) Appreciation Programme on Sustainable Management of Biodiversity (APSMBIO)

## Online Delivery of Programmes

In the first phase, the programmes are being offered through online mode depending on the profile of the target groups. On the other hand, there is also a strong need for tapping the progress of ICT in India in order to take education to the targeted groups. Therefore, this course is in harmony with the growth of ICT for educational purposes. Another important factor that needs to be considered is that *sustainability science* is a highly dynamic and challenging discipline which is still in infancy stage and needs to be nurtured with the active participation of stakeholders involved.

## Uniqueness of Online Education

Education through online mode of delivery mechanism can be interpreted as, *access knowledge wherever you go through the available ICT*.

The online platform is accessible at <http://www.ignouonline.ac.in>. The platform provides a complete virtual learning environment covering all the activities, from registration to certification. It is developed and managed by eGyankosh team of the University. Ample space is given to the Programme Co-ordinators to improve the platform with innovative ideas. The main page of the online programme is shown in Fig. 23.2. If we look into the issues of existing distance education scenario in the country and stakeholders response in participation of programmes through distance mode, online may be superior in terms of production and delivery, especially in this era of technology.

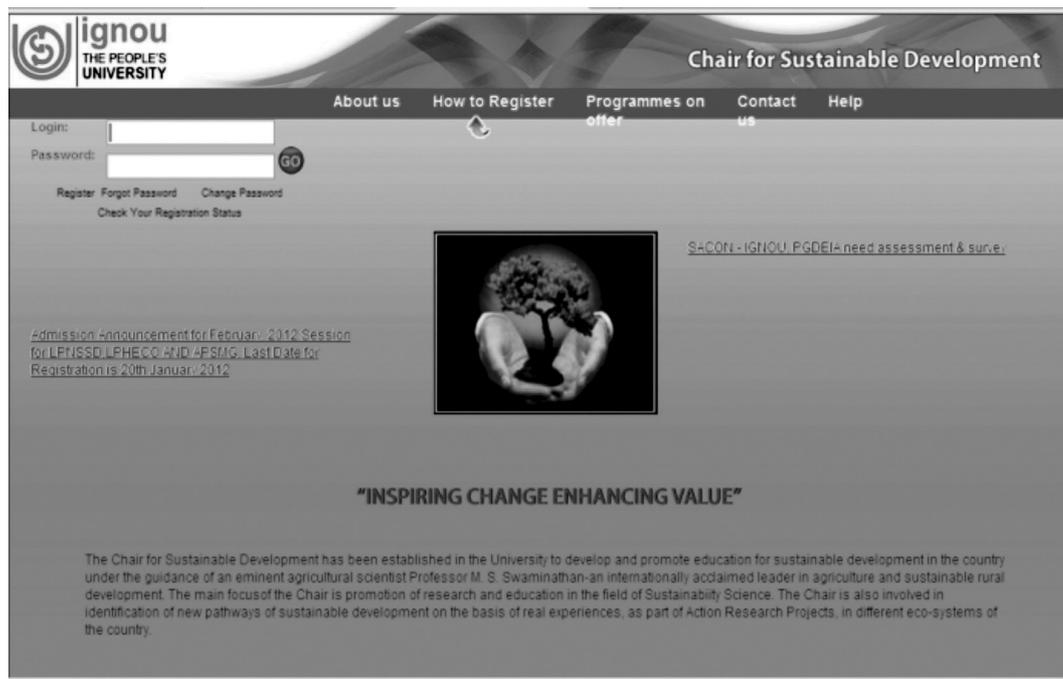


Fig. 23.2: The SAVE Home Page

The various unique features available to learners, programme coordinators and evaluators are mentioned here. The instructional material (text, audio/video) is available to the students through this platform. The status of application, assignments, synopsis, projects and evaluation can be tracked easily wherever the internet connection is available.

As a **Programme Coordinator**, one can get the progress of the following processes through auto generated e-mail;

- Application Status
- Account activation
- Assignment submission
- Synopsis submission
- Evaluation status (Assignment, Synopsis, Project, and Term End Examination)

The learner is sent an email as soon as his/her account is activated. The Learner Profile page is shown in Fig. 23.3.



Fig. 23.3: The Learners Profile

The learner can also see who else is there in the class through the *Class Group* page shown in Fig. 23.4. Information is also provided about the teachers who are going to teach and mentor the students through the course.



Fig. 23.4: A Class Group

The *Announcement* page provides all the relevant information to the learners regarding the programme such as the counselling schedule, scheduled web conferencing, scheduled chat sessions, etc as shown in Fig. 23.5.



Fig. 23.5: The Announcement Page

The **learner** can also check his/her status from time to time.

- Application status
- Account activation
- Study Materials at the platform (HTML and PDF format, with download option)
- Evaluation status (Assignment, Term End Examination, Synopsis approval, and Project)
- Counselling

The learner can go through the study material in HTML format or s/he can also download it if required, from the *Download Study Materials* page as shown in Fig. 23.6.

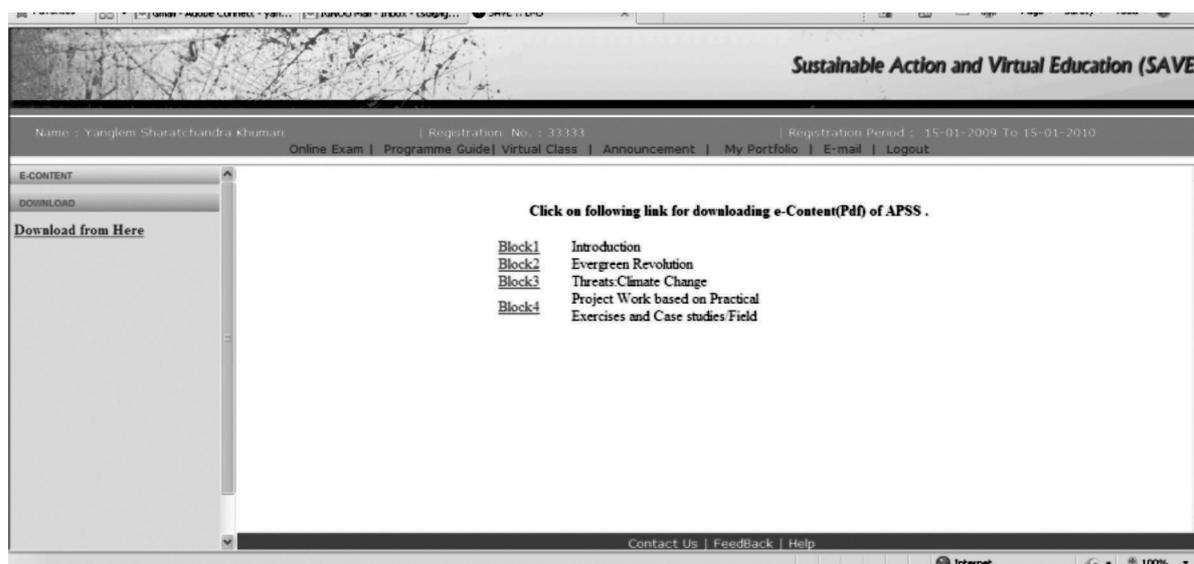


Fig. 23.6: The Download Study Materials Page

The learner can check his/her progress from the *Check Your Progress* page shown in Fig. 23.7.

Fig. 23.7: The Check Your Progress Page

The learner can check his/her status from the *Transcript* page shown in Fig. 23.8.

S. No.	Details	Max Marks	Marks Obtained
1.	Term End Exam Marks	70	47.6
2.	Assignment Marks	30	23
	<b>Total Marks</b>	<b>100</b>	<b>70.6</b>

Project Grade : **B**  
Scheme of awarding division is as under :-  
Percentage Range                      Letter Grade

Fig. 23.8: The Online Transcript Page

As an evaluator, one can check learners' assignments, projects, term end paper etc. through online mode within the specified duration. There are provisions for Online evaluation, Assignments, Term End Paper, and Project/Dissertation as shown in Fig. 23.9.

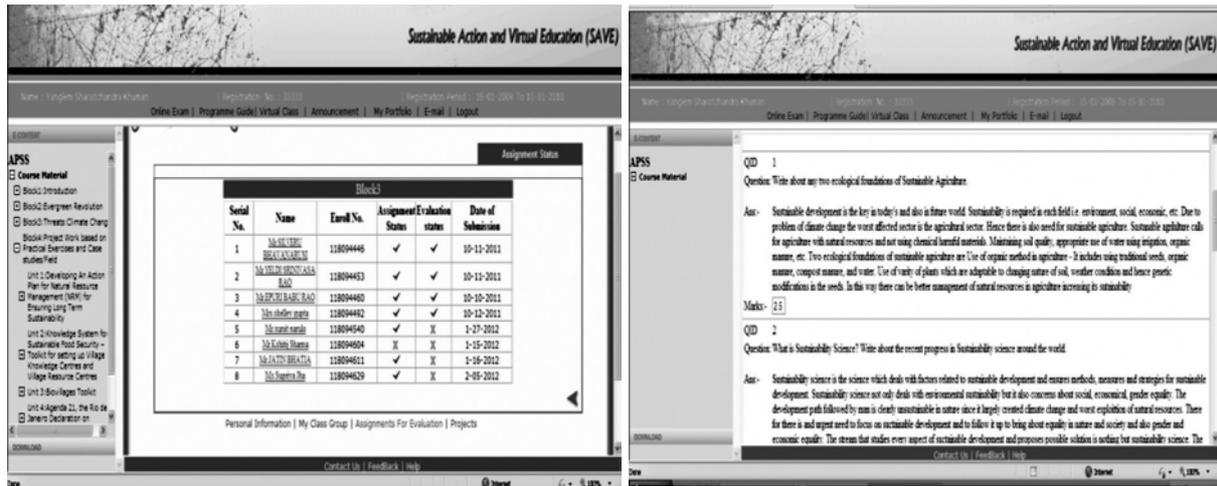


Fig. 23.9: Evaluators can Check the Papers Online

Online counselling sessions are conducted for the benefit of the learners as shown in Fig. 23.10.

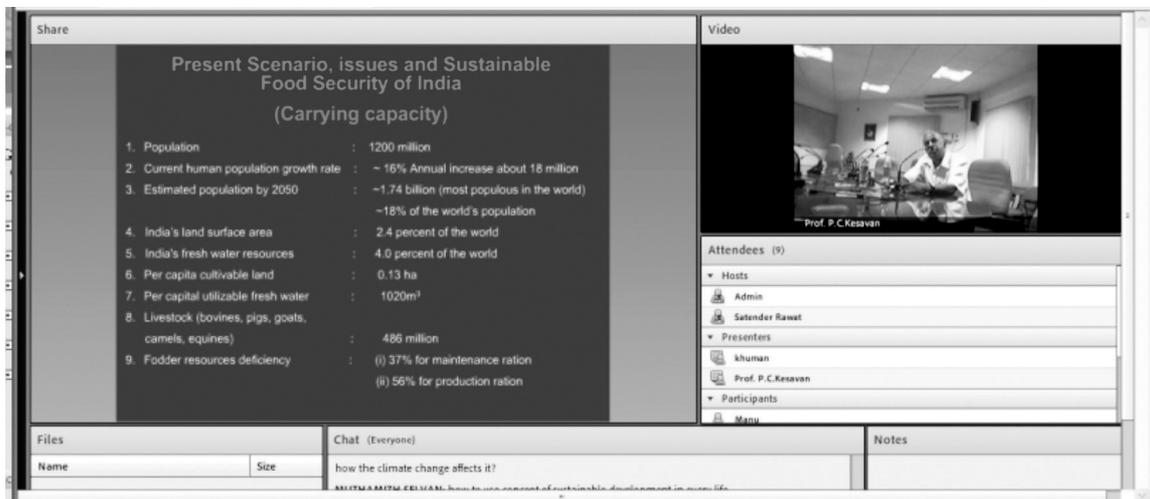


Fig. 23.10: The Counselling Session in Progress

The counselling sessions conducted through the programme are recorded and archived for the use of learners. The page showing the list of counselling sessions is shown in Fig. 23.11. A learner can access this page and take part of any counselling session as per his/her convenience.

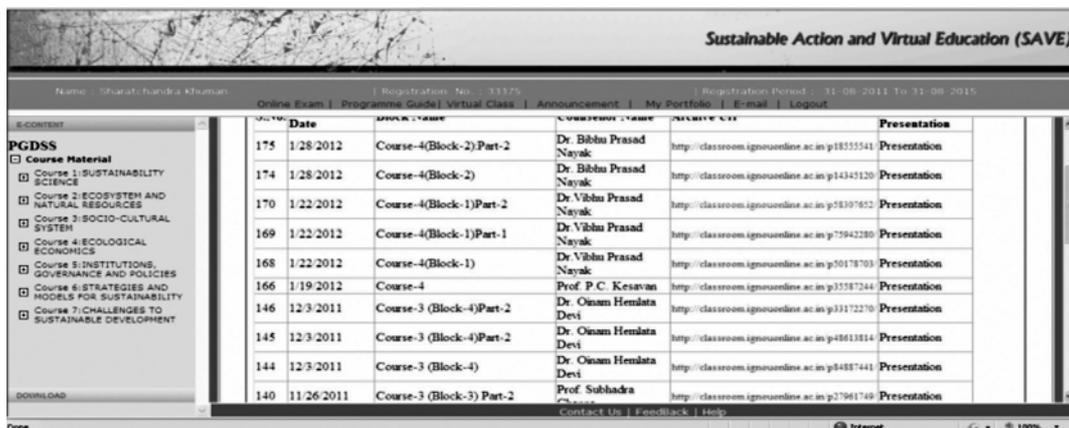


Fig. 23.11: List of Recordings of Counselling Sessions

## The Challenges

With all the existing superior facilities to meet the present demands, these are certain the challenges faced by stakeholders. It seems that due to the delay in streamlining the online education mechanism in our university, coordinators are involved in a number unrelated administrative responsibility that affects in reviewing the status of programmes. For example, we are caught among different divisions in admission announcement, in finalising Term End Examination Centre, payments to counsellors, evaluators etc. For learners and counsellors, it may be difficult to attend counselling sessions from a network (especially educational Institutes) where Port 1935 and Port 80 are blocked. These ports need to be opened for running Adobe Connect.

## Conclusion

A number of gaps still exist but we need to look in a progressive way and we hope the challenges will slowly wipe out. Teaching sustainability science is everybody's concern, and so the onus is on us to facilitate the process of learning. Online mode brings active participation of learners, their involvement in nurturing this new discipline and effective way of delivery mechanism is met. Through this mode, up to some extent, we are able to reach our target groups. We conclude by saying that by way of the innovative approaches taken we have come a long way and we need not look back.

**Acknowledgement:** We would like to thank Dr. C.K. Ghosh and his team for giving the opportunity to share our experiences in developing this new discipline in this special teleconferencing session, Prof. Uma Kanjilal for her support, encouragement and giving much freedom in managing the online SAVE platform. Our sincere regards to Prof. M. S. Swaminathan and Prof. P. C. Kesavan for accepting us as their students in the field of sustainability science.

# 24

## Mathematics as a Way of Life

C. K. Ghosh

### Introduction

In general there exists a fear psychosis among the students about mathematics. There are instances of students getting unusually tense prior to the mathematics examination. There are even instances of unfortunate incidents like students committing suicide on being unable to bear the stress or the shame of under-performance. Perhaps the fear is more with the guardians and their wards cannot escape the infection of this avoidable disease. There is a tendency among the mathematics teachers to give emphasis towards development of numerical capability in the child, which of course is desirable. But more than that, some effort is required from their side to see to it that the children feel mathematics. Play-way techniques of teaching-learning transactions in mathematics have been practiced by many experts and those have yielded positive results. The idea behind such techniques is to develop interest in the subject. One of the ways to make the students feel mathematics can be to sensitise them to the issue that mathematics can be a way of life. It is not an obscure subject departed from the real life situations. Rather, it pervades several issues of our life.

We are aware of the applications of mathematics in explaining a variety of natural phenomenon ranging from the microcosm to the macrocosm. However, the objective of this article is not to discuss such hard core mathematical tools. It aims at presenting very simple examples from real life situations which help in unfolding the apparently hidden beauties of mathematics. At the very onset it is being ensured that the examples chosen here require the applications only of very elementary level mathematics. I hope that the mathematics teacher will use them for creating excitement among the students in the subject.

### Travelling in a Train

Many daily commuters keep travelling between Howrah Station and the suburbs of Kolkata which come enroute Bardhamaan, an important junction station. There are two routes for travelling between Howrah and Bardhamaan. One is called the Main Line and the other Chord Line. The Main Line goes northbound and turns westward from a junction station, Bandel, whereas the Chord Line deviates from the Main Line at Bally, the fourth station from Howrah and heads north-west and again meets the Main Line at Saktigarh, the third station from Bardhamaan. The distance between Howrah and Bardhamaan along the main line is 107 km, whereas along the Chord Line it is 95 km. This example is very handy in explaining the meaning of the term chord, which is a straight line joining two points on a curve. For similar reasons the distance between Asansol and Mughal Sarai is 544 km along the Main Line, but 461 km along the Grand Chord Line. It has been observed by the author that many passengers have the impression that the Main Line is straighter than the Chord Line. They have such a misconception perhaps because of the word 'main'. One must appreciate that the expression 'chord' has the same meaning irrespective of it being found in the geometry text-book or the railway time table.

These days the computerised railway reservation ticket carries the message regarding the position of the berth (lower, middle, upper, side lower, side upper). One can easily verify the same in case of any doubt. It is basically a problem of Modulo. If it is the case of

reservation in a three-tier compartment then it is a problem of Modulo-8 and if two-tier, then Modulo-6. The algorithm (Berth Number = N) is as under:

- For 3-tier if, N modulo 8
- = 1 or 4, then lower berth
  - = 2 or 5, then middle berth
  - = 3 or 6, then upper berth
  - = 7, then side lower berth
  - = 0, then side upper berth
- For 2-tier if, N modulo 6
- = 1 or 3, then lower berth
  - = 2 or 4, then upper berth
  - = 5, then side lower berth
  - = 0, then side upper berth

Thus, if your Berth Number is 27, then in case of a 3-tier/2-tier compartment your allocation is respectively upper/lower berth.

### The Famous Hurdler, Edwin Moses

Edwin Moses (Fig. 24.2) was a famous hurdler from USA, who won the gold medal in the 400 m hurdles race event in the 1976 and 1984 Olympics. Had USA taken part in 1980 Olympics, perhaps then too he would have won the gold medal. He maintained a record of winning 122 consecutive races. His trademark technique was to take 13 steps between two consecutive hurdles. At times he used to take 12 steps between hurdles but finally settled for 13 steps. Now, 12 being an even number the implication of taking that many number of steps is that the stress corresponding to the lift for taking the jump over a hurdle was always on the same leg. He practiced secretly and changed from 12 to 13 steps. 13 being an odd number, the stress would be on different legs for consecutive hurdles. Perhaps he felt that his performance would be enhanced if the stress alternates between the two legs. Moses was a Master Degree holder in Business Administration but basically a student of physics. Let us see how he could have gone about making the adjustments.

For the said event, the distance of the first hurdle from the start is 40m and that of the tenth and last hurdle from the finishing line is 45m which means that the ten hurdles are spread over a length  $400\text{m} - (40 + 45)\text{m} = 315\text{m}$ . Since there are ten hurdles, the number of spaces between two consecutive hurdles is nine, each being equal to  $315\text{m} \div 9 = 35\text{m}$ .



Fig. 24.1: Edwin Moses

Edwin Moses was famous for his 9 feet 9 inches stride, which is almost equal to 3 metres. But he optimised on the extent of his strides to get the ultimate best possible result. As mentioned earlier, he wanted to take 12 or 13 steps within a stretch of 35 metres. Here, we also have to take into account the length covered while crossing a hurdle. 35 metres minus that length has to be a multiple of 12 as well as 13, that is a multiple of their L.C.M., which is  $12 \times 13 = 156$ . Incidentally  $156 \times 0.2 = 31.2$  which is less than 35 by 3.8. So he adjusted his hurdle jumping stride (HJS) to 3.8m so that the remaining 31.2m can be covered either in 12 or 13 strides. The HJS for any athlete is always larger than the running stride and he was able to stretch that upto 3.8m, that is more than 0.8m beyond the maximum possible stretch of his running stride. So, while taking 12 steps, each stride was  $31.2\text{m} \div 12 = 2.6\text{m}$  and corresponding to 13 steps it was  $31.2\text{m} \div 13 = 2.4\text{m}$ .

Thus Moses optimised his stride length for overall efficiency. Its maximum extent could have been about 3m. He chose to bring it down to 2.6m or 2.4m depending on the circumstances. The process was facilitated by the arithmetic mentioned above. However, it does not imply that anybody knowing that much of arithmetic would be able to perform like Edwin Moses. Rather, it is significant that Moses could tailor his physical capability in tune with the arithmetic – no wonder, he was a great athlete.

## **Application of Mathematics in other Sports**

Mathematics is used to a great extent in sports. For example, the Duckworth-Lewis (Fig. 24.2) method is used in cricket to determine the results of rain-affected matches. The method is concerned with very systematic and logical mathematical analysis for arriving at the required figure of runs to be scored by the team batting second for a victory at an One-day international or a T20 match.



**Fig. 24.2: Duckworth and Lewis**

As a matter of fact it was a mathematician's plan and modern technology that helped in keeping Sachin Tendulkar's bat unusually quiet during the 4-0 whitewash of India by England in 2011. The Strategy adopted by the English team was basically to draw Tendulkar (Fig. 24.3) outside his off-stick in the early part of his innings rather than allowing him to get runs on the on-side. Out of the 261 balls bowled to Tendulkar by the quickies of England till the Edgbaston test, 254 have been pitched outside his off-stick, six on the line of the off and middle stick and just one on the leg stick. Tendulkar scored 34, 12, 16, 56, 1, 40, 23 and 91 from eight innings, i.e. a total of 273 with an average of 34.13. The ploy was an outcome of a computer-simulator plan masterminded by the team analyst Nathan Leamon.



Fig. 24.3: Sachin Tendulkar

Mathematics is applied in determining the results of a diving or a gymnastics competition. Here the evaluation is subjective in nature. However, in order to bring in an element of objectivity the following steps are taken: In such a competition there are seven judges. Evaluation of the performance is done by all of them. The highest and the lowest points are struck off and the average of the remaining five determines the score. Let the scores of a diver be the following: 9.5, 9.2, 8.8, 9, 8, 8 & 7. So the highest and the lowest, 9.5 and 7, are to be struck off. The average of the rest is one – fifth of  $(9.2 + 8.8 + 9 + 8 + 8)$ , i.e.  $43 \div 5$ . So the diver scores 8.6.

Another aspect is related with the issue of judgment. There are certain dives which are compulsory. For these dives, the procedures explained above are followed. Apart from the compulsory dives, a diver has to perform certain optional dives. These dives are supposed to be more difficult than each of the compulsory dives. Each such dive is assigned with a degree of difficulty depending on its difficulty level. If say, the diver 'A' scores '8' in a dive for which the degree of difficulty is 1.2, then he actually scores  $8 \times 1.2 = 9.6$ . Now 'B' may score 7 in a dive whose degree of difficulty is 1.4, then the actually score of 'B' is  $7 \times 1.4 = 9.8$ . So 'B' scores less (7) than 'A' (8), but finally 'B' scores more than 'A'.

### Some Significant Numbers

Interest in mathematics among the pupils can be developed by exposing them to several significant numbers. One of them (1729) is attributed to Srinivas Ramanujan. It is called the Ramanujan Number or the Taxicab Number. The famous mathematician, G. H. Hardy, the mentor of Ramanujan came to meet him when he was sick in a taxi having the number 1729 and mentioned to Srinivas Ramanujan about it. Ramanujan readily recognized that it is the least among the numbers which can be expressed as the sum of two cubes in two different ways,  $12^3 + 1^3$  and  $10^3 + 9^3$ . It has several other interesting properties some of which are as under:

- It is a **Harshad Number**, which is a number divisible by the sum of its digits,  $1 + 7 + 2 + 9 = 19$ , which exactly divides 1729.
- It is the third **Carmichael Number** ( $n$ ) which is supposed to be a non-prime, non-perfect square natural number, such that if a prime number ' $p$ ' is a factor of  $n$ , then  $(p - 1)$  is a factor of  $(n-1)$

The first three such numbers are 561, 1105 and **1729**.

$$561 = 3 \times 11 \times 17 ; \quad 2, 10 \text{ and } 16 \text{ are all factors of } 560$$

$$1105 = 5 \times 13 \times 17 ; \quad 4, 12 \text{ and } 16 \text{ are all factors of } 1104$$

$$1729 = 7 \times 13 \times 19 ; \quad 6, 12 \text{ and } 18 \text{ are all factors of } 1728$$

- 1, 81, 1458 & **1729** again constitute a peculiar class of numbers. It has the interesting property that the product of the sum of its digits and the same expressed in reverse order is equal to the number.

$$(1) \quad \rightarrow \quad 1 \times 1 = 1$$

$$(81) \quad \rightarrow \quad 8 + 1 = 9; \quad 9 \times 9 = 81$$

$$(1458) \quad \rightarrow \quad 1 + 4 + 5 + 8 = 18; \quad 18 \times 81 = 1458$$

$$(1729) \quad \rightarrow \quad 1 + 7 + 2 + 9 = 19; \quad 19 \times 91 = \mathbf{1729}$$

It had been the experience of the author that an exposure to these and several other peculiar features of Ramanujan Number not only generates an interest in mathematics among them, they start taking a sense of pride in India's contribution to mathematics and get the impetus to know more about it.

Inspired by Ramanujan Number, I take this opportunity to share the peculiar properties of few other numbers which also generates interest among the students.

i) **153, 370, 371, 407**

$$1^3 + 5^3 + 3^3 = 1 + 125 + 27 = 153$$

$$3^3 + 7^3 + 0^3 = 27 + 343 + 0 = 370$$

$$3^3 + 7^3 + 1^3 = 27 + 343 + 1 = 371$$

$$4^3 + 0^3 + 7^3 = 64 + 0 + 343 = 407$$

ii) **1634**

$$1^4 + 6^4 + 3^4 + 4^4 = 1 + 1296 + 81 + 256 = 1634$$

iii) **145, 40585**

$$1! + 4! + 5! = 1 + 4 \times 3 \times 2 \times 1 + 5 \times 4 \times 3 \times 2 \times 1$$

$$= 1 + 24 + 120 = 145$$

$$4! + 0! + 5! + 8! + 5! = 4 \times 3 \times 2 \times 1 + 1 + 5 \times 4 \times 3 \times 2 \times 1$$

$$+ 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 + 5 \times 4 \times 3 \times 2 \times 1$$

$$= 24 + 1 + 120 + 40320 + 120 = 40585$$

There are many other numbers which exhibits peculiar properties. Only a few examples have been provided with the hope that the mathematically minded reader would use some of these in real life situations, wherever practicable and share the same with the students.

### **What is the missing link?**

Is there any missing link between the dates 14 March and 22 July? Apparently there is none. However, if we write the first one in the American style, that is month first, then date with dot in between then we have 3.14; whereas if the latter is written in the English style, that is date first, then month with slash in between, then we have 22/7. Both 3.14 and 22/7 are approximate values of the transcendental number,  $\pi$ . There is nothing great about it, but the coincidence is quite remarkable.

Now, as the final example we shall seek the missing link between the following dates: **23 January, 30 January, 01 May, 02 October** and **25 December**. For finding the link, we shall apply plain and simple arithmetic, not any puzzle solving trick. All are important dates. These are respectively Netaji's Birthday, Martyr's Day, May Day, Gandhiji's Birthday and Christmas.

One aspect of the commonality is that these are all important dates. But there are many other important days which we observe specially. Incidentally, some other crucial link exists between these dates. Let us try to find that.

**Difference in days between**

First and Second	= 7
Second and Third = 1 + 28 + 31 + 30 + 1	= 91*
Third and Fourth = 30 + 30 + 31 + 31 + 30 + 2	= 154
Fourth and Fifth = 29 + 30 + 25	= 84

(\* It is not valid for a leap year).

Now, 7, 91, 154 and 84 are all exactly divisible by 7, the number of days in a week. So, all these dates will fall on the same day irrespective of the year, provided it is not a leap year. For example, in 2013 all these are on Wednesday. If it is a leap year then the first and the second will be on the same day and the third, fourth and fifth will be on another same day, one day ahead of the common day for the first and the second. For example, in 2012 the first two were on Monday and the latter three on Tuesday.

So the missing link is the commonality of the day. If one of them is a Sunday, so will be the others. Such was be the situation in 2011. As a matter of fact each one of them except the second is a holiday in West Bengal. Thus four holidays got spoiled for the people of West Bengal in 2011. Such a situation would arise again in 2022. Anyway, with the above piece of information at least the reader would not get the shock after seeing the calendar of 2022.

**Conclusion**

A few examples, which are by no means linked with each other, have been presented here to establish that mathematics is not dissociated from issues pertaining to our existence. It is unfortunate that the average mathematics teacher seldom talks about application of the subject in real life situations. The attitude of the teachers in giving exposure to the students towards applications will be able to remove the fear psychosis about mathematics and generate confidence in the student.

We learn from mathematics that if we give something from what we have then it gets lessened. It is the principle of subtraction. However, after stating so much about real life application of mathematics I shall appeal to the teacher to be **non-mathematical** in one respect that is in giving the students the much desired affection and confidence. They should give these in such a manner that the said virtues possessed by the teachers defy mathematical principles by growing rather than getting lessened.

**References**

- [http://en.wikipedia.org/wiki/Edwin\\_Moses](http://en.wikipedia.org/wiki/Edwin_Moses)
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## Introduction

Language serves primary function of conveying information, and communicating feelings and emotions. Language also reflects information like social status, occupation of a person, and region to which s/he belongs. We also use language for aesthetic purposes to express ideas, thoughts, beliefs and feelings creatively and imaginatively.

- Primary Function of a language is to convey information.
- Language is used to communicate feelings and emotions.
- Language gives information about a person (like region s/he belongs to, social status, occupation).
- Language is also used for aesthetic reasons.

Language consists of words. The total stock of words of the English language or any language is known as lexicon. Let's face it, English is a complex language and can be confusing. A lot of words are similar but with different meanings. It is almost impossible to avoid making mistakes in English, but you might be able to avoid making these ones. The language is extremely rich and offers a wide range of possibilities in terms of sentence construction, synonyms, antonyms etc. But it also has many confusing aspects related to the rules of grammar and spelling. There are a number of words which are similar but have different meanings. All these complexities make it almost impossible to avoid making mistakes in English, but let us look at some common errors that can be easily avoided.

## Common Errors in writing of English Language

There are a number of common mistakes that generally occur in our use of English language. Some of the common errors that we generally make in English are in the use of words and phrases, use of punctuations and in the formation of sentence structures. These errors distort the intended meaning and make the sentences very humorous. Some common errors that we make in English relate to the

- Use of punctuations,
- Formation of the sentence structures, and
- Use of words and phrases.

## Words often misused: Homophones

Homonyms are words which have the same spelling and pronunciation but different meanings and origins. Here, 'Homo' means the same and 'nym' means name. Some of the Homonyms are:

fair (county fair)  
 fair (reasonable)  
 left (opposite of right)  
 left (past tense of leave)  
 quail (cower)  
 quail (bird)

So what are Homophones? .... Homophones are words which have the same pronunciation but different spellings and meanings. Some of the Homophones are:

pear (fruit)  
pair (couple)  
see (with your eye)  
sea (the ocean)

Whereas Homographs are words which are spelled alike but which are different in meaning, and sometimes pronunciation.

row (argument)  
row (propel with oars)  
tear (in the eye)  
tear (rip)

In common usage homophones and homonyms can lead to confusion in comprehension as shown in the following example. The pronunciation being similar, one is not able to comprehend the intended meaning and this leads to confusion.

Once day in school, David was feeling extremely thirsty. He wanted to drink water. But he knew that he would have to ask the teacher for that.

So he did:

“Miss Roberts, can I drink water?”

Miss was in an angry mood that day. She replied shortly:

“Allowed.”

“Miss, can I drink water?” repeated David. At his repeated question Miss turned impatiently, (thinking that he just wanted to confirm) giving the same answer:

“Allowed.”

“Miss, can I drink water?” again repeated David. At this Miss lost her temper

“Why are you doing this, David? To cheek me?” she stormed.

“Of course not, Miss,” David replied, puzzled. “I was just repeating for the sake of you, as you couldn’t hear it.”

“Who said that I couldn’t hear?”

“Miss, you said yourself. When you said the word ‘aloud’, I repeated it out loud.”

In this example because of the pronunciation being same the student could not differentiate between ‘Aloud’ and ‘Allowed’. He got confused and had to face the ire of teacher.

### Some common mistakes

Apart from confusing words there are many common mistakes that we unknowingly make in our usage of English. We often use the words *LPG gas* or *CNG gas*. The word *Gas* should not be used with terms *LPG* and *CNG* as it only adds duplication to the meaning. Similarly, we often say ‘blunder mistake’. However, the words blunder and mistake convey the same meaning so they need not be used together.

Incorrect: It was a *blunder mistake*.

Correct: It was a *blunder*.

Correct: It was a big *mistake*.

Incorrect: Please *return* my book *back*.

Correct: Please *return* my book.

Incorrect: The *fish aquarium* is very large.

Correct: The *aquarium* is very large.

Incorrect: The *dance ballet* was lovely.

Correct: The *ballet* was lovely.

When you return a book, you give it back to the owner so we need not say “*return back*” as it is incorrect. In case of fish aquarium and dance ballet, the descriptive word is unnecessary, as an aquarium houses fish and a ballet is always a dance.

Incorrect: I’m going to *give an* examination.

Correct: I’m going to *take an* examination.

Incorrect: I will *revert back* to you shortly.

Correct: I will *revert* to you shortly.

We often say ‘I’m going to give an examination’. However, this is incorrect as an examination is not given but taken. Similarly, we often come across the usage ‘revert back’. The word revert means to return to a previous subject or condition so the use of the word ‘back’ in the sentence is incorrect.

Incorrect: Could you *repeat* that last line *again*?

Correct: Could you *repeat* that last line?

Incorrect: It would have been *more better*.

Correct: It would have been *better*.

When we say, “Could you repeat it again?” It is wrong. The word ‘repeat’ itself implies saying it again, so there is no need to use the word ‘again’ with it. Similarly, it is incorrect to use the phrase “more better”. Here, the word better implies that the mentioned option is superior therefore the use of the word ‘more’ is inappropriate.

We often make mistakes in the usage of words such as data, media, strata, anyway and criteria. The words data, media, and strata are Latin words; and the words criteria and phenomena are Greek words that are used as plurals. The singular form of data is the word datum. Traditionally, datum takes a singular verb, and data takes a plural verb. Therefore, words medium, criterion, datum, stratum and phenomenon denote the singular form.

Incorrect: The *data* shows us some interesting facts.

Correct: The *data* show us some interesting facts.

Correct: This *datum* is the most important piece of information in our research.

Correct: These *data* are inconclusive.

Incorrect: Their *criteria* is easy to fulfill.

Correct: Their *criteria* are easy to fulfill.

Correct: Their *criterion* is easy to fulfill.

Correct: The *criteria* seem easy to meet, for most people.

Correct: This specific *criterion* is too harsh.

Incorrect: The *media* gets a lot of blame.

Correct: The *media* get a lot of blame.

The word 'anyway' is an adverb and adverbs cannot be plural, so the use of 'anyways' is incorrect and should be avoided.

### Words often misused: *Accept vs Except*

We often confuse between accept and except due to their somewhat similar spelling and pronunciation. However, the meaning of accept and the meaning of except are totally different. The word 'accept' is a verb and it means to receive something. Whereas, the word 'except' is used as a preposition or conjunction and it means to exclude something.

**Accept** is a verb, which means to agree to take something.

*For example:*

I always *accept* good advice.

I *accept* everything you're offering, *except* for the fruitcake.

I *accept* your invitation to go to the concert.

**Except** is a preposition or conjunction, which means leaving out.

*For example:*

I teach every day *except* Sunday(s).

He bought a gift for everyone *except* me.

### Words often misused: *Advice vs Advise*

The words *advice* and *advise* are also confusing because of their somewhat similar spelling and pronunciation. Advice is a noun, which refers to an opinion or a suggestion that you give. You give someone some advice. Advise is a verb which means something that you do. It refers to some action. You advise someone. *Advice* sounds like *rice* and *advise* sounds like *realize*.

**Advice** is a noun, which means a suggestion or a recommendation.

*For example:*

I need someone to give me some *advice*.

Take my *advice* and focus on your startup business.

I need your *advice* about this problem.

What *advice* did I give you?

**Advise** is a verb, which means to suggest.

*For example:*

I *advise* everybody to be nice to their teacher.

What did I *advise* you?

When a columnist *advises* people, she gives them *advice*.

I *advise* everybody to be nice to their teacher.

### **Words often misused: *Beside vs Besides***

The words *beside* and *besides* are also confusingly similar. *Beside* is used only to mean “close to or next to”. *Besides* should be used for ‘in addition to’, ‘as well as’ and ‘except for or apart from’. When *besides* is used as a preposition, it means ‘in addition to’ or ‘apart from’ but as an adverb it means ‘in addition’. In formal writing one can use connective words or phrases, such as “moreover” and “in addition to”.

**Beside** is a preposition of place that means by the side of or next to.

*For example:*

The house was *beside* the Thames.

He dreamed of a house *beside* the sea.

She sat *beside* her friend.

**Besides** is an adverb or preposition. It means in addition to.

*For example:*

Besides water, we carried some fruit. = “In addition to water, we carried some fruit.”

*Besides* water, we carried some fruit. (*in addition to*)

What are you studying *besides* English? (*in addition to*)

*Besides* the prize money, he won a trip to Goa. (*in addition to*)

Who was there *besides* Ram? (*apart from*)

*Besides* him, everyone liked the idea. (*except*)

### **Words often misused: *Complement vs Compliment***

Let us now look at the words such as complement and compliment. Complement is a transitive verb. It comes from the Latin word *complementum*. It is something that fills up, completes, or makes perfect.

*For example:*

The new software will *complement* the existing product.

The colours blue and green *complement* each other perfectly.

The word compliment comes from Italian word *Complimento*. It is also a transitive verb. It is an expression of respect, affection or admiration. In plural *compliments* can also mean best wishes.

*For example:*

The dancer received many *compliments* for her performance on stage.

It was the nicest *compliment* anyone had ever paid me.

### Words often misused: *Practice vs Practise*

The words *practice* and *practise* are also confusing because of their somewhat similar spelling and pronunciation. *Practice* is a noun and refers to an act in itself.

*For example:*

You need more *practice*. (You need more preparation.)

I have done my football *practice*.

*Practice* makes perfect.

Without enough *practice*, she would not get better at English.

*Practise* is a verb. It means to 'do something repeatedly to improve one skill'.

*For example:*

To learn English well you have to *practise*.

You should *practise* more. (You should prepare more)

I *practise* the piano.

The doctor has been *practising* for 10 years.

### Words often misused: *principal vs principle*

The words *principal* and *principle* are also confusingly similar. *Principal* is an adjective meaning "most important" or "main" or a noun designating the "chief or main person".

*Principal* as an adjective means "first in order of importance"

*For example:* The Mississippi is the *principal* river of the United States.

*Principal* as a noun means the head teacher in a school/ college.

*Principal* as a noun also means the original amount of a debt on which interest is calculated.

*For example:* She lives off the interest and tries to keep the *principal* intact.

*Principle* is a noun referring to a fundamental law or concept or to a code of conduct, often used in the plural, as in "moral principles." It means a basic idea, standard of behaviour or rule that explains or controls how something happens or works.

*For example:* The country works on the *principle* that all citizens have equal rights.

### Words often misused: *to see vs to watch*

*See* means to perceive anything in general. *To see* means to be aware of what is around you by using your eyes. It is unintentional.

*For example:*

I can *see* the smoke from here.

Can you *see* the blue car over there?

I *saw* you driving to work today.

I *see* what you mean.

*Watch* means to look at something carefully/attentively for a period of time, usually at something that is changing or moving. We *watch* things that move, such as TV, a film, sport. We *look* at static things, such as a photograph, a painting, the stars.

*For example:*

I'm going to stay home and *watch* TV tonight.

I *watched* the cricket.

*Watch* out for pickpockets.

*Look* means to look at something for a reason, with an intention.

*For example:*

*Look* at that strange man.

*Look* at the pictures I took on holiday.

### **Words often misused: *stationary* vs *stationery***

The words *stationary* and *stationery* are also confusingly similar. *Stationary* means standing still or not moving. *Stationery* means the items needed for writing, such as paper, pens, pencils and envelopes.

The word *stationary* can be used an adjective or an adverb. It means 'not moving' or 'still'. When something is standing still, it's *stationary*.

*For example:*

The drunk driver hit the *stationary* van.

Please remain *stationary*.

The word *stationery* means writing and office supplies (e.g., writing paper, envelopes, and pens). It can be used an adjective or a noun.

*For example:*

I received beautiful *stationery* with my name printed on it as a birthday present.

They went to the store to buy some *stationery*.

He wrote a note to procure the *stationery*?

### **Words often misused: *between* vs *among***

*Between* refers to two. *Between* is used when somebody or something is between two or more clearly separate objects. *Among* is used for three or more people or things.

*For example:*

You have to choose *between* these two options.

The United Nations tries to maintain peace *among* the nations of the world.

### **Words often misused: *Be* vs *If***

Incorrect: *Be* in Trouble. Please 110!

Correct: *If* in trouble, please call 110!

*Be* in all its forms (like *is*, *are*, *was*, *were*) is used as a connecting/linking verb because they link/connect the subject with a following word.

*For example:*

*Be* quiet. (a command or request)

*Be* a good girl.

I *am* writing.  
She *is* sleeping.

*If* is used to introduce a condition (i.e. in a conditional sentence) and in a conditional sentence, a condition has to be satisfied before something occurs.

*For example:*

*If* you win, I'll give you a pen.

He will catch you *if* you fall.

*If* you lower the price, a lot more people will buy your product.

### **Words often misused: loose vs lose**

We often confuse between the words loose and lose as they are somewhat similar spelling and pronunciation. *Loose* is an adjective refers to something that is not tight or contained. The word *lose* is a verb. *To lose* means to be defeated or to not have possession of an object anymore.

*For example:*

*Loose* clothing.

*Loose* the bond of faith.

My shoes are *loose*.

I win! You *lose*!

Don't *lose* your keys.

### **Hilarious Examples of Wrong English**

Most of the time use of incorrect or wrong English words makes the sentences very humorous.

*For example:*

Incorrect: Child Beer

Correct: Chilled Beer

In the above example, the word "chilled" has been spelled incorrectly as "Child" This makes it "Child beer" instead of "Chilled beer", thus making it very funny to read and also distorts the intended meaning.

Similarly in the following examples wrong use of English makes the sentence very funny to read.

Incorrect: If you would like to clean up your room. Please contact the Reception.

Correct: If you want to have your room cleaned, please contact the receptionist.

Incorrect: The ancient building is renovating. Excuse me for bringing trouble to you.

Correct: The building is under renovation, inconvenience caused is regretted.

Incorrect: Building asks a smoked visitor in the outside smoking section that you cannot smoke in.

Correct sentence: No smoking in the building premises.

In the above example wrong usage distorts the intended meaning of the sentence. Such a long sentence is not required here; the message can be conveyed easily through a brief and correctly worded sentence.

Incorrect: Please *push* out for exit.

Correct: Please *push* for exit.

In the above example, *push* is a verb which means to use your hands, arms or body in order to make somebody/something move forward or away from you. So we need not use the preposition out with it.

Some more examples are:

*Push* hard when I tell you to.

You *push* and I'll pull.

He *pushed* his chair back and stood up.

Try and *push* your way through the crowd.

Similarly, you aren't ignorant to a fact; you're ignorant of it.

Things don't happen on accident, but by accident (though they do happen "on purpose").

Incorrect: Welcome for coming.

Correct: Welcome!

(This is sufficient.)

Here welcome itself implies a cordial greeting or hospitable reception given to an arriving person. Therefore there is no need to use the words "for coming" here.

Some other examples:

You are *welcome* to join us. (adj.)

You are *welcome* to call. (adj.)

a welcome guest, a *welcome* gift (adj.)

They gave the stranger a very friendly *welcome*. (noun)

Don't overstay your *welcome*. (noun)

Incorrect: Class teacher said to the student, "Pick up the paper and fall in the dustbin."

Correct: Class teacher said to the student, "pick up the paper and put it in the dustbin".

Here, the preposition "put" is missing and the verb "fall" has been used instead. This has distorted the intended meaning.

Incorrect: Teacher said to the students, "Don't create pendulum, the principal is oscillating in the corridor."

Correct: Teacher said to the students, "Don't create pandemonium; the principal is making rounds in the corridor."

Incorrect: A teacher says, "I have three daughters, all are girls."

Correct: A teacher says, "I have three daughters."

In the above example, the words daughters and girls have been used, which refer to the same meaning. This makes it very redundant and also humorous.

Incorrect: Write down your name and father of your name.

Correct: Write down your and your father's name.

In the above example, "father of your name" has been used for "father's name". This has made the sentence very humorous.

We often make mistake while using "me and I".

*For example:*

Incorrect: He is smarter than me.

Correct: He is smarter than I.

One can understand this easily as "He is smarter than I am" is obviously better than "He is smarter than me am."

Incorrect: "will u hang that calendar or else I'll HANG MYSELF."

Correct sentence: Hang that calendar *or else* I'll do it myself.

Here, the sentence starts with lower case, which is wrong. The sentence is neither imperative (a command or polite request) nor interrogative (a question). The subordinate conjunction "or else" is used in this sentence which means "otherwise".

Some more examples:

Please be careful, *or else* you may have an accident.

You'd better do what I say *or else* you will get into trouble.

We'd better get to the airport by five *or else* we may miss the flight.

## Conclusion

The issue of errors in language is a little complicated. Minor deviations from the standard use of English as judged by sophisticated users lead to errors in English and these may result in low grades, lost employment opportunities, lost business, and amusing situations. Avoiding these errors helps one to express oneself in a clearer, more acceptable and easily comprehensible way.

## Introduction

Creativity is inherent in all of us. It finds expression in the form of hobbies or interests that we pursue in life. Creativity can be instrumental in devising innovative solutions for difficult problems. Therefore, creativity forms an integral part of any innovation process. Creativity empowers us to sustain in a dynamic world and unleashes a universe of possibilities. With enhanced creativity, instead of challenges you see opportunities; instead of problems you see a chance to create breakthrough solutions. Creativity is not just writing poems or making an art or solving complicated mathematical problems. Creativity exists in our day-to-day life, in all areas of human activity, even at work and play.

Creativity is an essential human ability that can be applied to a wide range of activities. Each and every human being has creative abilities, and all of us have them differently. When we are able to channelise the power of creativity in ourselves, it produces a great impact on our overall achievements.

## What is Creativity?

Creativity is an integral and important part of the innovation process. Creativity requires right-brain thinking for imagination, intuition, and feelings and the left-brain thinking for analysis and collation of data.

Albert Einstein was once quoted saying that “Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution.” (Calaprice, 2000)

According to OSHO “Creativity is the quality that you bring to the activity you are doing. It is an attitude, an inner approach – how you look at things. “So the first thing to be remembered: don’t confine creativity to anything in particular. A man is creative – and if he is creative, whatsoever he does, even if he walks, you can see in his walking there is creativity. Even if he sits silently and does nothing, even non-doing will be a creative act. Buddha sitting under the Bodhi Tree doing nothing is the greatest creator the world has ever known.”

*“Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others.” – Robert E. Franken, Human Motivation*

Plato argued that creativity (such as a poet’s work) involved dictating whatever the Muse chanced to speak. (Rothenberg & Hausman, 1976)

According to Wikipaedia, creative problem solving is the mental process of searching for a new and novel creative solution to a problem, a solution which is novel, original and not obvious.

What we understand about creativity is that, creativity is the ability to generate ideas for products, services or processes that are new or those which never existed earlier. It requires deviating from old methods and patterns of thinking and embracing new methods. It is a process of producing something new, innovative and useful.

## The Idea of Creative Solutions

Creative solutions are more than ideas - they must work in the real world. Therefore they need to have the following three main attributes:

- a) New
- b) Useful
- c) Feasible

Creative ideas, simply by themselves, cannot be of much help. They need to be developed into feasible solutions. The creative solutions have to work for the real world.

The idea has to be new (otherwise it would not be creative). The idea has to be useful, in that it solves the problem (otherwise it would not be a solution). The idea has to give rise to a new product or service or process. The product, service or process has to be useful as well. Further, the mass production of the product or mass use of the service or process has to be feasible, given the messy real world constraints like money and time.

A creative solution is a combination of a creative environment, creative person, and creative process. A creative process involves both the tools and techniques. This means that

Creative Outcome=CEPP

where C is for creative, E is for environment and P is for person and process. This is shown in Fig. 26.1 below.

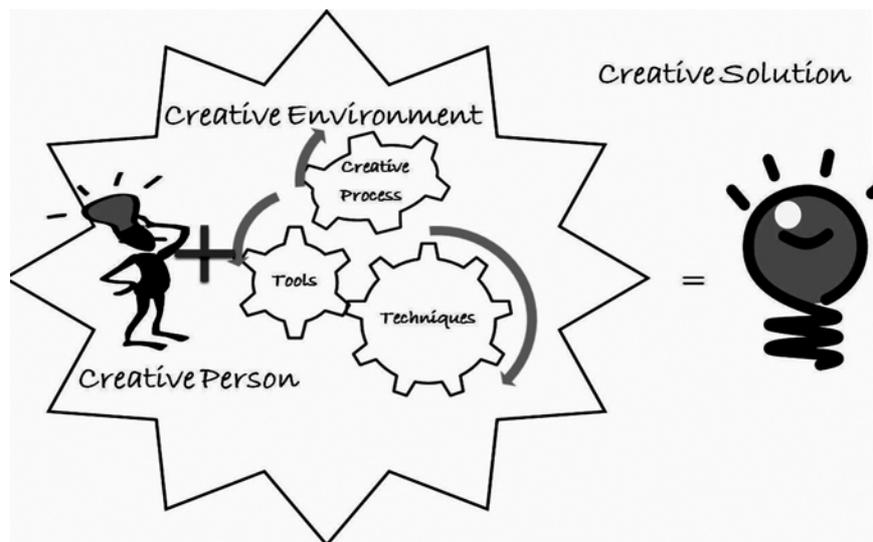


Fig. 26.1: Creative Outcome=CEPP

- **The Creative Person:** A Creative Person is someone who can:
  - o channelise the curiosity through knowledge and imagination
  - o use imagination as a catalyst to generate and consider new alternatives
  - o have an attitude which apply strategies to solve problems
- **Tools:** To foster creativity and generate innovation, many techniques or tools are available. Some of these are:
  - o Divergence
  - o Convergence

- o Going with the flow
- o Feel the situation
- o Letting the subconscious lead
- o Common ground rules
- o Multiple methods

To begin with, a large number of ideas are generated through the divergence tools such as brainstorming or taking videos. The ideas are then filtered and converged through selection tools such as anonymous voting, consensus mapping, etc. Another tool is to encourage the creator to relax and do whatever comes to the mind. The creators are usually asked to closely understand a situation that needs the innovative solution. Then s/he should feel the intuition and work as it directs. There are some common rules during idea generation, such as only one person should speak at a time for generating ideas, and then another person can speak, and this pattern has to be followed. These methods can be followed in isolation or together in a group.

- **Techniques:** Various techniques are used to generate and finalise an idea. Then the idea has to be implemented to develop a product or process. The techniques used are:
  - o Problem Definition
  - o Idea Generation
  - o Idea Selection
  - o Idea Implementation

At the outset, the nature of the problem is defined. Then the ideas for possible solutions are generated through a brainstorming process and these are elucidated through idea selection process. The final step involves the idea implementation process. The process of idea implementation is explained in Fig. 2.

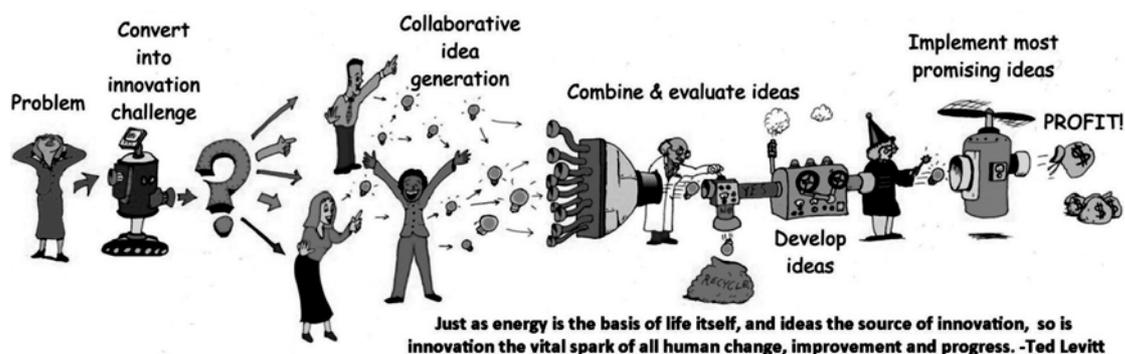


Fig. 26.2: Idea Implementation Process  
(Source: Massey, 2012)

## Encouraging Creativity of Workplace

Creativity needs to be encouraged at the workplace for optimum performance of the individual and the team. Employers need to create a conducive environment where creativity and expression of an individual can blossom. The multinational giants have set an example in this.

As mentioned by Strickland (2008) in his article at Google the 20 percent time programme is a great success. This is a scheme which enabled the employees of Google to use full one day every week, to work on a project unrelated to their normal workload. This is quite a

successful scheme at Google which also empowers the employees to be creative. Google claims that many of their products in Google Labs started out as pet projects in the 20 percent time programme.

A presentation by Toth (2012) on 'Social and Workplace Innovation' mentions that

- 3M has a 15 percent programme that promotes employees spending paid time dreaming, brainstorming and testing their own ideas.
- Gore & Associates provides 'dabble time' where employees are not held to bureaucratic policy manuals and instead are empowered to experiment without fear of punishment for failure.

## Conclusion

In a world of increasing complexity, change and competition, generating new ideas and implementing them in day-to-day life has become essential to thrive. The ability to think creatively and drive innovations is an important skill for everyone. Creativity is futile and useless if it is not followed with actions. It is extremely essential to evaluate, polish and market ideas properly to make them valuable. The idea should not only be original and useful, it should also be possible to convert it into action. Various tools and techniques can be used for this. These can be used as part of problem solving, artistic expression, or therapy. Creativity and knowledge creation are considered extremely important to the success of organisations. Creativity of the workforce has a considerable influence on the capability and efficiency of any organisation. Therefore, it is essential to foster creativity in individuals. Special emphasis on encouraging and promoting motivation and problem solving can help in achieving this.

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## Introduction

It is true that science develops an attitude of logical thinking and inculcates the spirit of inquiry. Scientific attitude or scientific temper is characterized by traits like healthy skepticism, freedom from prejudice, objectivity, open mindedness, rationality, curiosity, and positive approach to failure. Normally, a person having scientific attitude uses the method of science in decision making process in the course of life, whether it is knowingly or unknowingly. Scientific attitude is not the prerogative of only the scientists or the students and teachers of science. It is a way of life. The entire population can be put into three categories - one category may include the well educated people having good accomplishments in science, the second category may include the well educated people having no background in science and the third category includes the uneducated or less educated people. But a common feature of most of the people from these groups is that they act scientifically and if I may be permitted to say so, they have a scientist in them. I would say here that you also have a scientist in you. Don't you believe? Let us see how is it possible?

## Who is a Scientist?

Before we justify that there is a scientist in every one of us, let us try to understand who can be called a Scientist? Can a doctor be called scientist? Think for a while.

### A scientist is a person who...

- **is curious about the world:** Curiosity is one of the important trait of a scientist. For example, Galileo Galilei's curiosity about the heavenly bodies made him the first person to use a telescope to study the moon, the sun, the planets and the stars.
- **is logical and systematic:** You might be knowing that Gregor Mendel discovered the principles of heredity when others had failed. This was because of his logical experiments, systematic work and accurate record keeping of the observations.
- **is open-minded and free of bias :** An open-minded person is one who is ready to accept criticism and modify plans or discard hypotheses, if necessary. Johannes Kepler was one such person who was hired to develop evidence that planets moved along perfect circles.
- **is intellectually honest:** Isaac Newton gave laws of motion on the basis of the previous work of Galileo and others and very honestly he gave them credit for their previous work. In this context, Newton said, *"If I could see little further than others, the reason was that I was sitting on the shoulders of giants like Galilio and Kepler"*
- **works hard and is persistent:** If one takes the example of the discovery of radium, one should not be surprised to know how hard Marie Curie had to work to extract a grain of radium after processing hundreds of tons of residual waste of Pitch bland. Because of her hard work and persistent efforts she became the first person ever to be awarded the Nobel Prize twice.
- **does not jump to conclusions :** Scientists do not take decision at once. They perform on experiment several times and then come to a conclusion. For example, John Dalton's

atomic theory was backed by several experimental evidences. He is not the first to propose that the atom is the smallest particle of matter, but he is the first to use experimental evidence to support his theory.

- **is a creative and critical thinker:** Creativity and critical thinking are two very important characteristics of a scientist which help him in deriving theory or concrete conclusions. For example, Albert Einstein was able to derive his theory of relativity because of his creative thinking. In fact he was able to think beyond what was given and known at that time. He saw links and connections where others did not. He looked at things from different perspectives.
- **is rational who believes that everything that happens has a reason.** For example, while taking bath in a water tub, Archimedes felt lighter. Keeping it in mind that everything that happens has a reason, he could explain the principle of floating.
- **is willing to suspend judgement** until he is sure of his results. For example, Edison believed that nothing is final in science, and patience and perseverance pay in arriving at the result. Thomas Edison tested over 3000 filaments before he came up with his version of a practical light bulb.
- **tries new approaches** to arrive at solutions. For example, Rayleigh had explained the blue colour of the sky adequately by using the theory of scattering. But why the ocean is blue, could not be explained by the theory of scattering. For this Raman tried a new approach and explained it on the basis of molecular scattering.

In brief we can say that a scientist has considerable knowledge of science, applies scientific principles/concepts and uses method of science for solving different problems.

## Where do we stand?

Now the question is where do we stand? Do we also have some traits of a scientist? Lets us see.

- 1) **It is true that all of us have considerable knowledge of science.** For example, if we take up the health related issues, we find that most of us have some knowledge about diseases, their prevention, and some medicines. At the same time we know what kind of food should be taken and which food items have good nutrients. We have knowledge of measurement of various quantities like time, length, volume, speed, temperature, etc. and their units. We know about energy like heat, light, and electricity and its forms and their uses. We have fair idea about the environmental issues and related problems, importance of oxygen for breathing and burning, and importance of carbon dioxide for fire extinguishing and food production by plants, etc. It shows that all of us have considerable knowledge of the facts and figures of science.
- 2) **Secondly, it is also a fact that we apply scientific principles in our daily life even without knowing them.** For example, while cooking we put the flame to low after one whistle by a pressure cooker or once boiling temperature is reached. Similarly, you would have noticed that people make guess whether a bucket kept under water tap is filled or not just on the basis of the changing sound without actually looking at the bucket. Here they unknowingly apply the principle of vibration of air column. While choosing which type of clothes to use in which season and why, we apply principle of science. Another very common observation is that normally we bend our body on one side while carrying bucket full of water in a hand. Similarly, we lean forward while climbing a mountain or bend the bicycle while taking a turn on a curved road. In all such happenings we apply one or the other principle of science even without knowing the basic concepts or principles.

3) **The third important thing is that we use method of science in our daily life for solving different problems.** In order to understand how we use method of science in our day to day activities, let us take an example.

One day you arrive home late at night, walk up to the door, unlock it, reach out to the switch just inside the front door and switch it on. You encounter a problem that the light is not switched on. Can you think for a while, as a normal human being what do you do in this situation?

In fact in this situation you use the method of science for solving your problem. Before coming to this problem, let us first understand what is the method of science?

### Method of Science

The method of science consists of following steps in a systematic way. First you encounter a problem and ask a question, then review the background of the situation, based on the background you draw a hypothesis and then test the hypothesis by performing an experiment. Based on the experimental observations you analyse the result and find whether the hypothesis is true or not. If the hypothesis is true, you take decision accordingly and if the hypothesis is false, you construct another hypothesis and this process continues until you come to the final conclusion. All these steps of the method of science are shown in the flow chart (Fig. 27.1). This method is used by all of us knowingly or unknowingly for solving the day to day problems.

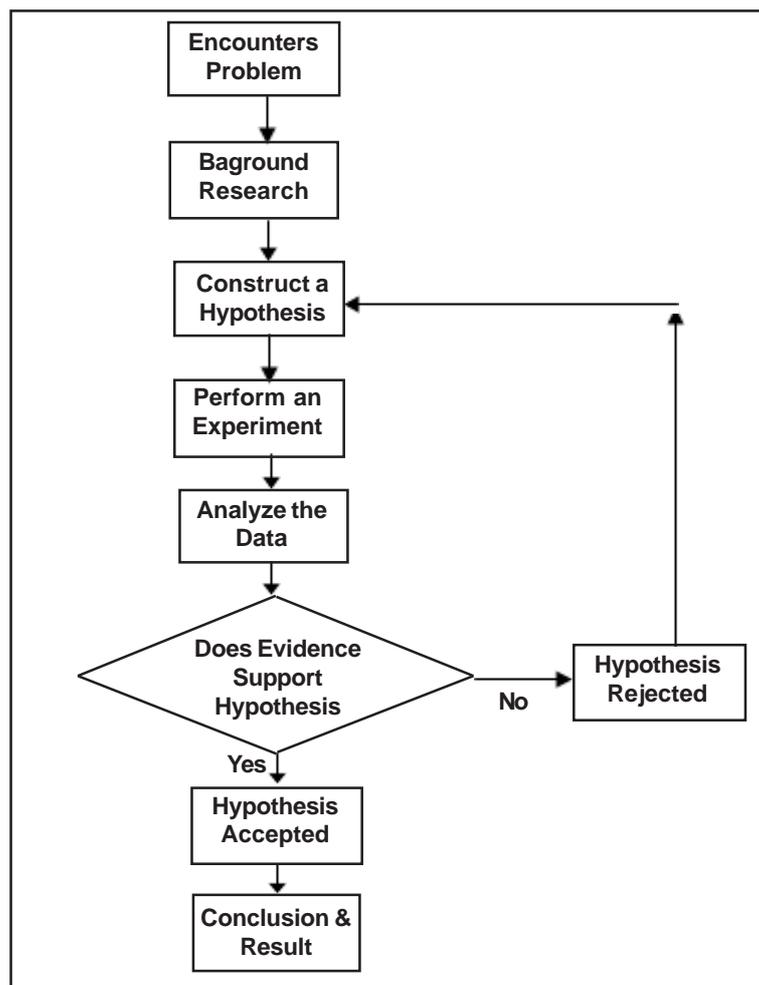


Fig. 27.1: Steps of the Scientific Method

Now, let us take your problem again to understand how you use method of science for solving the problem.

1. First you switch on the light, but find that still it is dark. This is the first step of the method of science i.e. **Observation**
2. This is now the origin of the **problem**
3. Now you **Question** yourself: *Is power supply there?*
4. Immediately you make **Hypothesis**: *Is it a case of no power supply.*
5. Now, you perform some **Experiment** based on the idea that in case of a power cut the lights in the neighbourhood should also remain off. So you observe the situation regarding the neighborhood lights (this is an indirect evidence as you are not responsible in any way about the switching on/off of the lights in the neighbourhood).
6. Based on the evidence you make an **Analysis**:
  - a) If any other house has lights on then your prediction or hypothesis fails.
  - b) If all houses are dark then your prediction or hypothesis is true.
7. Based on the analysis you draw **Conclusion**. If there is no power cut then your **hypothesis is rejected** and if there is power cut then your hypothesis stands accepted.

**If power supply is there, still lamp does not glow, what will you do next?**

Obviously, you will try another switch in the house, with a revised hypothesis/prediction. This is a **new experiment** under a revised hypothesis. You may switch on another bulb or tube light, or you may check to ensure that the bulb is not fused, you may check the connections, and so on.... In every case you will make a revised hypothesis, test it, analyze the data and take decision. But in the entire process you are following the method of science.

However, like any scientific experiment, there is possibility of error also. For example, in this case if there are inverters or generators in some of the neighboring houses, then your prediction may not be as discussed above.

In this way, you will notice that in almost all such cases we follow the method of science in our daily life. This we can call a common man's approach of solving the day to day problems. Let us compare the two approaches of solving the problems.

S.No.	The Scientific Approach	The Common man's Approach
1.	Identification of a problem (specific question) Hypothesis formulation	Ordinary questions Guess ("This fruit is eatable")
2.	Methodology (Experimentation) Data and Information Collection (Systematic way)	Methodology (trial and error) Data and Information Collection (not so systematic )
3.	Analyzing data	General kind of Analysis
4.	Conclusion (generally meant for the masses)	Conclusion (normally meant for the Individual)

Now, we can say that all of us have considerable knowledge of science, we apply scientific principles/concepts in our day to day life even without knowing and we use method of science in our daily life for solving different problems. If it is so why can't we say that there is a scientist in each one of us?

In fact, there is no doubt that we have a scientist in ourselves, but the need is to nurture the scientist and keep it alive by inculcating scientific attitude and following method of science in daily life.

In order to keep the scientist alive in ourselves, we should

- be a keen observer,
- be curious about the world around us by asking whys and hows about the events and happenings,
- think rationally and shun blind faith & superstitions,
- be logical and systematic in our daily activities,
- be open-minded and free of biases,
- be ready to accept positive criticism,
- be intellectually honest,
- not jump to conclusions without having firm evidence,
- be creative and a critical thinker, and
- try new approaches to arrive at solutions, and pursue our goal persistently

## **Conclusion**

Now after knowing about the characteristic traits of a scientist, you should be able to tell whether the statements like 'The sun rises in the east in the morning', and 'The sun is not going to rise in the east in the morning tomorrow,' are scientific or not and why? Think whether the predictions or explanations of Stock Markets provided by Finance Reporters through television, newspaper or radio are scientific or not.

Conclusively, it can be said that the science is not just a subject to be studied, but it is a way of life. For a progressive and meaningful life, we should not only have a minimum knowledge of science, but we should develop a scientific attitude and follow method of science for solving the problems. Curiosity to know the reason behind any event and asking questions will certainly help in inculcating scientific attitude. I would like to conclude by saying that think scientifically, act scientifically and live scientifically to keep the scientist in you alive.

## Introduction

The power of computers to do almost anything is fascinating and interesting. With the rapid technological advances today, such computers are being developed, which can 'think' or in other words, are 'intelligent'. The science and engineering of making 'intelligent' machines, especially 'intelligent' computer programmes is called artificial intelligence. This paper deals with various aspects related to artificial intelligence such as Realisation and architecture of Artificial Intelligence and how Artificial Intelligence differs from human intelligence.

## What is Artificial Intelligence?

Artificial Intelligence can be easily defined once we define intelligence. Intelligence is the capability to think, solve problems, and learn. Therefore, intelligence is the general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience. Since humans are capable of doing so, we are considered intelligent and a machine is not considered so. Let us now define what artificial intelligence is.

When intelligence is created artificially in machines, it is called Artificial Intelligence, abbreviated as AI. A machine, which is made capable to replicate the human brain to think, learn or reason is said to possess artificial intelligence. Essentially it is a machine that replicates the functionality of the human brain. It is called an intelligent machine. An intelligent machine can be anything from a calculator, bionic arm to a full-fledged robot or android. It is created in order to ease some work of humans.

Intelligent machine proves helpful to humans in aiding them in reasoning, planning, taking decisions, moving objects in case of humans who are handicapped, etc. It makes use of expert knowledge to take decisions. Therefore, an intelligent machine is one that does a specific task that traditionally has been done by human beings.

While creating such Artificial Intelligence, researchers and engineers treat each specific work application as an engineering problem. The researchers working on future intelligence machines hope to achieve the following traits to be exhibited by the machines:

- Reasoning
- Commonsense knowledge
- Planning
- Learning
- Communication
- Perception
- Ability to move and manipulate objects

## Realization and Architecture of Artificial Intelligence

Artificial Intelligence is used in entertainment, exploration, automation, human aid, etc. Depending on the application, the complexity of architecture, cost, reliability varies. For example, the cost of Artificial Intelligence in entertainment is less and can be less reliable than that for space or mine exploration. The application of Artificial Intelligence in exploration involves use of high-end machines, which are built carefully.

The architecture of an Artificial Intelligence requires sensors to get information of the world. For example, in autonomous driving, cameras are required. The camera has to collect information regarding speed of other cars, distance, speed breakers, signals, etc while driving. For taking decision of movement, the system should be capable of recognising things on the road, predict the movement of other vehicles, take final decision based on factors present, and then actually implement it by driving. It should also be able to learn from its wrong decisions. So, the Artificial Intelligence architecture of autonomous driving has the components of sensors, recognition, decision maker, and actuator. Fig. 28.1 provides a schematic diagram regarding realisation and architecture of Artificial Intelligence.

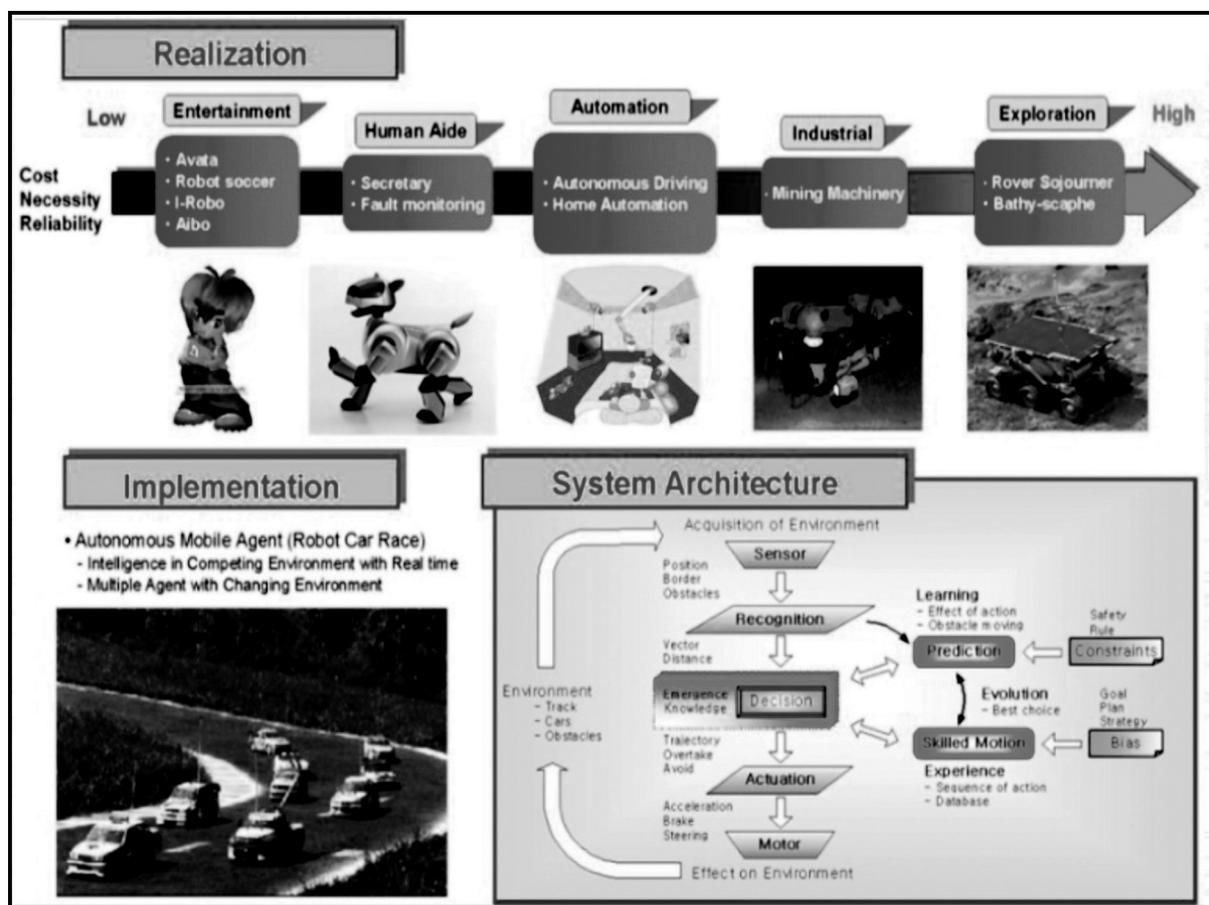


Fig. 28.1: Realization and Architecture of Artificial Intelligence

## Some Examples of Artificial Intelligence

There are examples of both successful Artificial Intelligence seen every day and successful Artificial Intelligence not seen every day. These examples are presented below:

**Successes in AI (Seen in daily life):** The examples of Artificial Intelligence seen in daily life include the following

- Restricted Speech Recognition (in Banking and Airline reservation systems, etc)
- Face recognition software used in many applications
- Web tools like search engine crawlers, shopping suggestion program in online shopping portals, Google translations, Mechanical Translation, some intelligent chat programs, etc.
- Credit Card Fraud Detection
- Simple Robots (e.g., Asimo)
- 1D and 2D Bar Codes (in stores)

**Successes in AI (Not seen every day):** The examples of Artificial Intelligence not seen every day include the following

- Chess Playing Machines (Belle)
- Optical Character Recognition Readers
- Space Exploration
- Industrial Inspection (Mining)
- Biometrics (Fingerprints, Iris, etc)
- Medical Diagnosis (MYCIN)
- Androids

These systems are built by collecting expert knowledge from experts in various domains and making the system capable of updating this, based on experience.

## **How does Artificial Intelligence Differ from Human Intelligence?**

Although intelligent systems are very intelligent but they cannot match humans as they are both very different. Humans and animals use prior knowledge to deal with sensory input. They have prior knowledge and also learn from experience. The process involves a complex of bottom-up and top-down processes. This mechanism is not present in artificially intelligent systems as this initial knowledge and the capability to learn from experience is to be induced by humans artificially into them. Certainly, we cannot compare human behaviour with a machine unless the machine has prior knowledge of its environment.

It is hard to develop algorithms for a barely understood process going on in the environment of the machine. There could be some problems and situations which cannot be interpreted logically or algorithmically for the computer or machine to understand. A successful Artificial Intelligence system must look at the data it has presented and determine what is important (sometimes referred to as the 'signal') and what is not important (referred to as the 'noise'). Then using this data, or signal, it will ask a series of questions to try to help it achieve its goal. To understand this more, let us take an example of toasting a bread slice.

How would an intelligent machine toast a slice of bread? First it will collect data which are relevant to solve the problem of toasting the bread slice, such as the temperature, time, etc. Data presented to the toaster may be the following:

- 1) How long the slice has been there for toasting?
- 2) The temperature setting of the toaster.
- 3) The model number of the toaster.

The data regarding the make and company of the bread and toaster is irrelevant. The relevant data is considered as signal and the irrelevant data is noise. For collecting the data about the environment it can collect more data by asking questions. Now for the toaster to toast the bread, it should toast it taking care it won't burn. If your toaster oven detects that the toast is burning, it should turn off the heat. If a human detects that the toast is burning or smoke is coming, he will turn off the heat but for the toaster to take this decision it should be programmed to do so. It should be able to detect the burning of the toast based on many factors like time of toasting, temperature. For humans this is a very obvious decision but for an intelligent toaster it is not. For a human, this is an obvious thing to do. If you let the toast burn, it will probably start to smoke and set off the smoke detector. For the toaster, and the computer that controls it, this is not so obvious and thus it will burn the toast. Therefore, the Artificial Intelligence system of the toaster must have a set of rules that will help focus on the signal so that the toast would not burn. For accomplishing the task of toasting the bread, it needs a set of rules to take decisions. For this it will run the following programme:

Question: "Is the toast in danger of burning?"

Rule: Check the temperature setting and for how long the toaster has been toasting.

(If the temperature is set to 300 degrees Fahrenheit, and the toast has been in the oven for 10 minutes, the chances are very high that it has got burned.)

If it is 'true' that the toast is in danger of burning, there is another rule the toaster will go through which says, "This is what to do if the toast is in danger of burning."

Therefore, to decide whether the toast is burning or not, it needs to check the time of toasting and temperature. If it detects the temperature to be 300 degrees fahrenheit and the time to be 10 min then the answer would be true to the question whether it is burning or not. Then if the answer is true it should turn off the heat.

There can be many such rules which should have answers in true or false to help an artificially intelligent machine to take decision.

## **The Factors in Favour Of and Against Artificial Intelligence**

There are many Hollywood movies like *Frankenstein* in which androids created by man go against their creator and try to rule their world. There are movies like *Artificial Intelligence* too which depict them as good creatures. The message movies like *Frankenstein* give is that although Artificial Intelligence is good; there is a possibility that these machines might develop such capabilities which they can use against the humans, who are their creators. Therefore, although Hollywood is often accused by scientists of misrepresenting the robot, their stories often reflect the real fears of society and in turn, these fears will affect the way we receive robots as they come to feature more prominently in society. Since these machines do not have any emotions, we cannot expect them to feel guilty or consider social, ethical or mythological factors in their behaviour. Humans should be held responsible to whatever happens and they should consider all risk factors before creating any such machine.

Humans have some virtues and morals values and because of which we know what is right and what is not. But how would the machines differentiate this? Intelligent machines should have some moral duty and virtues. They should contain a set of rules that most people share, such as, "do not kill, unless in self-defense" or "do not lie, unless the suffering caused by honesty is large".

## **Artificial Intelligence: Good or Bad? Think Again**

As computers get faster and more numerous, the possibility of randomly creating an artificial intelligence becomes real. However, we should think twice before attempting any such thing as this can also cause massive unemployment and unexpected creation of dangerous virus, self modifying and self replicating computer programme which can be disastrous. Artificial Intelligence learning is never completely predictable and can lead to dangerous, unexpected results, such as a new and frequently mutating computer virus. We cannot predict the outcome but we should be careful in making any such thing.

We must be careful as there is possibility of intelligent machines imitating human behaviour and also causing harm to human existence as they will want to develop their own existence like humans do, may want to acquire resources, they might even want to overcome human intelligence and these are some dangerous factors which throw challenge to human existence. Therefore, while designing intelligent machines with clear preferences (Rational Agents) we would have to keep the following in mind:

- Self improving AIs will want to be rational
- Rational agents will want to preserve their utility
- Rational agents will have a drive to preserve themselves
- Rational agents will have a drive to acquire resources

## **Conclusion**

At present, the human brain and its working is still a mystery, and it is very difficult to create a machine which can think. So, there is still time for humans to plan accordingly to create a perfect intelligent machine with all the key ethical, moral and social considerations. The future of Artificial Intelligence is no doubt exciting.

## Introduction

The new technology has brought on new demands for information as well as new and more sophisticated computing systems. Today, almost every one of us interacts with computers on a daily basis to create new things and ideas, to produce documents, to correspond with friends and associates, and for many other purposes including research. But do you know that the excess and unsafe use of computers can have adverse effect on our health and performance?

The answer of the above question is ergonomics. Ergonomics, also known as human factors, is the science of designing the workplace environment to fit the user. Proper ergonomic design is necessary to prevent repetitive strain injuries, carpal tunnel syndrome, which can develop over time and can lead to long-term disability. Ergonomics is concerned with the 'fit' between people and their technological tools and environments.

The long-term use of computers has been linked to a range of potential health problems. Over the past few years a great many questions have arisen concerning the links that may exist between the use of computers and the health and safety of those who use them. There are health problems associated with working with computers, which include repetitive strain injury, eye strain, back pain, stress and fatigue, skin complaints, and upper limb disorders.

Here are some of the factors that may impact our health and performance while using computer with solutions to these problems.

### 1) Sitting and Posture

The human body was designed to move. One of the most important aspects of a good sitting habit is movement. Standing up from your chair and frequently adjusting your sitting posture can be one of the best methods to guard against injury and fatigue. The best chair design in the world will not force good posture or prevent the need for the human body to move. In the following figure, you have seen poor and correct working posture.

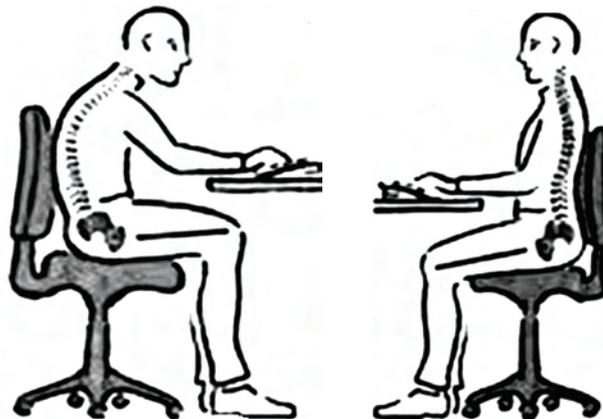


Fig. 29.1: Poor Working Posture and Correct Working Posture

- i) **Height:** Your feet should rest comfortably on the floor or if necessary, should be supported by a footrest. For most people the knees should be at a level equal to or slightly lower than the hips. Adjust the chair height to attain a natural inward curve of the spine and optimise the comfort of your lower back. If the chair is too low, your lower back will flatten or round out. If the chair is too high, your feet, and therefore your back, are unsupported. Circulation to the lower leg can also be compromised if the chair is too high.
- ii) **Length of the seat pan:** There should be 2-3 inches between the back of your leg and the seat of the chair. This will allow for a natural bend in your knees. If the seat pan is too short, it can create pressure points and discomfort in the back of the thigh. If the seat pan is too long, you will not be able to sit back in the chair. Some chairs have adjustments that shorten or lengthen the seat pan if necessary. Lumbar pillows can also be used as a method to improve the fit of a seat pan that is too long.
- iii) **Lumbar support:** The curve of the backrest should support the natural curve of your back. You should not feel too arched, nor should you feel unsupported. If your chair does not provide sufficient lumbar support, you might be able to use a lumbar pillow or towel roll to improve the fit.
- 2) **Upper and Lower Body Factor**
- i) **Back:** The spine is one of the most important organs that needs to be taken care of. Right and wrong postures have their effects not only on wrist and hands but a tremendous effect is on the back also, so due care must be taken.
- ii) **Position of Legs:** You should make sure that your legs are comfortable while you are working on the computer for long durations. Generally, if you are a little aware, you can know yourself in the beginning itself whether your sitting position is right for your body or not. Depending on your height you might need to keep some extra footrest underneath your feet to support your seating.
- iii) **Wrist:** It has been recognised that repetitive movement at the wrist, as occurs with prolonged use of a computer keyboard can lead to inflammation in the carpal tunnel and the resultant painful syndrome. Patients usually feel pain in the forearm area as well as numbness in the affected hand in the finger distribution.

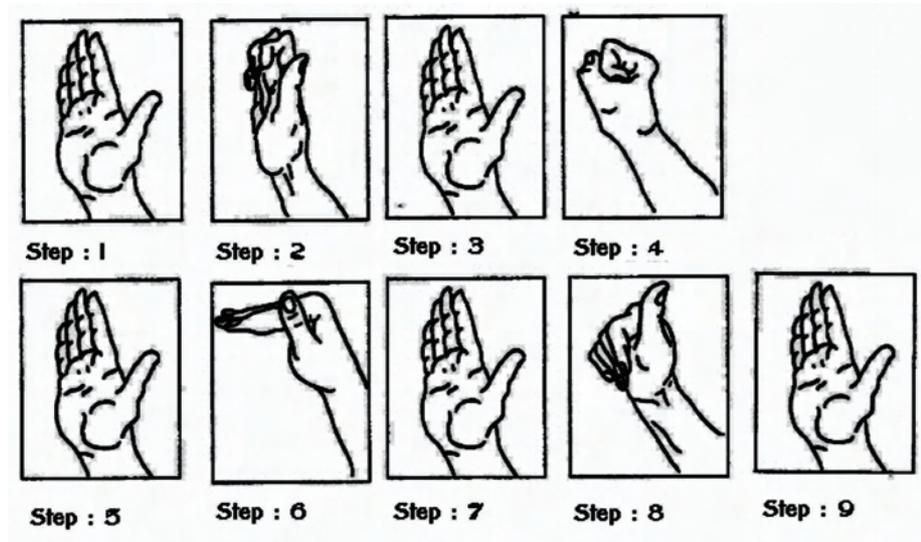


Fig. 29.2: Hand Exercises for Carpal Tunnel Syndrome

### 3) Eye and Vision Problems

Eye and vision problems are the most common health complaints of computer users. Using computers for extended periods can cause visual discomfort, headaches and vision challenges. It is very unlikely that you will suffer permanent changes or damage to your eyes. Rather, you may experience these symptoms whenever you use a computer intensively for periods of a couple of hours or longer; the symptoms will diminish soon after you stop working on the computer. Typical symptoms of vision challenges include eye strain, blurred vision, burning, itching or tearing eyes, temporary change in ability to see colors and headaches. Let us know more about eyes' related problems.

- i) **Eye strain:** Eye strain refers to ocular fatigue, eye discomfort and headaches associated from intensive use of the eyes. Common causes include glare on the computer screen, reading small character sizes on the screen, and poor contrast between text and background on the monitor.
- ii) **Blurred vision:** Blurred vision can be caused by normal physiological changes in the eye. It can also be caused by constant focusing on objects within 12" of the eyes, which often occurs when reading in low light.

### 4) Tension and Headaches

A tension headache is a condition involving pain or discomfort in the head, scalp, or neck, usually associated with muscle tightness in these areas. Tension headaches occur when neck and scalp muscles become tense, or contract. The muscle contractions can be a response to stress, depression, a head injury, or anxiety.

Any activity that causes the head to be held in one position for a long time without moving can cause a headache. Such activities include typing or other computer work, fine work with the hands, and using a microscope. Sleeping in a cold room or sleeping with the neck in an abnormal position may also trigger a tension headache.

## Helpful Tips for Working on Computer

- i) **Correct way of using a mouse:** A well-designed mouse should not cause undue pressure on the wrist and forearm muscles. A large bulky mouse may keep the wrist continuously bent at an uncomfortable angle.

Pressure can be reduced by releasing the mouse at frequent intervals and by selecting a slim-line, low-profile mouse. Keep the mouse as close as possible to the keyboard, elbow bent and close to the body. At Fig. 29.3 we have shown right and wrong way of holding a mouse.

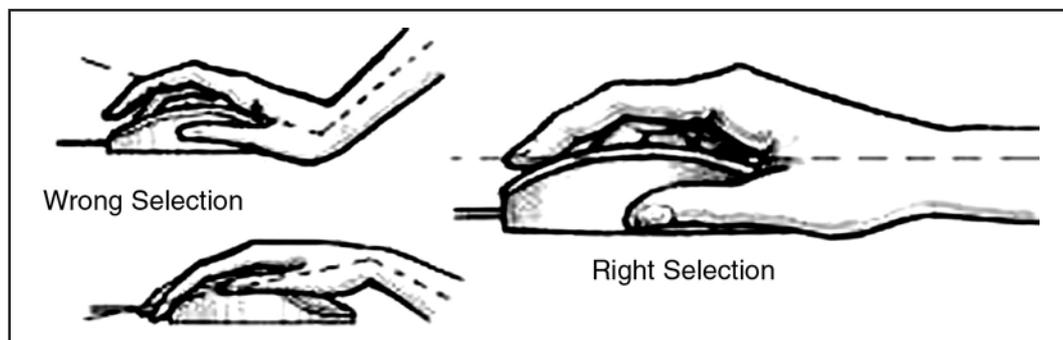


Fig. 29.3(a): Right and Wrong ways of holding a mouse

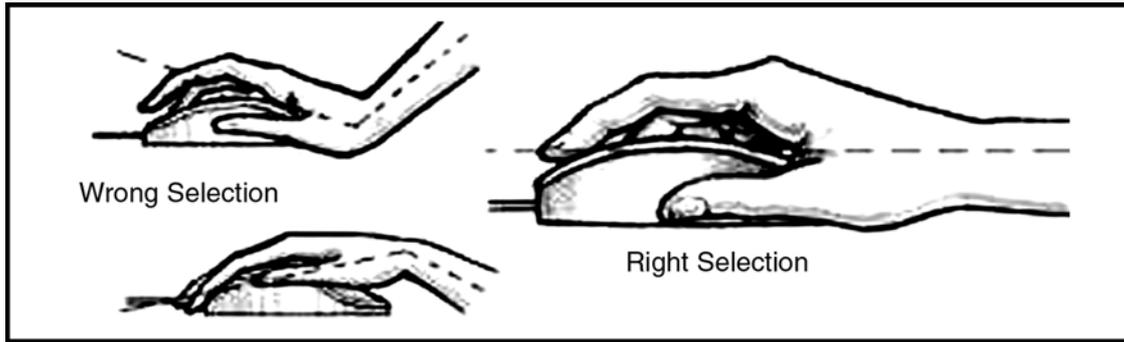


Fig.29.3(b): Right and Wrong ways of holding a mouse.

- ii) **Positioning is everything:** Correct positioning of your computer, keyboard and typing copy is essential. Your screen should be positioned about an arm's length from your eyes and 20 degrees below eye level. Consider foot and wrist rests for added comfort.
- iii) **Proper Position of Keyboards:** Place the keyboard in a position that allows the forearms to be close to the horizontal and the wrists to be straight. That is, with the hand in line with the forearm. If this causes the elbows to be held far out from the side of the body then re-check the work surface height. Some people prefer to have their wrists supported on a wrist rest or the desk. Be careful not to have the wrist extended or bent in an up position.
- iv) **Room Lighting:** Proper lighting in the room is very important. Try to reduce glare and reflections from your screen and set your color, contrast and brightness levels to suit you.
- v) **Palming:** Sit straight at your workstation and rub your palms against each other till you feel them warm. The warmth of your palms helps soothe and relax tired eyes. Then, lightly cup your eyes with your palms and relax for 60 seconds.
- vi) **Splash water on your face:** During breaks, splash water on your face while closing your eyes. This has an overall relaxing effect and helps you feel refreshed.

Finally I would like to suggest you to take time out and follow our 20-20-20 rule. This rule involves three steps.

**In the first step,** after every 20 minutes of looking into the computer screen, turn your head and try to look at any object placed at least 20 feet away. This changes the focal length of your eyes, a must-do for the tired eyes.

**In the second step,** try and blink your eyes for 20 times in succession, to moisten them.

**In the third step,** you should walk 20 paces after every 20 minutes of sitting in one particular posture. It helps blood circulation for the entire body.

With so many of us spending lots of time in front of the computer every day it comes to no surprise that research is showing a rise in visual problems. What can one do? First, it is important to find out how you can protect your eyes through eye health exams and by making a few minor changes in your computer viewing habits.

## **Conclusion**

One may raise doubts regarding the innovative angle of this topic. Needless to mention, that there is nothings as such. However, most of the activities at the National Centre for Innovations in Distance Education at the Indira Gandhi National Open University are technology based where use of PC is an essential part of each activity. So it was felt that a popular talk on the topic would be helpful for all the members of staff. Thus its inclusion gets justified.

## Introduction

The year 2012 was observed as the National Year of Mathematics to commemorate 125<sup>th</sup> birth anniversary of Srinivasa Ramanujan, this famous Indian mathematician (Fig 30.1). Here, we present his life and works in brief and some glimpses of his contribution to mathematics. The reason for presenting his life and work is that he was an inspiration to an entire generation of Indians at a time when India was under the British rule. His work gave confidence that they too could do significant work in Science. Subramaniam Chandrashekar, a Nobel laureate in Physics, talks about this in a documentary on Ramanujan produced by Christopher Sykes. Indeed, his work continues to inspire mathematicians around the world due to its sheer profundity and his deep insights. The hallmark of his contribution was that he used to arrive at strikingly remarkable results quite intuitively and he could legitimately be called as an innovator in mathematics.

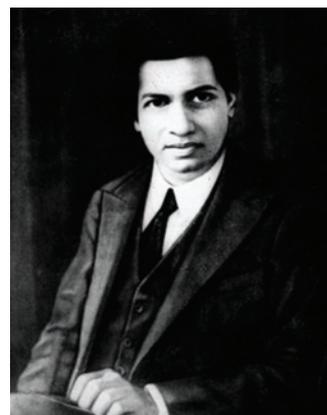


Fig. 30.1 Srinivasa Ramanujan

## Early Life of Srinivasa Ramanujan

He was born in a poor Brahmin family on 22<sup>nd</sup> December 1887 at 6.00PM in Erode, Madras Presidency, Tamil Nadu, India. His father K. Srinivasa Iyengar was a clerk in a cloth store. He joined primary school in Kumbakonam in 1892 and joined Town High School (Fig. 30.3), Kumbakonam in 1898. Ramanujan's favourite pastime was to sit behind the window at his home (Fig. 30.2) and do all his school related work there.



Fig. 30.2: House where Ramanujan lived around 1900



Fig.30.3: Kumbakonam Town High School where Ramanujan studied

He was a very promising student at his school. Ramanujan had mastered algebra, arithmetic, geometry and trigonometry. He borrowed second volume of Loney's Trigonometry from a college student and mastered it when he was 12 years old.

As an example of his precocious nature, the following anecdote about his school days is often told. His teacher was teaching division. His teacher told the class that 'If you distribute

three bananas to three students, each will get one banana' (Fig. 30.4). His idea of Division, lead to the Generalization:  $n / n = 1$ , for every integer  $n$ .



Fig. 30.4: To show that three divided by three is one

Ramanujan is supposed to have asked his teacher that, "If we distribute no bananas to no students, will the students get one banana each?". Basically, he wanted to know the value of  $0/0$ . He is supposed to have told his friends that, "it may be anything. The zero of the numerator may be many times the zero of the denominator and vice versa. The value cannot be determined."

He received a scholarship to study at Government College, Kumbakonam for his proficiency in Mathematics and English. He joined the college in 1904. He came across the book, Carr's *A Synopsis of Elementary Results in Pure and Applied Mathematics*, when he was still in school. This book opened a new world for Ramanujan. The book contained statements of results without proofs and he set about proving all the results in the book. He failed in FA because he did not pay any attention to subjects other than Mathematics.

When Ramanujan was in IV Form, his schoolmate C.V. Rajagopalachari raised the question (given to him by a student in sixth form (11th Standard)  $x = 7$  and  $y = 4$ : "If  $\sqrt{x} + y = 7$  and  $x + \sqrt{y} = 11$ , what are the values of  $x$  and  $y$ ? Ramanujan's quick answer, was considered an unexpected achievement by a student of Form IV.

In July 1909, Ramanujan was married to Janaki. It was an elaborate five-day, double wedding ceremony at Rajendram, where Janaki's elder sister Vijayalakshmi's marriage also took place. Ramanujan's father was not present at that time. The strong will of his mother was solely responsible for this major event in Ramanujan's life.

Ramanujan continued his work on Mathematics and recorded the results he found in what was later to be known as his Notebooks. The notebooks were as under:

Notebook 1 (around 333 pages), Notebook 2 (around 356 pages) Notebook 3 (around 30 pages) and a 'lost notebook', in fact a sheaf of approximately 100 loose pages. The 'lost notebook' was found by George Andrews amongst the papers of G. N. Watson. It was given to Watson by G. H. Hardy and later it could not be found and was considered as lost.

These Notebooks were his treasures, which he showed to convince influential men of his abilities as a mathematician. As the eldest son of the family, he yearned for a job, to eke out a livelihood and to support his parents and two brothers. He tutored a few students in mathematics in Kumbakonam and sought employment as a tutor in mathematics but with no success.

During 1906-1912 Ramanujan was constantly in search of a benefactor. Unfortunately he did not have any one to direct him in his mathematical researches. Ramanujan continued noting down his results in his notebooks, despite the pecuniary circumstances and the stresses and strains of day-to-day existence.

In 1910, Ramanujan went to meet Mr. Ramaswamy Aiyar, who was Deputy Collector in Tirukoilur, a small town in South Arcot district of Tamil Nadu, with a request to give him a clerical job. Mr. Ramaswamy Aiyer, who was himself a good mathematician, felt that the genius of Ramanujan should not be wasted in a small place. So, he sent him to Mr. P. V. Seshu Aiyer, who was the Principal of Government College, Kumbakonam, with a letter of introduction. Mr. Seshu Aiyer got him a temporary job in Accountant General's office. When this post came to an end, Ramanujan survived by giving tuitions. Mr. Seshu Aiyer sent Ramanujan to Dewan Bahadur Ramachandra Rao, who was the collector at Nellore. Ramachandra Rao, who had earlier met Ramanujan, felt his talents will be wasted in a small place like Nellore and sent him back to Chennai, offering to support him monetarily so that he can continue his work in mathematics.

Finally, he was offered a job with salary Rs. 20 per month with the help of Mr. Ramachandra Rao. The job was for a clerical post in the Accountant General's Office in 1912. In March 1912, Mr. Narayana Aiyer, who was a manager in Madras Port Trust, got a clerical job for him in Madras Port Trust.

When he was employed in Port Trust, other than the time he spent in office, he spent all the time doing mathematics. He used to stay awake the whole night doing mathematics, go to sleep at 6 O'clock in the morning, sleep for some time before leaving for office. He showed some of the results to Mr. Ramaswamy Aiyer who brought to his notice a tract called 'Orders of Infinity' written by G. H. Hardy. Ramanujan wrote to him explaining the results he obtained.

Ramanujan was introduced to Mr. Griffiths of Madras Engineering College. Ramanujan's talent was brought to the notice of Sir Francis Spring by Mr. Griffiths. He started writing to mathematicians in England explaining his work and asking for help.

When Ramanujan approached Prof. Seshu Aiyar, at Presidency College, with some theorems on Prime Numbers, his attention was drawn to G.H. Hardy's Tract on 'Orders of Infinity' which dealt with some of the topics on which Ramanujan had found some results. Prof. Seshu Aiyar suggested to Ramanujan that he should communicate his results to Prof. G.H.Hardy (Fig. 30.5), by then a Fellow of the Royal Society and a renowned British mathematician.

He wrote to G. H. Hardy on 16<sup>th</sup> January 1913 outlining his results. After persistent efforts he got due recognition at last.

#### **Extracts from the first letter to Hardy written by Ramanujan on 16.03.1913**

*"...Very recently I came across a tract published by you styled Orders of Infinity in page 36 of which I find a statement, that no definite expression has been as yet found for the number of prime numbers less than any given number. I have found an expression which very nearly approximates to the real result, the error being negligible. I would request you to go through the enclosed papers. Being poor, if you are convinced that there is anything of value I would like to have my theorems published. I have not given the actual investigations, nor the expressions that I got, but I have indicated the lines on which I had proceeded."*

#### **Hardy's Reaction**

*"A single look at them showed that they could be written down only by a mathematician of the highest class. They must be true because, if they were not true, no one would have had the imagination to invent them."*



Fig. 30.5: Prof. G.H. Hardy

## **A Journey from Madras to Trinity**

While working at the Madras Port Trust, a special scholarship of Rs. 75 per month, for two years was offered to Ramanujan. He accepted this first research scholarship of the University of Madras. Mr. E.H. Neville, a Fellow of Trinity College, Cambridge visited the University of Madras in January, 1914. Neville wrote on January 28, 1914 to the Registrar of the University of Madras about the importance of securing to Ramanujan a training in the refinements of modern methods and a contact with men who knew what range of ideas have been explored and what have not.

Within a week, the University of Madras at its Syndicate meeting decided to set aside Rs. 10,000 to offer Ramanujan a scholarship of £ 100 for a passage by ship and for his initial outfit. Ramanujan wrote to Hardy about his having secured a scholarship of the University of Madras, for two years. Ramanujan set aside his misgivings regarding travel by the sea and Hardy stated that, "Consent was at last got very easily" when "his [Ramanujan's] mother announced that she had a dream in which she saw her son seated in a big hall amidst a group of Europeans and that the Goddess Namagiri had commanded her not to stand in the way of her son fulfilling his life's purpose". Ramanujan took up residence at Hanumantharayan Koil Street in Triplicane. He lived with his mother and Janaki, his wife. Soon after receiving the University's Scholarship offer, in February 1914, he sent his wife and mother back to Kumbakonam. He changed his hair-style, from the traditional Brahminical style of a tuft, to the 'English Crop', equipped himself with western dresses and prepared for his departure to England.

Ramanujan left Madras by the passenger ship S.S. NEVASA (of British India Lines) on 17th March 1914. Mr. Arthur Davies and Prof. Littlehales attended to all the details regarding Ramanujan's passage to England. Prior to his departure, he arranged with the University that £ 60 (out of scholarship amount of £ 250) a year be sent to his parents in Kumbakonam. Thus, he fulfilled his responsibilities as the eldest son of the family.

After reaching England Ramanujan wrote to his friend Krishna Rao, "*Mr. Hardy, Mr. Neville and others here are unassuming, kind and obliging. As soon as I came here, Mr. Hardy paid £ 20 to the college for my entrance and other fees and made arrangements to give me a scholarship of £ 40 a year.*"

During his five year stay in Cambridge, Ramanujan published twenty one research papers containing theorems on diverse topics like definite integral, modular equations, Riemann's zeta function, infinite series, summation of series, analytic number theory, asymptotic formulae, modular functions, partitions and combinatorial analysis. His paper entitled Highly Composite Numbers which appeared in the Journal of the London Mathematical Society, in 1915, is 62 pages long and contains 269 equations. This is his longest paper. The London Mathematical Society had some financial difficulties at that time and Ramanujan was requested to reduce the length of his paper to save printing expenses. Five of these 21 research papers were in collaboration with Hardy. Ramanujan also published five short notes in the Records of Proceedings at meetings of the London Mathematical Society and six more in the Journal of the Indian Mathematical Society.

Year	Number of Publications
1914	1
1915	2
1916	3
1917	7
1918	4
1919	4

Ramanujan was awarded the B.A. degree by research in March 1916 for his work on *Highly Composite Numbers* and published in the Journal of the London Mathematical Society. Ramanujan's dissertation bore the same title and included six other papers. This work of Ramanujan, according to Hardy: "...is a very peculiar one, standing somewhat apart from the main channels of mathematical research. But there can be no question as to the extraordinary insight and ingenuity which he has shown in treating it, nor any doubt that the memoir is one of the most remarkable published in England for many years". He was elected a Fellow of the Royal Society of London in February 1918. Ramanujan was elected to a Trinity College Fellowship, in October 1918, which was a Prize Fellowship worth £250 a year for six years with no duties or conditions.

## His Illness

Ramanujan suffered illnesses before and after his marriage to Janaki (1909) and before his departure to England. From May 1917, when he was first admitted to the Nursing Hostel in Cambridge for five months, he seemed to have been in and out of TB. He stayed at Sanatoria - Mendip Hills in Somerset (2-3 weeks in Oct. Matlock House in Derbyshire (Nov. 1917 - June 1918), Fitzroy House in London (June - Dec. 1918) Colinette House, Putney (end of Dec. 1918) - until his departure to India in March 1919.

## Return to India

Ramanujan was persuaded by Hardy to return to India with the hope that he would recover soon and return to take up the Trinity College Fellowship awarded to him for five years. After completing nearly five years at Cambridge, early in 1919, when Ramanujan appeared to have recovered sufficiently to withstand the rigours of a long voyage to India. He left England on 27th February 1919 by S.S. Nagoya. Four weeks later on 27th March he arrived at Bombay and soon after at Madras, thin, pale and emaciated, but with a scientific standing and reputation such as no Indian enjoyed ever before.

## His Untimely End

Ramanujan was subject to fits of depression, had a premonition of his death and was a difficult patient. He spent three months in Madras, two months in Kodumudi and four months at Kumbakonam. The house where he stayed in Kumbakonam is shown in (Fig. 30.6). It has now been converted into a memorial in his name.



Fig. 30.6: The House where Ramanujan Stayed at Kumbakonam

When his condition showed signs of further deterioration, after great persuasion, Ramanujan was brought to Madras for expert medical treatment, in January 1920. Despite all the tender attention he could get from his wife who nursed him throughout this period, and the best medical attention from the doctors, his untimely end came on 26th April 1920, at Chetput, Madras, when Ramanujan was 32 years, 4 months and 4 days old.

## Ramanujan's contribution to Mathematics (some glimpses)

### Ramanujan Number

'1729' is called the *Ramanujan Number*. It is the least number which can be expressed as the sum of two cubes of positive integers in two different ways.

$$\begin{aligned}
 1729 &= 1000 + 729 \\
 &= 10^3 + 9^3 \\
 1729 &= 1728 + 1 \\
 &= 12^3 + 1^3
 \end{aligned}$$

### Partitions

A *partition* of an integer  $n$  is a division of  $n$  into any number of positive integral parts

$n=2,$	$n=3,$	$n=4,$	$n=5$
$= 1+1,$	$=2+1,$	$=3+1,$	$=4+1,$
	$=1+1+1,$	$=2+2,$	$=3+2,$
		$=2+1+1$	$=3+1+1,$
		$=1+1+1+1$	$=2+2+1,$
			$=2+1+1+1,$
			$=1+1+1+1+1,$
$p(2)=2$	$p(3)=3$	$p(4)=5$	$p(5)=7,$ etc

In a path breaking work with Ramanujan and G.H. Hardy proved a formula that gave the number of partitions of  $n$  with a very small error.

## Prime Numbers

Ramanujan was interested in primes he computed tables of primes to understand their properties.

The following is the list of 168 prime numbers less than 1000 that was found in one of his notebooks.

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61,  
67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, 113, 127, 131,  
137, 139, 149, 151, 157, 163, 167, 173, 179, 181, 191, 193,  
197, 199, 211, 223, 227, 229, 233, 239, 241, 251, 257, 263,  
269, 271, 277, 281, 283, 293, 307, 311, 313, 317, 331, 337,  
347, 349, 353, 359, 367, 373, 379, 383, 389, 397, 401, 409,  
419, 421, 431, 433, 439, 443, 449, 457, 461, 463, 467, 479,  
487, 491, 499, 503, 509, 521, 523, 541, 547, 557, 563, 569,  
571, 577, 587, 593, 599, 601, 607, 613, 617, 619, 631, 641,  
643, 647, 653, 659, 661, 673, 677, 683, 691, 701, 709, 719,  
727, 733, 739, 743, 751, 757, 761, 769, 773, 787, 797, 809,  
811, 821, 823, 827, 829, 839, 853, 857, 859, 863, 877, 881,  
883, 887, 907, 911, 919, 929, 937, 941, 947, 953, 967, 971,  
977, 983, 991, 997.

## The constant $\pi$

The circumference of a circle bears a constant ratio to its diameter and this constant is denoted by the Greek alphabet,  $\pi$

$$\text{i.e, } \pi = \frac{\text{Circumference of the circle}}{\text{Diameter of the circle}}$$

This constant appears almost everywhere in calculation pertaining to mensuration in geometry.

It is important to the ancients for doing astronomical calculations for prediction of seasons.

A very common approximation is  $22/7$ , due to Archimedes. Actually,

$$223/71 < \pi < 22/7 \quad (3.1408 < \pi < 3.1429)$$

$\sqrt{2}$  satisfies the equation  $x^2 - 2 = 0$ ,  $\sqrt{1+\sqrt{5}}$  satisfies  $x^4 - 2x^2 - 26 = 0$ . But,  $\pi$  doesn't satisfy any such equation: If  $a_0, a_1, \dots, a_n$  are any rational numbers, and  $a_0, a_1, \dots, a_n$ , not all of them zero,  $a_0 + a_1\pi + a_2\pi^2 \dots + a_n\pi^n$  is never equal to zero! So, it is a **transcendental number**.

## Ramanujan and $\pi$

Ramanujan had an extraordinary memory and entertained all by reciting the value of correct upto several digits. He came up with some formulae for obtaining the value of  $\pi$  in his work. Two of them are as under:

$$1) \quad \frac{1}{\pi} = \frac{\sqrt{8}}{9801} \sum_{n=0}^{\infty} \frac{(4n)!}{(n!)^4} \times \frac{26390n + 1103}{396^{4n}}$$

This was first found by Ramanujan. It was his favourite formula – an innovation by Ramanujan. According to him, he has no idea, how it worked.

2) *The following series converges and the sum equals  $\frac{1}{\pi}$*

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}}$$

Needless to say, the convergence is extremely fast. For example, if we only use the sum for  $n=0$ , we obtain the following approximation

$$\pi = \frac{9801}{2(1103)\sqrt{2}} = 3.14159273001\dots$$

and the error is (in absolute value) equal to 0.0000000764235... In 1994, the value of  $\pi$  was accurately computed correct up to over four billion digits through a supercomputer, using an algorithm, which was similar in essence to the formula given by Ramanujan. The origin of this formula is a problem in geometry, known as 'Squaring the Circle'.

## Squaring the Circle

Greeks had asked the question: Is it possible to construct a square with area equal to that of a given circle using ruler and compass alone?

The answer is 'No!', known only in the 19th century.

If a circle has unit radius, its area is  $\pi$ . The square with area equal to  $\pi$  will have side of length  $\sqrt{\pi}$ . Is it possible to construct a line segment of length  $\sqrt{\pi}$ ? It is possible to construct a line segment of length  $\ell \Rightarrow \ell$  satisfies a polynomial with rational coefficients of degree of power of 2, which is impossible. Ramanujan in 1914 gave a ruler-and-compass construction which was equivalent to taking the approximate value of  $\pi$  to be

$$\left(9^2 + \frac{19^2}{22}\right)^{1/4} = \left(\frac{2143}{22}\right)^{1/4} = 3.1415926525826461252\dots,$$

giving a value correct upto eight decimal places.

## Ramanujan's Magic Square

### A Typical Magic Square

4	9	2
3	5	7
8	1	6

The sum of all rows, all columns and the diagonals is 139

### Ramanujan's Magic Square

22	12	18	87
88	17	9	25
10	24	89	16
19	86	23	11

It has many interesting properties:

- Sum of the numbers in any row is 139. Observe that  $1 = 3^0$ ,  $3 = 3^1$ ,  $9 = 3^2$ !
- Sum of numbers in any column is 139.
- Sum of numbers in any diagonal is 139.
- Sum of the numbers in four corners is also 139.
- Sum of the middle two numbers in first row and the middle two numbers in last row,  $12+18+86+23$ , is 139.
- Sum of the middle two numbers in first column and the middle two numbers in last column,  $88+10+25+16$  is 139.
- Sum of both the diagonals of order two, clockwise, i.e  $88+12+16+23$  is 139.
- Sum of both the diagonals of order two, anti-clockwise, i.e  $18+25+86+10$  is 139.
- Sum of the numbers in the four squares in the centre,  $17+9+24+18$  is 139.
- Sum of the squares in the four corners is also 139 ( $22+12+88+17$ ), ( $18+9+87+25$ ), ( $10+24+19+86$ ), ( $89+16+23+11$ ).
- And, finally the climax!. The first row of the square is his date of birth, 22nd December, 1887, i.e 22.12.1887.!

It is our misfortune that Ramanujan passed away prematurely. Had he got a normal life span he would have contributed immensely to the world of mathematics.

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# 31

## Tower of Hanoi

C.K. Ghosh

### Introduction

Tower of Hanoi (ToH) is quite an age old mathematical game. It has a very interesting link with the 'Icosian Game' which became popular during the middle of 19<sup>th</sup> century. However, we shall not discuss the link with the 'Icosian Game' here, rather we shall use the game to present the 'Method of Induction' (used particularly in algebra) in a very innovative way. First, let us talk briefly about the game, *'Tower of Hanoi'*.

### The Game

It is said that the *'Tower of Hanoi'* was invented by the French mathematician Edouard Lucas in 1883 and was sold as a toy. Originally it was called *'Prof. Claus'* of the College of *'Li-Sou-Stian'*. As a matter of fact the two names within the single inverted commas are the anagrams of *'Prof. Lucas'* of the College of *'Saint Louis'*.

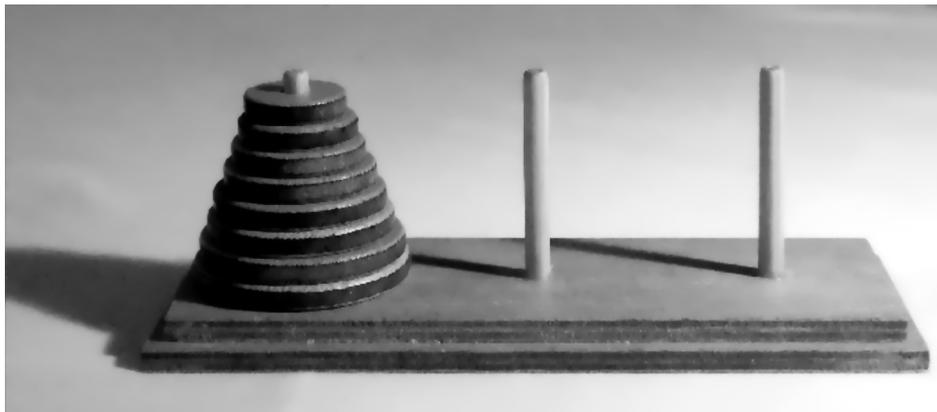


Fig. 31.1: The toy with rectangular base and three pegs

The toy is depicted in Fig. 31.1. It shows a rectangular base with three pegs. There are eight circular discs fitted into one peg in the form of descending order of diameter from bottom to top. The problem is to transfer the eight discs to any of the two vacant pegs in least possible number of moves. In each move only one disk can be moved and a larger disk cannot be placed over a smaller one.

It is not difficult to establish that the minimum number of moves irrespective of the number of discs is  $(2^n - 1)$  where  $n$  is the total number of discs. Thus one disc can be shifted in 1  $(=2^1 - 1)$  move, two discs in 3  $(=2^2 - 1)$  moves, three discs in 7  $(=2^3 - 1)$  moves, four discs in 15  $(=2^4 - 1)$  moves and five discs in 31  $(=2^5 - 1)$  moves. For seven discs, the number of moves should be 127  $(=2^7 - 1)$ , whereas for eight discs shown in the figure the number would be 255  $(=2^8 - 1)$ .

The original description of the toy is based on a temple called *'Tower of Brahma'* in the city of Varanasi. The Tower is said to consist of 64 discs of gold. So the total number of moves for shifting the 64 discs would be  $2^{64} - 1$ , that is 18,446,744,073,551,615 which is a 20-digit

number. If someone is asked to accomplish the task and for the sake of argument let us presume that he is capable of shifting one disk in one second then it would take him many thousand of million of years to finish the job, which is much more than the predicted age of the universe.

The number of moves corresponding to the number of discs which we had spelt out earlier can be obtained in the form of a logical sequence. We shall now present that and also show that the method of Mathematical Induction can be illustrated very elegantly using the example of the 'Tower of Hanoi'.

## Mathematical Induction

Mathematical Induction is a method of using inductive logic for mathematical derivations. It is essentially a method of mathematical proof typically used to establish that a given statement is true for all natural numbers ( $n$ ). The idea is to show that the statement is true first for  $n = 1$  then  $n = 2, 3$  and so on. It is presumed that statement is true for  $n=m$  and based on that it is shown that it is also true for  $n = m + 1$ . If this can be established, it means that if the statement is true for  $n = 1$ , it is true for  $n = 1+1$ , i.e. 2, again  $n = 2+1$ , i.e. 3, and thus for all natural numbers.

Let us illustrate this first by proving the statement that the sum of the first natural numbers

is equal to  $\frac{1}{2} n(n+1)$ . Or in other words,

$$S_n = 1 + 2 + 3 + \dots + n = \frac{1}{2} n(n+1) \quad \text{---(1)}$$

Let us presume that (1) is true for  $n = m$ , which means

$$S_m = 1 + 2 + 3 + \dots + m = \frac{1}{2} m(m+1)$$

Now,

$$\begin{aligned} S_{m+1} &= S_m + (m + 1) \\ &= \frac{1}{2} m(m + 1) + (m + 1) \\ &= (m + 1) \left( \frac{m}{2} + 1 \right) \\ &= \frac{1}{2} (m + 1)(m + 2) \\ &= \frac{1}{2} (m+1) [(m+1)+1] \end{aligned}$$

So the result is also true for  $n = m + 1$

Now, let us look for the sequence of moves of the discs of the *Tower of Hanoi*.

Let us name the discs  $a, b, c, d, e, f, g, \dots$  when  $n=1$ , we have 1(one) move, i.e. 'a' when  $n = 2$ , we first move  $a$ , say counterclockwise, then we move  $b$  clockwise and place it on

a blank stick, then we move  $a$  again counterclockwise and place it over  $b$ . Thus in 3 (three) moves, the two-disc tower gets shifted from one position to another. The three moves can be recorded as  $(a\ b\ a)$ .

Basically, it may be observed that we have applied the method of induction. The disc  $a$  has been moved in the same manner as was done in case of  $n=1$ . In between, during the second move,  $b$  was shifted. We shall understand the method of induction better with  $n=3$ .

The third disc is  $c$ . It would be moved only once to the location where the tower is to be shifted. It would be the central move flanked by the moves pertaining to  $n=2$ , before and after. So the sequence will read as  $a\ b\ a\ c\ a\ b\ a$ . It can be seen that  $(aba)$  has been placed on either side of  $c$ . The total count is  $3 + 1 + 3 = 7$ , which is what we expect for  $n=3$ . Again for  $n=4$ , we have to move the fourth disc  $d$  once to the location where the tower is to be shifted. It would be the central move flanked by the moves pertaining to  $n=3$ , before and after. So the sequence will read  $a\ b\ a\ c\ a\ b\ a\ d\ a\ b\ a\ c\ a\ b\ a$ . We have placed  $(a\ b\ a\ c\ a\ b\ a)$  on either side of  $d$ . The total count is  $7+1+7=15$ , which is what we expect for  $n=4$ .

Again the total count for  $n=5$  is  $a\ b\ a\ c\ a\ b\ a\ d\ a\ b\ a\ c\ a\ b\ a\ e\ a\ b\ a\ c\ a\ b\ a\ d\ a\ b\ a\ c\ a\ b\ a$  is  $15+1+15=31$ , where  $e$  appears at the centre flanked by the sequence corresponding to  $n=4$  on either side of it. One has to remember that the crux of the movements is that the alternate discs would be moving respectively in counterclockwise and clockwise manners. In other words, if  $a$  moves first, say in the counterclockwise sense, then  $a, c, e, g, \dots$  would always move in the counterclockwise sense and  $b, d, f, \dots$  would always move in the clockwise sense.

Thus one aspect of mathematical induction gets reflected from the sequences and the manner in which the respective sequences for  $n=2,3,4,5 \dots$  evolve from  $n=1,2,3,4, \dots$ . The other aspect is the derivation of the result for the number of required moves, which is  $2^n - 1$ .

As in the case of the proof for the sum of first  $n$  natural numbers, we presume that the result is valid for  $n=k$ , say. So we need to prove that the result is also valid for  $n=k+1$ .

We find that while moving from  $n=k$  to  $n=k+1$ , we express the number of moves as

$$\begin{aligned} & (2^k - 1) + 1 + (2^k - 1) \\ &= 2 \times 2^k - 1 + 1 - 1 \\ &= 2^{k+1} - 1 \end{aligned}$$

So, the result is also valid for  $n=k+1$ , which establishes the truth behind the fact that required number of moves for  $n$  disks is  $2^n - 1$ .

Thus we see that the game of *Tower of Hanoi* provides us with a very elegant method of understanding the Method of Mathematical Induction.

## Introduction

Sukumar was an unparalleled genius. He was a Bengali humorous poet, story writer and playwright. He lived a short life but created many valuable literary pieces. His works display the innovativeness of a literary genius who devised new expressions for reaching out to his young readers and igniting the flame of creativity in their minds.

## Early Life of Sukumar Ray

Sukumar Ray, father of legendary filmmaker Satyajit Ray, was born in 1887 in the illustrious Ray Chaudhuri family of Calcutta. Born in the era which can be called the pinnacle of the Bengal Renaissance, he grew up in an environment that fostered his literary talents. His was a literary family where innovation seemed to be the ruling philosophy. His father Upendrakishore was a versatile genius, a talented writer of children’s literature, a musician, artist, painter and illustrator extraordinaire, and a pioneer of printing technology, the founder of the U Ray and Sons, a printing press. He was a reputed printer and publisher, author of theoretical works on printing in the British journal *Penrose*. He wrote story books for children which he charmingly illustrated and published himself. He is most remembered for his simplified versions of the Ramayana and the Mahabharata that he wrote and illustrated for children. His illustrations were humorous aimed at tickling the funny bone in adults and children. He also did pioneering work in art and printing technology and was internationally renowned as an innovative pioneer in the process-engraving field. Process-engraving or photo-engraving is referred to in popular parlance as half-tone block-making. Upendrakishore was also a close friend of Rabindranath Tagore, who directly influenced Sukumar. Among other family friends were the famous scientists, Jagadish Chandra Bose and Prafulla Chandra Roy.

He was the founder and editor of a very popular children’s magazine, *Sandesh*, which literally means ‘candy’ as well as ‘news’. The journal carried funny and sweet stories as well as articles on general knowledge. After Upendrakishore, Sukumar continued to edit it until he passed away prematurely in 1923. Satyajit Ray revived it in 1961, his son Sandip is now the editor.

From an early age, Sukumar showed the same versatility as his father—versifying, drawing, photographing, and directing amateur theatricals with almost equal proficiency. Sukumar was also a book designer. In him, we find a writer who not only illustrated his own writings but was also well acquainted with state-of-the-art reproduction and printing.

In 1906, Ray graduated with Honours in Physics and Chemistry from the Presidency College, Kolkata. Sukumar received the Guruprasanna Ghosh Scholarship in 1911 to study photography and print technology in England. He was a pioneer of photography and lithography in India. While in England, he also delivered lectures about the songs of Rabindranath Tagore before he won the Nobel Prize. Meanwhile, he had also drawn acclaim as an illustrator. After studying in London and Manchester, he returned to India

and involved himself with the running of the family firm U. Ray & Sons, then a market leader in graphic arts and photo processes. After the death of Upendrakishore in 1915, Sukumar took over the editorship of the children’s magazine *Sandesh*. It was in the pages of *Sandesh* that his apparently whimsical literary genius found its most complete expression (Ghosh, 2004). He created a unique genre of nonsense literature built on a world of fantasy and whimsy. Among his works, two especially shine: *Abol Tabol* and *Ha Ja Ba Ra La (HJBRL)*, the first in verse, the second in lovely pictorial prose with occasional sprinkles of spectacular verse.

At some point before 1911, when Sukumar was sent off to England, Suprabha Das, the beautiful teenaged granddaughter of the visionary Kalinarayan Gupta, was introduced to Sukumar’s Nonsense Club. On Sukumar’s return from England in 1914, he married Suprabha Das and their son, Satyajit, was born on May 2, 1921. Satyajit Ray later became the most well known of Indian filmmakers. By this time Sukumar was attacked by the bacteria of the then fatal disease of blackwater fever. Fever penetrated deeper and deeper with the bacteria affecting one organ after another until Sukumar was bound to a wheelchair. Yet he continued to write. Persistently he continued to bring out *Sandesh*, the children’s magazine. His undying sense of humour and a yearning for surreal visions and images are evident in his last poem *Abol Tabol* written in his death bed. Sukumar Ray died prematurely at the age of 36 on September 10, 1923 of severe infectious fever, leishmaniasis, for which there was no cure at the time. He died just nine days before the publication of his book of nonsense verse *Abol Tabol*. The last poem in it, *Abol Tabol* was Sukumar’s last composition.

## Master of Science and Nonsense

Sukumar Ray was also a scientist but the scientist in him has not received adequate recognition. Sukumar Ray’s genius had varied ingredients - a thorough grasp of scientific principles, which transformed his outlook on everything from print technology to Brahmanism and nonsense verse (Robinson, 1987). Sukumar also had an active and serious interest in photography. He was awarded the Award of Merit by ‘*Boy’s Own Paper*’ for excellence in photography in November, 1904 at the age of 17. He designed the sliding calculator to help in setting up the camera during process work. In 1922 he became a Fellow of the *Royal Photographic Society*, only the second Indian at that time to become a Fellow. He published several articles on photography as well. His article on the Pin-hole theory was published in July, 1913 issue of *The British Journal of Photography*. In the area of print technology, he did technical work of exceptional quality first in London and later in Manchester. He also developed new methods of halftone block making, and published many papers in reputed journals in England. His articles ‘*Half-tone Facts Summarized*’ and ‘*Standardizing the Original*’ were also published in *Penrose Annual*.

While he was a student of the Presidency College, he formed a club known as the ‘Nonsense Club’. The membership of the club was open to those with a flair for the ridiculous, practical joking and acting. The members were free to express their irreverent opinions about the world at large. The very name of this club suggests the direction in which his imagination worked. A number of delightful poems were penned by Sukumar Ray in relation to the matters concerning the club. The two plays that he wrote for the club—*Jhalapala* (Cacophony) and *Lakshmaner Shaktishel* (Lakshman and the Wonder Weapon)—are instances of Ray’s uproarious finesse. In *Lakshmaner Shaktishel* the mythological characters are distorted into utterly ludicrous figures as in Aristophanes’ *The Frogs*. Ravan picks pockets; Hanuman is quite reluctant to get the magical herb ‘*Bishalyakarani*’ to save

Lakshman's life and has to be bribed with a banana. There are flares of witty dialogues too. As Satyajit puts it, "These contain the first expressions of Sukumar's humour. In the second play, characters out of Ramayana descend from the epic heights to a world of spoof and horseplay... mixed up with vegetable curry, chemists, homeopathic drugs, Sandow, the muscleman, and recurring decimals. Hanuman, the monkey-god, eats sugar-puffs; the messenger of Death finds his salary in arrears and Jambuban is annoyed by the stink of Bibhisian's beard. Sukumar also made his debut here as a composer of songs, his simple tunes and rhythms adding greatly to the fun." (Dutta, 2004)

In *Sandesh*, Ray provided brief biographies of scientists, explorers, martyrs and famous personalities, which play a significant role in shaping the minds of the young readers. The language he used was simple, supple, entertaining and colloquial. The information was presented in the form of a conversation without any erudite tinge that makes it detestable to the young readers. Besides writing on the lives of great men, he also provided enriched information on wild animals, marine creatures, plants and insects. He introduced his readers to worlds beyond India, with their famous men and women, strange customs and curious animals (Sen, 2012). He also published essays, world news, folktales, puzzles and riddles with colourful illustrations of poetry. Around 92 essays were published in *Sandesh* dealing with science and astronomy, on inventions like the telephone, radio, airplane, calculator, underwater telegraphic cables and skyscrapers (Mitra, 2005). It was in *Sandesh* that *Khichuri* (hotch-potch) (illustrations shown in Fig. 32.1), the first poem in his famous *Abol Tabol* (Rhymes without Reason), appeared. It was Sukumar's earliest nonsense rhyme on animals, followed by *Old Man of the Woods*, *Chandidas's Uncle*, *The Shadow-Catcher*, *The Lug-Headed Loon* and others.

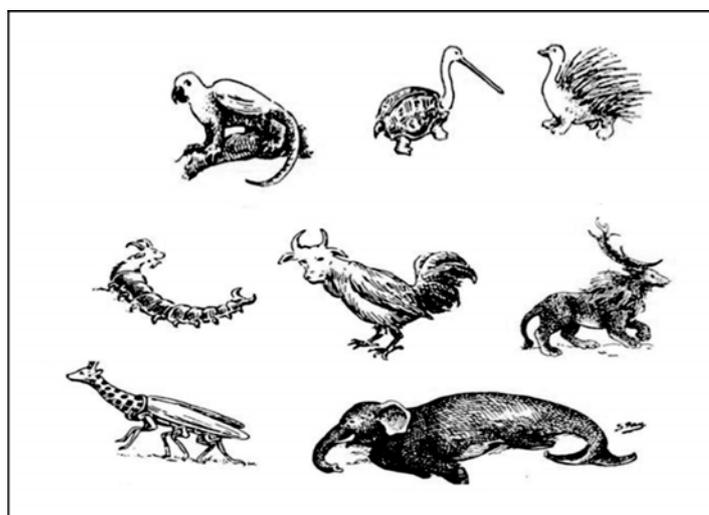


Fig. 32.1: Illustrations by Sukumar Ray in *Khichuri* (hotch-potch)

Sukumar Ray is also known as the most famous practitioner of 'literary nonsense' in the subcontinent and is often compared to Lewis Carroll and Edward Lear. His works such as the collection of poems - *Abol Tabol*, *HaJaBaRaLa*, short story collection *Pagla Dashu*, and play *Chalachittachanchari* are considered nonsense masterpieces equal in stature to *Alice in Wonderland*, and are regarded as some of the greatest treasures of Bangla literature. It has often been mentioned that Sukumar's characters resemble creations by Lewis Carroll

and Edward Lear. “There is a similarity,” admits Satyajit, “but there is also a basic difference: while the creatures of *Jabberwocky* belong to the world of imagination, Sukumar’s creations, whatever they may look like, belong to our familiar, everyday world. And many of them, like his lug-headed loon, actually belong to Bengal.” (Mitra, 2005)

Carroll combines two words into one to formulate a Portmanteau, and we come across weird sounds and words in his poems. Ray was also indebted to Lewis Carroll for the portmanteau words. Portmanteau terms have created new animals in Ray, like the *Hasjaru* (swan+porcupine), *Bakacchaap* (crane+tortoise), *Girgitia* (chameleon+parrot), or the *Singharin* (lion+deer) as shown in Fig.32.1 above. Some of Ray’s ‘inventions’ are immortalized by being used in the native language frequently (Mitra, 2005).

Just like Lear, and later Wilhelm Busch, Sukumar illustrated his own texts. They are considered quite brilliant although he never had any formal training in art. We are introduced to a series of unusual animals in Ray and all these introductions are well illustrated.

### Madness and Magic in Ray’s Works

Through his work he brings a world of absurd but lovable characters to life. More often than not, they resemble particular types of creatures with weird habits that all of us are familiar with. He pegged his *Kaathburo* (illustration shown in Fig.32.2), *Chandidaasher Khuro* (Chandidaash’s uncle), the inventor of *Futoscope*, the trader in catching *chhaya* (shadows) and the *Borobabu* (head-clerk) of the head-office on fussy and finicky characters whom we encounter around us everyday. In a way he appears to be mocking people who make much of simple things in life, and therefore miss the fun in it.



Fig. 32.2: Illustrations by Sukumar Ray – *Kaathburo*

His creations often emerge as fictitious absurd creatures sporting uncanny qualities that we are familiar with. Often they are citizens of an imaginary world where logic and fiction seem to have blurred into one another. Characters like *Hunkomukho Hyangla* (Fig.32.3), *Tyanshgoru* (Fig.32.4), *Kumropotash* (illustration shown in Fig.32.5), *Paantobhooter Jyanto Chhana*, and *Raamgorurer Chhana* are absurd but wonderfully alive figments of Sukumar Ray’s fertile imagination.



Fig. 32.3: Illustrations by Sukumar Ray - *Hnuko Mukho Hyangla*

They may remind you of the *Jubjub Bird* or the *Jabberwock* from Carroll's poem 'Jabberwocky', or *Yonghy-Bonghy-Bo* and *Clangle-Wangle* from Edward Lear (Sen, 2005).



Fig. 32.4: Illustrations by Sukumar Ray - *Tyanshgoru*

*Tyanshgoru* (shown in Fig.32.4) is actually a bird, and Ray gives us the details of its food habits and lifestyle. His creations—*Kumropotash* (shown in Fig.32.5), *Hnuko Mukho Hyangla* (Fig.32.5) and *Ramgorurer chhana* —have found their permanent place in Bengali lives. Obese men are compared with *Kumropotash* (Fig.32.5), grave and serious men with *Ramgorurer chhana*, and anglophiles as *Tnyasgoru* (shown in Fig.32.4) (Mitra, 2005). Though his target readership was chiefly children, Sukumar's adult relationship has continued to grow steadily. In fact, postcolonial Bengal discovered a streak of non-conformism, a critique of contemporary *bhadralok* culture, lurking behind the apparently amusing poems and prose by Sukumar (Ghosh, 2004).

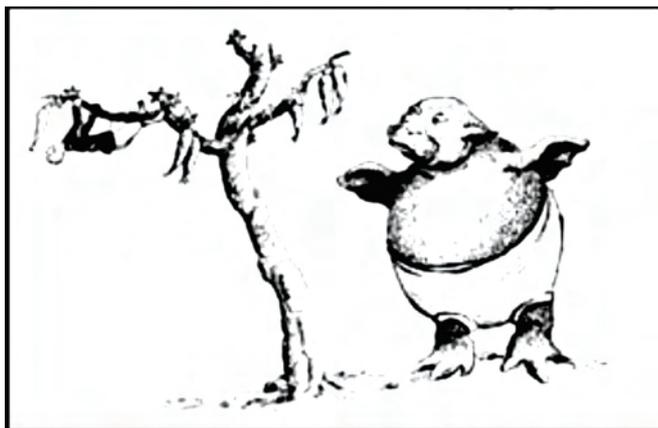


Fig. 32.5: Illustrations by Sukumar Ray - *kumro-patash*

In *Bombagarer Raja* Ray envisions a kingdom which is totally bizarre and where anything is possible. The king hangs framed, fried and solidified mango juices— ‘*Chabir fremenadhiye rakhe amsatto bhaja*’. The queen of the state has a pillow tied to her head, while her brother is busy fixing nails on buns. The king howls like a fox and there are broken bottles hanging from the throne (shown in Fig.32.6). These kinds of weird associations form the basis of Ray’s nonsense verses. In Ray’s *Abol Tabol* meaningless ideas combine with recognizable norms making the poems comprehensible. To smell the sour sky, to lick it after a shower and find that it has become sweet is a pleasant distortion of ideas that could only have occurred to a genius like Ray. His creations are unparalleled, if not unprecedented (Mitra, 2005).

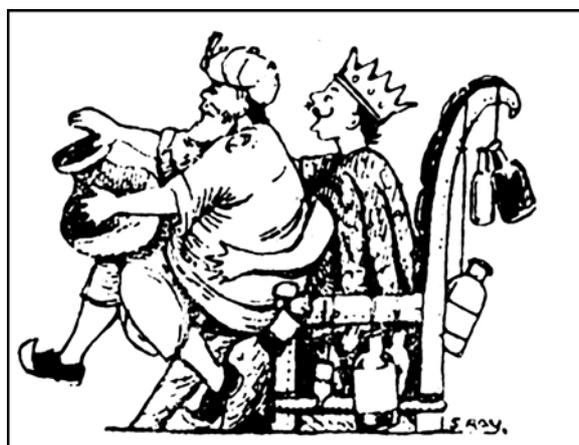


Fig. 32.6: Illustrations by Sukumar Ray - *Bombagarer Raja*

There is a gentle satire in Ray’s *Gnofchuri*, where the manager creates bedlam because his moustache has been stolen. In *KaThbuRo* his head is full of strange theories of researches on timber. In the poem *Pakapaki* he plays with the word *paka* (ripe) and how its application to different things gives different shades of meanings to the same word. *DnaRer Kobita* is a terrific wordplay on *dnaR* (oar), *daRi* (beard) and *dnaRi* (period, oarman) and similar sounding words. In *Khai Khai* he gives us a catalogue of all that can be swallowed—and his list includes fists and bribes (Mitra, 2005).

## Humour, Wit and Irony in His Works

In his works Ray evokes laughter that, with a trace of malice, is a unique expression of a rare genius. Sukumar Ray's humour is magical. He is the inimitable creator of funnies and whimsies, adorable animal hybrids, peculiar humans who tell tales in playful prose and verse. His are books with pictures and conversation, *porcuduck* is a duck and porcupine joined together in Ray's drawing, as is *stortle*, a stork with a turtle's torso. There is an insecure old boss in a crazy British government office who is convinced that all the clerks working under him are thieves. He cracks all of a sudden and croaks hoarsely at his underlings, believing his whiskers have been stolen," Man is slave, moustache is master, losing which man meets disaster", he declares (Basu, 2005).

It is usually the polished and educated gentlemen of the society who is the main target of Ray's satire. This can be seen in poems like *Tejiaa*, *Jiboner Hishaa*, *Babu*. He also provides illustrations portraying well-dressed Bengali babu with spectacles. In his poem, *Lakshmanar Saktishel*, Sugrib protests furiously - "Don't abuse me by calling me a human", when he is compared to a human being by Bibhisan. In this instance the entire mankind becomes the target of his ridicule. In poems like *Ramgorurer chhana* he makes fun of those who are scared to laugh and thus grave and serious men also become objects of his satire.

Sukumar Ray's *Hesoram Hnusiarer Diary* is a spoof on Conan Doyle's *Professor Challenger* and *The Lost World*. In Sukumar's version, Professor Challenger becomes Professor *Hesoram* and the Amazon forest becomes the forest of *Karakoram*. There we find a profusion of prehistoric animals. There are animals that ravish bread and boiled eggs, and also animals that complain even after devouring jelly. These peculiar animals are named in amusing and matchless compounds of Latin and Bengali such as *hyanglatheriam*, *gomratheriam*, *lyagbyagarnish*. Expressions he coined, like *huko muhko hangla*, *ramgarurer chhana*, and *kumro patash*, have been household words ever since they appeared in print. In fact, it is impossible to think of humour in Bengali without remembering Sukumar Ray (Dutta, 2004).

In *Ha Ja Ba Ra La*, Ray takes us to a world where our sturdy, conditioned mind faces a challenge. HJBRL is written in a casual and conversational style. *Ha Ja Ba Ra La* reminds the reader of the Lewis Carol's 'Alice in Wonderland' (1865). The narrator is a child who is both intelligent and observant, and his descriptions are rich if not flowery. Like Alice, he faces a dull reality. In his case, it is a mountain of mathematics and grammar homework. He lapses into mid-day reverie that lands him face to face with a cat that magically comes out of a handkerchief. He meets a raven who scribbles furiously away on a tiny board and stares at the boy with a cocked head. A little man, barely over a foot tall with a shiny bald head, bumps into him. He flips his hookah like a telescope to size him up. Then there is Grammabarom Homer, the goat (Basu, 2005). There is also a great trial as in 'Alice in Wonderland'. The court scene—where a sleepy bat is the judge, a crocodile an advocate shedding crocodile tears, witnesses are valued because they have been purchased and money is ultimately valuable—brings out the total corruption of the system in a good-natured humour. When the old man asks the narrator of *Ha Ja Ba Ra La* his age and the narrator replies that he is eight years three months old, he is confronted with a strange question—whether his age is in the process of increasing or decreasing. The *Ha Ja Ba Ra La* people turn their ages backwards after forty with fear of dying of old age. In reality also most of the people are eager to hide their age and state the years less than what they actually are (Mitra, 2005).

Conventionally, a plot should have a proper beginning, middle and end. In *Ha-Ja-Ba-Ra-La*, the Old Man, while telling a story, defies all of these conventions. He begins in the middle of an action; even the first sentence begins with *Taarpor* (and then), the characters encroach without proper introduction, and the story stops in the middle leaving us guessing for the rest. Moreover, Sukumar’s wonderful illustrations bring to life a tale of confusion and chaos, intellectualism and innocence.

In the words of Rabindranath Tagore “The spontaneous effusion of Sukumar’s humor has enriched Bengali literature and is unparalleled. The wide gamut and the dynamic movement of his faultless rhyme-scheme, the unimaginable incongruity of his emotive associations astound us at every turn. He had a scientific sobriety in his nature and therefore has been able to evoke a play of the binaries with such promptness. Indeed, there has always been some real resonance of humour in the domain of Bengali literature but Sukumar’s hallmark of humour is unique and all surpassing. The immense gift of his refined humour along with the pity of his premature demise would forever be aflame in the reader’s mind.”

## Famous Works

When he was just eight years old Sukumar’s first poem *Nadi* (River) was published in *Mukul*, a children’s magazine. When he was nine, he wrote *Tick, Tick, Tong* which was a translation of the well known nursery poem *Hickory, Dickory, Dock*. Some of his famous works are:

- *Abol tabol* (Gibberish),
- *Pagla Dashu* (Crazy Dashu)
- *Khai-Khai* (Eat-Eat)
- *Heshoram Hushiyarer Diary* (The Diary of Heshoram Hushiyar)
- *HaJaBaRaLa* (Mumbo-Jumbo)
- *Jhalapala O Onanyo Natok* (Cacophony and Other Plays)
- *Lakkhaner Shoktishel* (The Weapon of Lakkhan)
- *Chalachittachanchari*
- *Shabdakalpadrum*
- *Bohurupi*
- *Bhasar Atyacar* (Torture of Language 1915)

## Conclusion

Sukumar Ray’s literary style is very difficult to translate. His nonsense writing which is in Bengali, and is his chief claim to immortality, is in the least translatable of literary forms. He is a magician with words and language but this also makes translation of his works difficult. It is also not possible to convey humour and jokes with deep vernacular voices in other language and so he has unfortunately remained unknown outside Bengali circles. Thus his greatest asset becomes his greatest limitation.

### Baburam The Snake Charmer

Hullo, there Baburam – what have you got in there?  
Snakes? Aha – and do you think there’s one that you could spare  
You know, I’d love to have one, but let me tell you this–  
The ones that bite aren’t right for me – nor the ones that hiss.

[Original: ‘*Baburam Shapure*’ (Bengali), Translation by: Satyajit Ray (the able son of Sukumar Roy)]

### **Khichuri**

Was a duck, porcupine (to grammar I bow not)  
Became Duckupine, but how I know not.

Stork tells turtle, "Indeed it's a delight—  
Our Stortle shape is exactly right!"

Parrot-Head Lizard feels decidedly silly:  
Must he spurn all bugs for a raw green chili?

The goat now hatches a plan to wed—  
Mounts scorpion's neck—body unites with head!

[Original: *Khichuri* (Bengali), Translation by: Prasenjit Gupta]

### **Old Tickler**

Go East or West, go North or south, by land sea or air,  
But before you go, make sure the old Tickler isn't there.  
Tickler is a terror, and I'll tell you what he's after –  
He'll have you stuffing tickle chops until you choke with laughter.

It's hard to tell where he lives, and harder to restrict him,  
He's always round the corner looking for a victim.  
His method is quite simple; he'll grab you by your sleeve  
And tell you anecdotes which he insists you must believe.

[Original: '*Katukutu Buro*' (Bengali), Translation by: Satyajit Ray (the able son of Sukumar Roy)]

### **Stew Much**

A duck once met a porcupine; they formed a corporation  
Which called itself a Porcuduck (a beastly conjugation!).

A stork to a turtle said, "Let's put my head upon your torso;  
We who are so pretty now, as Stortle would be more so!"

The lizard with the parrot's head thought: taking to the chilli  
After years of eating worms is absolutely silly.

A prancing goat - one wonders why - was driven by a need  
To bequeath its upper portion to a crawling centipede.

The giraffe with grasshopper's limbs reflected: Why should I  
Go for walks in grassy fields, now that I can fly?

The nice contented cow will doubtless get a frightful shock  
On finding that its lower lombs belong to a fighting cock.

It's obvious the Whalephant is not a happy notion:  
The head goes for the jungle, while the tail turns to the ocean,  
  
The lion's lack of horns distressed him greatly, so  
He teamed up with a deer - now watch his antlers grow!

[Original: 'Haan chilo sojaru' (Bengali), Translated by: Satyajit Ray (the able son of Sukumar Roy)]

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## Introduction

The name of Jamini Roy shines among the most notable painters of India, especially modern India. Art is a form of beauty and it needs encouragement to be developed. This encouragement must come from a wider circle and Jamini Roy took his art works to all classes of people. No wonder, his art not only received appreciation but also motivation from the common masses. He gave a fresh expression to his ideas and thoughts through colours. Jamini Roy (1887-1972) is one of the greatest and most innovative Indian painters of the 20th century, who changed the concept of Indian modern art. Achievements of Jamini Roy are a proof of his laudable art works that brought fresh lustre to the country. Perhaps he is the most prolific Indian painter who has created more than 15,000 paintings and drawings.

## Early Life and Works of Jamini Roy

Jamini Roy was born on 11th April, 1887 at Beliatore village in Bankura district of Bengal. In 1903, when he was only 16 years old, Jamini Roy came to Calcutta (now Kolkata) to enroll himself in the Government School of Art. He learned from Percy Brown who was the Principal of the Art School from 1909. He also received teaching from Abanindranath Tagore, famous for his valuable contribution in the field of modern art, who was the acting Principal of the college from 1906 to 1909. He did his Diploma in Fine Arts in 1908 and learnt traditional drawing and painting. He started as a painter of academic style and became a significant painter of that style. When he started painting, some of the existing trends in the art and painting scenario in Bengal were:

- 1) European academic style with painters like Bamapada Bandopadhaya (1851-1932), Sashi Hesh (1869-?), Hemen Majumdar (1894-1948), Atul Bose(1898-1977).
- 2) Bengal school led by Abanindranath Tagore (1871-1951) and his student like K.N Majumdar (1891-1979), Mukul Dey (1895-1992) and many others.
- 3) Indian cubism of Gagendranath Tagore (1867-1938).
- 4) Late Bengal school of Nandalal Bose (1882-1966).
- 5) Appearance of Rabindranath Tagore (1861-1941) as a painter from 1928.
- 6) Younger contemporaries - Binode Behari Mukherjee (1904 - 80) and Ramkinkar Beij (1910-80).

His initial work seems inspired by Western style of painting. He made some brilliant forays into a Post-Impressionist genre of landscapes and portraits, yet Roy's early career was calamitous and his early paintings came across as lack-lustre, bland and dull. He did odd jobs in order to survive. He worked at the printing press in Allahabad, worked at a litho press in North Calcutta, worked in the theatres, worked for a Jewish greetings card dealer and used to paint cards in hundreds. He also worked for a cloth shop and for a wood-engraver in North Calcutta. In the 1920s many experiments in art practices were taking place in Calcutta and Santiniketan, and Jamini Roy was very much a part of that.

## **Inspiration from Traditional Folk and Local Art**

Bankura is famous for traditional art and crafts. Since it had close contact with the neighbouring state of Orissa, the traditional art of Orissa had an influence on the Bankura art. Rajput miniature painters settled there and had interaction with local artists which influenced their art. Jamini spent his childhood in village and noticed all the art forms in the district. This made him develop his art base through traditional art forms, while his training in Western art gave some kind of refinement to his art.

Till 1920s he continued painting in oil in western style following the impressionists and post-impressionists though some experimental art practices were taking place in Calcutta and Shantiniketan. He had also assimilated Egyptian, Byzantine and Classical European art. From late twenties onwards he realised that the Western style is not working for him although his work was being appreciated. Although trained at the Government School of Art with classical artistic impulses he got influenced by the bold sweeping brush-strokes of *Kalighat Pat Chitra*. It was in 1925 that he looked towards his own culture, and studied the living folk and tribal art for inspiration. He returned to his own roots to understand the folk arts of Bengal. And naturally he moved away from his earlier impressionist landscapes and portraits. To reach the very source of the folk tradition Jamini Roy went back to his native place, and there he studied the style and technique of *Pat Chitra* from the *Patuas*. But the task of deriving a personal idiom of modern concept from a popular expression was an uphill task. He worked hard for about seven years at his North Calcutta residence to solve problems related to shaping his new visual language on certain principles. And ultimately he succeeded in substituting the conventionally pursued 'high art', by pictorial values of a rustic 'popular' art. Successively he mastered a style of painting conceived entirely on two-dimensional terms.

Jamini recognised his preference as well as interest in the field of Kalighat paintings. From that time onwards, his paintings started reflecting the Kalighat style. Roy's rejection of the then modern style of painting and his foray into the realm of Bengali folk paintings marked a new beginning in the history of Indian modern art. He started painting in a traditional manner with elements from the folk paintings, Kalighat *Patas*, scroll paintings of *Patuas*, motifs terracotta temples of Bengal, clay and wooden dolls, maxi *kanthas* (embroidered quilts), designs of *Baluchari* sarees and tribal art of *Santhals* and other elements of the local community. In his art, there can be noticed elements of Dainhata (Burdwan district centre for traditional stone sculpture of Bengal) in particular the stone sculptures.

His drawings and sketches reveal their connection with traditional art forms and some of them are uncommon like the drawings which remind us of the embroidered quilts and the *Baluchari* sarees. Certain elements of *Dasavatara* cards and manuscripts, as well as of paintings of the Bankura region can also be found in his work. The influence of the designs of *alpana* and tribal wall paintings of the Western part of West-Bengal is also strongly present. He translated the clay toys, horses and other animals into paintings (as shown in Fig. 33.1). Jamini Roy also wrote an essay in Bangla titled "Patua Shilpa" in which he detailed his observation of Pata (scroll painting) and square *patas* (Non-Kalighat style).



Fig. 33.1: Cat with Prawn, Painting on board (17" x 14")

By the early 1930s he had made a complete switch to indigenous materials. His fascination with the indigenous art of Kalighat painting and the terracottas of the Vishnupur temple grew unabated. Quietly, yet firmly, the bold simplicity, linear flow began to fill his work. The difference between *Kalighat Patas* and Jamini Roy's drawings and paintings can be mentioned here. *Kalighat Patuas* are traditional artists for generations, who have shifted to Calcutta from various parts of Bengal and are trained indigenously. Jamini Roy belonged to a family of rural origin and was trained in an art school. He later realised that by merely copying from the Western style he will not be able to become a true artist. He also wanted to take a path different from the Bengal School style of Abanindranath and therefore, he started painting in indigenous style with his own innovation. His lines are simple but lead to complex moments whereas in the *Kalighat Patas* lines are simple, bold and roundish initially derived from clay images. In an interview with Bishnu Dey, he mentioned that, "Painting like Europeans is not possible for me - I cannot paint like the Chinese, Persians or Mongols, for all this is not possible since I am not in that atmosphere. Therefore I have to search for my way out of my own quest. My aim is to have a different style. Now it is accepted that I am having a different style." This made him a unique painter and a great artist of 20th century. This style also added a new dimension to Indian art.

Jamini Roy wanted his art to spread among the common people and not just be confined to museums or galleries. He sold his paintings at very affordable price. He made several copies of his paintings to meet the collectors' demands. Apparent simplicity of his paintings attracted common people apart from art lovers and critics. Various critics from different countries including English novelist Foster wrote about his works.

## Theme and Subject of His Paintings

Jamini adopted the theme from local life to paint. He was very much inspired by the tribes of *Santhal*. The *Santhals*, a tribal people who live in the rural districts of Bengal became an important subject for Roy (Fig. 33.2). A series of works done a decade before World War II is a very good example of how he captured the qualities that are a part of native folk painting and recombined them with those of his own. He fused the minimal brush strokes of the Kalighat style with the elements of tribal art from Bengal like that of the terracotta work found in the Bishnupur temple. He rendered images from *Ramayana* and *Krishna Leela*. He painted ordinary men and women from the village, reinventing popular images from the patua's repertoire.



Fig. 33.2: Santhal, Tempera on Board (Size: 27"X26")

Jamini's presentation of *Santhal* drummers, working blacksmith (Fig. 33.3), *Krishna-Balaram* (Fig. 33.4) and women figures like *Mother and Child* (Fig. 33.5) and *Radhas, Gopis, Pujarinis* (Fig. 33.6) became very popular during the 1940s and his collectors included the middle class Bengalis as well as the European community.

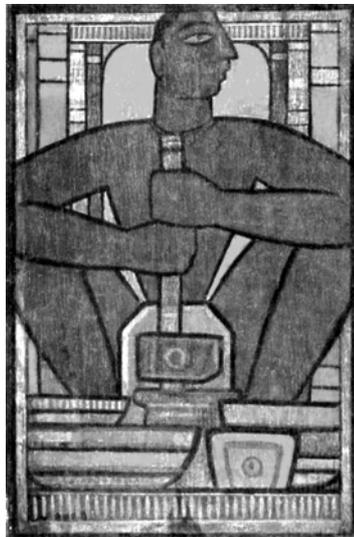


Fig. 33.3: Blacksmith  
(Source: National Gallery of Modern Art, New Delhi)

In Jamini Roy's drawings and paintings figures of *Ramayana*, *Krishnaleela*, *Gasthaleela*, *Radha-Krishna*, *Christ*, *Shiva-Parvati-Ganesha*, *mother and child*, *kirtanias*, folk dancing, village man and woman, *Chaitanya Deva*, decorative flowers, landscape, birds and animals frequently appear.



Fig. 33.4: Krishna and Balarama, Tempera on card (Size: 27"X26"), 1940

The mother and child (Fig. 33.5), Radha and animals were painted in simple two-dimensional forms, with flat colour application and an emphasis on the lines.

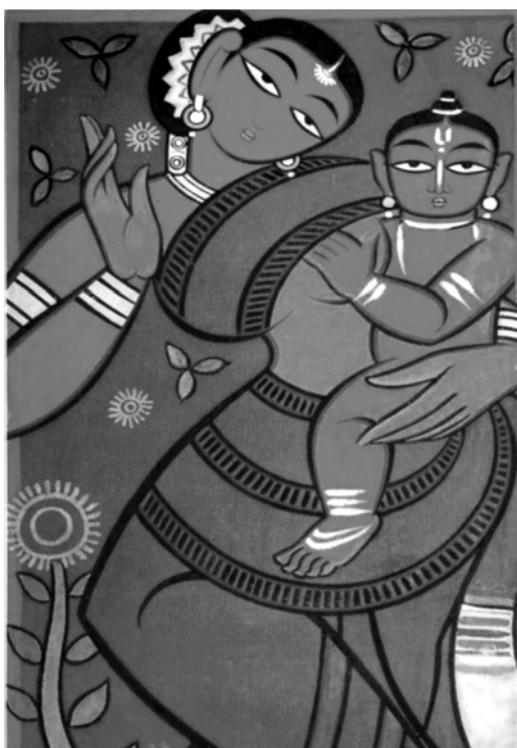


Fig. 33.5: Mother and Child



Fig. 33.6: Three Pujarinis

The main subjects were often enclosed within decorative borders with motifs in the background. The figure of the Christ was also a subject that Roy often painted.

## Innovative Style of Painting

He began with experimentation with the Santhal dance as his starting point. His innovative new style was a reaction against the Bengal School and Western tradition. His quest became threefold - to capture the essence of simplicity embodied in the life of the folk people; to make art accessible to a wider section of people; and to give the Indian art its own identity. He fused the minimal brush strokes of the Kalighat style with elements of tribal art from Bengal. Jamini Roy's drawings, sketches and designs can be sub-divided into four groups:

- 1) Sketches in pen and ink – These resemble Bankura style of *pata* paintings, *terracotta*, and clay toys. These are basically key drawings for final paintings. The items lines are more sophisticated in nature, which reminds his training in art school. In the *patas* of Bankura traditions there are a few groups and styles. *Beliatore Patas* are more primitive, closer to *Santhal Patas*. Jamini Roy's sketches are mixture of these two styles of *patuas*.
- 2) Jamini Roy also followed the style of Bankura clays toys and presented it like a series of designs. Some of these are made in paper stencils and touched up with colours afterwards. These are all in colours – *Gouache* (Fig. 33.7). Thus he was experimenting how those figures could be presented in paintings.
- 3) Embroidered *Kantha* and *Baluchari* saree designs.
- 4) Few designs are drawn repeatedly in a similar way on papers. This shows a planning of how these designs can be combined with other figures and motif in a painting. These combinations helped him in the preparation of his final painting.

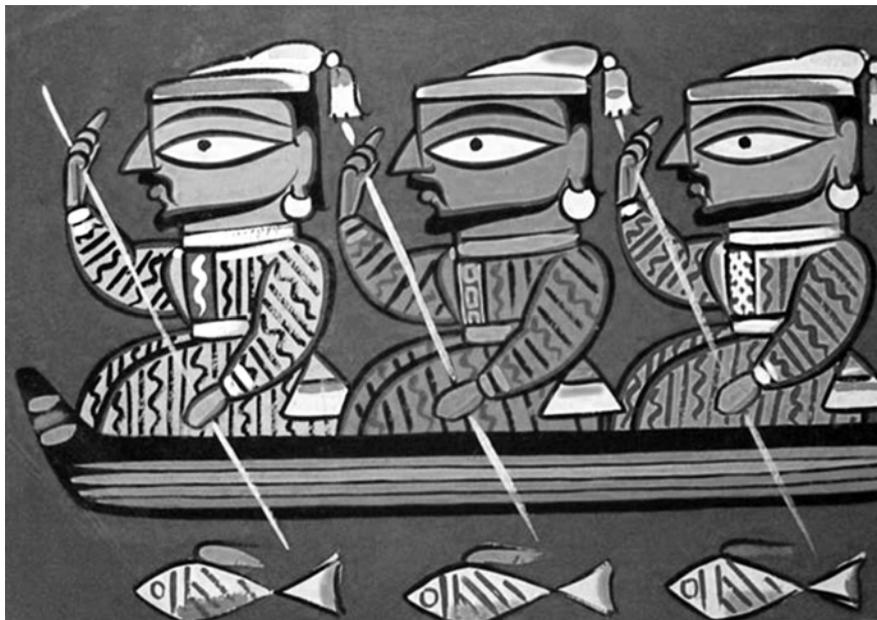


Fig. 33.7: Three Fisherman, Gouache on card (13.5" x 20")

In terms of compositional discipline, his work sometimes reminds the rhythmic as well as symmetrical arrangements of figures on the panels of late medieval Bengal. The lines define the contours of the forms in neat sweeps and the colors, which are deep and saturated, making Jamini Roy's paintings thrive in rare vitality (Fig. 33.8).



Fig. 33.8: Drummers, Tempera on board (13.5" x 9.5")

Roy adopted the simplification of the forms, the bold, flat colours and the medium, material and themes of local folk paintings. The appropriation of folk idioms manifested in various ways. There was a phase in which he adopted the calligraphic brush lines of *Kalighat Patuas* to create sophisticated forms. The austerity of lines only serves to highlight Roy's superb control over brush. The lines drawn lyrically and sometimes even sensuously with lampblack over white or pale grey background show not only vigour, but also the poetry latent in the human form. Roy brought the sensibilities of a formerly educated artist to his appropriation of folk idiom. He did not escape sophistication in his figuration. Moreover, the monumentality that he often brings to his figuration recalls the quality of classical sculptures. His paintings are unique in nature giving us some exceptional presentation from the mythic world, the world of folk tales, tribal man and village girls.

### **Innovativeness of Medium**

Roy adopted the simplification of the forms, the bold, flat colours and medium, the material and themes of local folk paintings. He discarded expensive canvas (Fig. 33.9) and oil paint and opted for the more inexpensive material and medium of the folk artist.

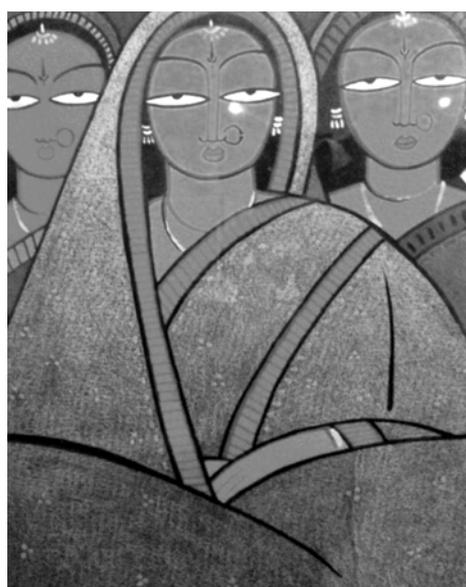


Fig. 33.9: Three Women, Oil on Canvas (18"X24")

He made his own painting surfaces out of cloth, wood, and even mats coated with lime; and painted using earth and vegetable colours. Jamini Roy restricted his palette to seven colours – Indian red, yellow ochre, cadmium green, vermillion, grey, blue, and white. In his mid-thirties, he abandoned his conventional art practice. By the early 1930s, Jamini Roy became fully conversant with the lines of the Kalighat idiom and switched over to the native materials. His medium remained the tempera (Fig. 33.10 & 33.11).

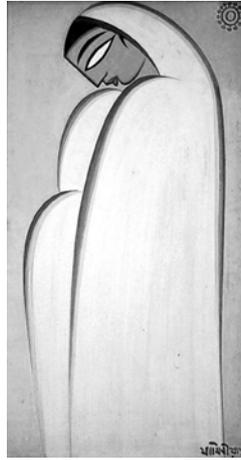


Fig. 33.10: Mother, Tempera on card (27 "x 14.5")

Tempera, also known as egg tempera, is a permanent fast-drying painting medium consisting of colored pigment mixed with a water-soluble binder medium (usually a glutinous material such as egg yolk). Tempera is traditionally created by hand grinding dry powdered pigments into a binding agent or *medium*, such as egg, glue, honey, water, milk, and a variety of plant gums.



Fig. 33.11: Krishna with Cow, Tempera on board (12" x 17")

Tempera painting starts with placing a small amount of the pigment paste into a palette, dish or bowl and adding about an equal volume of the binder and mixing. Some pigments require slightly more binder, some require less. A few drops of distilled water are added; then the binder (egg emulsion) is added in small increments to the desired transparency. The more egg emulsion, the more transparent the paint. Tempera paint dries rapidly. It is normally applied in thin, semi-opaque or transparent layers.

He also used Gouache on panels, cards, and boards as a medium for some of his paintings (Fig. 33.12).



Fig. 33.12: Bankura Horse (with Durga), Gouache on board (38cm x 61 cm), 1935

## Famous Works

Jamini Roy themes are drawn from joys and sorrows of daily life of rural Bengal for his paintings. Besides painting scenes from the lives of the indigenous Santhals he worked upon religious themes such as Jesus Christ, Sri Chaitanya, Ramayana and Radha-Krishna but he illustrated them without narratives. *Cats Plus, Cats Sharing a Prawn, Crucifixion with Attendant Angels, Kitten, Krishna and Balarama, Krishna and Radha Dancing, Krishna with Gopis in Boat, Makara, Queen on Tiger, Ravana, Sita and Jatayu, Santhal Boy with Drum, and Seated Woman in Sari* are some of his celebrated works.

Coates described one of his paintings, *Bride and two Companions*, which appeared in 1952 (Fig. 33.13) as, "Note the magnificent indigo of Bengal, and how the palms of the bride's hands are smeared with red sandal paste. Jamini Roy's choice of colours looks at first sight purely decorative. In fact, nearly everything in his pictures has a reason and a meaning."



Fig. 33.13: Bride and two Companions  
Tempera on card, 75cm×39 cm



Fig. 33.14: Dual Cats with one Crayfish  
Tempera on card, 55.5cm × 44 cm

About *Dual Cats with one Crayfish* (Fig. 33.14) he said, "Yet another new style, colours reduced in number and very restrained, an almost overwhelming sense of formality."

## Recognition and Honours

Jamini Roy received a Viceroy's gold medal in an all India exhibition for one of his works in 1934. His work dominated extensively in international exhibitions and found a place of honour in many private and public art galleries including prestigious Victoria and Albert Museum, London. His work was exhibited in Calcutta in 1938, London in 1946 and in 1953 in New York. He was honoured with a Padma Bhushan by the Government of India in 1955. Jamini Roy died as a much illustrious and innovative artist on 24th April, 1972, in Kolkata. His commendable works can be found in several galleries across the planet and in his home as well. Achievements of Jamini Roy echo the diligent work done by him and industriousness with which he still lives among us in the form of his paintings and unique style.

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# 34

## Web-based Application Development: A Security Perspective

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### Introduction

The usage of networked Systems/Applications/ Services is increasing day by day and at same time, hackers are playing a vital role in destructing the systems, applications and services. Security is essential to protect the network, systems, services and applications from hackers and in turn protect the sensitive data. Due to rapid developments in web technology and tools, the entire software development for applications involves use of web technology and tools such as LAMP (Linux Apache MySQL PHP) or WAMP(Windows Apache MySQL PHP) or other Web tools (ASP, Dot net, IIS and so on). Since web-based application development and deployment involves different web tools, web-based applications are prone to compromise by a hacker due to vulnerabilities and security breaches. The application developer has to pay attention during software development and ensure secure coding to avoid vulnerabilities that protect the application from security breaches and attacks.

### Security Services

The violation in one or more of security services such as authentication, authorisation, availability, confidentiality, integrity of a network, system or application leads to a security breach (Mao, 2009; Rao, 2010; Rao, 2012).

- Authentication confirms the identity of a person or a system and permits one system to determine the origin of another system.
- Authorisation and Access Control is the level of access control that is permitted to use systems and services.
- Availability ensures that the system or an Application or a Service is always available to the authorised parties when needed.
- Confidentiality provides the secrecy of information and allows only authorised users to have access to information.
- Integrity ensures that only authorised parties are able to modify computer system assets and transmitted information. It also provides for the correctness of information.
- Nonrepudiation ensures that neither the sender nor receiver of a message be able to deny the transmission.

These can be made secure by protecting the sensitive resources at the network, system and the application domains. The components and sensitive resources at network domain consist of the configuration files and access control lists at organisation's gateway level network. Sensitive Resources at System Domain consist of file system, system memory, processes, IPC Objects (Shared memory, Message Queues, Semaphore) and system clock, etc. Sensitive resources at services/ application domain include the setup and configuration

files of specific services like Email, Web, DNS and Proxy. It also includes the Programme Code, the controls and other such related area of a specific application (E-commerce).

### **Vulnerabilities in Web-based Application Development and Proactive Measures**

Web-based applications are prone to compromise by hackers due to vulnerabilities or security breaches in programme code. OWASP (Open Web Application Security Project) (<https://www.owasp.org/>) is a worldwide non-profit, charitable organisation focused on improving the security of software. Its mission is to make software security visible, so that individuals and organisations worldwide can make informed decisions about true software security risks. The OWASP community includes corporations, educational organisations, and individuals from around the world. The OWASP provides practical guidance to the web-based application developers (J2EE, ASP.NET, PHP and related) to develop secure coding. The OWASP development guide covers an extensive array of application-level security issues, from SQL injection to modern concerns such as phishing, credit card handling, session fixation, cross-site request forgeries, compliance, and various other privacy issues.

The following are various types of vulnerabilities that are to be addressed by the developers while developing web-based applications:

- Unvalidated Input
- Broken Access Control
- Broken Account and Session Management
- Cross-Site Scripting (XSS) Flaws
- Buffer Overflows
- Injection Flaws
- Error Handling Problems
- Insecure storage
- Denial of service
- Insecure Configuration Management

### **Un-validated Input**

Web applications use input from HTTP requests to determine how to respond. Attackers can tamper with any part of HTTP request, including the URL, query-string, headers, cookies, form fields, and hidden fields to bypass the site's security mechanisms. The impact of unvalidated input is that all web servers, application servers, and web application environments are susceptible to parameter tampering.

*Measures to be taken:* Server side checks should be enforced to defend against parameter manipulation attacks. Once these are in place, client side checking can also be included to enhance the user experience for legitimate users and/or reduce the amount of invalid traffic to the server. Web application should have a strong, centralised mechanism for validating all input from HTTP requests to protect the malicious input. In addition to these measures web application firewalls can also be used to provide some parameter validation services.

The Parameters should be validated for - data type (string, integer, real, etc.), allowed character set, minimum and maximum length, whether null is allowed, whether the parameter is required or not, whether duplicates are allowed, numeric range, specific legal values (enumeration), and specific patterns (regular expressions).

## **Broken Access Control**

Web application's access control is closely tied to the content and functions that the site provides. In addition, the users fall into a number of groups binding with roles and privileges. To ensure proper access control, a web application must ensure both authentication and authorisation checks. The impact of broken access control is that the web servers, application servers, and web application environments are susceptible and frequently prime targets for attack by both outsiders and insiders. If application is not configured properly, hackers could gain access to sensitive files and deface the site, or perform other mischief.

*Measures to be taken:* The authorisation on every page of the application should be properly checked. It should not inadvertently become a proxy for services behind a firewall and only short amounts of time for token sessions should be allowed. Tokens on the server side on user logout should be destroyed, all demo/debug code must be removed before going live with an application, defaults in third party code or applications should be changed verified, one must also ensure not to use higher privileges than are necessary and limit file permissions on web files.

## **Broken Authentication and Session Management**

Authentication and session management includes all aspects of handling user authentication and managing active sessions. Development teams frequently underestimate the complexity of designing an authentication and session management scheme that adequately protects credentials in all aspects of the site. If the session tokens are not properly protected, an attacker can hijack an active session and assume the identity of a user. The impact is that web servers, application servers, and web application environments are susceptible to broken authentication and session management issues.

*Measures to be taken:* Each aspect of authentication mechanisms should be carefully reviewed to ensure that the user's credentials are protected at all times, while they are at rest (e.g., on disk), and are in transit (e.g., during login). Both code review and penetration testing can be done to diagnose authentication and session management problems. Proper password usage policy also needs to be implemented.

## **Cross-Site Scripting (XSS) Flaws**

Cross-Site Scripting (XSS) is a type of computer security vulnerability typically found in web applications. XSS enables attackers to inject client-side script into web pages viewed by other users. XSS vulnerability may be used by attackers to bypass access controls. The XSS impact is such that the web servers, application servers, and web application environments are susceptible to cross site scripting attacks such as stored attacks and reflected attacks. The most severe XSS attacks involve disclosure of the user's session cookie, allowing an attacker to hijack the user's session and take over the account. Other damaging attacks include the disclosure of end user files, installation of trojan horse programmes, redirecting the user to some other page or site, and modifying presentation of content.

*Measures to be taken:* The best way to protect a web application from XSS attacks is to ensure that the application should perform validation of all headers, cookies, query strings, form fields, and hidden fields.

## Buffer Overflows

Buffer overflow occurs when a programme or process tries to store more data in a buffer (temporary data storage area) than it was intended to hold. Attackers use buffer overflows to corrupt the execution stack of a web application. By sending carefully crafted input to a web application, attacker can cause the web application to execute arbitrary code – effectively taking over the machine. The impact is that web servers, application servers, and web application environments are susceptible to buffer overflow attacks.

*Measures to be taken:* It is essential to keep up with the latest bug reports for web and application server products and other products. The latest patches to these products should be applied. Scanning of the website periodically with one or more of the commonly available scanners that look for buffer overflow flaws in your server products and your custom web applications is also required.

## Injection Flaws (Shell Commands and SQL)

Injection flaws allow attackers to relay malicious code through a web application to another system. These attacks include calls to the operating system via system calls, the use of external programmes via shell commands, as well as calls to backend databases via SQL (i.e., SQL injection). SQL injection is a particularly widespread and dangerous form of injection. To exploit a SQL injection flaw, the attacker must find a parameter that the web application passes through to a database. The impact is that due to improper coding, web application environment allows the execution of external commands such as system calls, shell commands, and SQL requests and as a result web application is prone to attack.

*Measures to be taken:* Bind variables should be used wherever possible. If not possible, it is important to escape all user variables which can be used in a SQL statement or on the command line. Pattern matching can be used to verify user input. If input is not what is expected, it should throw an error. These error messages should be generic. In order to avoid giving an attacker potentially useful information one can turn off/control debug messages. At database level one should limit access to the web account that is accessing the database, write procedures to insert records and update data rather than give the application direct access to the tables and limit application to READ-only access where ever possible - at the user level as well as database level.

## Improper Error Handling

Improper handling of errors can introduce a variety of security problems for a website. Internal error messages such as stack traces, database dumps and error codes reveal implementation details. Such details can provide hackers important clues on potential flaws in the site. The impact is that web servers, application servers and web application environments are susceptible to error handling problems.

*Measures to be taken:* It is essential to return a simple error message to the user and log a more detailed error message to the server. The user should be provided with diagnostic information (e.g., data validation errors), but not developer level diagnostic/debug information. It is also required to limit error messages regarding user ID and password errors. The password complexity should not be described. Other important steps are to review the access logs, to look for anomalies, if your site contains sensitive data, to log access to the system and to review error logs periodically.

## **Insecure Storage**

Most web applications have a need to store sensitive information, either in a database or on a file system somewhere. The information might be passwords, credit card numbers, account records, or proprietary information. The impact is that most web application environments get affected.

*Measures to be taken:* The easiest way to protect against cryptographic flaws is to minimize the use of encryption and only keep information that is absolutely necessary. For example, rather than encrypting credit card numbers and storing them, simply require users to re-enter the numbers.

## **Denial of Service**

Web servers can handle several hundred concurrent users under normal use. Attacker can generate enough traffic from a single host to flood many applications. Once an attacker can consume all of required resource, they can prevent legitimate users from using the system. The impact is that web applications are particularly susceptible to denial of service attacks.

*Measures to be taken:* Defending against denial of service attacks is difficult, as there is no way to protect against these attacks perfectly. As a general rule, one should limit the resources allocated to any user to a bare minimum.

## **Insecure Configuration Management**

There are a wide variety of server configuration problems that can plague the security of a site. These include un-patched security flaws in the server software, server software flaws or misconfigurations that permit directory listing and directory traversal attacks, sample files, including scripts, applications, configuration files, and web pages, improper file and directory permissions, and remote administration. The impact is that web servers, application servers, and web application environments are susceptible to misconfiguration.

*Measures to be taken:* It is essential to configure all security mechanisms. Turning off all unused services, setting up roles, permissions, and accounts, including disabling all default accounts is also required.

## **Conclusion**

Web based application security problems are as serious as the network security problems, but have received considerably less attention. Attackers are focusing on web application security problems and exploiting the vulnerabilities. The above specified vulnerabilities at application level are a starting point for those flaws that represent the most serious risks to web application security. Apart from it, it is also essential to continuously monitor the sensitive resources at Network System and Application domains for deviations, if any and protect the same as part of proactive measure. It is important to consider security as process-based, and not product-based. A number of software tools are also available that can be used in the discovery (and sometimes removal) of vulnerabilities in a computer system. It is always advisable to have security audit on web-based applications before deployment as it helps in taking care of various issues related to the computer based systems and their vulnerabilities. All these processes and mechanisms help in ensuring that the application is safe from instances of hacking or data breaches.

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स्वाधीनता प्राप्ति प्रेमचन्द के लेखन मात्र का नहीं, जीवन का उद्देश्य था। यह महज संयोग नहीं है कि उनके साहित्य का अधिकांश स्वाधीनता आन्दोलन के बाह्य और आन्तरिक पक्षों का सूक्ष्म विश्लेषण करता है। आज की आलोचनात्मक भाषा में कहें तो स्वाधीनता-विमर्श प्रेमचन्द के लेखन का बीजतत्व है। यहाँ इस बात पर ध्यान देना बहुत जरूरी है कि प्रेमचन्द पूर्ण स्वराज के हिमायती थे और स्वराज की उनकी धारणा इस देश के शोषितों-पीड़ितों के स्वराज से पुष्ट होती थी।

## Lok/khurk vknkyu vkj i ɛpln

प्रेमचन्द ने जहाँ एक ओर स्वाधीनता आन्दोलन के पक्ष में मुक्त हृदय से अपने लेखन के माध्यम से हिस्सा लिया वहीं उन्होंने इसमें भाग ले रहे उच्च मध्यवर्ग को संदेह की दृष्टि से देखा। प्रेमचन्द का स्पष्ट मानना था— “हमें अधिकार की जरूरत इसलिए नहीं है कि थोड़े से शिक्षित आदमियों को मोटी-मोटी असामियाँ मिलें और वह शान से जीवन व्यतीत करें, बल्कि इसलिए और केवल इसलिए कि हम राष्ट्र को सुखी और सन्तुष्ट कर सकें, शिक्षा का प्रचार कर सकें, कृषकों की हालत सुधार सकें, बेकारी की बला दूर कर सकें। देश में ऐसा वातावरण पैदा कर सकें कि छोटे से छोटे आदमी को भी रहने को झोंपड़े और रोटी की कमी न रहे, बड़े से बड़े आदमी छोटे से छोटे आदमी पर भी अत्याचार करके बेदाग न बच सकें, सूद के नाम से गरीबों को लूटा न जा सके, अदालतों में न्याय अधिक महँगा और संदिग्ध न हो। पूँजीपति मजदूरों का रक्त चूसकर मोटे न हो सकें, जमींदार अपने असामियों पर मनमानी न कर सकें, राज कर्मचारी रिश्वत का बाजार न गर्म कर सकें, तरह तरह के नए व्यवसाय खोले जाएं। हम अधिकार चाहते हैं—राष्ट्र सेवा के लिए।”<sup>1</sup> स्वाधीनता आन्दोलन के विषय में एक महत्वपूर्ण बात यह भी है कि उसकी ठीक-ठीक शुरुआत राष्ट्रीय चेतना के आविर्भाव के बाद ही हुई, और इसकी पृष्ठभूमि बना सन् 1857 का विद्रोह। इस विद्रोह के सन्दर्भ में एक विदेशी इतिहासकार का यह मत द्रष्टव्य है— “गंगा पार के इलाके में ही नहीं, दोआब के जिलों में भी ग्रामीण जनता उठ खड़ी हुई थी और जल्दी ही ऐसा कोई आदमी, गाँव और शहर में नहीं बचा जो अंग्रेजों के विरुद्ध न उठ खड़ा हुआ हो।”<sup>2</sup>

विचारधारा विचार की धारा नहीं होती है।<sup>3</sup> यह कोई बनी बनायी चीज नहीं है। इसमें निरन्तर परिवर्तन और विकास होता है। प्रेमचन्द के सन्दर्भ में भी यह बात सही बैठती है। प्रेमचन्द की विचारधारा अपने समय की समाज-समीक्षा करती है। कथा-साहित्य के अतिरिक्त प्रेमचन्द के विचारपरक लेखन में भी उनका दृष्टिकोण स्पष्ट हुआ है। प्रेमचन्द पर गांधी का प्रभाव स्पष्ट है लेकिन देखने की बात यह है कि वे “न कभी अभिभूत गांधीवादी थे और न कभी गांधीवाद के एकदम विरोधी।”<sup>4</sup> हाँ, उस समय के लगभग सभी सकारात्मक आन्दोलनों के साथ प्रेमचन्द के साहित्य का गहरा संबंध है। कर्मभूमि में स्वाधीनता आन्दोलन है तो प्रेमाश्रम में किसान आन्दोलन और गबन में स्वदेशी आन्दोलन है। इसी प्रकार कहानियों में “जुलूस”, “समरयात्रा” और “आहुति” इत्यादि में स्वाधीनता आन्दोलन की गूँज है। स्वाधीनता के ही संदर्भ से जुड़ी कहानी “मैकू” शराबबन्दी आन्दोलन पर केंद्रित है। “ठाकुर का कुँआ”, “सद्गति”, “दूध का दाम” आदि कहानियों पर दलित मुक्ति के लिए चल रहे आन्दोलनों का प्रभाव है।

स्वाधीनता आन्दोलन में उपनिवेशवाद का विरोध एक व्यापक और जटिल मामला था। प्रेमचन्द जैसे सजग रचनाकार इसको महसूस कर रहे थे। “विदेशी अंग्रेजों” को हटाकर “देशी अंग्रेजों” को सत्तासीन करना

उनका उद्देश्य न था। उनका विरोध सिर्फ गोरी चमड़ी से न होकर सत्ता और शोषण के तन्त्र से था। उनके कथा साहित्य में "देशी अंग्रेजों" पर भी गहरी चोट की गई है। उन्होंने सन् 1930 में पंडित बनारसीदास चतुर्वेदी को लिखे एक पत्र में यह इच्छा प्रकट की कि उनकी प्रबल अकांक्षा है, हम भारतीय स्वराज-संग्राम में विजयी हों।<sup>5</sup>

### jk"Vbkn I s erHkn

प्रेमचन्द स्वाधीनता के साधक थे। किन्तु स्वाधीनता के रूप और उसके साथ विकसित हो रहे राष्ट्रवाद से उनका मतभेद था। उन्होंने अपने स्वराज का आशय अपनी कहानी "आहुति" की नायिका रूपमणि के मुख से कहलवाया है। वह कहती है—"अगर स्वराज आने पर भी संपत्ति का यही प्रभुत्व बना रहे और पढ़ा लिखा समाज यों ही स्वार्थान्ध बना रहे तो मैं कहूँगी कि ऐसे स्वराज का न आना ही अच्छा है। अंग्रेज महाजनों की धन-लोलुपता और शिक्षितों का स्वहित ही आज हमें पीसे डाल रहा है। जिन बुराइयों को दूर करने के लिए आज प्राणों को हथेली पर लिए हुए हैं, उन्हीं बुराइयों को क्या प्रजा इसलिए सिर चढ़ाएगी कि वे विदेशी नहीं स्वदेशी हैं? कम से कम मेरे लिए तो स्वराज का यह अर्थ नहीं कि जान की जगह गोविन्द बैठ जाए। मैं समाज की ऐसी व्यवस्था देखना चाहती हूँ, जहाँ कम से कम विषमता को आश्रय न मिल सके।"<sup>6</sup> यह प्रेमचन्द का स्वप्न था। वे "गबन" में दलित पात्र देवीदीन के माध्यम से भी लगभग यही प्रश्न करते हैं।

स्वतंत्रता के बाद की स्थितियों पर ईमानदार सेनानियों को संदेह था और कितना दुःख है कि वह संदेह सोलह आना सही साबित हुआ है। फिर भी यह महत्वपूर्ण बात है कि संदेह के बावजूद लोग इस देश की बृहत्तर आबादी की मुक्ति की लड़ाई में अपना तन-मन-धन अर्पण कर रहे थे। यहाँ याद करने की जरूरत है कि स्वाधीनता आन्दोलन में जो लोग हिस्सा ले रहे थे उसमें समाजवादी समाज का बेहतर सपना लेकर लड़ने वालों की कमी न थी और इस धारा के महान नायक सरदार भगत सिंह थे। यह आकस्मिक नहीं है कि स्वराज के मुद्दे पर भगत सिंह और प्रेमचन्द के विचार मिलते-जुलते हैं। भगत सिंह ने कांग्रेस के राष्ट्रवादी नेताओं की आलोचना करते हुए लिखा था—"यदि आप सोचते हैं कि किसानों और मजदूरों को सक्रिय हिस्सेदारी के लिए आप मना लेंगे तो मैं बताना चाहता हूँ कि वे बेवकूफ नहीं बनाए जा सकते। वे साफ-साफ पूछेंगे कि उन्हें आपकी क्रान्ति से क्या लाभ है, वह क्रान्ति जिसके लिए आप उनसे बलिदान मांग रहे हैं? भारत सरकार का प्रमुख लार्ड रीडिंग की जगह यदि सर पुरुषोत्तम ठाकुर हों तो इससे क्या फर्क पड़ेगा। एक किसान को इससे क्या फर्क पड़ेगा यदि लार्ड इर्विन की जगह सर तेज बहादुर सप्रू आ जाएं।"<sup>8</sup> यहाँ यह याद रखना होगा कि प्रेमचन्द देवीदीन और रूपमणि से यह विचार व्यक्त कराकर छोड़ नहीं देते बल्कि "ब्रह्म का स्वांग" कहानी के नायक स्वराजी वकील अर्थात् "पति महाशय" की इस सोच से उनके संशयों को आधार देते हैं—"वृन्दा सोचती होगी कि भोजन में भेद करना नौकरों पर अन्याय है। कैसा बच्चों जैसा विचार है! नासमझ ! यह भेद सदा रहा है और रहेगा। मैं राष्ट्रीय ऐक्य का अनुरागी हूँ। समस्त शिक्षित समुदाय राष्ट्रीयता पर जान देता है किन्तु कोई स्वप्न में भी कल्पना नहीं करता कि हम मजदूरों या सेवावृत्त धारियों को समता का स्थान देंगे।"<sup>9</sup> लेकिन यहाँ यह भी ध्यान देने की बात है कि अपने इस संशय के बावजूद प्रेमचन्द स्वाधीनता का हर संभव समर्थन कर रहे थे। वे यह भी देख रहे थे कि स्वराज की लड़ाई में तन्मय होकर भाग लेने वाले लोग शोषित वर्ग से ही आ रहे थे।

वे "समरयात्रा" कहानी की नायिका "नोहरी" का उदात्त चरित्र हमारे समाने रखते हैं और उससे कहलवाते हैं— "आज तुमने देख लिया न कि हमारे ऊपर कानून नहीं, लाठी से राज हो रहा है। हम इतने बेशरम हैं कि इतनी दुर्दशा होने पर भी कुछ नहीं बोलते। हम इतने स्वार्थी, इतने कायर नहीं होते तो उनकी मजाल थी कि हमें कोड़ों से पीटते। जब तक तुम गलाम बने रहोगे, उनकी सेवा टहल करते रहोगे, तुम्हें भूसा चोकर मिलता रहेगा; लेकिन जिस दिन तुमने कन्धा टेक किया, उसी दिन मार पड़ने लगेगी। कब तक इस तरह मार खाते रहोगे? कब तक मुर्दों की तहर पड़े गिद्धों से अपने को नुचवाते रहोगे? अब दिखा दो कि तुम भी

जीते जागते हो और तुम्हें भी अपनी इज्जत आबरू का ख्याल है"।<sup>10</sup> यहाँ एक बार फिर यह देखने की जरूरत है कि प्रेमचन्द का विरोध जितना उपनिवेशवाद से था उतना ही सामन्तवाद से भी। उन्होंने इसे जड़ से उखाड़ने की बात की है। वे हिन्दी के पहले ऐसे लेखक हैं, जिन्होंने "प्रेमाश्रम" में जमींदारी उन्मूलन की बात कही है।

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स्वाधीनता आन्दोलन के दौरान ही राष्ट्र जैसी अवधारणा का जन्म हुआ। दुनिया के तमाम औपनिवेशिक देशों में राष्ट्रवाद का सीधा संबंध स्वाधीनता आन्दोलनों से रहा है। श्री सुरेन्द्रनाथ बनर्जी ने "ए नेशन इन मेकिंग" में भारत के राष्ट्र बनने की प्रक्रिया का पहली बार जिक्र किया है। उसके बाद से भारतीय राष्ट्र की अवधारणा पर काफी बहस हुई है। रणधीर सिंह ने अपने एक व्याख्यान में, जो कि "हंस" पत्रिका के नवम्बर 1999 में प्रकाशित है, इस बहस को एक नवीन धरातल दिया है। भारतीय राष्ट्रवाद के विषय में रणधीर सिंह कहते हैं – "भारत में 1947 के पहले का राष्ट्रवाद वास्तव में प्रगतिशील था, वह एक अलग, ज्यादा प्रगतिशील वर्गीय नेतृत्व और कार्यक्रम के तहत था। वह ज्यादा रेडिकल और क्रान्तिकारी भी हो सकता था। वह प्रगतिशील इसलिए था, क्योंकि इसका उद्देश्य साम्राज्यवाद के भीतर ठहरे हुए भारतीय समाज के बुनियादी ढाँचागत अन्तर्विरोध को हल करना था।"<sup>11</sup> यहाँ प्रेमचन्द को याद करना प्रासंगिक है। उन्होंने भी राष्ट्रीयता पर इस दृष्टि से विचार किया है। 30 अक्टूबर 1933 को उन्होंने अपनी एक टिप्पणी में लिखा— "जागा हुआ राष्ट्र कभी अपने को गुलामी की दशा में रखना बर्दाश्त नहीं कर सकता।"<sup>12</sup> और जब कोई जगेगा तो राष्ट्रीयता का मतलब भी समझेगा। उन्होंने फिर 4 दिसम्बर 1933 को लिखा— "कोई जाति सदैव आश्रित बनकर नहीं रह सकती। शिक्षा के साथ उसका स्वाभिमान भी जागृत होगा और वह राष्ट्रीयता का महत्व समझेगी।"<sup>13</sup> प्रेमचन्द के इस कथन को समझने के बाद यह स्पष्ट हो जाता है कि उनकी राष्ट्रीयता सिर्फ उपनिवेशवाद के विरोध तक ही सीमित न थी। वे राष्ट्रीयता का एक व्यापक अर्थ लेकर चल रहे थे। जब उन्हें अपने समय में विकसित हो रहे राष्ट्रवाद की नियत पर संदेह हुआ तब उन्होंने लिखा था – "राष्ट्रीयता वर्तमान युग का कोढ़ है, उसी प्रकार जैसे मध्यकालीन युग का कोढ़ साम्प्रदायिकता थी। नतीजा दोनों का एक ही है। साम्प्रदायिकता अपने घेरे के अन्दर पूर्ण शान्ति और सुख का राज्य स्थापित कर देना चाहती थी, मगर उस घेरे के बाहर जो संसार था, उसको नोचने-खसोटने में उसे जरा भी मानसिक क्लेश न होता था। राष्ट्रीयता भी अपने परिमित क्षेत्र के अन्दर रामराज्य का आयोजन करती है। उस क्षेत्र से बाहर का संसार उसका शत्रु है।"<sup>14</sup> यह संकीर्ण राष्ट्रवाद था, जिसकी वे आलोचना कर रहे थे।

अपने वैचारिक राष्ट्रवाद के विषय में उनका कहना था— "और हम जिस राष्ट्रीयता का स्वप्न देख रहे हैं, उसमें तो जन्मगत वर्णों की गन्ध तक न होगी। वह हमारे श्रमिकों और किसानों का साम्राज्य होगा, जिसमें न कोई ब्राह्मण होगा, न हरिजन; न कायस्थ, न क्षत्रिय; उसमें सभी भारतीवासी होंगे, सभी ब्राह्मण होंगे या सभी हरिजन होंगे।"<sup>15</sup> प्रेमचन्द साम्प्रदायिकता को बहुत सतर्क और वस्तुनिष्ठ ढंग से देखते थे। उन्होंने फरवरी 1929 को मुंशी दयानारायण निगम को "कर्बला" नाटक के विषय में एक पत्र में लिखा था— "इसका यकीन रखिए मैंने एहतराम कहीं नजर-अन्दाज नहीं होने दिया है। एक-एक लफ्ज पर इस बात का ख्याल रखा है कि मुसलमानों के मजहबी एहसासात को सदमा न पहुंचे। मकसद पोलिटिकल है, बादमी एतहाद को बढ़ाना है और कुछ नहीं।"<sup>16</sup> प्रेमचन्द ने अपनी कहानियों "जिहाद", "हिंसा परमो धर्मः", "मुक्तिधन" और "पंच परमेश्वर" में साम्प्रदायिकता के चित्रण के साथ ही हिंदू-मुस्लिम एकता को भी चित्रित किया है। इस एकता के लिए उन्होंने प्रयास भी बहुत किया। 26 अक्टूबर 1932 को साम्प्रदायिकता और राष्ट्र के विषय में उन्होंने लिखा— "ईश्वर से हमारी यही प्रार्थना है कि हिन्दू-मुस्लिम समझौता सफल हो और भारत एक राष्ट्र और एकात्मा होकर अपने अभ्युदय के पथ पर अग्रसर हो।"<sup>17</sup>

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दलित-वंचित जीवन और स्त्री-समस्या भारतीय समाज की ज्वलंत सच्चाइयां हैं। स्वाधीनता आन्दोलन के दौरान ये दोनों समाज कैसी स्थिति-परिस्थिति में थे और स्वाधीनता आन्दोलन से इनका क्या रिश्ता था, इसकी जाँच के लिए प्रेमचन्द का कथा साहित्य एक प्रमुख आधार है। "ठाकुर का कुआँ", "सद्गति", "दूध का दाम" और "कफन" जैसी कहानियों तथा "गोदान" एवं "कर्मभूमि" आदि उपन्यासों में प्रेमचंद ने दलित समाज की समस्याओं को उठाया है और उसे मुक्ति आंदोलन से जोड़ा है। इसी प्रकार "कुसुम", "जीवन का शाप", "महातीर्थ", "घासवाली", "बेटों वाली विधवा" और "शांति" जैसी कहानियों तथा "निर्मला", "सेवादसदन", "गोदान", "गबन" और "कर्मभूमि" आदि उपन्यासों में स्त्री-जीवन और स्त्री-समस्याओं को चित्रित करते हुए उन्होंने स्वाधीनता के एक बड़े अर्थ के साथ जोड़ा है। "कर्मभूमि" में तो स्त्रियाँ उपनिवेशवाद के विरुद्ध स्वाधीनता आन्दोलन में भाग लेती हैं और कहीं न कहीं सामन्तवाद को एक जोरदार धक्का देती हैं। आज इतिहास की सबाल्टर्न व्याख्या इन हाशिए के पात्रों द्वारा अपने समय के समाज की व्याख्या प्रस्तुत करती है। इस प्रकार हम पाते हैं कि प्रेमचन्द का कथा साहित्य इतिहास दृष्टि-निर्मित करने में महत्वपूर्ण भूमिका निभाता है।

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प्रेमचंद हिन्दी के ऐसे पहले लेखक थे जिन्होंने वर्ण व्यवस्था और जमींदारी व्यवस्था को समूल नष्ट करने का प्रस्ताव किया। वे पहले ही लेखक थे जिन्होंने पति की सम्पत्ति में पत्नी के अधिकार का पक्ष लिया। वे स्त्री-पुरुष संबंधों में बराबरी के पक्षधर थे। जाहिर है, ये तमाम कारण हैं जिनकी वजह से प्रेमचंद को बार-बार पढ़ा जाना चाहिए।

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