Innovation Workshop

November 27-30, 2013
Mallya Aditi International School, Bangalore
A cubicle stands in the middle of the room. The cubicle has three chambers with sand on the floor. The cubicle is lit from above. Each chamber is connected to the viewer's cubicle with one-way reflective glass separating them. The other walls of each chamber are lined with mirrors. The entrance has thick velvet black curtains.

The viewer walks into a room of installations. In the middle of the room is a large black box with a curtained entrance on one side. The viewer may expect a small installation inside the box, because of the tangibility of its external dimensions, but finds, upon entering, that it is actually an illusion of the sense of space where he perceives a large, seemingly infinite desert within the small space he enters. This play on the viewers’ sense of space aims to cast an illusion on his or her psyche and lead him or her to understand the magnitude of the paradox of having an infinite space within a finite space on his state of mind.

### Events

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In November 2013 the exploration and convergence of Science, Art and Technology found new expression via workshops and exhibitions aimed at Classes 9-11, across a wide spectrum of Bangalore schools representing different curricula and socio-economic strata. The workshops focused on involving, inspiring and transforming these curious minds with an experiential and interactive approach.

Mallya Aditi International School (MAIS) won an International Call for papers to set up their Illusion - Infinite Desert at Science Gallery, Dublin in the month of August 2013. A group of six students and two teachers not only set up their installation merging physics and art but were given the opportunity to participate in a week-long series of workshops run by scientists from Trinity College Dublin.

It was decided to run a similar workshop here in Bangalore in partnership with Science Gallery International (SGI) and Trinity College Dublin (TCD). Government of Karnataka generously stepped in to support the same and the result culminated in a 4-day workshop at Mallya Aditi International School, Bangalore between November 27, 2013 - November 30, 2013.

The methodology involved hands on experiential learning, listening to and interacting with scientists, artists, academicians and technologists. A series of lec-dems were held in the mornings starting at 9.00 am followed by hands on sessions until 5.00 pm. It was possible to lean on Science Gallery International and its partners such as NIMHANS and NCBS and garner Aditi’s parent community. Prominent researchers delivered lectures and key note addresses to the students on themes connected with illusions.

The themes of ‘Illusion’ and ‘Synthetic biology’ were chosen; within illusion - light and sound which lend themselves more easily to the creation of illusion and within synthetic biology, the creation of clones of transformed bacteria.

FIAT LUX
The world of light and optics which is filled with illusions was the focus of the Physics workshop. The things we see, colors we perceive, mirages we conjure, all are part of day-to-day illusions. The physics behind light was explored at the FIAT LUX Light Lab and application of the same in science and art using new technologies of the future was explored.

SOUNDSCAPE
Sound as a medium which is widely used for its illusory effects was the focus of the SOUNDSCAPE Sound Lab. This captured the excitement of creating hands-on Foley soundtracks that film and television productions mandate - and delve deep into every audible nuance of an actor’s movement and the art and technology that goes into recreating and making it sound better.

BioBITS synthesising New Bacteria
Through cloning, tweaking genes and other procedures, synthetic biology has explored the possibility of changing the way energy is created, food produced, how diseases are detected and also how they are cured. At the BioBITS Lab, students got a hands-on experience of genetic modification of E.coli by inserting chosen genes using plasmids as vectors and cloning the modified organisms.

Highlights
A conscious move from STEM (science, technology, engineering and math) to STEAM (science, technology, engineering, art and math). One-on-one interactions with real time scientists and artists involved in cutting edge research and practice. A focus on peer-to-peer learning, that fostered activity-based experiments. Inquiry-based learning which led to self discovery and exploration. Collaborative and challenging projects that developed teamwork and project management skills. Interdisciplinary integration of curricular subjects. Simulation of out-of-the-box thinking across boundaries that leveraged new forms of creativity and socio-economic innovation. Inculcation of cooperation and respect in order to dissolve the divide between the urban and rural, privileged and underprivileged schools. Lunch and snacks provided. No fee charged for registration or participation. Students ferried across from common pick-up and drop-off points daily.
Department of IT & BT, DST – Government of Karnataka

The State Government, created the Department of Information Technology and Biotechnology with the objective of promoting the growth of Information Technology (IT) and Biotechnology (BT) Industries in the State. Later, Department of Science and Technology (DST) also came to be attached to this department in the year 2003-04 and the Department was accordingly renamed as the Department of Information Technology, Biotechnology and Science & Technology. The Department of Science and Technology is the nodal agency for the government of Karnataka and responsible for formulation of acts, policy and guidelines for development of Science and Technology in the State. DST is also involved in coordination and extending necessary support for implementation of various science and technological activities of DST are being implemented through five subsidiary organizations namely – Karnataka State Council for Science and Technology (KSCST), Karnataka State Natural Disaster Monitoring Center (KSNDMC), Karnataka Science and Technology Academy (KSTA), Karnataka Rajya Vijnana Parishath (KRVP) and Jawaharlal Nehru Planetarium (JNP).

Global Science Gallery Network was officially launched by Science Gallery International in 2012 with the support of Google.org and aims to incorporate eight university-linked Science Gallery nodes worldwide by 2020, engaging an audience of 2-4 million local visitors annually. Their mission is to ignite creativity and discovery where science and art collide, through the development of an international network of science engagement activities inspiring young adults through exhibitions, educational workshops, training programmes and public events.

Trinity College Dublin

Trinity College builds on its four-hundred-year-old tradition of scholarship to confirm its position as one of the great universities of the world, providing a liberal environment where independence of thought is highly valued and where staff and students are nurtured as individuals and are encouraged to achieve their full potential. Trinity has expanded over the centuries to become a modern university with some 15,600 students and 3,700 staff. It is now one of the great universities of the world, widely recognized for the high quality of its graduates, the international standing of its research and scholarship, and the value it places on contributing to Irish society and the wider world.

Mallya Aditi International School

Mallya Aditi International School founded in 1984 by a pioneering group of committed teachers and parents, remains true to its values and to the continuous development of its core competence: teaching and learning. The school strives to create a learning environment that is child centered, international in perspective, engaging, active and critical, its ways of working are democratic and decentralized.

Science Gallery International

Trinity College Dublin established Science Gallery International (SGI) in 2012 with the aim of creating a global network of Science Gallery locations in partnership with leading universities and research centres in key urban locations. Led by Dr Michael John Gorman, Founding Director of Science Gallery Dublin (SGD), Science Gallery International is a registered charity headquartered in Dublin. The

BrainSTARS

BrainSTARS is a Bengaluru-based organisation dedicated to fostering and nurturing the movement of Science, Maths and Skills education in India. It bridges the gap between the formal education sector and innovative educational research by continuously exploring the requirements of contemporary Science, Maths and Skills education. Highly qualified, trained and sensitive facilitators are the backbone of the organization. Children are encouraged to create their own knowledge with information provided at home, school and the larger environment.

Aristogene

Aristogene is an organization founded in the year 2006 by a group of scientists with extensive industrial experience in the areas of biotechnology. From Bacterial Identification Service, Protein expression in E.coli and purification and custom monoclonal antibody development service, they provide customized services to pharmaceutical and biotechnology majors, on a strong platform of confidentiality and intellectual property protection. They offer custom designed experiential sessions in cutting edge areas of genetics and microbiology to students with the aim of inspiring and exciting an interest in the life sciences, especially genetics and microbiology.
The Innovation Workshop from Nov 27th–30th was an offshoot of this earlier engagement of Mallya Aditi International School, Trinity College Dublin and Science Gallery International. It was conceived to bring the same experience to a larger cross-section of students crossing socio-economic and curricular boundaries in Bangalore.

During the first week of August 2013, six students of grades 10 to 12, from the Mallya Aditi International School in Bangalore accompanied by two teachers, embarked upon a trip to Science Gallery Dublin to set up their installation - ‘Infinite Desert’ in the summer exhibition - ‘Illusions’. The students were Abhyankar Panth, Rajat Nair, Pranika Kar, Dhruva Gowda Storz, Neha Bhalchandra and Meghana Singh and their two teachers Balakrishnan V. P and Geeta Paul. The school’s proposal was selected through an international call for papers.
Participating Schools

Canadian International School
Sarala Birla Academy
Clarence High School
Peoples’ Trust School
Delhi Public School-East
Delhi Public School-North
Vidyashilp Academy
Inventure Academy
Indira Gandhi International Academy
Mallya Aditi International School

Government Kannada High School, Hebbal (Agastya Foundation partner school)

Government Kannada High School, Yelahanka (Agastya Foundation partner school)

Gear International School
The Innovation Workshop took off to a smooth start with the inaugural event. Luminaries from the world of contemporary Science and Technology from Trinity College Dublin and Science Gallery International and the Principal Secretary of the Department of IT/BT, Science and Technology, Government of Karnataka addressed the gathering on the bright, crisp November morning with over 50 students from across schools in Bangalore. Faculty and MAIS students listened with rapt attention and enthusiasm at the venue - the amphitheatre at Mallya Aditi International School.
The session commenced with the Principal of Mallya Aditi Mr. Sathish Jayarajan extending a warm welcome to the faculty and participating students from various schools across Bangalore as well as the distinguished guests present for the inaugural event. He said, “Mallya Aditi International School is proud and honoured to be organising this Innovation Workshop in association with Science Gallery Dublin, Trinity College Dublin, and the Government of Karnataka’s Department of Science and Technology. Partly inspired by the visit of a group of our students and faculty to Science Gallery Dublin, this workshop gives a diverse group of students, from different schools in Bengaluru, opportunities for creative and exciting explorations at the intersection of science and the arts. Over four days, these students will engage in hands-on projects which will emphasise collaboration, engagement and active learning. The workshop highlights our school’s commitment to working with like-minded partners to create an art and science exploration hub for our city.”

Mr. Srivatsa Krishna, Principal Secretary - Department of IT/BT, Science and Technology, Government of Karnataka congratulated the team and emphasised the importance of collaborative teaching and the benefit of interdisciplinary learning for students. He talked about how important it was to introduce students to the creative arts while maintaining the pursuit of science bringing in a new educational dimension to the classroom and a great way to teach in-depth science in today’s holistic space. He hoped that Bangalore would become the home for the collision of Science, Innovation, Art and Technology with accessibility for the common man to evoke scientific temper and curiosity in Karnataka. He said it was critical for India to maintain its advantage in the domain of the pure Sciences, yet adapt our skill sets for the evolving global market-place.

Dr Michael John Gorman, Founding Director and CEO, Science Gallery Dublin said, “The Science Gallery philosophy is all about the creative collisions that happen when art and science collide, leading to new insights and innovations. This workshop, exploring the theme of ILLUSION and how the senses can be deceived, is a great example. Both, in the Summer Innovation workshop held in Dublin and the ILLUSION workshop in Bangalore we have been blown away by the creativity of the students and their ability to combine scientific rigour with artistic intuition. We are truly excited about the potential for establishing a Science Gallery in Bangalore as part of the Global Science Gallery Network, involving leading universities in key cities around the world in engaging young adults with the creative and transformative potential of science, technology and the arts.”
Finally, Professor Clive Williams, Dean of the Faculty of Engineering, Mathematics and Science of TCD addressed the gathering with a short but crisp speech on the relevance of the merging of Science and Art today in an interdisciplinary manner.

A key presence at the inaugural event was Kalpana Kar, donning several caps as Aditi parent, member of the South Asia Board for Trinity College and member of the Steering Committee for Science Gallery Bangalore – who has been the tour de force in bringing the diverse elements of the Innovation Workshop together.

The Ambassador of Ireland to India, H.E. Feilim McLaughlin, released a statement, welcoming the initiative, describing it as a highly innovative collaboration which brings together the best in Indian and Irish artistic and scientific endeavour. ‘The intersection of art and science has inspired many of the world’s finest minds over the centuries and I am delighted to see Trinity College involved in this initiative,’ he said. ‘When the Science Gallery at Trinity opened in Dublin it revolutionised the way that the public thought about and engaged with the sciences. The fact that Trinity, with the support of the Government of Karnataka, has now brought this interactive experience to Bangalore will allow the Science Gallery experience to be shared by many thousands of people here in India. Trinity has developed strong links with educational institutions in the country and this initiative is a good example of their innovative approach to building those relationships, drawing on centuries of heritage in the arts and sciences.’

Post the inaugural event, the dignitaries along with the audience dispersed to view the illusion installations on the MAIS campus. These included the ones that played with the brain’s perception of depth as in the crane lent by Agastya Foundation, the eye’s ability to form images and those using software technology to fool the senses. This was marked by a lot of fun and excited exclamations of surprise and wonder by the participants – amazed at the science behind the same.
Lecture Series

It is this series of stellar talks and free flowing interactions highlighted by a one-on-one dialogue that brought fresh perspectives of the scientists to the participants in simple layman language using illustrations and examples that they could all relate to. The merger of art and science was enabled by nudging and enthusing the participants to focus on the big picture that struck them during the science activities. The elements of curiosity, personalized reactions and the images it conjured were brought in during the artists’ talk. The installations and the work on Day 4 was a huge tribute to the assimilation of ideas and the safe open dialogue these interactions provided.

As was expected, these sessions were very special, not only to the students, but also to the speakers. They all expressed a huge satisfaction at the end of the sessions at the enthusiastic response of the students and the multitude of questions they raised. Most importantly, what stood out was the ability of the participants to connect the talks and the discussions that ensued from these connections.

Lectures were held throughout the workshop with the aim of students interacting on a one-on-one level with scientists, artists, academicians and fore-runners in technology. Here we drew upon existing partners of Mallya Aditi International School, Trinity College Dublin and Science Gallery Dublin.

Throughout the duration of the workshop, participants were addressed by subject matter experts via interactive lectures with an “exposure and ignite your mind” session featuring scientists and practitioners like Dr. Joseph Roche (Astrophysicist), Dr. Mukund Thattai (Biologist), Dr. Sriraghavan (Physicist), Dr. Anand Anandkumar (Chip specialist), Balakrishnan V. P (Artist), Dr. Sanjeev Jain (Neuroscientist) and Dr Sumantra Chattarji (Neuroscientist).
Lecture 1
Dr Joseph Roche (SGD)

The Marvel of Astrophysics

“What is the relationship between Albert Einstein and Astronomy? Is there only one universe? What is light made of? And what exactly is dark matter?” These were some of the questions that were posed to Dr. Roche as he addressed the participants gathered eagerly for his lecture – on Day 1 of the Innovation Workshop at MAIS.

The participants were in awe at the sheer vastness of space that was a key highlight of Dr. Roche’s address – every measurement calculating distance or time of any element outside of our atmosphere – runs into a numeral followed by endless zeros. This was supported by colourful and vibrant images of deep space – nebulas spanning 20 billion light years. Also, the students were given a preview into the latest technology advancements into global satellite telescopes, satellite probes, etc. That the beginning of our universe as we know it – started with the death of a star.

He fielded questions and responded to every one of the queries shot at him, showcasing his tremendous subject matter expertise and intellectual prowess – demonstrating the vastness of science, his passion for the subject and very subtly egged on each participant to embark on a journey of discovery of the magnificence of the physical world through scientific inquiry.

When asked for his observations on the group of participating students, Dr. Roche said that he found the group extremely intelligent and quick on the uptake. “Thank you for your curious questions and I would encourage you to keep them coming”, he said as he wrapped up his cracker of a session at the Innovation Workshop.

Lecture 2
Dr. Mukund Thattai (NCBS)

DNA as a Recipe of Life

Key proposition of the lecture – DNA as a Recipe of Life

Dr. Mukund Thattai, biologist and a scientist at the National Centre for Biological Sciences (NCBS), and a strong supporter of the convergence of Science and Art spoke about the origin of life on this planet. He elaborated on the biological ‘recipe book’, our very own DNA, which brings humans alive – much to the delight and seemingly endless curiosity of the young participants.

He wove a captivating spell on the students via his gripping presentation and videos on the most complex cell structures in the body. An audiovisual, animated documentary was played on the structure and working of the cell – that helped the participants understand and infer how optimum efficiency principles in function and structure (inherent to the natural intelligence of any single cell) can render an overarching benefit to all aspects of life itself. The students could infer that as in the microcosm the single cell is designed to function as a universe within itself – where each component has a definite and specific function and set of tasks to carry out in context to the overall smooth functioning of the organism – so also in the macrocosm, every entity functions similarly. In other words – form and function of the tiny cell bears a striking resemblance to the structure and functioning of the vast universe.

He fielded diverse questions and responded to each one patiently, steering the interactive session to those enquiries only that fall outside the curriculum and textbooks – making the session truly invaluable for the students.

“Biology has complex terms like meiosis, mitosis, mitochondria, etc, but what is important are the concepts and the willingness to learn”, said Dr. Thattai as he wound up his inspiring talk. He further invited the students to his state-of-the-art research lab at NCBS at the end of his session.
Lecture 1
Dr. Sriraghavan (BrainSTARS)

Key Proposition of the session – Light and the Universe

Dr. Sriraghavan’s lecture provided a different perspective about light to the students other than the conventional textbook concepts. The ideas like day and night, sundogs and zodiacal light, shadows and eclipses, energy of light and our ability to see and capture the effects of light, along with the astronomers’ view of the universe through various types of light. The origin of light was also discussed as part of the evolution of the universe.

Students were definitely surprised at the effects of light like the sundogs and zodiacal light and one could sense their curiosity and enthusiasm to know more by their rapid-fire questions such as “was the day first or the night” as well as “how do we take photos of the stars and galaxies” and also “how does the sun compare with other stars” were a few samples of questions that participants directed at Dr. Sriraghavan.

He found the curiosity and energy of the students was very encouraging throughout the lecture and said that questions like “is the sun the brightest star when compared to others” was indeed the best question of the day.

Lecture 2
Dr. Anand Anandkumar (CELLWORKS)

Key proposition of the session – The impact of biology on the world at large

Dr. Anandkumar’s address was received with much enthusiasm – where he started off eliciting responses from the students as to what they thought were the most compelling problems the world faced today – students narrowed the problems down to 4 in number – health, food, environment and energy.

Dr. Anandkumar then drew the focus of the students as to how in an interconnected world, all fields in biology and the sciences today lead to these very same areas. He shared that at the cutting edge of research and development in the field of biology – scientists are deploying genetically modified bacteria which can be used to clear up oil spills, PCBs, radioactive waste, mercury and gasoline. The students were amazed that a process called bioremediation (which involves using organisms that either naturally eat contaminants or have been genetically tinkered to program them to consume toxins) are being used to devour the toxic, dead and inert material that currently litters the surface of the Earth. He said, “That this may be a resort that can be used to clean up the environmental messes large scale – and is clearly a step towards a cleaner planet for our children. In terms of renewable sources of energy, genetically modified bacteria can generate large amounts of fuel while also reducing the strain on fossil fuel reserves and reducing the carbon footprint to a considerable extent.”
peeling a layer from it using basic adhesive tape. The students were amazed that such a simple experiment could win one of the premier prizes in science. The question about superconductivity led the group to discussing how superconductors have the potential to solve the world’s energy crisis if we can find a way of making them maintain their superconducting properties at room temperature.

The 45 minute Q & A session concluded with a challenge to the students from Dr. Roche to keep their curiosity and passion for knowledge, so that someday they would be the ones solving the global energy crisis and making the world a better place.

Participants once again displayed their incredible enthusiasm and all-encompassing curiosity by asking questions about worm holes, time travel, parallel dimensions, the speed of light, special relativity, dark matter and superconductivity. These questions led Dr. Roche to explain the theories as we understand them today but also pointed out that these theories are very difficult to test which is why we must only accept them as theories. On the other hand, special relativity and the speed of light are things that can be tested and until we find a way to disprove them we accept them as laws of physics.

The importance of the scientific way of thinking was a discussion that led from the questions. The talk revolved around how science is much more about a way of thinking rather than a body of knowledge (as was first pointed out by the great astrophysicist, Carl Sagan). Dr. Roche discussed with the students how although he loves science there are always parts he struggles with and that they should not be put off if there are parts of science they find difficult to understand.

To emphasize how sometimes the best ideas in science are simple ones, Dr. Roche explained that the 2010 Nobel Prize in Physics was given for the production of graphene - an experiment that involved scribbling on a page with an every-day graphite pencil and then...
Lecture 1
Balakrishnan V. P (Head of Creative Arts, MAIS), Nikita Jain (Artist & Design professional)

Merging Science and Art

Balakrishnan V. P supported by Nikita Jain introduced the merging of science and art to the audience; the idea of presenting scientific concepts and its underlying principles to the audience.

The talk revolved around thinking like an artist and the significance of creating an artist statement; how does one create a statement about a work and most importantly how to create an art work. During this talk, the difference between writing about an art work and writing a leave letter or a note about a scientific experiment was discussed. Participants were guided on how to look at an idea and artwork as an expression and how the thinking process versus the creation process was different from a scientific model.

A presentation of examples of illusion was made and the process of how to translate their ideas into Science + Art Installations was discussed.

During the session, Balakrishnan threw light on visual concepts, ideas of illustration, visual thinking, use of tools such as cutters, assembling various units and materials using tapes and glues, planning, and organizing.

Even though the facilitators were a little apprehensive, the students were open and receptive about the creative process, art and aesthetics, display methods and presentation, scope of merging Art & Science and the spirit and joy of teamwork and sharing.
Workshops
Hands-on & Interactive sessions
Fiat Flux
Bio-Bits
Fiat Lux
Hands-on & Interactive sessions
IMAGING

Exercise 1 - Pupil dilation
Materials Used: Convex lens, mirrors, torch
Observing pupil using a convex lens and mirror with bright and diminished light shining on their eye
Drawing the pupil dilation and explaining the dilation process
Learning: Realization of a daily physiological phenomenon in their own eye.

Exercise 2 - Create your eye
Materials Used: Convex lens, white screen
Given a convex lens and a white screen, participants created an image of a distant object
Explaining which parts of the eye corresponded to the set up and at the distance needed to form a clear image
Learning: Simulating the working of a human organ outside the body and connecting it to basic physics principles.

Exercise 3 - Create an optical instrument
Materials Used: Convex lens, pencils, white screen
With three convex lenses and an object, creating a telescope or a microscope
Explaining the set up used, the instrument it corresponded to and image formation
Learning: An instrument when broken down to the bare minimum, is a set of basic principles in action.

Exercise 4 - With mirrors
Materials Used: Plain mirrors, LASER pointer
Bending light in a semicircular path using a set of plain mirrors and a bright LASER pointer
Explaining the pattern of their chosen path and its underlying principle
Learning: Multiple principles can be used to achieve the same objective. Ability to apply prior knowledge in conducting a specific task

Exercise 5 - With prisms and glass slabs
Materials Used: Prisms, glass slabs, LASER pointer
Bending light in a semicircular fashion using a set of prisms, glass slabs and a bright LASER pointer
Explaining the pattern of their chosen path and its underlying principle
Learning: Multiple principles can be used to achieve the same objective. Ability to apply prior knowledge in conducting a specific task

Exercise 6 - With liquids
Materials Used: Plane mirrors, laser pointer.
Bending light in a semicircular fashion using a set of prisms, glass slabs and a bright LASER pointer
Explaining the pattern of their chosen path and its underlying principle
Learning: Making sense of how and what different kinds of eyes can be and what kind of view they provide if their lens or retina changes. Application of what they learnt through the whole day.

AUDIO-VISUALS: A few videos based on illusion and light shown to lead participants to thinking about how and what they knew about light could be used in different ways.

Images clockwise: Students and facilitators during the session.
Exercise 1 - Creating the Invisibility Box

Materials Used: Innovation Workshop Workbook, Mirrors, KG cardboard, plastic doll, patterned wrapping paper, scissors, glue stick, adhesive tape, cutter

Learning: Designing and executing an existing illusion while explaining its underlying principle.

Exercise 2 - Head in the Box (virtual reality)

A Leap Motion controller was used to create an interactive display of a human skull on a television screen; this could be moved using the movement of hands in space by the viewer. This interface can initiate thoughts on how new technology is built using similar concepts that one comes across every day. The theme of reverse engineering also comes into play.

Images clockwise: Students and facilitators during the session.
24 students
Three work stations
Hands-on activities
Individual or in groups of two/three
Close interaction with facilitator
No one correct answer
Explain the thought process in a logical manner.

Methodology: Short introduction to the evolution of hearing, the physics of sound, and a definition of Foley Sounds - the creation of audio illusions for movie and tv sound.

The hands-on, active learning utilizes the science of hearing and illusion as well as giving students the opportunity to be creative and original.

Exercise 1 - Choosing which sounds to create.
Materials Used: Printed copy of script, pencils/highlighters
Activity: Each team given a separate script to work on.
Team had to go through the script and highlight where they thought a Foley sound should be inserted.
Team had to creatively decide how to make the sounds and then record them.

Exercise 2 - Record the sounds
Materials Used: Several directional microphones, a mixing board and a computer running “Audacity” software.
Activity: Teams recording their sounds as a performance in front of the other teams.
Other teams invited to give constructive feedback on the sounds created.
Audio track recording done by Dasharath Sri- vatsa (MAIS student)
Bio-Bits

Hands-on & Interactive sessions
Exercise 1 - Synthetic Biology followed by cloning.

The BioBITS Session began with a short introduction to Synthetic Biology by Geeta Paul.

Materials Used: Instruments: Centrifuge, UV transilluminator, gel tank, powerpacks, micropipettes, cords.

Re-agents: LB Broth, Media plates, cell lysis buffer, vector, insert, ligase enzyme, gel loading dye, double distilled water, 50X TAE, TE buffer, transformation solution, ethidium bromide, bacterial pellet, 70% ethanol, isopropanol, DNA marker, plasmid DNA, ampicillin, X-gal, agarose.

Apparatus: Vials, tips, vial stand, petri plates, media components, glass spreaders, combs, gloves, cotton, tissue, scoop.

Activities: Training in handling of micropipettes of the following volumes - 20 µl, 200 µl and 1 ml.

Performing ligation (the covalent linking of two ends of DNA using DNA ligase) by adding vector, the insert and the ligase enzyme using micropipettes.

Incubating the ligation mixture overnight. Preparing L.B (luria broth) hard agar.

Sterilizing the media.

Learning: Each student doing hands on work with experimental techniques that they had only heard of in books before!
The BioBITS workshop began with a short introduction to bacterial transformation by Sudha L.

Materials and equipment used: Instruments: Centrifuge, UV transilluminator, gel tank, powerpacks, micropipettes, cords.

Re-agents: LB Broth, Media plates, cell lysis buffer, vector, insert, ligase enzyme, gel loading dye, double distilled water, 50X TAE, TE buffer, transformation solution, ethidium bromide, bacterial pellet, 70% ethanol, isopropanol, DNA marker, plasmid DNA, ampicillin, X-gal, agarose.

Apparatus: Vials, tips, vial stand, petri plates, media components, glass spreaders, combs, gloves, cotton, tissue, scoop.

Activities: Preparation of competent cells
Transformation of ligated mixture and plating by spread plate method
Pouring of media plates
Checking bacteria in different kinds of samples like pond water, distilled water and fingerprints

Learning: Each student doing hands on work with experimental techniques that they had only heard of in books before!

Images clockwise: Students and facilitators during the session.
The first merger session was intended to develop an understanding of visual dynamics of idea and image and elements of illusion.

The session started with a digital presentation of art works as samples for illusion. The visual development and visual dynamics behind each of the works was explained to the students. This was done through a series of images that explained the process behind it and how the illusion was formed. These were primarily based on the principles of chance, visual scope or predictability, and human perception.

Along with the presentation, we brainstormed, discussed the underlying set of processes and its visual development. This included how ideas could be translated to corresponding visuals, the nature and character of imagery, how it could be representational, conceptual, narrative and metaphorical or symbolical.

Brainstorming and planning through sketches or drawing and writing down conceptual as well as structural notes-concept of sketchbook- was introduced to the students.

Though there was some apprehension in the initial stage as the concept of Art-Science merger was new to the students, there was an enthusiastic and active participation from all groups as the sessions progressed.
The sessions began with a set of presentations. Following the presentation, the whole group was re-organized into smaller groups comprising 5 to 6 members.

There were 4 teams each in the area of biology and light and sound.

The team was given 2 to 3 hours to brainstorm and come up with a set of ideas.

Students were specifically asked to not limit the scope or scale of ideas at this stage. It was explained to them that the flow of thought should be allowed freely at first and statistical and functional aspects would be looked at later as a second stage of visual development.

At the end of this session, among the groups who worked in the area of light and sound, 3 groups came with ideas that explored the scope of light and shadow, one explored pure sound and the other group explored the scope of merging sound as well as light and shadow.

Each group presented the ideas to the facilitating team through sketches and written notes. Facilitators helped students to look at materials to use and the scope of the visual as well as the experiential aspects of each idea. After going through each idea, the most effective concept was selected based on the connection with previously learned concepts in physics and biology, the time available to execute the idea and the formal quality.

Groups that worked on the concepts of light and shadow were asked to create a prototype. The sound group was asked to work on materials to test and select resources to create Foley sounds.

In the area of Biology, the actual end result or the artwork was based on the glowing bacteria. The process of introducing a glow into the bacteria was one of the methods the students learned during the first two days of the workshop. This process involved transforming and cloning bacteria to express blue colour. Transformation was done using plasmids as vectors to insert genes. Students understood how to create patterns or drawings while transforming.

Among the 4 groups, one group came up with an idea of transformation of earth through illustration using symbolic images. Another group came up with the idea of a city at night. The third group came up with an idea of a DNA illustration with a sea pirate’s head in caricature style. The fourth group came up with the idea of patterns.

Looking at the ideas and drawings created by the students, facilitators discussed the scope of the element of illusion and how to break the whole visual into a set of Petri dishes, its numbers and size. The pattern created by the fourth group was lacking in aesthetic appeal and looked slightly random. To improve upon this, students were asked to look at more patterns including rangoli. A rangoli expert, the librarian at MAIS was brought in to interact with this group and run a short session on rangoli patterns.

Day three ended with collating students’ sketches for artwork, prototypes and list of materials needed for each piece of art sound installation. Biology students completed the transformation process and the plates were left overnight for bacterial growth.
Materials and Equipment: Materials and equipment included mirrors, one-way mirrors, LASER lights, ultra violet light, LED light strips and pipes, sun board, bowls, plastic, torches, papers, scissors, cutters, KG card board, cloth, ordinary bulbs, battery units, wires, one way and two way switch, cloth, pencil, pen, markers, highlighters, smoke machines, laptops, cameras, small speakers and raw materials for Foley sounds, and equipment for bio processes.

Resources used for Foley sound: cellophane, aluminium foil, wooden twigs and bubble wrap, stapler, disposable plastic cups, coconuts, frozen Romaine lettuce, umbrella, leather or suede gloves, heavy work shoes, heavy books, chains, metal tools - wrenches/levers etc., wood blocks, blank or old CD's, duct tape, plastic bottles, paper, old glass, rubber bands, bells, balloons, door latches, chalk boards, keyboard, clocks, fans or other battery operated gadgets, paper or metal pipes, drills, traditional saw, bouncing balls, dried tree branch or dried leaves and a basin of water.

Learning Involved: Students learned about visual concepts, ideas of illustration, visual thinking, use of tools such as cutters, assembling various units and materials using tapes and glue, planning, and organizing. Above all they learned about the creative process, art and aesthetics, display methods and presentation, scope of merging Art & Science and the spirit and joy of teamwork and sharing.

Key words learned: visual dynamics, brainstorming, lines, shapes, sound, pitch, volume, imagery, illusion, representation, concept/conceptual, narration, and metaphor, symbolic, soundscape, installation, display.

Student groups created structures by cutting paper and assembling various raw materials. They used light resources and paper cutouts, LASER and UV lights, speakers and laptops to create light, sound and shadow while creating visuals and Foley sound-scapes. All structures and visual formation were completed by lunch on the fourth day. Students began the display and installations after lunch. The whole presentation was ready by 4 pm and opened for guests and invitees.
A Train Journey
The installation attempts to simulate the experience of a train journey through the use of shadow and sound. The shadows are created using stencils as well as found objects. The soundscape is recorded using Foley Sounds.
We found ourselves marvelling at the beauty of the glowing bacteria. We experienced the isolation of a miniscule gene, used it to transform a culture of bacteria obtaining a beautiful result perceivable by the naked eye. The links between objects of varying sizes came flashing to us. Our presence in the vast universe was something we realized and exhibited through this project.

Small particles like atoms form bigger things, both living and non-living. Our project shows the interconnection between all things that form the material world. The arrangement of the circular shape is to show that all things are interlinked and even a very big thing, like the Universe, is made up of atoms. Atoms, the smallest particles of matter that exist independently, make up living molecules like DNA, which serve as the basis of life for all living organisms. Atoms also form gases and other chemical substances important for our lives such as land, atmosphere and water, that make up most of the Universe.
The Maze
To challenge visual perception, to reach certain areas of the brain, which trigger emotions, you don’t always see the big picture and sometimes even when things exist you do not see it. The closer you look, the less you see.

We have come up with a maze and the LASER and projections are supposed to make the maze audio-visually challenging. Our inspiration stemmed from daily occurrences such as when you are driving in the car, you turn down the volume when you’re trying to focus on something. Why? Through this maze, we show how the retina of the eye can adapt to even hostile visual and audio environments, for example strobe lights, LASERS etc.
The Dreamwell
The well and the stars seen in it reflects a village experience, something that is common to this group of children. It represents an inherent characteristic of Indian village life.
Valedictory Function
Professor Clive Williams, Dean of the Faculty of Engineering, Mathematics and Science of TCD said, “I’ve noticed between TCD and MAIS, Tata Institute and NCBS there is no shortage of people that are creative and really intelligent and exciting. And I see so many similarities between the group and the countries. It just meshes together naturally.” He then introduced Dr. Sanjeev Jain, Professor of Psychiatry, NIMHANS to take the stage. Dr. Jain’s presentation touched upon illusions of the mind, the perceptions of the real and of illusions. He also shared how NIMHANS is also partnering TCD and SGI in running genetic experiments in Bangalore.

Dr. Jain felt that, “the problem in India is that science learning is bookish in the conventional sense, and even today children are inculcating that. Unless such exposures and interactions are made available on a systemic and sustainable long-term basis, it will be difficult to break the pattern,” he said. So it’s important that these kinds of workshops transcend schools, location, and time in a pretty consistent way.

Dr. Sumantra Chattarji NCBS spoke about the need for experiential learning and said such workshops provide the environment for shared learning experiences – that break the pattern of learning by rote – helping children learn rather than just read their curricular portions.
Ms Kar hoped this workshop is a step in the direction of addressing the integration of Science and Art, she said “being a passionate believer in the integrative orientation to life itself, a natural corollary to this being an interdisciplinary approach to learning and education, one of the main challenges in the contemporary world is the creation of silos of excellence wherein deep vertical specialization happens with focus on the linear and very little understanding or appreciation of the lateral impact of the domain.” On the roadmap ahead, she shared, “we envision that the effort will need to be scaled so that our children have access to the best of resources that are offered anywhere in the world.”

A video capturing the meaningful and wow moments of the four days was played. It is not just the video which will remain etched in the minds of all those that attended but also that it was created in record time by a student, Dasharath Srivatsa of MAIS.

Certificates were distributed to all participants by the Principal of MAIS, Mr. Sathish Jayarajan and Professor Jane Ohlmeyer Vice-President for Global Relations, Trinity College Dublin.

Mr Jayarajan in summing up said “The Innovation Workshop has inspired us! We intend to continue to engage with our partners and with the Mallya Aditi team to create more learning opportunities like this one. The long term plan is to make the school a hub of innovation in Science education!”

Students shared their feedback and learning. With Ms. Geeta Paul delivering the vote of thanks the curtain came down on the truly first-of-its-kind Innovation Workshop at MAIS.
This lab is different; the workshop is different, as it teaches something more than what is in our textbooks. We practically did things rather than reading or listening about DNA and cloning. I made friends at the workshop. I feel happy to come here and learn. I wish it would have been for more days. Mangu Purthy

Nice set-up. Loved the inspiring talk by Dr. Roche and Dr. Mukund. Best was bending light as I love playing around with light. Shreya D Kumar

Extremely educational, helped understand principles taught in school better. Memorable experience. Inspirational speech by Dr. Roche cleared astrophysics doubts. Ruben Jacob

First I never understand the physics today I easily understand the physics. Shilpa L

We got an amazing opportunity to handle different kinds of instruments like pipettes, laminar airflow etc. The teacher taught us the theory in a very interesting and very understandable way. We synthesized a new kind of E. coli. We even checked for bacteria present in various objects such as water, hands, etc. We got to see the cloned bacteria under UV rays which were glowing. Finally we learnt about different steps about isolation of DNA and checked the isolated DNA under UV rays. This session helped us to know various instruments, techniques and measures used in biotechnology. Viveka Sri M

Learnt how to operate delicate devices like micropipette, Learnt how to cooperate with students from other schools, Learnt the easy bits of cloning, Learnt from Dr Joseph many interesting things about outer space. The interaction session was the highlight of the week. In BioBITS too, the learning was once-in-a-lifetime experience, playing with DNA was unbelievable. I thank all the teachers, students and scientists for the lovely time. Rohan James

More than knowledge, I learnt how to tackle and analyze problems. Arvind

Learnt how to think while building things. Sai Krishna

First I thought Physics was very hard. Today I think physics is very easy. Through models and activities I was taught very nicely and easily. Now I like Physics. Shilpa C

Have learnt more today while at the same time it has been enjoyable. Bavinsha
The highlight of the day for me was the fact that I learnt about different ways that sound travels. Also how sound can be created to sound like something else. I also learnt the ways in which people can see objects in different perspectives and angles. I enjoyed a lot today and also learnt a lot of new things. Zia

It was a great experience for me today and I liked the sound recording very much. Thank you all, was very good. Brunda V

One of the things I enjoyed most today about session was building the head on a platter. It was fun and innovative. Even though I am in the Physics group, I really liked the Biology talk that we got to attend. Another highlight of the day was the Foley sounds session although it spoilt the charm of movies by revealing the secret behind movie sound tracks. Aumika

We made a model about mirrors and reflection which was very impressive. The creating and building part was nice because it was something different. And the second motion sensor exercise was cool as well because it was something very different. I had never really wondered about how sounds were made or recorded. Now I will probably see movies or rather hear sounds in movies differently and try to figure out how they were recorded. Shambhavi

It was a great day. I loved the sound class a lot. Making Foley sounds was fun. Sanah Javed

We got an idea of how even sound could be an illusion to our brain and ears. Fantastic! Chandrashekar

We had a great time making an illusion by creating a model. It was interesting to know what are the steps for inventing something. And last was the recording- it was interesting to watch and hear. Rohan Jain

On Day 3, we learnt about isolation of DNA. Finally the gel electrophoresis method was used to see the DNA and RNA fragments. Pranav

Today was very enjoyable because I have learnt a lot by discussing things with people around. Not only today, the days before this was also very enjoyable, performing experiments in which we can improve our knowledge. Shipa S

This workshop was different from any other that I have attended. There were speeches and talks as well as interactive courses. After the workshop I was able to see many of the installations in not just a scientific perspective but an artistic one as well. One of the highlights for us was the Foley sounds workshop. It was very interesting to know what happens behind the scenes in a movie. It was nice to learn the practical application of the basic physics concepts that we learn. Aumika

I liked this workshop. I am really very proud to get this opportunity to learn here. It was wonderful and it was fun to do this. The lab teachers taught us all the experiments very nicely and it will be useful in my higher studies. Sania Firdaus
Core Team
Balakrishnan V. P
Geeta Paul
Kalpana Kar
Sathish Jayarajan

Coordination
Joel Kribairaj
Preeti Sarin

Logistics
Samyukta Muralidhar

Design
Balakrishnan V. P

Photographs
Arun Prasad

Documentation
Kalpana Kar, Geeta Paul

Compiled by
Sangeetha

Facilitators
Dr. Sudha, Jyothi, Dr. Srividya, Manjula (Aristogene)

Dr. Soumya, Jasmeet, Pramukh, Veena (Brainstars)

Nikita Jain (Artist & Design professional)

Curatorial Work
Balakrishnan V. P
We found ourselves marvelling at the beauty of the glowing bacteria. We experienced the isolation of a miniscule gene, used it to transform a culture of bacteria obtaining a beautiful result perceivable by the naked eye. The links between objects of varying sizes came flashing to us. Our presence in the vast universe was something we realized and exhibited through this project.

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