

INNOVATIVE LEARNING IN ARTS EDUCATION AND COMMUNITY-BASED ARTS THROUGH LIFE SCIENCE

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Abstract

This paper aims to demonstrate how life science can be used as a form of educational tool in enhancing innovative learning in arts education and in community-based learning. This paper also explores how trans-disciplinary knowledge can be applied in the artistic learning process through scientific thinking methodologies. This paper is illustrated in four sections.

Section one describes the key attributes that contributed to the creation of Infinite Saree¹ - Infinite Saree Project, Dna Saree, Dna Carnatic, Therukoothu, Movement Workshop, Music Workshop and Bio- Arts Workshop.

Section two introduces the DNA model, which can be applied in the art teaching process through scientific thinking within the teaching principles of: - Imaginative Thinking, Self-Directive Teaching, Materiality Thinking,, Critical Thinking, Mapping of the Language, Heuristic Judgment, Skill-based Knowledge and Knowledge of Continuity.

Section three examines how community-based learning can be applied (practiced?) through research principles such as Collective Thinking, Shared Knowledge and Ownership.

Section four explores how three various disciplines – Life Sciences, Theatre and Visual Arts can be interpreted through trans-disciplinary knowledge within the following research principles: - Systematic Enquiry, Scientific Perspective and Symbolic Representations.

Keywords: Life Sciences, trans-disciplinary studies, Community based learning and DNA teaching principles

INTRODUCTION

Jim Shelton's blog post in the Education Week, states that innovations are ideas and approaches that "shatter the performance expectations of today's status quo; to make a meaningful impact, these new solutions must also 'scale,' that is grow large enough, to serve millions of students and teachers or large

¹ For information on Infinite Saree, please refer to the website www.schandrasekaran.com

portions of specific under-served populations. True educational innovations are those products, processes, strategies and approaches that improve significantly upon the status quo and reach scale." (Shelton, 2011) For Shelton, the concept of innovation brings out new knowledge. Innovation should go beyond classroom teachings, provide new meanings and has to be able to be engaged widely. While we are establishing new teaching strategies to work with students, we are also re-defining our understandings about the creative process. It is within this site of enunciation, the making of the Infinite Saree project was developed through the experiences of individuals that facilitated new understandings about the creative process.

So, innovation in arts education is not only about establishing new teaching strategies, but also how we can transfer those teaching strategies as new knowledge. This sort of thinking is embedded within the collaborations between different individuals interacting with various skills and mixed knowledge. Hence, the experience gained from these skills and knowledge ultimately will serve to stimulate innovative thinking. Here, innovative thinking lies in the making (process) rather than in the seeing.

This paper is divided into four sections. The first section will elaborate how the individual research based workshops used in this production has influenced the Infinite Saree project. The second section will illustrate how the DNA model can be applied to teach art through scientific thinking. The third section will introduce key research principles used when engaged in community-based learning. The final section will explore the complexities that arise during trans-disciplinary studies of Life Science, Theatre and Visual Arts.

1 SECTION

This section illustrates the key attributes that contributed to the creation of Infinite Saree. I have divided these attributes into six aspects:

1.1. Infinite Saree Project

1.1.1. Making of Infinite Saree Project

Infinite Saree project is a theatre production created by the Biological Arts Theatre² (BAT). BAT aimed to initiate new ways of looking at theatre through Life Science, Theatre and Visual Arts. With BAT, I was hoping to strive for the following objectives:

Adopt a research platform that strives for a participatory research methodology with individuals from various fields such as science, engineering, medical, etc

Strive for a broader spectrum to achieve various creative outcomes; rather than one spectrum of creative output

Strive for new meaning in Asian aesthetics through interpreting materials, narrative, location and body

Bring new meaning to contemporary art practice in relation to Asian modernity.

Use of 'systematic enquiry' to translate research principles for the purpose of education and community engagement. (S.Chandrasekaran, 2011)

Through series of research-based workshops, we achieved two main outcomes - DNA Carnatic and DNA Saree. By creating DNA Carnatic and DNA Saree, we have revolutionized the ways of seeing arts through science, and how science is translated in arts. It is within this site of reasoning, that we have been provided with the understanding of how scientific thinking can influence certain fundamental concepts in teaching arts. It is this form of inter- relationship between scientific thinking and teaching arts that brings forth various methods of pedagogical skills in this paper.

1.2. DNA Carnatic

1.2.1. Concept of DNA Carnatic

In the making of the Infinite Saree, the musical script was produced by converting DNA sequence from a Cynobacteria³ (Fig.4) with reference to Carnatic music (South Indian Classical Music). During the workshop with the musicians, the formation of DNA Carnatic is developed by assigning musical notes to specific DNA base pairs as indicated in the below.

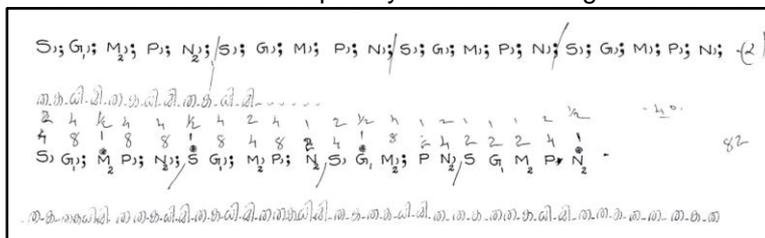
DNA Sequence of Cynobacteria and Musical Note

² Biological Arts Theatre (BAT) is a practice-led research platform founded by Dr.S.Chandrasekaran.

³ A group of photosynthetic bacteria (phylum cyanobacteria) containing a blue photosynthetic pigment named blue-green algae.

DNA Base Pairs	AA	A T	AG	AC	T T	T A	TG	TC	CC	CG	CT	CA	GG	GC	GT	G A
Musical Note	C	C #	D	D#	E	F	F#	G	G#	A	A#	B	C	E	G	B

DNA Carnatic musical developed by musician through the Harmonium⁴



When DNA sequence of Cyanobacteria was translated into Indian musical note, it was interpreted to Amla tala (Amla in Sanskrit means ‘acid’). This creation is probably one of the first of its kind in the world of South Indian music created through Life Science.

Underlying concept of Carnatic Music

The origins of Indian classical music can be traced back to the Vedic ages⁵. Saranga Deva’s Sangita Ratnakara (13th century A.D) was considered to be the earliest record available on the theory of music. Also valuable contributions made by Saints such as Sri Purandaradasa (15th century A.D), Sri Thyagaraja and Sri Shyama Sastri (18th century A.D) have left a legacy of composition.

The key emphasis in Carnatic music is the vocal music, which is constructed by four key foundations of composition – *sruti* (musical pitch), *swara* (musical sound of a single note) *raga* (melody) and *tala* (rhythm). The creation of DNA Carnatic from carnatic music achieved new interpretations of Indian music.

1.3. DNA Saree

1.3.1. Concept of DNA Saree

The infinite Saree project narrative was adopted from the story of Mahabharatha (footnote). Duryodhana, a king, commands his younger brother Dushasana to disrobe Draupadi, the wife of the Pandavas. As Dushasana unwraps layers of her saree, it keeps ‘unfolding’ in a never-ending infinite manner. Draupadi stayed fully clothed, whilst continually being disrobed by Dushasana.

The narrative notion of unfolding and folding (the disrobing process of Draupadi) is translated in a scientific context; where cells are constantly being manufactured to serve life, by dividing and multiplying within multi-cellular organisms. This sort of symbolic relationship between the regenerative notion of cellular replacement and unfolding of Draupadi’s saree inspired us to use the DNA sequence of the Phoenix Palm as the motif for the saree. These motifs were represented by the DNA sequence pattern composed of primary Nucleobases/base pairs - A, T, G and C⁶. Each of these base pairs was assigned to a specific colour. (S.Chandrasekaran, 2011, p. 7)

Each of the DNA bases – A,T, G and C are translated into symbolic colours. (Fig.2)

- A Yellow – colour adapted from ‘Pitambari’ which means ‘brass’
- T Red – vermillion (sign of matrimony)
- G Brown - colour of the tree’s bark Phoenix Palm
- C White - base colour of pure silk

1.3.2. Underlying concept of a Saree

Saree is an Indian woman garment typically layered and wrapped around the waist, with one end draped over the shoulder. In this project we extracted the cells from a tree, Phoenix Palm (Botanical name - Phoenix dactylifera), to create the pattern of the saree (Fig. 3).

⁴ Harmonium is a reed-organ

⁵ The Vedic period (or Vedic age) (ca.1750–500 BCE) was the period in Indian history.

⁶ Building blocks of the DNA double helix

1.4. Therukoothu

Therukoothu is a rural folk art theatre that originated from Tamil Nadu (South India). The system of acting in Therukoothu is organic⁷ and allows one to negotiate its vocabularies to accommodate the contemporary context. In this project, Therukoothu was introduced to interpret the vocabulary of theatre practice in relation to Life Science.

1.5. Movement and Music Workshop (Fig.6)

Movement and Music workshop conducted by Gary Cass, Dr.S.Chandrasekaran⁸ and Santha Bhaskar⁹ focused on working with the musicians and dancers for the project. Through this collaboration, we were able to finalizing the movements and melodically rhythms in relation to the DNA Carnatic music created.

1.6. Bio-Arts Workshop (Fig. 7)

Bio- Artworks Workshop was conducted by Gary Cass¹⁰ and Dr.S.Chandrasekaran. The workshop consisted of ten participants coming from various backgrounds. They were taught how to use biological lab techniques when extracting DNA and working with tissue and bacteria cultures. Through this workshop, we were able to visualize the final concept in creating the Infinite Saree in relation to molecular studies.

2 SECTION

In this section, we investigate how scientific thinking is applied in teaching arts for classroom learning and when working with arts groups or non-practitioners (such as engineers, scientist, etc). To understanding this process, I have divided it into three aspects:

They are

DNA Model

Community-Based Learning

Trans-Disciplinary Knowledge

2.1 DNA Model

The DNA model can be applied as an educational tool and how it contributes to classroom teachings. DNA model is a teaching pedagogy strategy that allows teachers to use scientific thinking to teach art. The key objective is to allow scientific thinking to explore new meanings in the art making process.

D (Design) - Artist/student **design** an investigation to record their art making process and observed their actions by seeking for answers, conducting studies and collection of data information.

N (Negotiate) - During the search for answers, it provides artist/student with tools to define problems and **negotiate** their evidence-based outcomes.

A (Analyse) - With evidence-based outcomes, artist/student will be able to **analyse** the various forms of complexities surrounding the art making process.

For DNA model to be applicable within a teaching environment, it has to be developed within the following teaching principles: -

Teaching Principles:

2.1.1 Imaginative thinking

To explore new ideas, the students should be engaged in imaginative thinking processes that allow them to encounter various challenges in their art making process. In this project, the participants were guided when confronted with challenges in finalizing their art works. Despite being guided with scientific reasoning, they were also able to stimulate imaginative thinking. For example, the participants have to learn about DNA functions and properties, and translating this learning into their final artwork encompasses the creative process (Fig.7)

⁷ Not as structured as other forms of theatre.

⁸ Dr.S.Chandrasekaran (myself), Chief Artistic director for the project

⁹ Santha Bhaskar, Artistic director, movement for the project.

¹⁰ Gary Cass , Scientific Director for the project.

2.1.2 Self-Directive Teaching

To create a self-directive teaching methodology, a flexible teaching environment needs to be available for students. In this project, a science laboratory and a dance studio was transformed into teaching environments (Fig.6 and Fig.7). With such teaching space, it creates an environment that facilitates the sharing of ideas among participants in great flexibility. Also, it encourages the participants to be self-directive and independent when resolving problems. During the dialogue with the participants, the instructors allowed them to lead the discussion the problems surrounding the art making process. This sort of self-directive engagements by the participant brings out creative thinking, which goes beyond classroom teaching spaces.

2.1.3 Materiality thinking

The materiality thinking is part of the visual imagery skill that brings forth a clear understanding between the application of tools and usage of materials. Such understanding is achievable only if the artist is able to direct the final outcome in relation to the material rather than the tools used to form it. By thinking with the material, it develops a language associated with the material in relation to the form. In this project, the participants created visual imagery through the use of plant cells, animal tissue and DNA strands taken from their bodily fluid (in this case, they used their saliva) seen microscopically. As most of them were not trained in the science field, they were focused on artistic imagery seen under the microscope rather than the application of the tool (microscope) when visualizing their final outcome (Fig.7). In this sort of relation, the technical intelligence about the tools becomes less importance rather than the use of material to form the final artwork.

2.1.4 Critical thinking

Critical thinking is the key form of knowledge that promotes intellectual skills, motivational stance and as well as acceptance of new knowledge. To engage with critical thinking it involves two cognitive skills – constructive thinking and critical dialogue. In this project, the constructive thinking and critical dialogue is a negotiation process between the student and instructor. During these workshops, the participants were able to engage in critical thinking with the instructors in order to analyze and develop their final artworks.

2.1.5 Mapping of the language

Students are challenged with various forms of metaphors, narratives and theories when discussing concepts. To gain an understanding of the concept, we need to map a language. The mapping of language is attained by observation, through listening to others and the sharing of ideas. In this project, the science laboratory became a site where a series of learning outcomes were implemented. For example: - listening to various forms of scientific thinking in creating the artworks, sharing artistic knowledge resulting in creating new visual imageries, and the learning of various observational skills when dealing with scientific tools. Such form of learning outcomes contribute to the mapping of the language in understanding the participant's concept.

2.1.6 Heuristic Judgment

Heuristic judgment is important in communicating the critical stance that exists between student and the teacher. By articulating concepts, it gives rise to the discussion of how students frame theories and how those theories are relevant in the making of their artwork. In doing so, it is also indicative of how ideas of biasness are framed by students themselves. Teachers' critical stance always provides a different point of view when addressing the students' biasness regarding the framing of concept. This process relates to heuristics judgment.

In this project, the participants were open to various forms of discussions from scientific thinking aspects to artistic reasoning. In examining their concepts, they had to negotiate between artistic reasoning and scientific thinking. The instructors provided different point of views while conversing their concepts and this was reflected by how the participants re-examined their artistic reasoning in relation to scientific thinking. By doing so, it contravene the ideas of biasness that has been framed by the participants. This process identifies with heuristic judgment.

2.1.7 Skill-based Knowledge

Skill-based knowledge ensures that the students have acquired appropriate knowledge in using various tools and materials. Appropriate skill-based knowledge (fundamentally) cultivates good practice among the students. In this project, the instructors taught the participants how to use laboratory tools and equipped them with necessary skills to extract DNA strands before they engaged with final artworks. (Fig.7)

2.1.8 Knowledge of Continuity

The most important aspect of developing new knowledge lies in the sense of continuity between past, present and future outcomes - what has been created, how it has been created and why we are creating for the future. In the Infinite Saree, the narrative of the past (in this case, Mahabharata) becomes a living story for the present. When dealing with the past memories of stories, it is also like bringing back the past stories to a living state. By knowing the past, present and future, we can work on creating a 'new' meaning about the narrative.

3 SECTION

3.1. Community Based Learning

The Infinite Saree project found opportunities for artists to work with community based art groups to engage ideas by seeking, sharing and co-operating at various levels. I introduced three research-based workshops – The Bio-Arts Workshop (Fig.7), Dance Workshop and Music Workshop (Fig.6). The following research principles were applied in working with the community based art groups.

Research Principles:

3.1.1. Collective Thinking

Collective thinking enabled us to develop a platform where we were able to share our differences and similarities. For instance, Gary explained to the musicians how the DNA sequence code is formed and how these codes' pattern can be translated into melodies. As for the musicians, they were keen to share their musical knowledge with Gary. Without doubt, both Gary and the musicians experienced difficulties in decoding the DNA sequence and assigning the most appropriate musical notes to each base pair, but they resolved these complexities as a group. Thus, this sort of shared reasoning is defined as collective thinking.

3.1.2. Shared knowledge

Shared knowledge is an essential component in working with different art groups. In this project, shared knowledge provided a platform that developed artistic ideas at various perspectives. Such a platform brings different individuals to share their individual knowledge and translate them into shared knowledge, thus contributing in the making of the final artworks. Santha Bhaskar, a choreographer was working closely with Gary (scientific director) and myself (artistic director) to develop the sound and movements for the production that complimented each other's artistic directions. Here, we shared our differences in addressing the complexities in the production, which lies between scientific thinking, dance movements and artistic process. The process was focused on identifying the differences between individual understanding of the concept for finalizing the productions. Through a series of discussions of differences, we were able to form common objectives in finalizing the artistic inputs in finalizing the production. In doing so, we are sharing our knowledge to achieve the common objective of finalizing the production. It is within this site of engagement, the concept of shared knowledge is sited.

3.1.3. Ownership

In having ownership over a project, it creates personal interest to be involved in the decision making process. When participants become involved in the decision making process, they develop a vested awareness in building a true sense of "ownership" to the project. Ownership leads to the feeling of respect and responsibilities for the project. In this project, the participants were reminded that they have ownership towards the project. As the artistic director, I ensure that all the participants were updated of their progress of the project through emails and meetings. Also, they were encouraged to email me their ideas about the project at any given time. This sort of openness empowers the participants to have a sense of ownership and commitment towards the project.

4 SECTION

4.1. Trans-disciplinary knowledge

In this project, artistic directors and participants were focused on examining the complexities found within the three different disciplines – Life Science, Theatre, and Visual Arts. To engage with these disciplines, we

evoke new ways of interpreting the art making process, hence forming trans-disciplinary knowledge. The trans-disciplinary knowledge was applied in the workshops below: -

4.1.1. *Movement Workshop and Music Workshop. (Fig.6)*

The main objective was to develop new ways of reading Indian classical notes and forming dance movements through scientific reasoning. I worked closely with Gary Cass and the musician to translate their understanding of musical knowledge into their new understanding of DNA coding systems (Fig.3). During this process, we constantly encountered differences in the language of genetics and Carnatic music. It is through these differences that we try to align the similarities associated with the decoded pattern of the DNA sequence within Indian ragas. We also constantly worked with the dancers to develop new ways of movement that would synchronize with the DNA music created. Such form of working process with the dancers and musicians contributed to the creation of DNA Carnatic for the final production.

4.1.2. *Bio- Arts Workshop (Fig.7)*

The key aim of the workshop was to teach participants to produce their artworks by using such biological science techniques such as extracting DNA and working with animal tissue and bacteria cultures. During the working process, the students were introduced to various understandings and application of scientific tools that served the analyzing purpose of artistic concepts. Such form of sharing of knowledge between disciplines introduced new ways of creating Infinite Saree for the final production.

Overall the working processes gathered through these workshops were integrated within the context of dealing with the three disciplines – Life Sciences, theatre and Visual Arts. To engage with these three disciplines, the process had to be trans-disciplinary in approach. With trans-disciplinary studies, it is composed of knowledge that is structured based on three research principles (Fig.1): -

Systematic Enquiry

Scientific Perspective

Symbolic Representations

With these research principles, we are able to develop clear expectations when resolving the problems that arise whenever we engage with trans-disciplinary studies. Also, the participants were able initiate clear strategies in developing new aesthetics for the project.

Research Principles:

4.1.3. *Systematic Enquiry*

The process of systematic enquiry is to systematically demarcate the key attributes that will be able to contribute to new aesthetic. In this project, the key attributes are 'Disrobing of Draupadi', 'DNA Carnatic' and 'DNA Saree'. These attributes are the fundamental constituents in providing artistic language in relation to other two key research principles – Scientific perspective and symbolic representation.

4.1.4. *Scientific Perspective*

The process of scientific perspective is to introduce the scientific framework that can be applicable to the art making process. The scientific frameworks used in Infinite Saree were multi-cellular properties, DNA Sequence of Cynobacteria and DNA Sequence of Phoenix Palms. Within these frameworks, the participants were able to interpret an artistic process, resultant of the DNA Saree and DNA Carnatic used in this project.

4.1.5. *Symbolic Representation*

The process of symbolic representation elicits the cannons for the artistic process in creating the DNA Saree and DNA Carnatic. In this project, the cannons are 'Ever-ending saree' (Notion of Infinity), 'Earthy Elements' (*Pancha Boothas*¹¹ – Fire, Air, Earth, Wind and Ethereal Space) and 'Living Story' (Draupadi). Through these cannons, the participants were able to explore the differences and similarities identified between scientific thinking and the art making process.

CONCLUSION

In creating DNA Carnatic and DNA Saree, we established new artistic dimensions through the field of trans-disciplinary studies. For the creation of DNA Carnatic, we introduced new *tala*, which opened up boundaries

¹¹ Pancha Boothas is a Sanskrit word for Five Earthly elements

in creating new ragas in Indian music. With DNA Saree, it not only conceals the woman's body, but also reveals how materiality thinking, scientific reasoning and narratives in relation to the body. Through trans-disciplinary knowledge, we were able to redefine the meaning of aesthetics in relation to Life Sciences, Theatre and Visual Arts. In essence, this project has initiated new interpretation of Asian Aesthetics.

This paper has provided researchers, scientists, teachers and students, and including art groups, a new understanding about innovative learning in arts education. Innovation does not only give birth to new idea, but also continually challenges our existing knowledge. For our art education and contemporary art practices in Asia to promote innovative learning, pedagogy and art making process has to be constantly challenged in an unconventional manner.

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Systematic Enquiry	Scientific Perspective	Symbolic Representations
Disrobing of Draupadi	Multi-cellular	Ever-ending saree (Notion of Infinity)
DNA Carnatic	DNA Sequence of Cynobacteria	Earthy Elements (Pancha Boothas – Fire, Air, Earth, Wind and Ethereal Space)
DNA Saree	DNA Sequence of Phoenix Palms	Living Story (Draupadi)

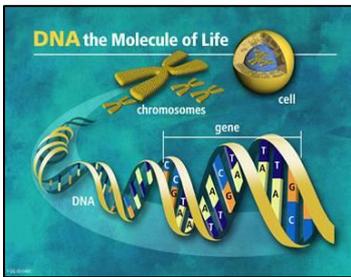
Fig.1 Trans-Disciplinary Studies

	A	Yellow – colour adapted from 'Pitambari' which means 'brass'	
	T	Red – vermilion (sign of matrimony)	
	G	Brown - colour of the tree bark's Phoenix Palm	
	C	White - base colour of pure silk	

Fig.2 DNA Saree Coding Sequence



Fig. 3 DNA Saree Pattern



With the Infinite Saree project, the musical score was translated from the DNA sequence of Cynobacteria with reference to Carnatic music (South Indian Classical Music).

The approach in creating DNA Carnatic was adopted from an Asian perspective. The aim was to localise the creative process and provide new interpretations to Asian music.

Fig.4 DNA Sequence of Cynobacteria

DNA	Musical Code	Note
AA		C
AT		C#
AG		D
AC		D#
TT		E
TA		F
TG		F#
TC		G
CC		G#
CG		A
CT		A#
CA		B
GG		C
GC		E
GT		G
GA		B

T	full note	f
A	1/2 note	h
C	1/4 note	q
-		

DNA Carnatic
 DNA code sequence of *Cyanobacteria* was translated into a particular *tala* and *raga*. *Raga* that emerged is *Soudamini* or *Anada valli*, derived from the 57th *melakartha raga Simhendramadhyama*. This is an *audava raga*, i.e. five notes on *arohana* (ascending scale) and *avarohana* (descending scale).

Arohana: SA GA MA PA NI SA
Avarohana: SA NI PA MA GA SA

The *tala* is of 81 counts, which is not found in Carnatic music. It has been named *Amla tala*. (*Amla* in Sanskrit means 'acid').

This creation is probably one of the first of its kind in the world of South Indian music with Life Sciences.

Fig.5 Indian Carnatic Music



Fig. 6 Movement and Music Workshop, Venue: Bhaskar's Art Academy, Singapore

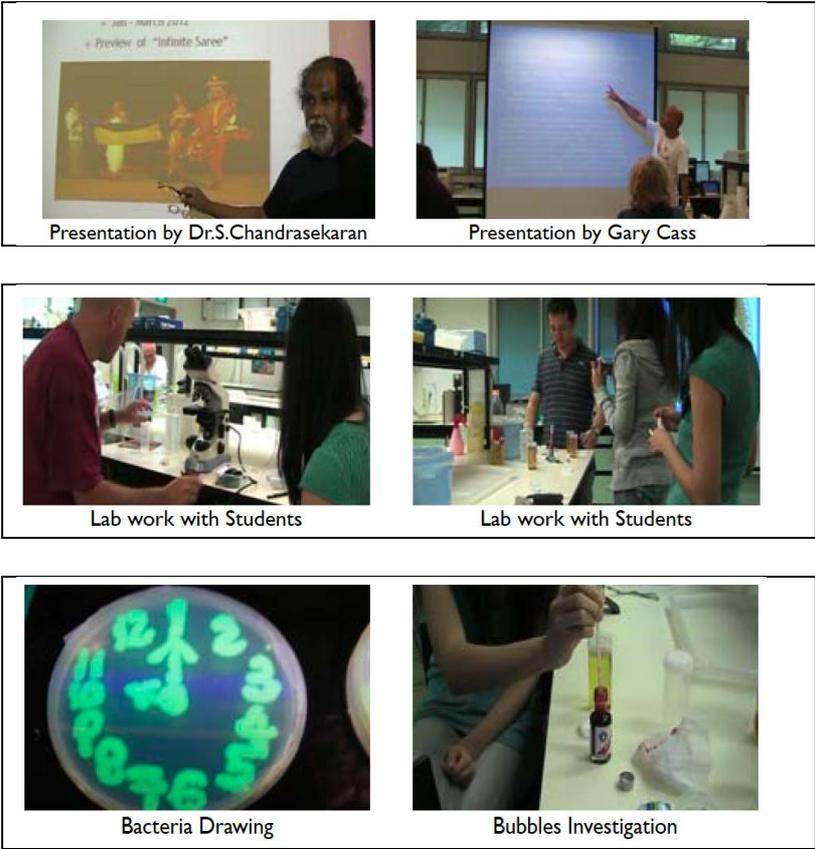


Fig 7 Bio Art Workshop, Venue: PSB Academy, Singapore