

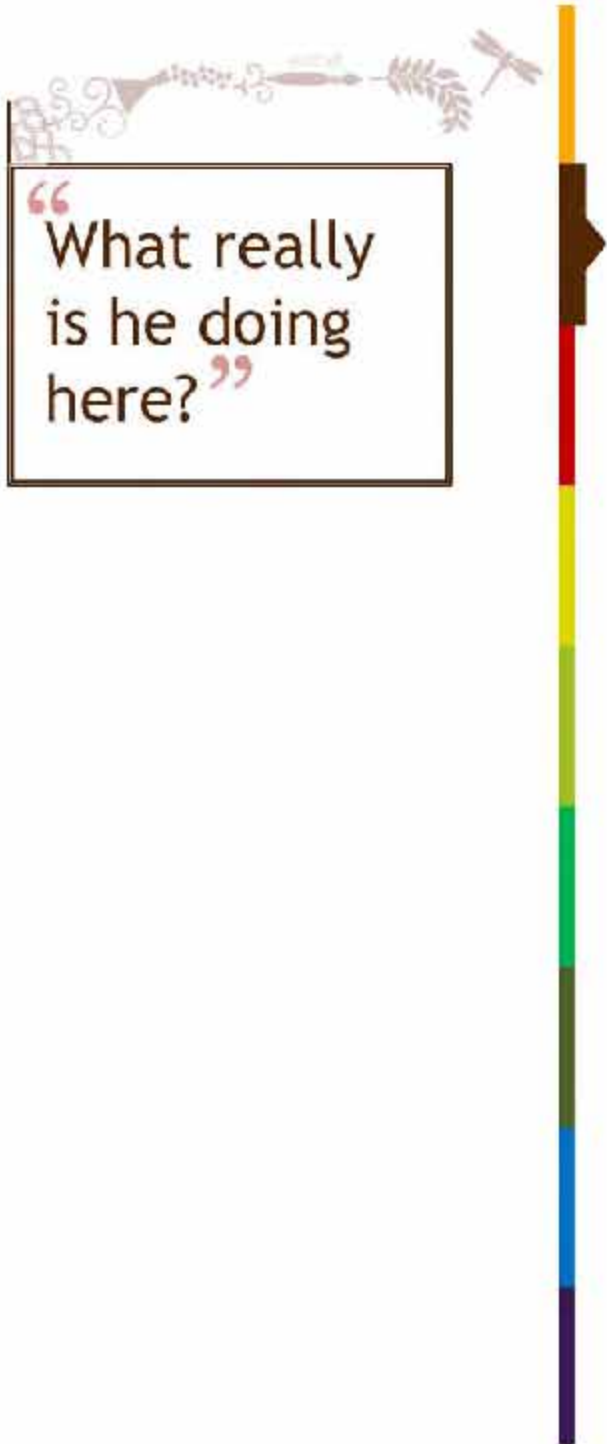
Teaching-Learning Resources in the Indian Context: Yes it's possible!



Tejas Joshi


At the Second
International Conference on
Education in Chemistry (ICEC),
Mumbai, India

December 14, 2014 | 9.50 a.m.



“What really is he doing here?”





“What really
is he doing
here?”

A simple start

2009


A B.Sc. student

Fascinated by
well-illustrated
books and
animations
that made life
simpler

Got selected
into this NIUS
programme



Ta-daa! HBCSE:
**Were there
centres for
Science
Education
too?!**



“What really
is he doing
here?”

A simple start

2009

2010

(struggled)
started a project
on the Biginelli
Multicomponent
reaction

A very different
experience

Opened me up to the world
of Science Education and
it's importance
(and work at HBCSE)

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↑
Attended
the first ICEC

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it's importance
(and work at HBCSE)



Severely stung by
the Chemistry
Education bee!



Attended
the first ICEC



“What really
is he doing
here?”

A simple start

2009

2010

2011

The International
Year of
Chemistry (IYC)

Chemistry was really being
celebrated everywhere!

*And we tried something
in college too*



“What really
is he doing
here?”

A simple start

2009

2010

2011


The International
Year of
Chemistry (IYC)

Chemistry was really being
celebrated everywhere!

*And we tried something
in college too*

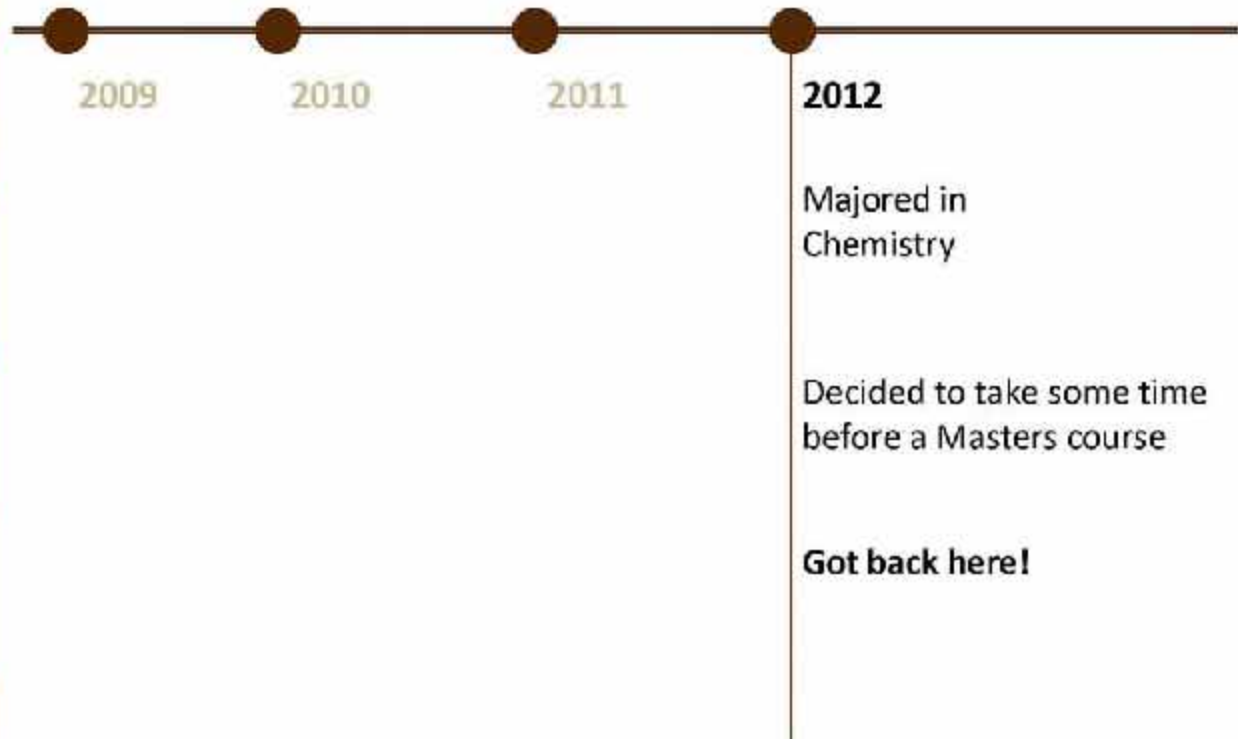



Stung by the
Communication
bee!



“What really
is he doing
here?”

A simple start





“What really
is he doing
here?”

A simple start

2009

2010

2011

2012

Majored in
Chemistry


Decided to take some time
before a Masters course

Got back here!

**This talk describes
the small project we
undertook**



Guess that
'poster' put
up in every
classroom or
laboratory?



That dull thing students dread and refuse to study,
and yet are forced to hang in a corner at home:
*only with the hope that some of the mammoth
data it contains will be retained!*



Guess that
'poster' put
up in every
classroom or
laboratory?

Yes! The periodic table!

That dull thing students dread and refuse to study,
and yet are forced to hang in a corner at home:
*only with the hope that some of the mammoth
data it contains will be retained!*



The starting
point

What we attempted

To enthuse and engage students, specially at high-school, with the periodic table and the elements

To try discussing and portraying the table in a slightly different perspective

To introduce a component of history, yet not be endlessly long

To create some 'resource' that doesn't feel like just another periodic table poster, but feels special and memorable





The starting
point

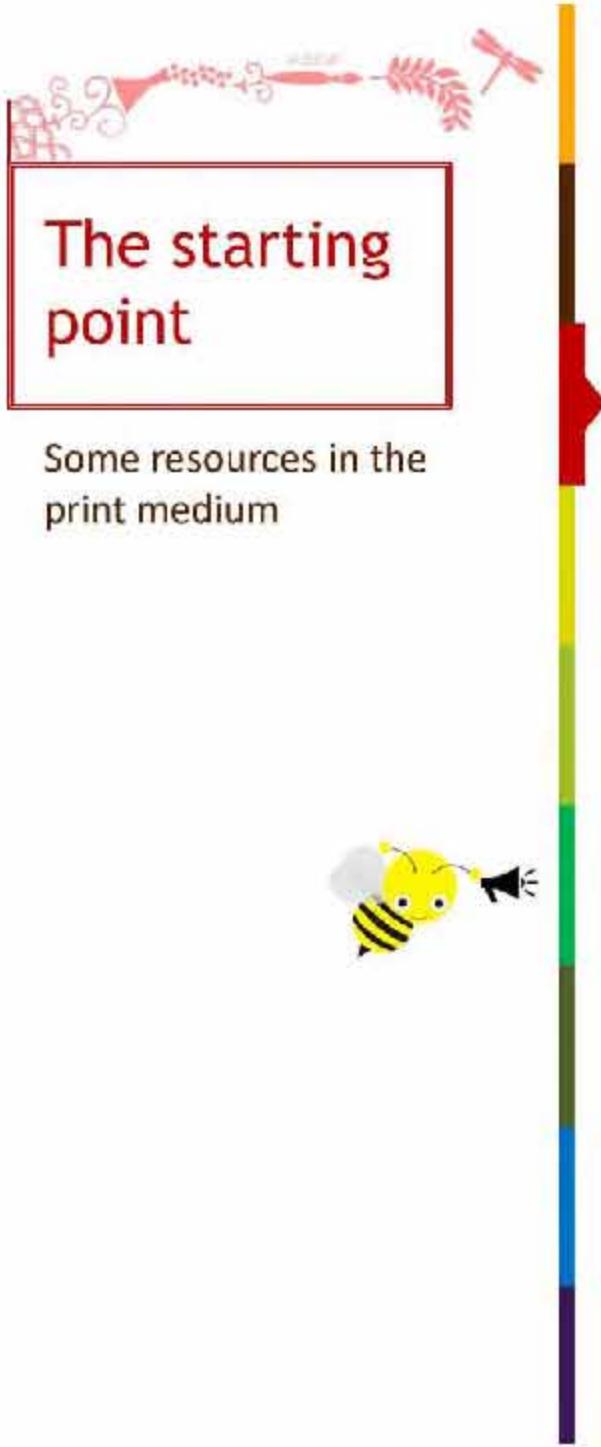
Why we attempted

A frequently re-visited concept from high-school onwards

A beautiful example depicting nature's architecture and human endeavours to decode it, and the corresponding evolution of Chemistry

Students only look at it as a ready-made table, without appreciating its development

They hardly spend time with it (apart from cramming the technical details)



The starting point

Some resources in the print medium

How we attempted

Content of the resources could act as a starting point for the reader to *explore more*

Compact and cost-effective: in the Indian backdrop, without compromising on the content

Visually appealing

Linguistically simplified

June 2013

The first outcome



A folded booklet- 'flyer':
discussing the milestones
in the development of the
periodic table

The first outcome



A folded booklet- '**flyer**':
discussing the milestones
in the development of the
periodic table

The first outcome

Begins with the notions about elements in the ancient times

The rise of experimental science

Introduction to scientists instrumental in this development, and their contribution

Some historical anecdotes

Issues surmounting the discovery of new elements, and their resolution

The first outcome



Opens into a small activity

A folded booklet- 'flyer': discussing the milestones in the development of the periodic table

Begins with the notions about elements in the ancient times

Incorporates some historical anecdotes

Introduces scientists instrumental in this development, and their contribution

The first
outcome

Opens into a small activity

5 ELEMENTS IN OUR DAILY LIFE!

You may have come across **Glass, Soil (Sand), Electronic Chips, Bricks, Pots, Silicones, Semi-conductors**. All of these have one element in common. Can you find the element? What makes it so versatile?

You often hear about **16** elements essential for plants. Which are the different ones used in cooking? Which of them are efficient and why?

Think of the different substances that are used as **fuels in our life**. (Eg. Petrol) Can you list the elements that these fuels are composed of?

Glass is one of the most important materials. And there are so many uses for it. You will be surprised because of different colors. And what elements are used in it? It would be very interesting to know.

Can you identify the elements used in the following? Till today, how many elements are known? Some elements are essential for life.

The first outcome

An incomplete periodic table, with clues and hints that the reader can fill up

Questions from everyday life

After filling the table, some reflection questions on the table

Place to note your own questions

Some resources to refer

Opens into a small activity

5 ELEMENTS IN OUR DAILY LIFE!

You may have come across **Glass, Soil (Sand), Electronic Chips, Bricks, Pots, Silicones, Semi-conductors**. All of these have one element in common. Can you find the element? What makes it so versatile?

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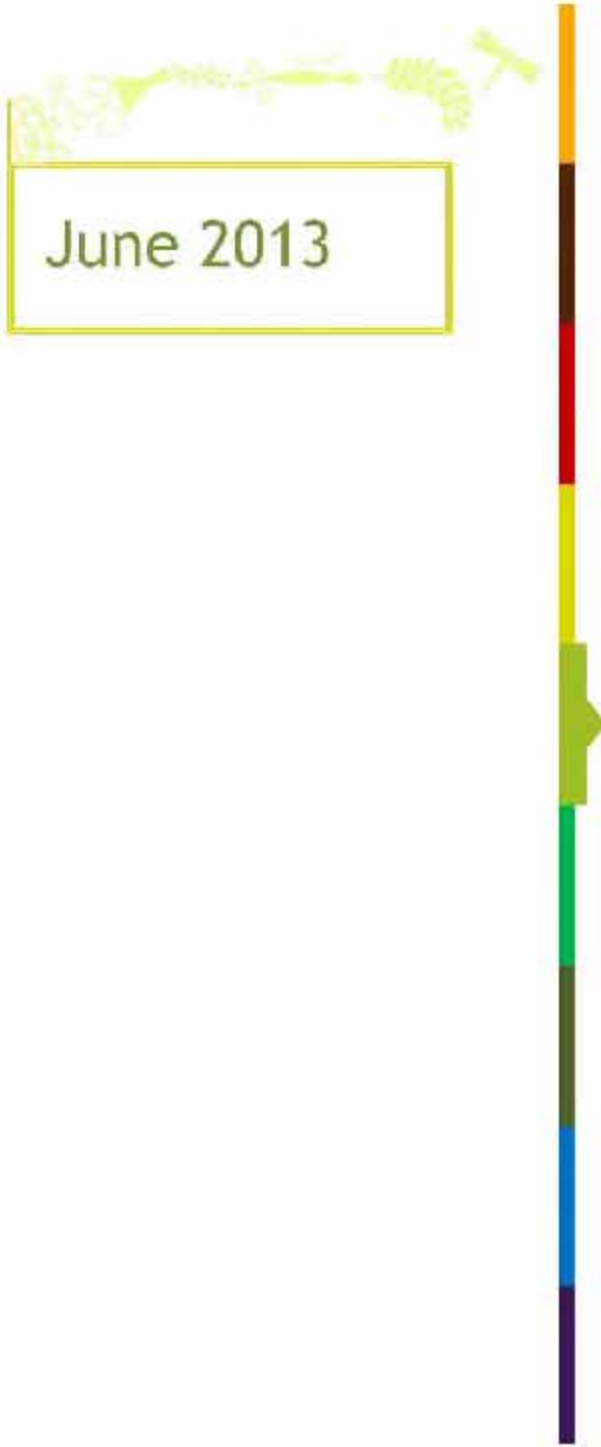
Which are the different cooking? Which of them efficient and why?

Think of the different substances that are used as **fuels in our life**. (Eg. Petrol) Can you list the elements that these fuels are composed of?

Glass is one of the most... And there are so many... it so? You will be surprised because of different co...

And what elements are... It would be very interest...

Can you identify... Till today, how... Some elements...



June 2013

This gave us a direction

Designing the activity in the first flyer led us to explore the elements next

Sept. 2013



The second outcome

A pack of 114 visual cards, one for each element

Sept. 2013



The second outcome

A pack of 114 visual cards, one for each element



Sept. 2013



The second outcome

A pack of 114 visual cards, one for each element



Not the conventional flash cards

Sept. 2013



The second outcome

A pack of 114 visual cards, one for each element



Attempt to introduce elements to the reader in an *atypical* way

The cards

The element introduces itself

Contextualization to everyday life

Color-schemed and illustrated

Front Face

s-block
alkaline earth metal

12 
Mg
24.31

12 
Sir Humphrey Davy

Density
1.74 g/cm³

Light is strong friend

The Car's Friend

Acetate/ Lactate
(10% of Magnesium)

IMAGINE ABOUT 200 ENZYMES IN YOUR BODY. BUT RATE THEIR ACTION IN MY PRESENCE.

Crystal Abundance
23000 ppm

Magic candles that light themselves have your Mg powder into the wick? It requires an O₂ reacts with it!

Magic Candles

Isotopes
Mg-24
79%

Crystal Structure
Hexagonal close packed

MAGNESIUM

At the outset let me tell you that I am present in every thing around you. Each chlorophyll molecule contains me in the center, making me omnipresent! Not just that, I am abundant in the earth's crust and seas as well. In times of war they used me a lot in bombs since I burn real big. With so many applications today, I never feel left out!

The element does the talking!

The cards

Front Face

Open-source photograph of the element

Application based visual tiles

The element does the talking!

The card displays the following information:

- Block:** s-block
- Category:** alkaline earth metal
- Image:** A photograph of a green, crystalline magnesium metal.
- Atomic Number:** 12
- Symbol:** Mg
- Atomic Weight:** 24.31
- Discoverer:** HANS CHRISTIAN ØRSTED
- Discovery Date:** 1808
- Properties:** Density: 1.74 g/cm³; Light is strong metal (e.g. cars, cables); Crystal structure: Face-centered cubic (FCC) of Mg atoms.
- Applications:** Magic candles that light themselves here when Mg powder is put into the wick. It requires an oxidant with air.
- Isotopes:** Mg-24 (79%), Mg-25 (10%), Mg-26 (11%).
- Fun Fact:** IMAGINE ABOUT 200 ENZYMES IN YOUR BODY INITIATE THEIR ACTION IN MY PRESENCE!
- Discovery Story:** Imagine their period.

MAGNESIUM

At the outset let me tell you that I am present in every thing around you. Each chlorophyll molecule contains me in the center, making me omnipresent! Not just that, I am abundant in the earth's crust and seas as well. In times of war they used me a lot in bombs since I burn real big. With so many applications today, I never feel left out!

Discoverer of the element

The cards

Front Face

Open-source
photograph of
the element

Application
based visual
tiles

The element
does the
talking!

Color-code,
block and
category of
element

Discoverer of
the element

The card for Magnesium (Mg) is color-coded in shades of purple and pink. It features a photograph of a magnesium tree at the top left. The card is organized into several sections:

- Header:** s-block, alkaline earth metal
- Element Info:** Atomic number 12, Symbol Mg, Atomic weight 24.31, Element name Magnesium.
- Discoverer:** A portrait of Sir Humphrey Davy.
- Properties:** Density 1.74 g/cm³, Light is strong metal (Fig. 1.4.10, Table 1), Crystal structure (Face-centered cubic), Atomic radius (130 pm), Melting point (923 °C), Boiling point (1363 °C).
- Applications:** Magic candles that light themselves (Mg powder ignites in air), Magic Candles, Magnesium alloys (Mg-24, Mg-26, Mg-28).
- Fun Facts:** "MAGNIFICENT ABOUT 200 ENZYMES IN YOUR BODY INITIATE THEIR ACTION IN MY PRESENCE.", "Magnesium does park!", "At the outset let me tell you that I am present in every thing around you. Each chlorophyll molecule contains me in the center, making me omnipresent! Not just that, I am abundant in the earth's crust and seas as well. In times of war they used me a lot in bombs since I burn real big. With so many applications today, I never feel left out!"

The cards

Front Face

Open-source photograph of the element

Application based visual tiles

Crustal abundance and minerals

The element does the talking!



Color-code, block and category of element

Technical Information: Eg. density, electronic configuration

Discoverer of the element

Natural isotopes

The cards

Back Face

Story of Discovery of the element

Magnesium Mg $\text{44}^\circ\text{C}$ $\text{1201}^\circ\text{C}$ [James Dumas (1808)] s-block 2002 24

It was in 1755 when it was first described - by scientist Joseph Black who proposed that any form of magnesium is different from lime (of our common Calcium). But in fact was an alkali metal (metals), reported by Thomas Berzelius about only years later. Things changed for the better with the advent of electrolysis (by Davy), and that marked my isolation - although qualitatively in 1808, Bussy, a French scientist reacted magnesium with Potassium, as he did for the alkaline earths, and obtained it quantitatively.

How is it produced?
 Magnesium is produced electrolytically by electrolysis. However, the most efficient method of recovering my metal is electrolysis of magnesium chloride.

Major Producers
 1 China (Largest producer)
 2 Russia
 3 Turkey

Important Compounds
 Magnesium Oxide (MgO)
 Magnesium Chloride (MgCl₂) (Mg₂)
 Magnesium Acetate (Mg(CH₃COO)₂)

My Major Applications
 Others in Economics: Aircraft Parts, Hard & Lightweight Alloys, Electronic Appliances, Low-Temp Production Processes.

Oh, is it?
 I've already told you about my presence as part of the chlorophyll molecule, but even in your body, I act as a catalyst to various life-sustaining functions of enzymes to work. Keeping bones strong, and even DNA replication!

Oh, is it?
 I appear very soft, but actually my salt is used as a salt used in steel and cast-iron.

Electrolysis Cell
 $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
 $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$

Reduction of Magnesium Oxide
 $\text{MgO} + \text{Si} \rightarrow \text{Mg} + \text{SiO}_2$

tifr **Netaji Subhas Centre For Science Education**
 Tata Institute of Fundamental Research, Mumbai, India
 V. K. Rajarshi Road, Colaba, Mumbai - 400 007, India
 For feedback, write to: writing@netajicentreforscience.edu.in

The cards

Back Face

Story of
Discovery of
the element

Biology and
environmental
anecdotes

Magnesium $[Mg]$ $44^{\circ}C$ $1300^{\circ}C$ $[Caesium to Barium s-block]$ $[1828]$

It wasn't 1755 when I was first described - by scientist Joseph Black who proposed that my Latin name was different from lime (of my contemporary Calcium). That in turn was my noble interest! (Mendeleev, reported by Thomas Edison about thirty years later. Things changed for the better with the famed process of electrolysis (by Davy), and that method my noblest - although synthetically in 1824, Davy, a French scientist reacted my chloride with Potassium, as he did for my noble brethren, and obtained me quantitatively...

How is it produced?
Samples of me are produced every year, mostly by the electrolysis. A more efficient method of reducing my oxide is being investigated.

Major Producers
1 China (Largest source)
2 Russia
3 Turkey

Important Compounds
Magnesium Oxide (MgO)
Magnesium Chloride Hexahydrate (MgCl₂ · 6H₂O)
Magnesium Acetate (Mg(CH₃COO)₂)

My Major Applications
Others like Biotechnology, Aircraft Parts, Hard & Lightweight Alloys, Recycled Appliances, Low-Temp Production Processes.

Use in IT
I've already told you about my use in systems as part of the microchip technology. But even in your body, I act as a catalyst, processes the useful byproducts of energy to work, keeping you strong, and even DNA replication!

Use in IT
I've already told you about my use in systems as part of the microchip technology. But even in your body, I act as a catalyst, processes the useful byproducts of energy to work, keeping you strong, and even DNA replication!

Use in IT
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tifr **Homi Bhabha Centre For Science Education**
Tata Institute of Fundamental Research, Mumbai, India
Vashishta Institute, Savitribai Phule Pune University, Pune, India
For Feedback, Write To: writing@tifr.res.in

Major
applications/
outlets for
the element

Interesting
tidbits about
the element

The cards

Back Face

Story of Discovery of the element

Production and compounds of the element

Biology and environmental anecdotes

Magnesium $[Mg]$ 12 $6490C$ $1381C$ $[Causes\ to\ form\ ionic\ state]$ s -block 1901

It wasn't 1755 when I was first described - by scientist Joseph Black who proposed that my Latin name is different from that of my contemporary Calcium. That in fact was my relative calcium. **Strontianite**, reported by Thomas Strevi about thirty years later. Things changed for the better with the famed process of electrolysis (by Davy), and that made my isolation - although synthetically in 1824, Berzeliu, a French scientist mixed my chloride with Potassium, as he did for my neighbor Barium, and obtained me quantitatively.

How and produced?
 Magnesium is produced electrolytically by the molten. A more efficient method of reducing my oxide is being developed.

Major Producers
 1 China (Large reserves)
 2 Russia
 3 Turkey

Important Compounds
 Magnesium Oxide (MgO)
 Magnesium Chloride (MgCl₂ · 6H₂O)
 Magnesium Acetate (Mg(CH₃COO)₂)

My Major Applications
 Others like: Electronics, Aircraft Parts, Hard & Lightweight Alloys, Domestic Appliances, Low-Cost Production Processes.

Did you know?
 I've already got you started on my existence as part of the chlorophyll molecule, but even in your body. I act as a catalyst in processes like making hundreds of enzymes to work, keeping bones strong, and even DNA replication!

Did you know?
 I appear to be a noble metal, but actually my sulfate, carbonate and nitrate are not considered noble metal derivatives.

tifr **Homi Bhabha Centre For Science Education**
 Tata Institute of Fundamental Research, Mumbai, India
 Vashi (Navi Mumbai) • Savita Ladage
 For feedback, write to: writing@homi-bhabha.org

Technical Information: Eg. Physical constants, placement in the table

Major applications/outlets for the element

Interesting tidbits about the element

The cards

LET'S MEET THE
CHEMICAL
ELEMENTS!

Start Here!

Welcome! You now have an opportunity to spend more time with the elements of the Periodic Table by the help of this set of visual Flash Cards. But before you begin, make sure you read this how-to-use booklet so that you know what type of information each card contains, and how you can locate it.

What's that Photograph?

A directory of what the photographs depict and their attribution.

In this pack of cards, there are 85 cards which have a photograph of the element, details of which are listed here. For the other 20 elements, the Radioactivity symbol has been depicted, because these elements are never present in a quantity that can be seen by the naked eye and be photographed! We appreciate these photographers/ scientists who have shared their work on the internet as open source material so that the world can have a glimpse of them too! We have incorporated these photographs to share the visual beauty of the elements, and purely for education. We attribute these images entirely to their creators!

Photographs

The box encloses a small 'Start here' booklet and 'What's that photograph?' directory



Jan. 2014

By now...

Doing this part opened us up to an array of resources available in a variety of media

Thus, the need to share and propagate this compilation

Could those who couldn't avail our prepared material still be able to access this?

Sharing this kind of a project



Jan. 2014

By now...

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Could those who couldn't avail our prepared material still be able to access this?

Sharing this kind of a project

The internet could address some of these



March 2014

Exploring the internet medium

Creation of a set of webpages for the project
www.letsmeetthechemicalelements.org



March 2014

Exploring the internet medium

Creation of a set of webpages for the project
www.letsmeetthechemicalelements.org

Acts as a compilation of resources on the periodic table and elements

Describes the project in detail, for a prospective executor

The entire flyer is now available for anyone to read and share on the site (cards to follow)

About the pages



Home

About this portal

The Fascinating Story of the Periodic Table

Let's Meet the Chemical Elements!

Important References and Resources

Contact us

The Homi Bhabha Centre for Science Education

HBCSE  tifr



This portal is the online component of the print resources on the Periodic Table being developed as part of a project. Hope you enjoy browsing the site and don't miss the 'References' section!

2014 | HBCSE, TIFR

Easy to load

Basic HTML and CSS structure

Compact layout to aid mobile devices

A good destination to house a detailed feedback form



Feedback

Students welcomed:

- The visual component
- The way the element 'talked' to them
- For once, Chemistry felt good to hold

- "I never knew that ___ was such an important element"

- "We normally learnt about Dobereiner, Newlands and Mendeleev, but not about other scientists"

- "I didn't get to see all elements, so this idea is nice"
- "I wish our books were so colorful!"


Feedback**Teachers/ Educators said:**

“I really enjoy seeing work in the types of Chemistry Education done internationally. The work you’ve done is really interesting and practically useful”

“Very nice initiative. Would be interested in learning its effectiveness once you have some data”

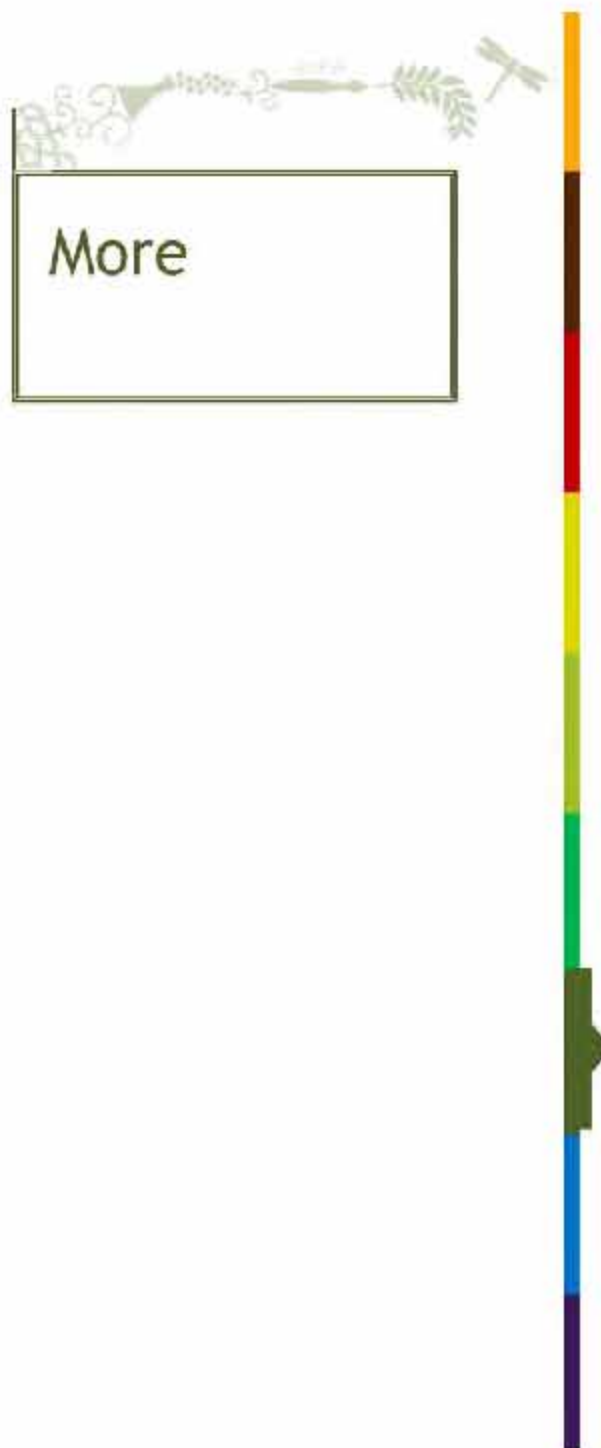
“This work is very well done , and I can see how this will capture the interest of students of all ages. It is a fabulous resource that can have a great impact on student learning”


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“I really enjoy seeing work in the types of Chemistry Education done internationally. The work you’ve done is really interesting and practically useful”

“Very nice initiative. Would be interested in learning its effectiveness once you have some data”

“This work is very well done , and I can see how this will capture the interest of students of all ages. It is a fabulous resource that can have a great impact on student learning”



The project was accepted for presentation at the IUPAC International Conference on Chemistry Education in July 2014 (and a poster award too)

A very encouraging response at the ICCE and BCCE

'Unterricht Chemie', a German journal of Friedlich Verlag included this work in the special issue on the chemical elements (Issue 143, July 2014)




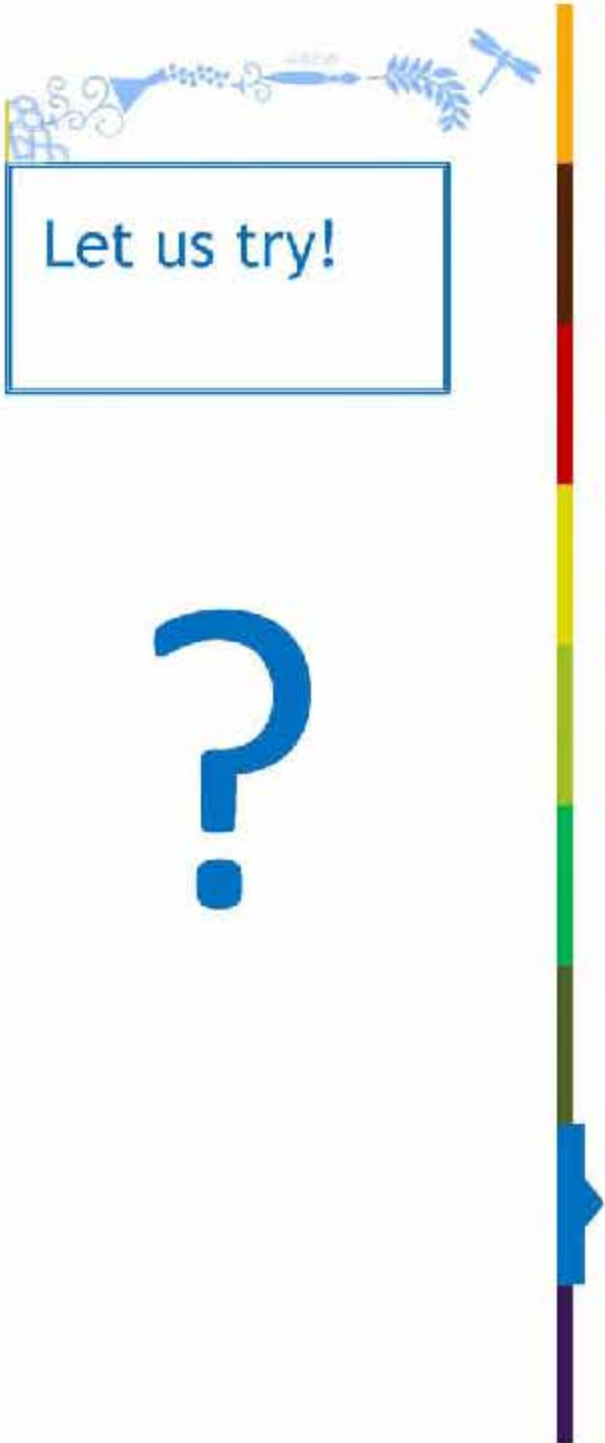
Let us try!

Let's take this project as an example and see how to go about creating any material

Teachers

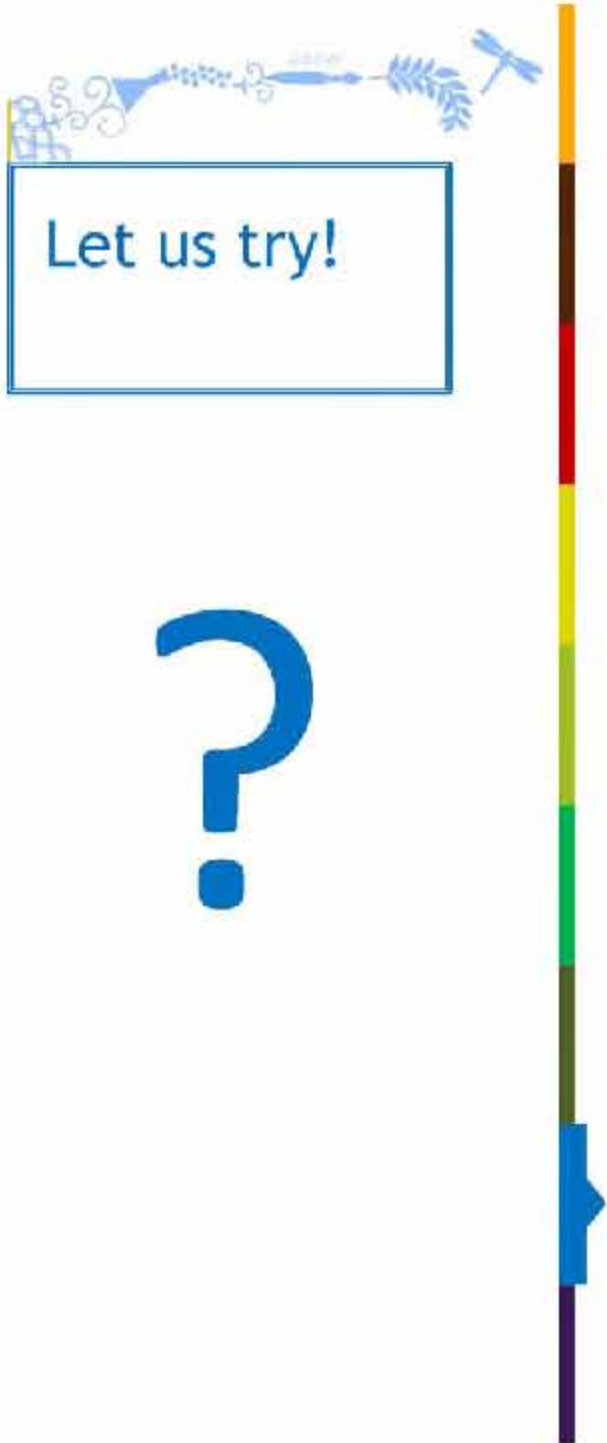
Students





Let us try!

?



The reason

An area of trouble you want to address



Let us try!





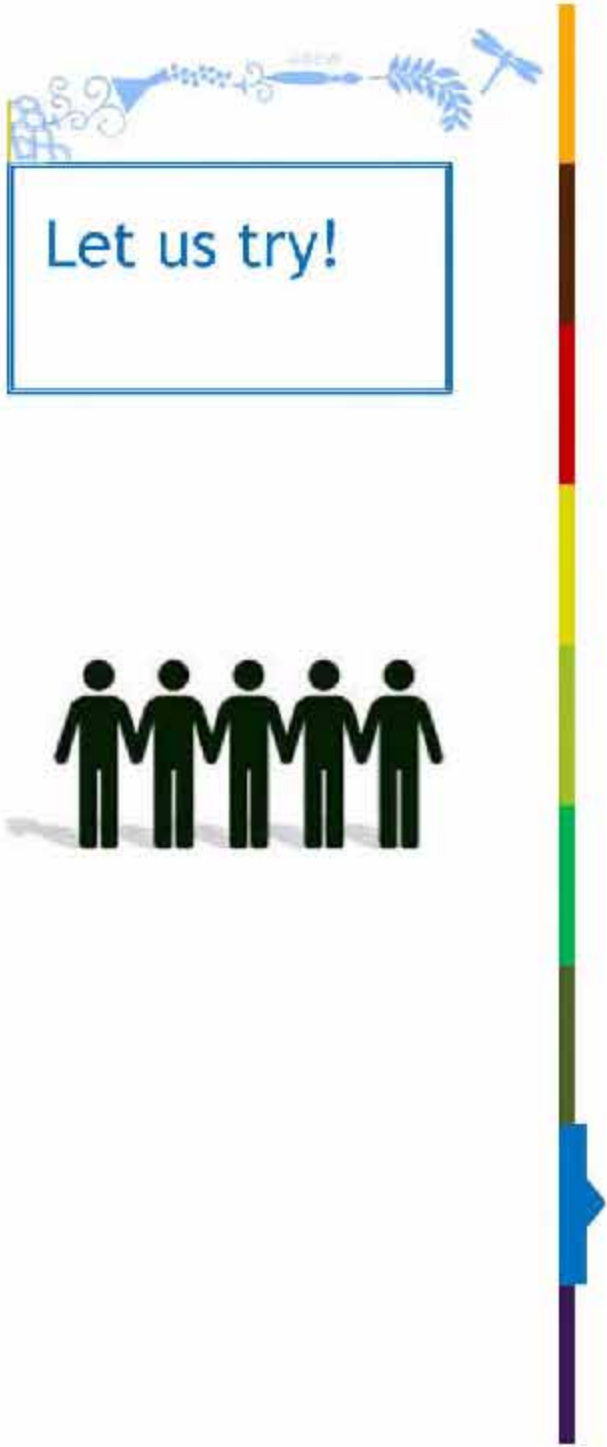
Let us try!



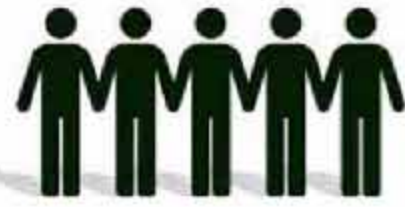
The idea

How you wish to address the issue, what ideas





Let us try!

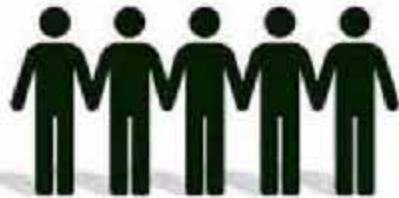




Let us try!

Who all, and for whom?

Alloting the work, deciding the audience





Let us try!



Reviewing what is already there

A great context: helps us decide better

Let us try!



What medium? What form factor?

Or a combination?





Let us try!





Let us try!



Economics

How to manage costs?





Let us try!

Preparing a detailed plan

Every big and small detail





Let us try!



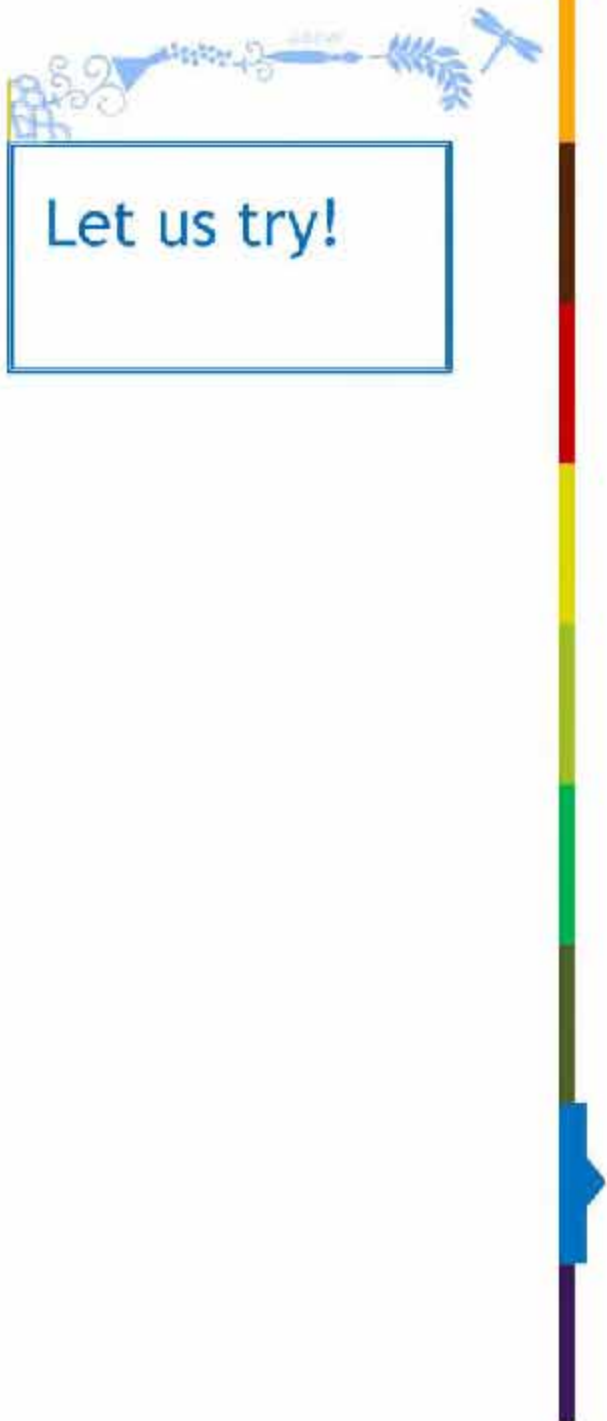


Let us try!



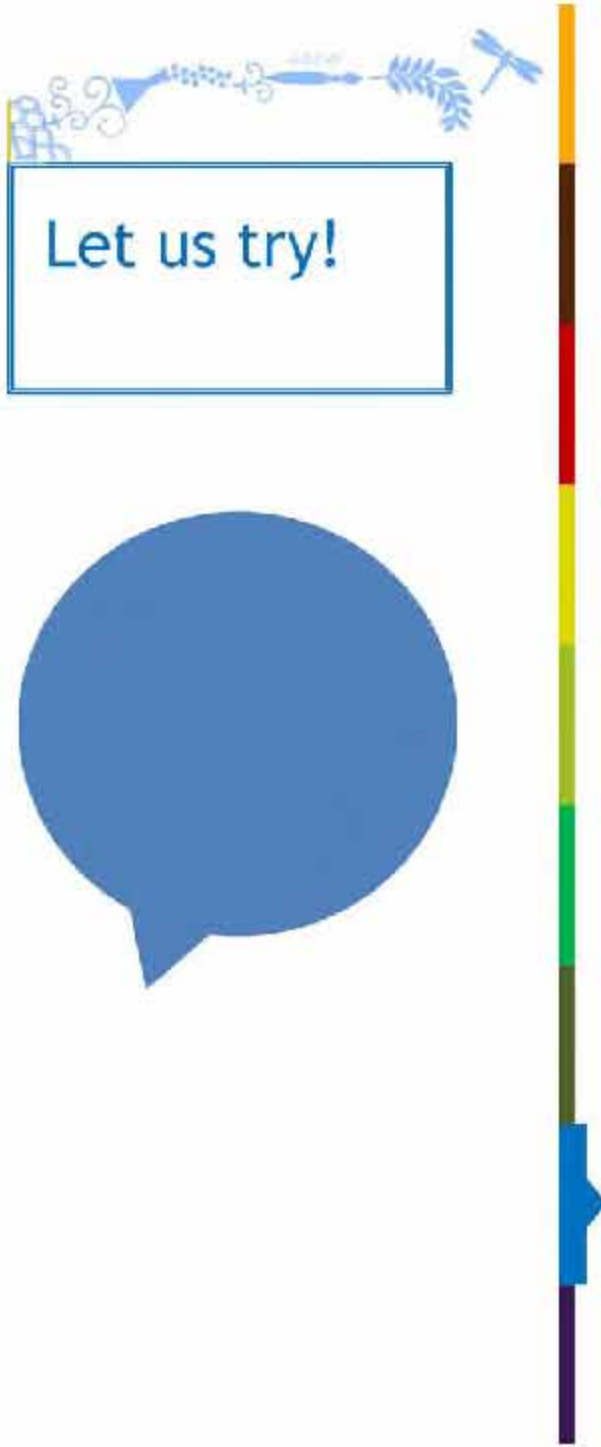
Planning a timeline

How much time can you allot for this? Spaced over what phases?



Preparing the resources

A first draft, finalization, readying the final outcome



Feedback

From experts

From teachers

From students

Outreach



Why?

Place for improvement, always

For our project, for example:

Translation to regional languages

Detailed Feedback form

Writing on more themes

Enhancing availability

Continuous review, tend towards improvisation



Why?

Why do this, really?

For the teacher:

- A rejuvenating and creative experience

- A way to connect and engage with the students

- A means to update knowledge

- A possibility to teach



Why?

Why do this, really?

For the teacher:

- A rejuvenating and creative experience
- A way to connect and engage with the students
- A means to update knowledge
- A possibility to teach

For the student:

- The joy of creation and ownership
- Developing different perspectives
- Understanding the role of Chemistry in their life
- The very important tool of communication
- Satisfaction of the geeky soul
- Makes them responsible



Inspiration

'Nature's Building Blocks' by *John Emsley*

Theodore Gray, and his awesome work on the elements! Photographs, the card deck, and that unbelievable element vault!

Bassam Shakashiri and his rigorous 'Chemical Demonstrations' volumes

The *Royal Society of Chemistry's* 'Learn Chemistry' portal (naturally!)
Resources cannot get more exhaustive than this

The *Journal of Chemical Education*
(Yes I seem to represent that 3 %, Norb!)

Wikipedia- a great example of knowledge sharing

University of Nottingham's Periodicvideos.com

Kevin Dunn's 'Scientific Soapmaking' workshops

Patricia Hill's art-infused workshops- These are mindblowing

The Jmol and ChemCollective project

Arvind Gupta and his extensive collection of resources



Thank You



V.G. Vaze College, Mumbai

Jayashree Ramadas, Chitra Natarajan,
The HBCSE Library,
Tilottama Shirodkar, Vijay Raul,
Madhavi Gaitonde, Sumana Amin, Manoj Nair,
Anjali- Ankita- Sandesh- Seema- Sharayu,
Cosmetic section members

S.K. Patil, Gomathi Shridhar

Hema Printers, Print Vision Thane

Everyone at Human Touch of Chemistry and TCL

S.D. Samant, D.V. Prabhu

Kelly Butler, Julie Henderleiter, Ilka Parchmann

Unforgettable learning

tejasoldifluff@gmail.com