'Small Science' in the classroom: Some observations on curriculum change

Colloquium at the Institute of Mathematical Sciences, Chennai
December 29, 2016.

Jayashree Ramadas
Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
V. N. Purav Marg, Mankhurd, Mumbai 400 088

Homi Bhabha Curriculum for Primary Science

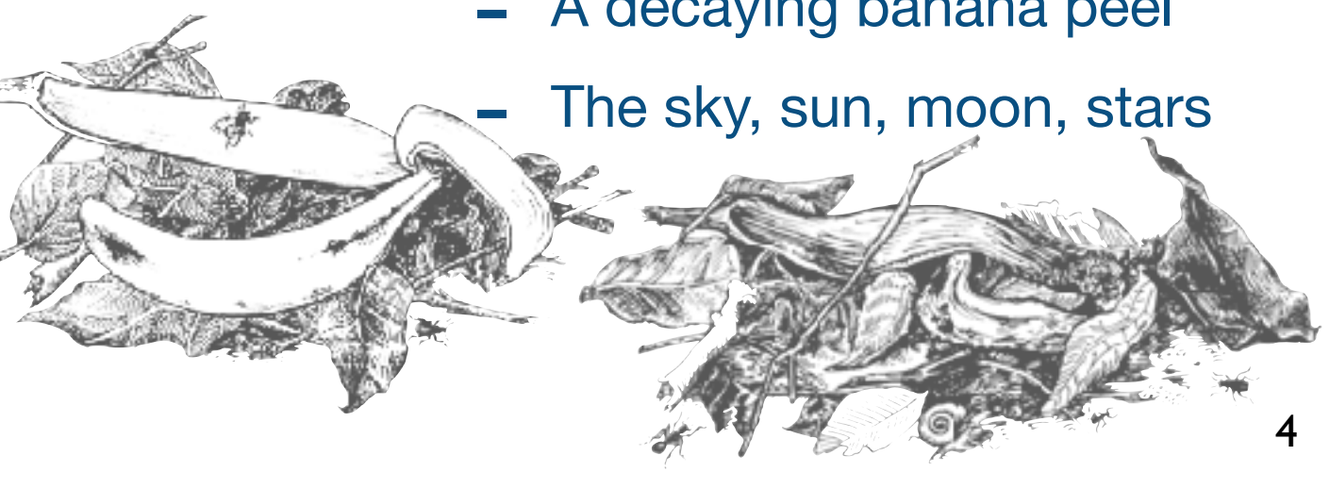
- 'Small Science' for I-V developed during 1998-2004
- Translations
  - हलका फुलका विज्ञान - Halka Phulka Vigyan
  - हलके फुलके विज्ञान - Halke Phulke Vidnyan
  - ہلکی یلقی سائنس - Halki Phulki Science
- English version published by OUP in 2007-12
- Distributed by InOpen 2012-16
- From 2016 distributed by HBCSE

Small Science usage

- Widely used as resource books
- As regular curriculum ~ 3000 students each year
- Max. 10,000 in 14 / 21 States; mostly in English
- Local languages - low feedback
- No follow up or support

The Small Science Approach

- Asking questions, making sense of the natural world
- Organised experiences enhance and enrich life experiences
- Experiences of the natural world
  - NOT a sanitised, idealised, prettified world
  - NOR a far-away, fantastic world (e.g. NatGeo Explorer)
  - But the world in which you live, which you engage with
- Authentic experiences
  - A decaying banana peel
  - The sky, sun, moon, stars



The Small Science Approach

- Engage with the world through observing, drawing, recording, analysing, expressing, discussing, arguing, writing ... communicating with peers
- Tools for learning and thinking:
  - Systematic observation
  - Counting, tabulating, graphing – Quantitative thinking
  - Expressing, describing, writing – Language skills
  - Planning, constructing – Design and engineering

Systematic observations

- Learning through inquiry

Try planting different dals, grains of rice, sago. Do they sprout? Make your own guess why they did not sprout?

3. Watch closely!
Which of the seeds sprouted first? Did you see the tiny root going into the soil? Which plants grew the tallest?

Systematic Observation

- Addressing student's conceptions

Students noticed that the bottle of cold drink got wet on the outside. A few minutes after they wiped the water off, the bottle was wet again!

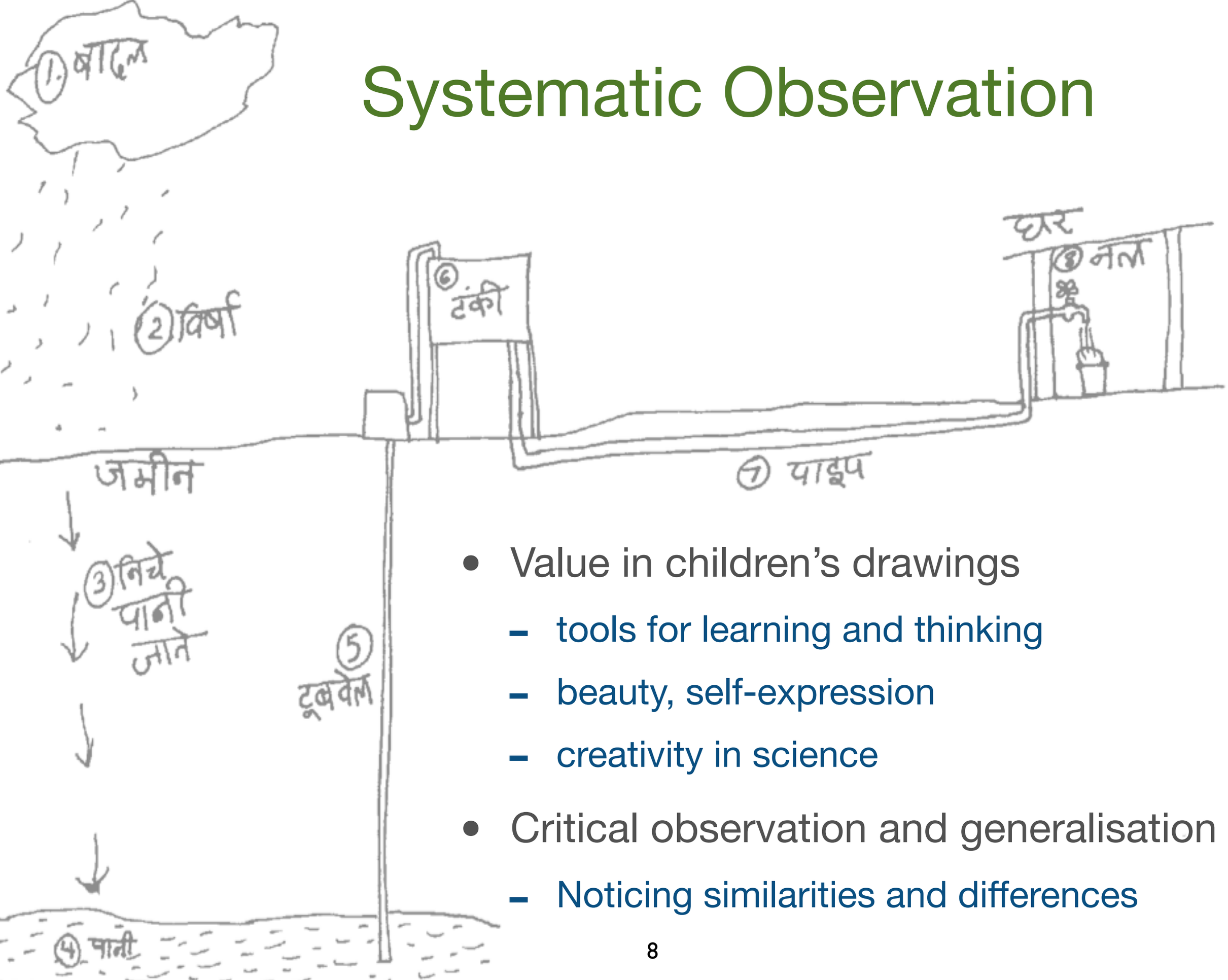
... Most of the students said, "(it is wet) because it is cold." ... Some thought that the water might come from the cold drink. Others disagreed. ... Their arguments:

"The water outside is not sticky like the cold drink."

"There are no holes in the ice-cream cup; it does not leak."

"If there is warm water in the bottle it does not come out. Why should cold water come out?"

Systematic Observation

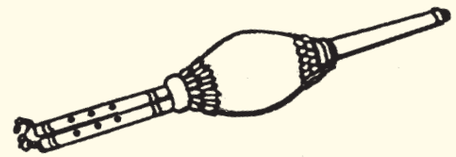


- Value in children's drawings
  - tools for learning and thinking
  - beauty, self-expression
  - creativity in science
- Critical observation and generalisation
  - Noticing similarities and differences

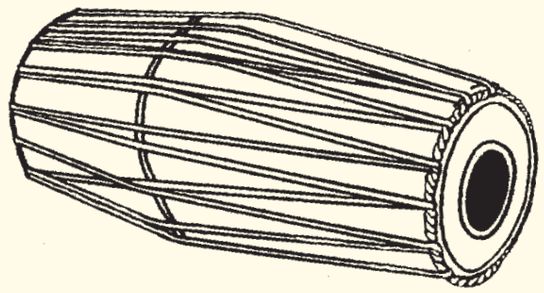
Observation and analysis

Write the name of each musical instrument underneath its picture:

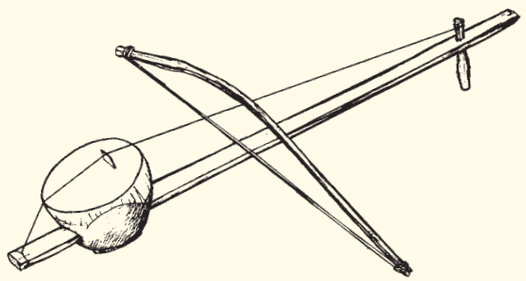
bansuri	ransingha	guitar	veena	chimta	santoor	mridangam
ghatam	sitar	mahudi	shehnai	sarangi	clapper	harmonica
tanpura	ektara	tabla	harmonium			



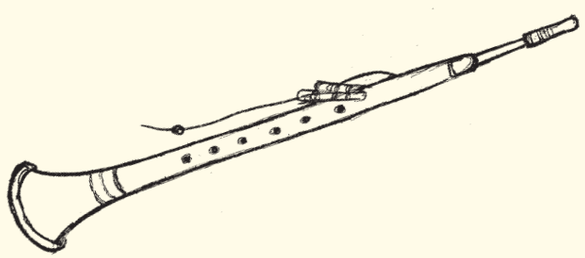
1 .....



2 .....

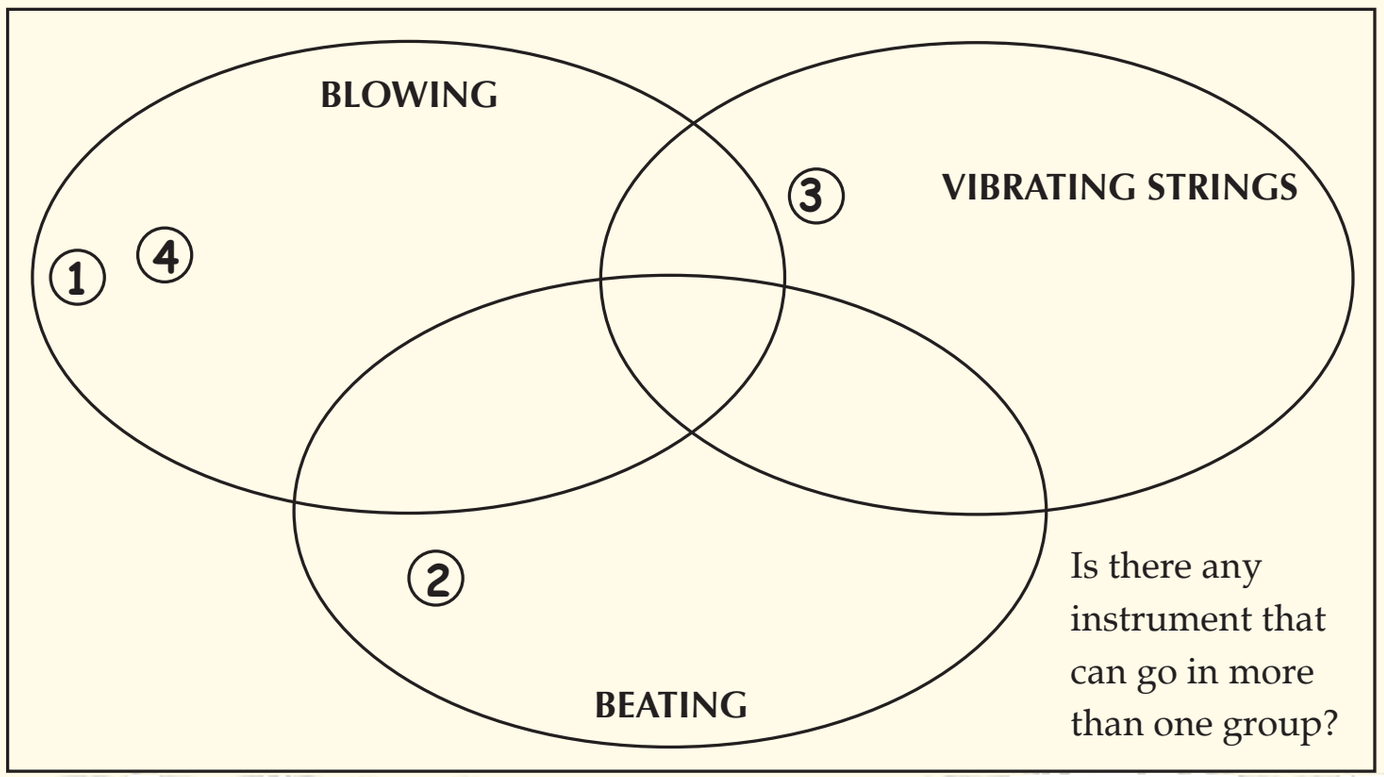


3 .....



4 .....

Sort all these instruments into the groups shown in the diagram. Write each instrument's number in the right place. The first four have been done for you.



Is there any instrument that can go in more than one group?

Observation and analysis

What's the same? What's different?

For each event listed below, put a tick if any of these polluting things are getting into the air.

Event	Poisonous gases	Dust	Smoke	Microbes
a. a bullock cart goes down a dusty road				
b. a truck goes down a dusty road				
c. a person spits				
d. a tree grows				

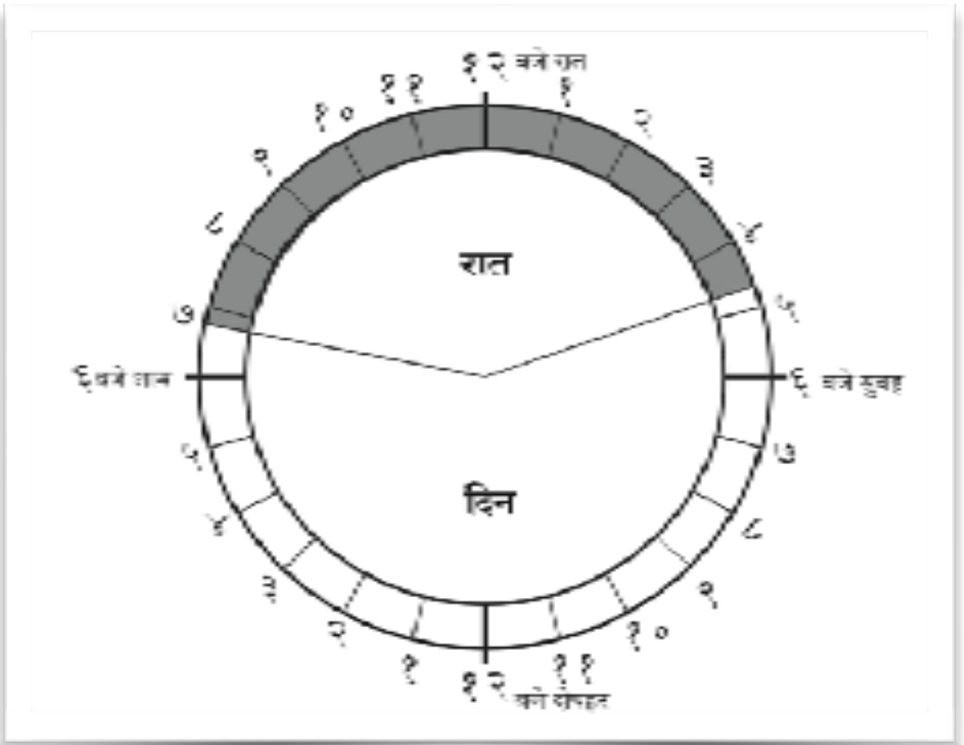
Quantitative thinking

- Watch for numbers
- Count, estimate
- Seriate
- Measure
- Shapes and sizes
- Picture graphs
- Venn diagrams

Count the number of plants and animals you see:

** in summer*

** when the rains begin*



Language skills

It bubbles, it blows
It creeps and it flows
It whistles, it sings
Lifts bird on their wings

- Language for fun
  - Stories and poems
  - Word play

Think of some 'sound words' …

bang! Trrnng hum squeak plop sshroooookh

Language skills

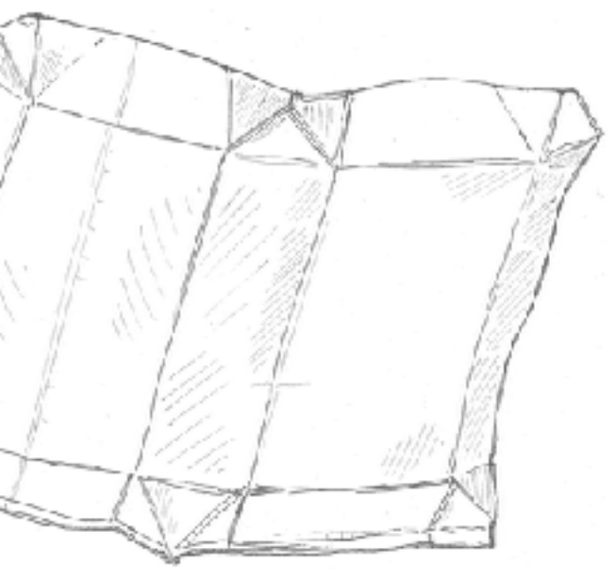
- Oral and written expression
  - Recounting experiences
  - Asking questions
  - Critical thinking, argument, debate

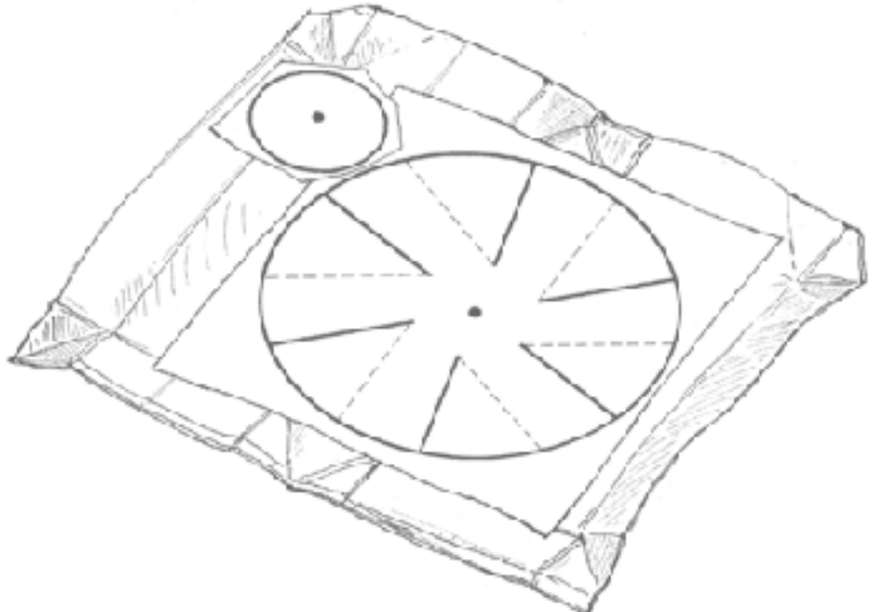
Talk and write

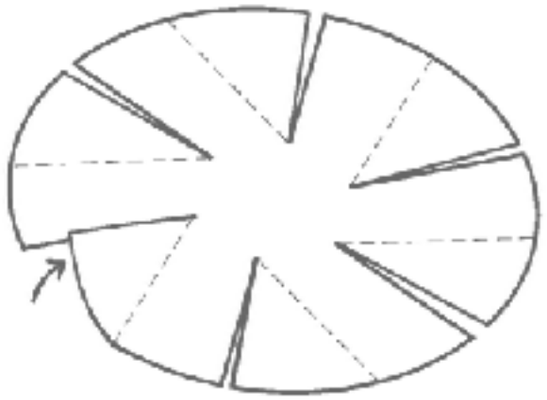
Think of the air you breathe every day. Is it clean or dirty? Why do you think so? What things make your air either dirty or clean? What can you do to get clean air?

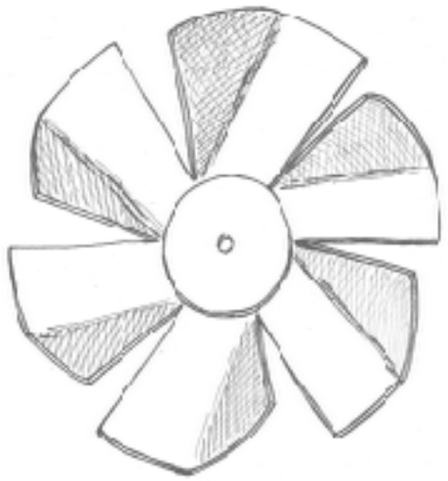
Design & Engineering

- Planning, drawing, constructing



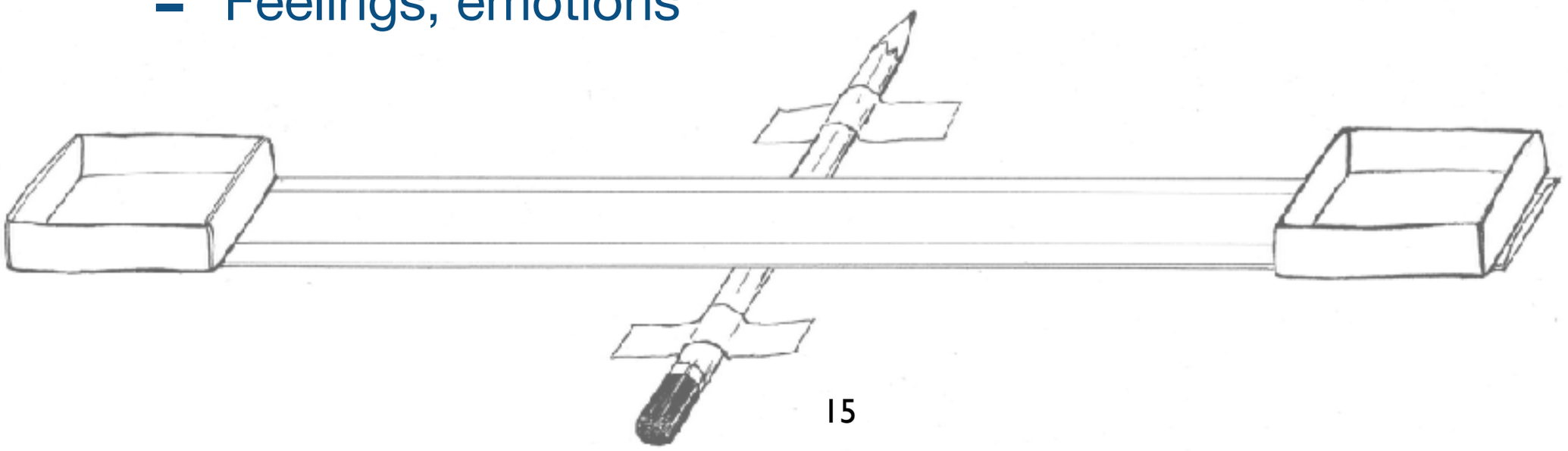






Values in Science Education

- Sensitivity to social issues
- Values conveyed implicitly
  - Caring for living things
  - Conserving resources
  - Community living, equity
  - Working with hands
  - Literary and aesthetic sensibilities
  - Feelings, emotions



Small Science Curriculum Books

Small Science Books in English

- J. Ramadas, A. Kawalkar and S. Mathai : Small Science Class 1 and 2 Teacher's Book, Mumbai: Homi Bhabha Centre for Science Education, 2004.
- J. Ramadas: Small Science Class 3 TextBook, Mumbai: Homi Bhabha Centre for Science Education, 1998; New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 3 WorkBook, Mumbai: Homi Bhabha Centre for Science Education, 1998; New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 3 Teacher's Book, Mumbai: Homi Bhabha Centre for Science Education, 1998; New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 3: Teacher's Book CD, New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 4 TextBook, Mumbai: Homi Bhabha Centre for Science Education, 2001; New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 4 WorkBook, Mumbai: Homi Bhabha Centre for Science Education, 2001; New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 4 Teacher's Book, Mumbai: Homi Bhabha Centre for Science Education, 2001; New Delhi: Oxford University Press, 2007.
- J. Ramadas: Small Science Class 4: Teacher's Book CD, New Delhi: Oxford University Press, 2007.
- J. Vijapurkar: Small Science Class 5 TextBook, Mumbai: Homi Bhabha Centre for Science Education, 2003; New Delhi: Oxford University Press, 2007.
- J. Vijapurkar: Small Science Class 5 WorkBook, Mumbai: Homi Bhabha Centre for Science Education, 2003; New Delhi: Oxford University Press, 2007.
- J. Vijapurkar: Small Science Class 5 Teacher’s Book, Mumbai: Homi Bhabha Centre for Science Education, 2006; New Delhi: Oxford University Press, 2007.
- J. Vijapurkar: Small Science Class 5 Teacher’s Book CD, New Delhi: Oxford University Press, 2007.

Small Science Books in Hindi

- J. Ramadas (Tr. K. K. Mishra): Halka Phulka Vigyan, Kaksha 3 - Pathya Pustika, Mumbai: Mumbai: Homi Bhabha Centre for Science Education, 1999.
- J. Ramadas (Tr. K. K. Mishra): Halka Phulka Vigyan, Kaksha 3 - Karya Pustika, Mumbai: Homi Bhabha Centre for Science Education, 1999.
- J. Ramadas (Tr. K. K. Mishra): Halka Phulka Vigyan, Kaksha 3 - Shikshak Pustika, Mumbai: Homi Bhabha Centre for Science Education, 2000.
- J. Ramadas (Tr. K. K. Mishra): Halka Phulka Vigyan, Kaksha 4 – Pathya Pustika, Mumbai: Homi Bhabha Centre for Science Education, 2002.
- J. Ramadas (Tr. K. K. Mishra): Halka Phulka Vigyan, Kaksha 4 – Karya Pustika, Mumbai: Homi Bhabha Centre for Science Education, 2002.
- J. Ramadas (Tr. K. K. Mishra): Halka Phulka Vigyan, Kaksha 4 – Shikshak Pustika, Mumbai: Homi Bhabha Centre for Science Education, 2007.

Small Science Curriculum Books

Small Science Books in Marathi

- J. Ramadas, A. Kawalkar and S. Mathai (Tr. Deepali Palshikar): Halke Phulke Vidnyan, Iyatta 1 va 2, Shikshak Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2010.
- J. Ramadas (Tr. Shivali Tukdeo): Halke Phulke Vidnyan, Iyatta 3 Pathya Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2000.
- J. Ramadas (Tr. Shivali Tukdeo): Halke Phulke Vidnyan, Iyatta 3 Kruti Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2000.
- J. Ramadas (Tr. Shivali Tukdeo): Halke Phulke Vidnyan, Iyatta 3 Shikshak Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2000.
- J. Ramadas (Tr.Deepali Palshikar): Halke Phulke Vidnyan, Iyatta 4 - Pathya Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2003.
- J. Ramadas (Tr.Deepali Palshikar): Halke Phulke Vidnyan, Iyatta 4 - Kruiti Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2003.
- J. Ramadas (Tr.Deepali Palshikar and Shobhana Bhide): Halke Phulke Vidnyan, Iyatta 4 - Shikshak Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2006.
- J. Ramadas, A. Kawalkar and S. Mathai (Tr. Deepali Palshikar) : Halke Phulke Vidnyan, Iyatta 1 va 2, Shikshak Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2010.
- J. Vijapurkar (Tr. Deepali Palshikar): Halke Phulke Vidnyan, Iyatta 5 Pathya Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2014.
- J. Vijapurkar (Tr. Deepali Palshikar): Halke Phulke Vidnyan, Iyatta 5 Kruti Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2014.
- J. Vijapurkar (Tr. Deepali Palshikar): Halke Phulke Vidnyan, Iyatta 5 Shikshak Pustak, Mumbai: Homi Bhabha Centre for Science Education, 2014.

Small Science Books in Urdu

Urdu translations of the students' books for Classes 3 and 4 are published by the Centre for Promotion of Science, Aligarh Muslim University, Aligarh 202 002, U.P., India.

- J. Ramadas (Tr. Nihal Saghar, Ed. Noman Ghani): Halki Phulki Science, Darja Teen Amli Kitab, Aligarh: Centre for Promotion of Science, Aligarh Muslim University, 2008.
- J. Ramadas (Tr. Wadoodul Haque Siddiqui, Ed. S.M.A. Hashim Rizvi): Halki Phulki Science, Darja Chaar Darsi Kitab, Aligarh: Centre for Promotion of Science, Aligarh Muslim University, 2008.
- J. Ramadas (Tr. Wadoodul Haque Siddiqui, Ed. S.M.A. Hashim Rizvi): Halki Phulki Science, Darja Chaar Amli Kitab, Aligarh: Centre for Promotion of Science, Aligarh Muslim University, 2008.

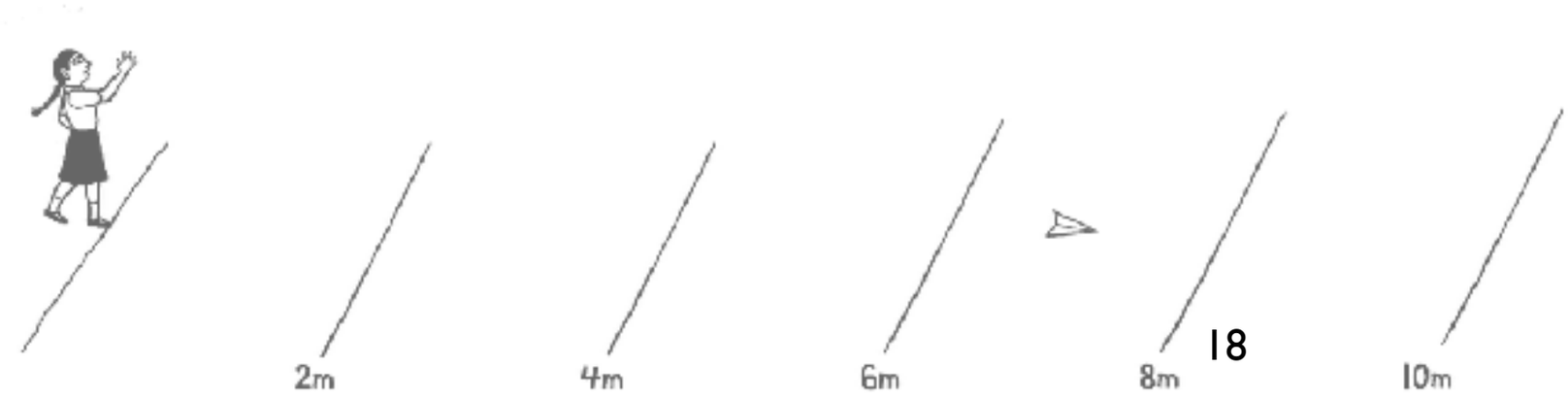
Comments from a teacher

"The children just loved the books so much that for the first few weeks throughout the school these books were in their hands, irrespective of whatever was being taught. The pictures, experiments and activities just touched them.

...

This year witnessed remarkable growth in EVERY SINGLE CHILD, in many aspects - including confidence, experimentation capabilities, observational skills, scientific temper, self reliance and co-operation, team building, sharing, criticizing, and a few kids have even shown signs of hypothesizing"

- Gunvant Jain, Teach for India, from a Pune Municipal School (2011)



Comments from a student

"Small Science was the first book that was compelling to me. It didn't just have a to-the-point chunk of text with a few illustrations instead, it had poetry, recipes, tips, amusing stories. All this was designed to engage and stir the curiosity of a child. It was a breath of fresh air. The books opened my eyes to a whole new way of learning - one I wish was implemented across all schools."

- Ramya Mohan, college student (2012), recalls from her school days

From idealisation to realisation

"Classroom materials in the form of innovative curricula are clearly not enough to achieve a meaningful change in science education. To ensure that classroom transactions move beyond the levels of naïve enthusiasm to purposeful conviction, programmes for the professional development of teachers is a primary concern which requires serious attention from developers of innovative curricula as well as the schools that choose to adopt them."

- Choksi, B. (2007) Evaluating the Homi Bhabha Curriculum for Primary Science: In Situ. Technical Report No. 1 (07-08), HBCSE, Mumbai, October 2007, 31+17 pp.

"The classroom observations and the teachers responses to the orientation workshop point to ...: the need for improving teachers' subject knowledge ... (and) the need for a shift in teachers understanding of the nature of science as well as of science teaching."

- Raveendran, A., (2009) Implementation of Small Science in a Mumbai School: Deriving Implications for Teacher Development, Internal Report, HBCSE, Mumbai, May, 2009, 12+10 pp

Follow-up in three schools

- July-September 2016
- Al Qamar Academy, Chennai (2010-)
  - Montessori school
  - Student strength: 120
  - Grade 3: 10
  - Grade 4: 17

http://www.alqamaraacademy.in/
http://smallscience.hbcse.tifr.res.in/category/view-from-the-classroom/al-qamar-academy-chennai/

Follow-up in three schools

- Vedavalli Vidyalaya, Walajapet and Ranipet (2015-)
  - Two CBSE schools
  - Student strength: 1364 (360 elementary); 771 (244 elementary)
  - Grade 3: 4 + 3 divisions
  - Grade 4: 4 + 3 divisions
  - Grade 5: 4 + 2 divisions
  - ~ 30 students per class

http://www.vedavallividyalaya.org/
http://smallscience.hbcse.tifr.res.in/category/view-from-the-classroom/vedavalli-vidyalaya/

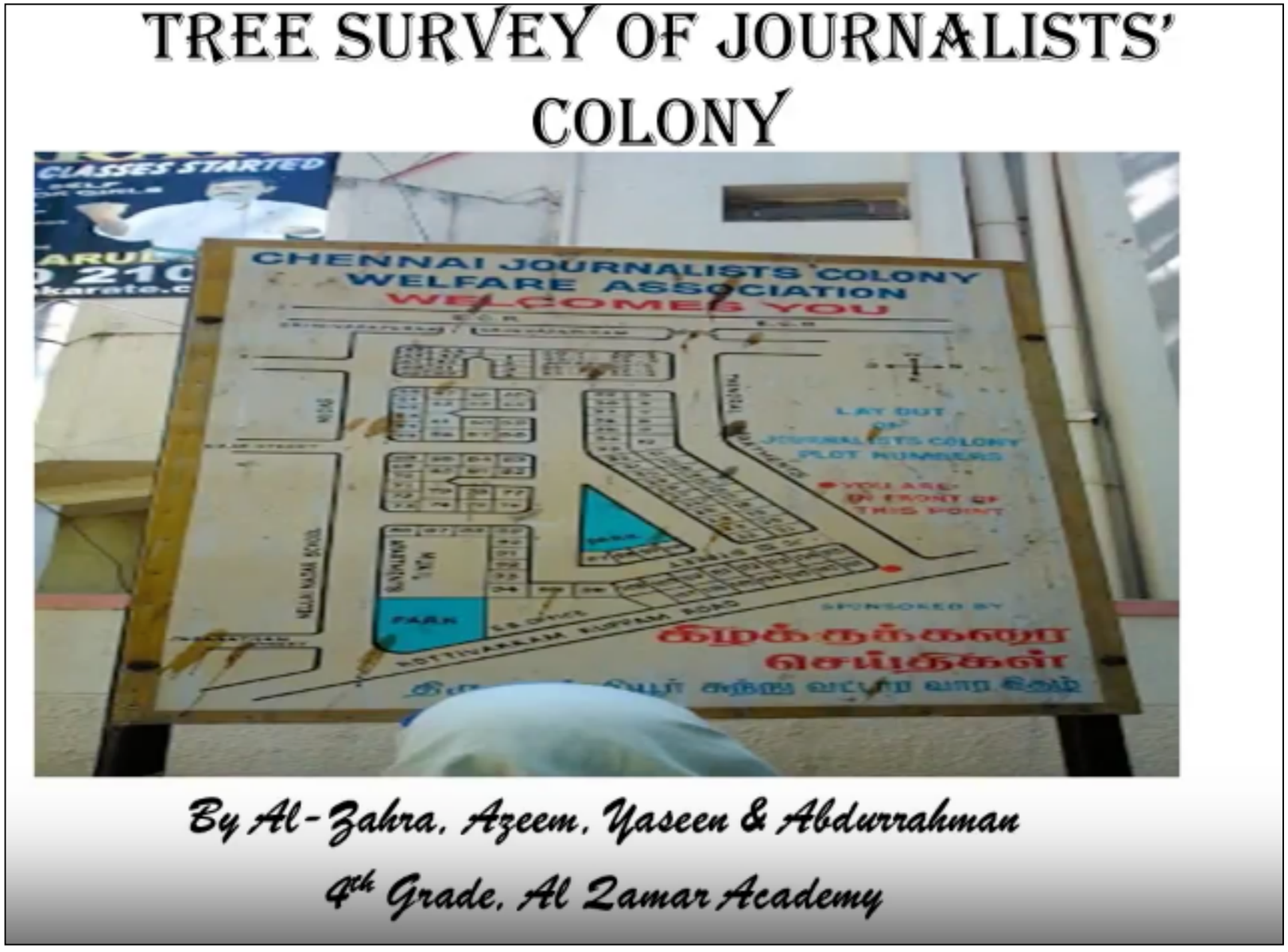
Issues of curriculum change

- Ownership, intention to change
- Finding common cause
- Peer support, Role models
- Reflective processes

- Local resources - human and documented
- From inquiry to learning

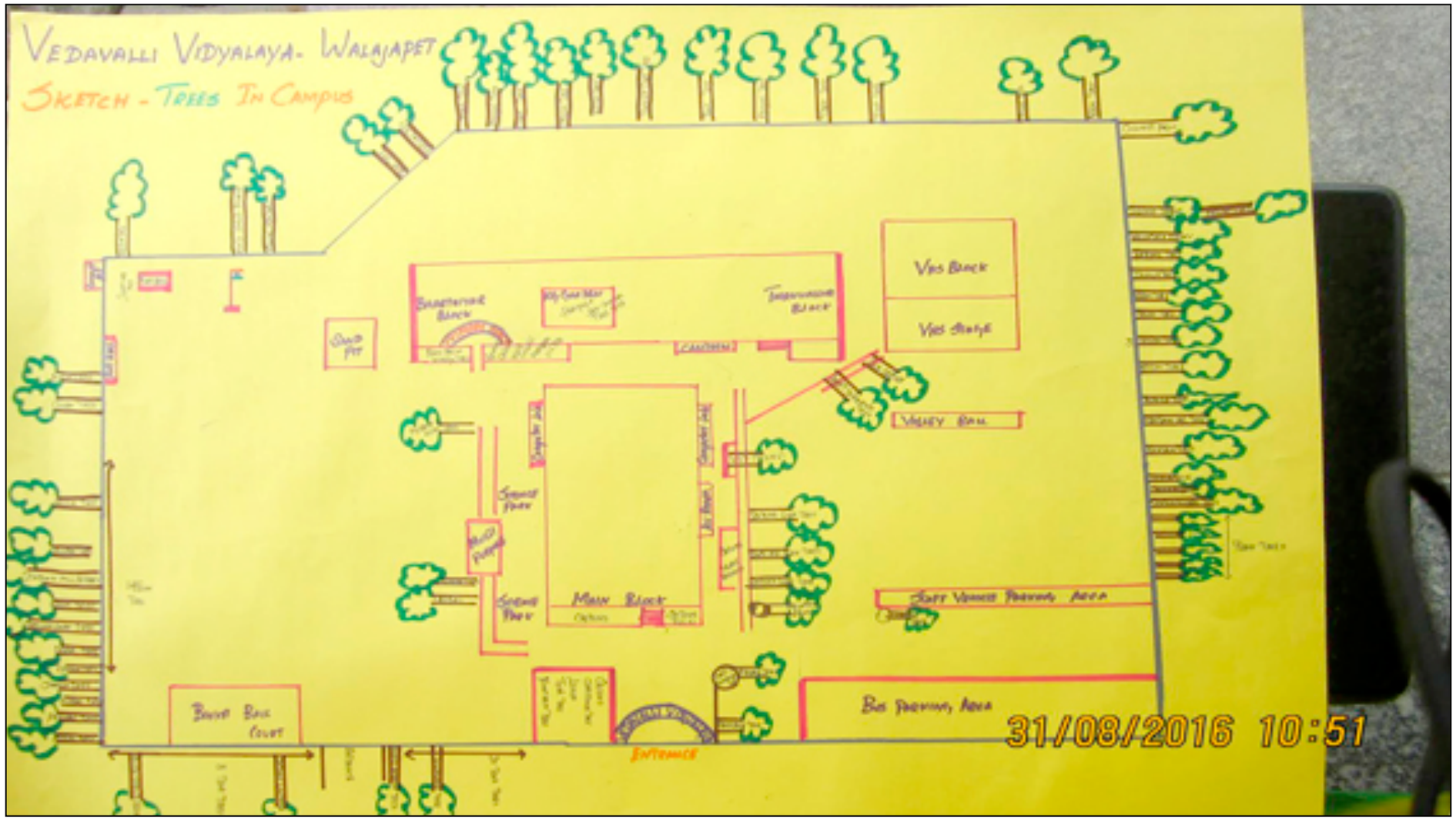
Documenting local resources

Tree survey by Grade 4 students (AQA)



Documenting local resources

Tree survey by Vedavalli Vidyalayas



From inquiry to learning

- Natural mechanisms of learning
  - Exploring
  - Seeking patterns
  - Evaluating evidence
  - Sensitivity to intentions
  - Peer learning

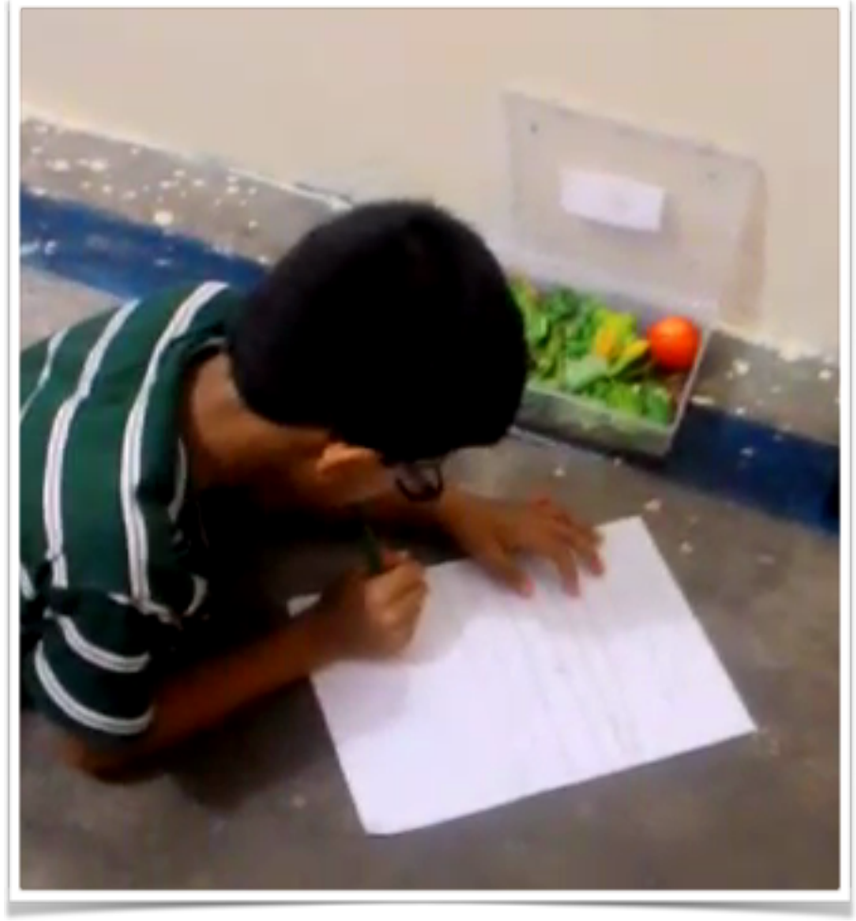
Gopnik, A. (2012). Scientific thinking in young children: theoretical advances, empirical research, and policy implications, Science, 337 (6102), 1623-7.

From inquiry to learning

- Workbook as medium
  - observe, record, analyse
  - reflect, express
- Assessment
  - Observation and ‘understanding’
  - Oral language
  - Written language
  - Design and engineering
  - Quantitative skills

Inquiry to learning - issues

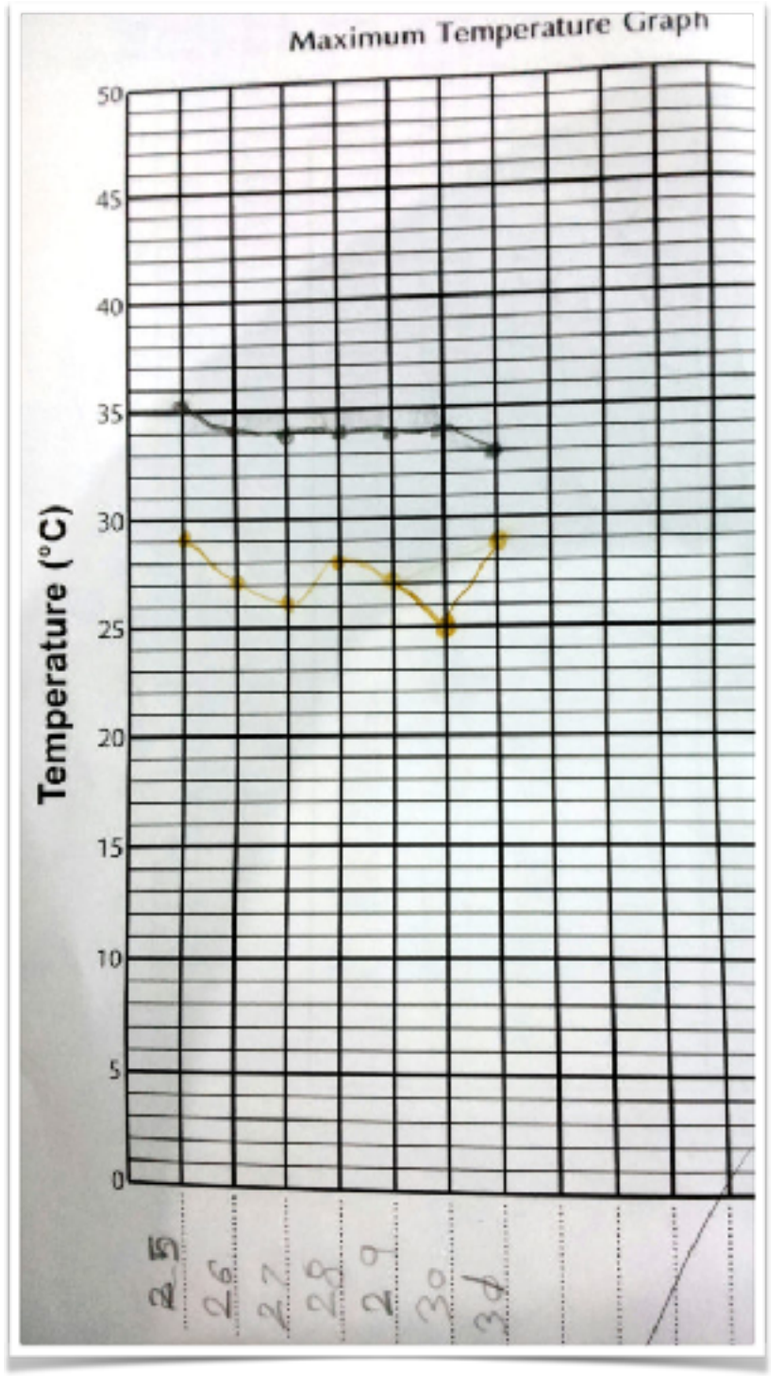
- Observing and recording
  - Observation vs. concepts and generalisations
  - Real or expected observations?
  - Sustaining focus
  - Linking to assessment



http://smallscience.hbcse.tifr.res.in/category/view-from-the-classroom/al-qamar-academy-chennai/
http://smallscience.hbcse.tifr.res.in/category/view-from-the-classroom/vedavalli-vidyalaya/

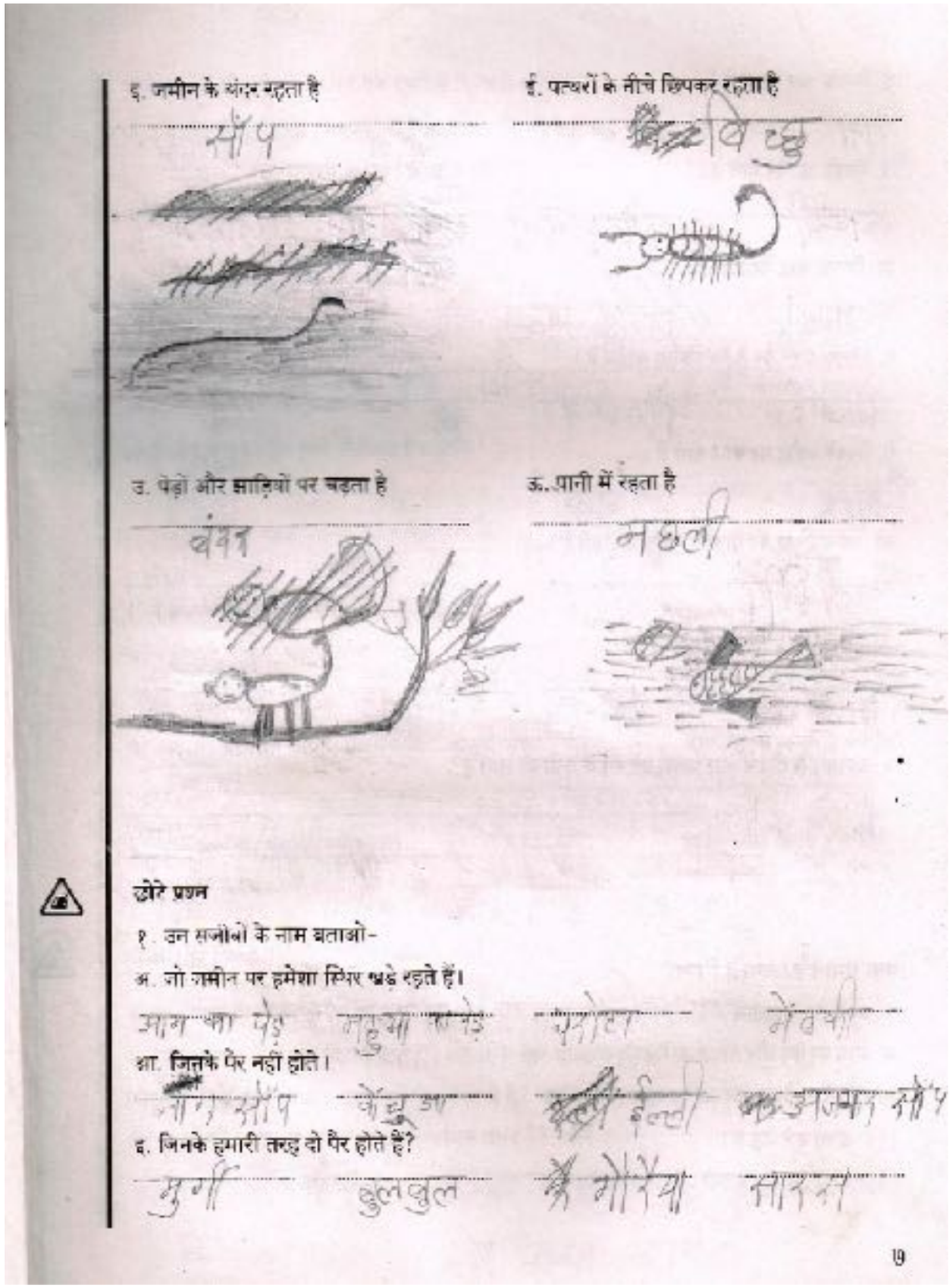
Inquiry to learning - issues

- Level of challenge
- Individual differences
- Language development



http://smallscience.hbcse.tifr.res.in/category/view-from-the-classroom/al-qamar-academy-chennai/
http://smallscience.hbcse.tifr.res.in/category/view-from-the-classroom/vedavalli-vidyalaya/

Inquiry to learning - example



इ. जमीन के अंदर रहता है

सांप

ई. पत्थरों के नीचे छिपकर रहता है

उ. पेड़ों और झाड़ियों पर चढ़ता है

बंदर

ऊ. पानी में रहता है

मछली

छोटे प्रश्न

१. उन सजीवों के नाम बताओ–

अ. जो जमीन पर हमेशा सिर झुके रहते हैं।

आम का पेड़ महुआ का पेड़ घोड़ा नेवली

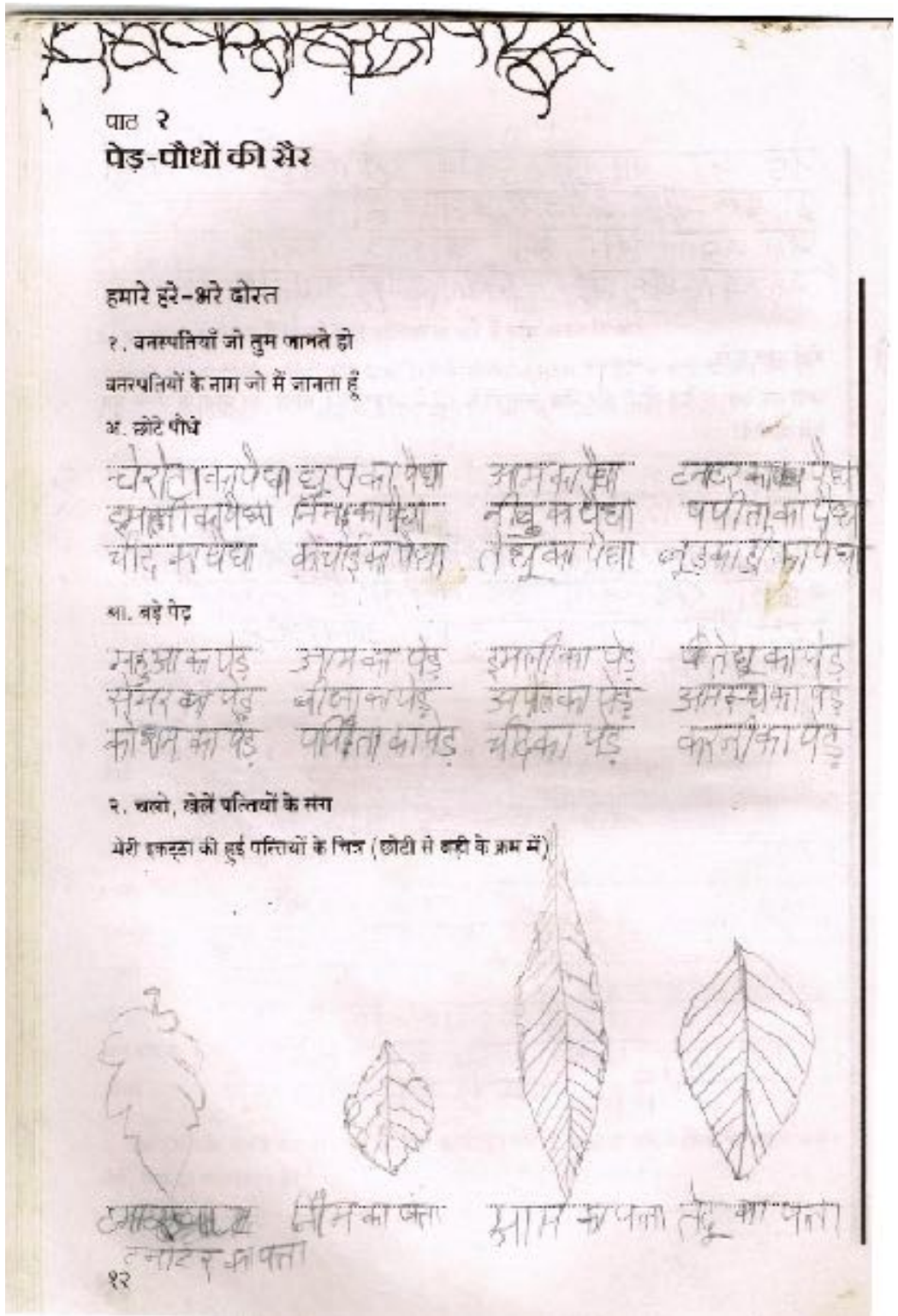
आ. जिनके पैर नहीं होते।

नाग सांप केंचुआ छिपकली इल्ली अजगर सांप

इ. जिनके हमारी तरह दो पैर होते हैं?

मुर्गी बुलबुल मैना गौरैया सारस

19



पाठ २

पेड़-पौधों की सैर

हमारे हरे-भरे दोस्त

१. वनस्पतियाँ जो तुम जानते हो

वनस्पतियों के नाम जो मैं जानता हूँ

अ. छोटे पौधे

चौराई का पौधा धूप का पौधा आम का पौधा बन्दर भाँड़ का पौधा
इमली का पौधा मिर्च का पौधा नीबू का पौधा पपीता का पौधा
चौलाई का पौधा बेशरम का पौधा तेंदू का पौधा बुढ़ाई का पौधा

आ. बड़े पेड़

महुआ का पेड़ आम का पेड़ इमली का पेड़ केतेंदू का पेड़
सेमर का पेड़ बरगद का पेड़ अमरूद का पेड़ अमरूद का पेड़
कोसम का पेड़ पपीता का पेड़ बेर का पेड़ कटहल का पेड़

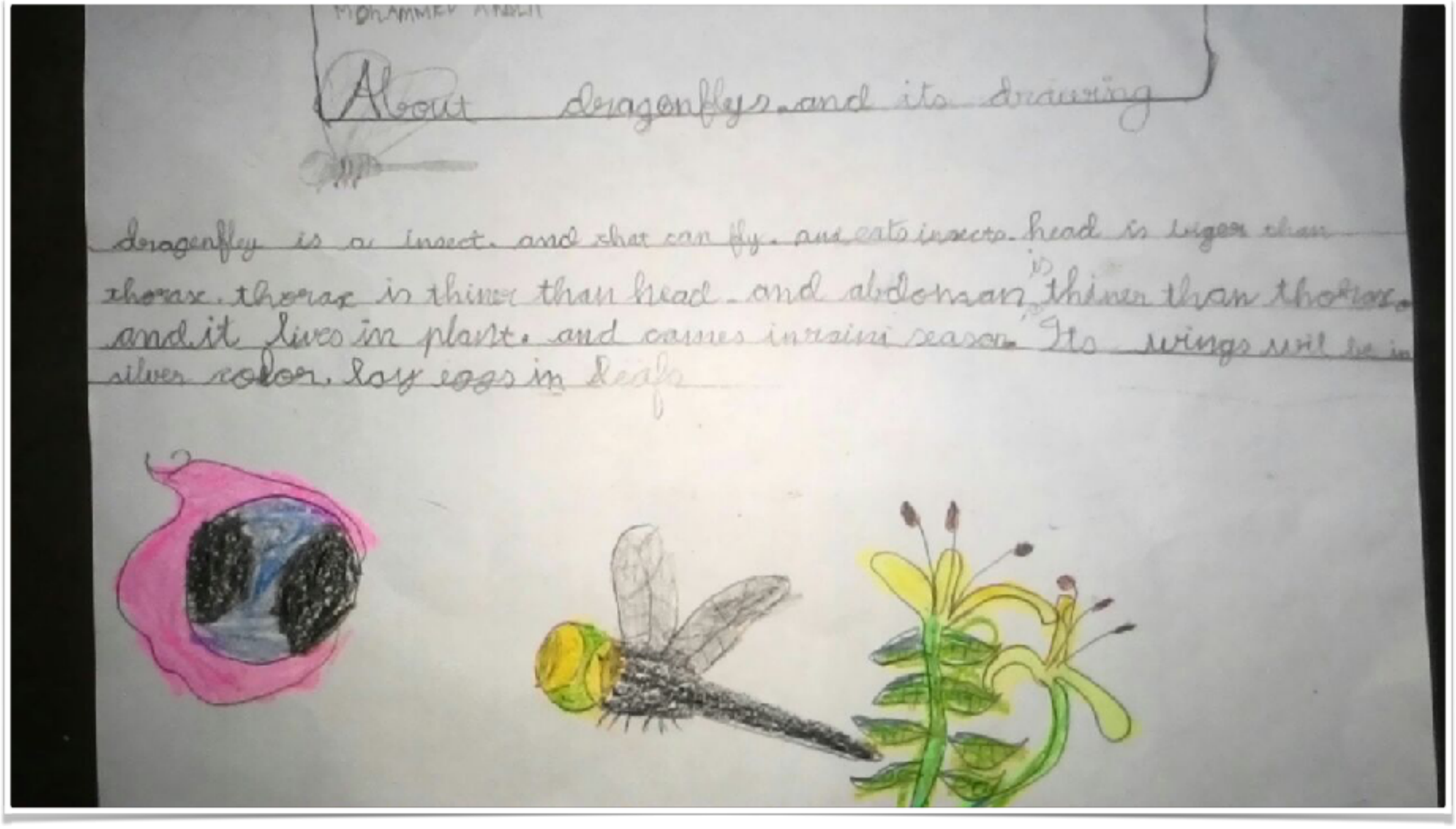
२. चलो, खेलें पत्तियों के संग

मेरी इकट्ठा की हुई पत्तियों के चित्र (छोटी से बड़ी के क्रम में)

आम का पत्ता तेंदू का पत्ता

१२

Inquiry to learning - example

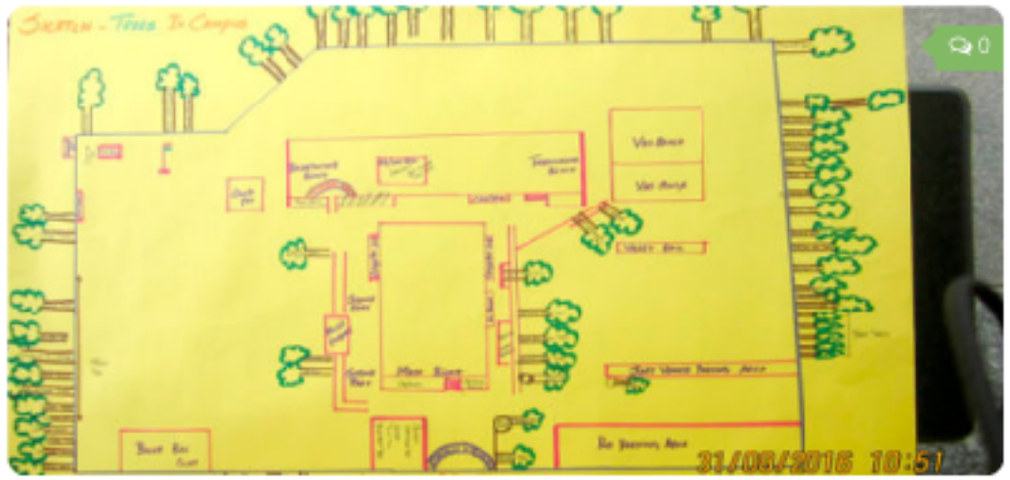


CATEGORY: VEDAVALLI VIDYALAYA, TAMIL NADU

RESOURCES / VEDAVALLI VIDYALAYA, TAMIL NADU / VIEW FROM THE CLASSROOM

Food in our bodies – 1

Vedavalli Vidyalaya, Walajapet, Tamil Nadu Class IV D, September 2016 Small Science – Class 4 Chapter 9 – Food in our bodies Food in our bodies – 1 I am very excited to share...



VEDAVALLI VIDYALAYA, TAMIL NADU / VIEW FROM THE CLASSROOM

Introducing Vedavalli

Vedavalli Vidyalaya, Walajapet and Ranipet Small Science at Vedavalli The Vedavalli Vidyalayas are two CBSE senior secondary schools founded by the Thirumalai Charity Trust about two decades ago at Walajapet and Ranipet in Tamil Nadu....

VEDAVALLI VIDYALAYA, TAMIL NADU / VIEW FROM THE CLASSROOM

The ants, the ants

Vedavalli Vidyalaya, Walajapet, Tamil Nadu Class: III A, August 2016 Small Science – Class 3 Chapter 4 – Looking at Animals The ants, the ants * Students of Class III A of Vedavalli Vidyalaya,...

VEDAVALLI VIDYALAYA, TAMIL NADU / VIEW FROM THE CLASSROOM

Weather calendar and clock

Vedavalli Vidyalaya, Walajapet, Tamil Nadu Class IV D, August 2016 Small Science – Class 4 Chapter 1 – Sun, wind, clouds and rain Weather calendar and clock I felt very excited to teach Small...

CATEGORY: AL QAMAR ACADEMY, CHENNAI

AL QAMAR ACADEMY, CHENNAI / RESOURCES / VIEW FROM THE CLASSROOM

Sky watch

Al Qamar Academy, Chennai, Grade 4 September – October 2016 Small Science – Class 4 Unit 1 – Sky and Weather Chapter 2 – Day sky, night sky Sky watch Our class has been...

AL QAMAR ACADEMY, CHENNAI / VIEW FROM THE CLASSROOM

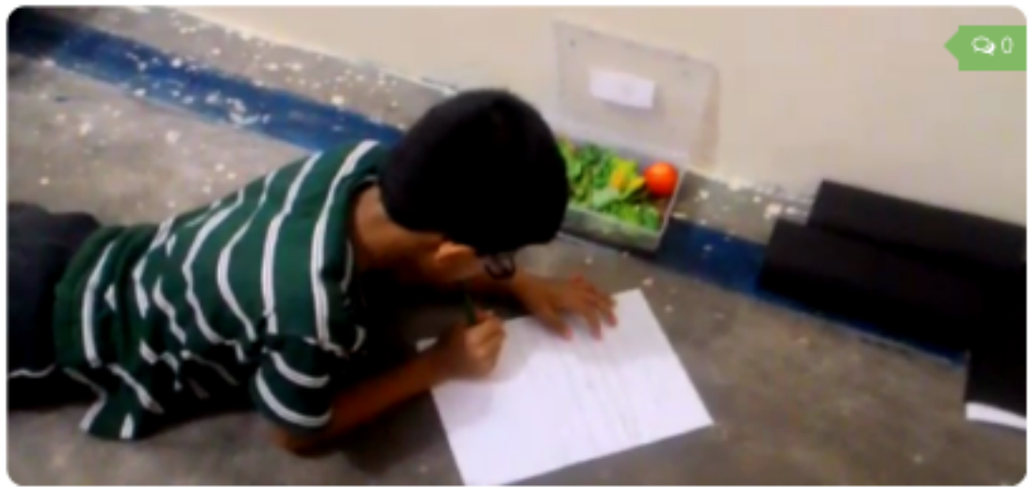
Tawny Coster

Al Qamar Academy, Chennai, Grade 3 August 2016 Small Science – Class 3 Unit 1 – The Living World Tawny Coster Only when the first butterfly emerged and spread out its handsome orange-brown spotted...

AL QAMAR ACADEMY, CHENNAI / VIEW FROM THE CLASSROOM

How many, How much?

Al Qamar Academy, Chennai, Grade 3 October 2016 Small Science – Class 3 Chapter 9 – How many, How much? How many, How much? One day in class Aneesa Aunty read us the story...



AL QAMAR ACADEMY, CHENNAI / VIEW FROM THE CLASSROOM

From inquiry to learning – 1

Al Qamar Academy, Chennai August – September 2016 Small Science – Classes 3 and 4 From inquiry to learning – 1 As adults and educators, when we see the Small Science Workbook, we are thrilled....

Thanks

Teachers and students of
Al Qamar Academy and Vedavalli Vidyalayas

Manoj Nair

Institute of Mathematical Sciences, Chennai