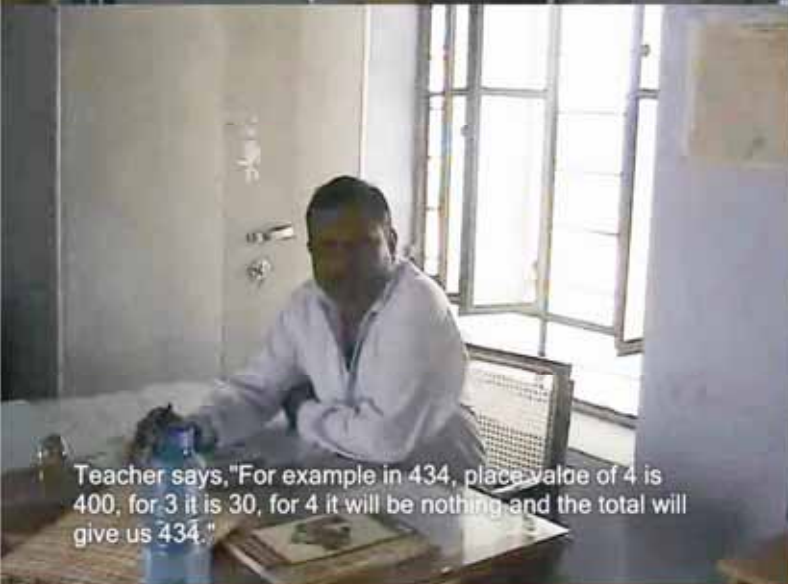


Interviewing Students to Understand Their Thinking on Key Concepts

El Working Paper Series - Issue 5



We acknowledge the support of many partners in making these studies possible.

Educational Initiatives (EI) believes that significantly improved student learning can happen only through systematic research into learning which includes assessment, as well as areas like misconception research. This working paper series will share learnings from various past and present EI projects as well as path-breaking work in these areas elsewhere in the world. Please write to us at assessment@ei-india.com for questions or comments.



Educational Initiatives Pvt. Ltd.

www.ei-india.com

■ WHY THIS IDEA HAS LARGER RELEVANCE

As teachers, we teach a lesson in the class and often assume that the students have understood the relevant ideas. However, when we test their understanding, we often find significant gaps in that understanding. So we re-teach the concept, thinking that the students may have missed some parts of it and will understand it when taught again. But if we test again, we still find that many wrong ideas (misconceptions) persist. What could be the cause for this and what is the solution?

The reason seems to stem from the fact that as students observe and experience various things in their day-to-day lives, they formulate their own notions, attribute meanings, and infer various concepts well before they are 'taught' to them. These understandings may or may not be scientifically correct (these include concepts like 'more spread out objects mean more objects', and 'we see due to light rays that emerge from our eyes' – both incorrect but possibly 'learnt' from specific situations or cartoon films, etc.) They continue to form such ideas throughout their school years. If these notions are ignored, it is likely that they will interfere with learning of new concepts. Many times such wrong notions stay with students (us!) throughout school life, unchanged, and even in adulthood. So though we teach and re-teach concepts, persistent wrong notions don't allow an understanding and internalisation of the correct concepts.

Hence, it appears that *understanding what students already know and think about a concept before it is taught or while it is being taught, is an important aspect of teaching*. Many of us may miss this aspect and hence students seem to face difficulty in learning. As a follow-up of the various large scale assessment studies, Educational Initiatives (EI) along with other partners, interviews students of different classes to gather more information on the ways in which students think about and answer different questions. The purpose of these interviews is to understand how students think about many concepts they learn in school.

■ TALKING TO STUDENTS TO UNDERSTAND THEIR THINKING

A large scale assessment study with well-designed tests often provides detailed performance data and the patterns underlying student responses. This also brings to light concepts that students have difficulty with and the common wrong notions they have on these concepts. This information is valuable to the teacher who can focus on these concepts to bring about improvement in student learning.

However, while assessment results identify the different wrong answers students provide for a concept, it does not fully explain *why* students answer in that way. In order to find that out, one approach was simply to ask students this in a 'student interview'. These interviews are typically conducted in the class itself by trained interviewers. It is common in research studies to conduct individual interviews and use the transcripts – one advantage of the whole-class interaction is that it allows for discussions among students. These interviews are carried out for or in partnership with various partner organisations. They are video recorded and then disseminated to schools where they are used mainly for teacher feedback and training.

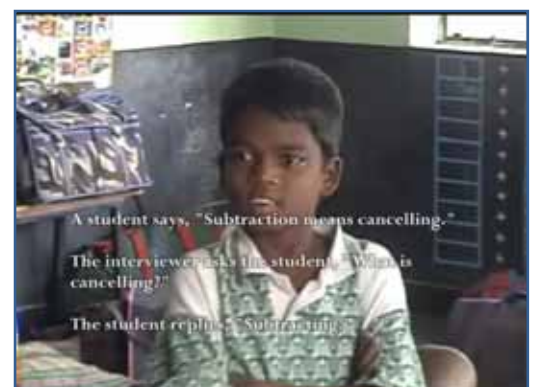


■ GOALS OF STUDENT INTERVIEWS

- To highlight the different misconceptions that students have on certain topics
- To understand the reasoning associated with different student responses related to a given concept
- To understand patterns underlying how students think and learn
- To video document learnings related to student misconceptions
- To disseminate the learnings to a larger teaching community for action

■ PROCESS

- Data obtained from the assessment studies is analysed to find out the most common wrong answers students give for different concepts
- Permission is then sought from the schools to carry out the student interviews
- Such interviews have been conducted in different types of schools – the elite private schools as well as government schools
- Each question is tried in different cities and across educational boards to capture the most common notions
- Teachers are often interviewed to understand difficulties students face in learning the related concept
- The raw video footage is analysed by experts to find out underlying patterns of student thinking
- The responses are compiled to make a video for each concept, highlighting the most common wrong notions and the reasons behind them
- The videos are suitably subtitled wherever required before dissemination to schools and experts



■ MAIN FINDINGS

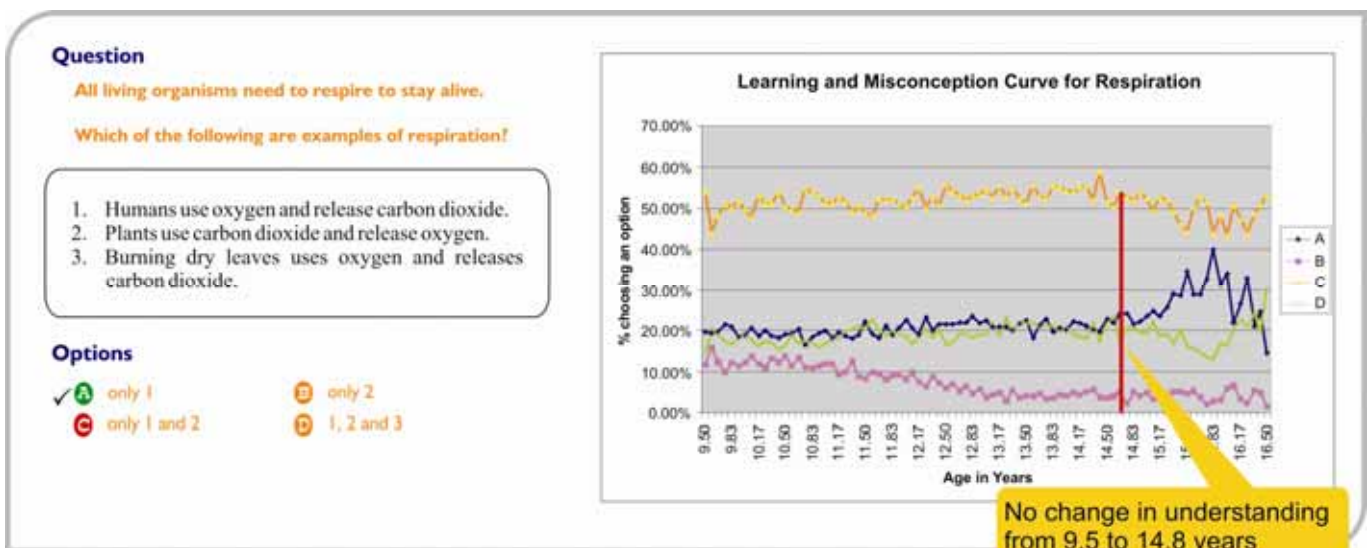
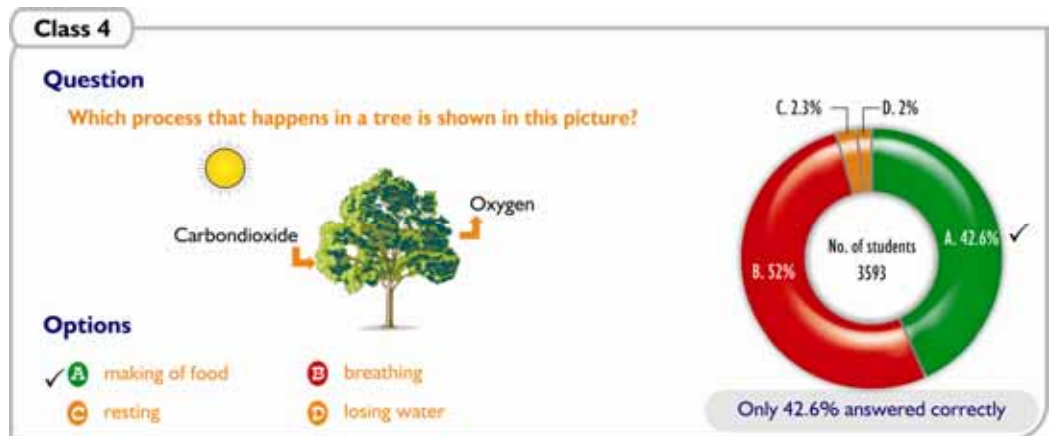
- In many cases, the same wrong notions and reasons seem to emerge from students across cities and boards. This suggests that the root cause of these wrong notions is similar – possibly observations or experiences or certain common teaching practices.
- Students are able to talk freely when engaged in a questioning method that is casual. The interviewer has to be very careful this his or her responses do not explicitly or implicitly (through body language, for instance) suggestive that a response is correct or incorrect. If this is ensured, then students freely speak out whatever is on their mind without fear or self-consciousness.
- Students tend to stick to their notions and do not give up their wrong ideas easily. These wrong notions often do not go away 'by themselves' with age either, and even older students tend to give similar reasons as the younger ones when questioned on the same concept.



■ USING ASSESSMENT AND INTERVIEW DATA TO GAIN INSIGHTS ON LEARNING

Student interviews can be used very effectively in conjunction with assessment data to understand the basis of common and often deeply-held misconceptions. In the following example, assessment data reveals a fascinating gap in student learning – only student interviews explain a plausible reason (and from that, a remedy) for the problem.

Students learn about basic life processes from class 3. But they confuse between the processes of respiration and photosynthesis as the question and data alongside shows. A majority of students say that plants breathe (respire) carbon dioxide. More surprisingly, this misconception does not go away with age as the data plotted below (on a similar question on respiration) shows. Rather, *the misconception persists unchanged through class 10*, though students learn about plants and photosynthesis along with the chemical reactions taking place and even the carbon cycle during this period. Student interviews are used to try and find the reason for this.



Insights from Student Interviews: The concept of respiration is more emphasized in the context of animals; so some students think that plants do not respire. Other students think that in plants, taking in carbon dioxide and giving out oxygen is respiration. Yet others – especially younger students - believe that plants can perform any one function at a time – so, in the day photosynthesis occurs and at night, respiration! Some older students think that the gaseous exchange taking place during photosynthesis and respiration is similar. Isn't it invaluable for a teacher teaching these concepts to be aware of these notions, as that would help the teacher to ask questions or give exercises that can specifically be targeted at removing these misconceptions?

RELEVANCE OF THIS METHOD IN ACTUAL TEACHING

The method of interviewing students is a simple yet a powerful tool to engage students in a discussion related to what they think and draw out the way they think. This method can be used in a classroom and can help a teacher deliver the lesson in a way that could help the students understand the concept in many different ways.

There are three stages at which this method of interviewing students can be used and each serves a different purpose.

- Before beginning the lesson: Before starting a new topic, students can be asked some very basic questions related to the topic or topics that may lead to any particular idea in the topic. This can help in listing down the various wrong notions students have and that might hinder in the way of learning that topic. Once identified, the teacher can design activities to clarify those wrong notions.
- While the lesson is going on in the classroom: As a part of the on-going lesson, students can be interviewed regularly and engaged so as to find out whether the activities are clarifying the prevalent misconceptions. This can provide a good feedback on the lesson plan which can be modified as required.
- After the lesson has been taught: It can be used to assess if the students have understood the concept correctly and to see if any point needs to be clarified.

It is important to keep in mind that the purpose of a method like this is to engage students in a discussion where they are able to speak without any fear. Students generally tend to speak about their ideas clearly and freely when they see that their ideas are being heard and there is no penalty that he will have to pay for possessing those ideas. And hence it becomes important for the teacher to be neutral in her responses and should not provide any approval or disapproval to the student responses. The following are to be kept in mind and followed while conducting a student interview.

- Do not prompt or show any kind of facial expressions even when the answer is wrong.
- Allow a single student to take his/her time to express the idea; do not jump from one student to the other quickly.
- Ask the students who change their answers during the interview process why and what made them change their answer.
- Encourage students to listen to each others' ideas and let them debate over points they don't agree to.
- If possible document the interview for future records.

SAMPLE STUDENT RESPONSES AND WRONG IDEAS

Concept	Class	Student responses and wrong ideas
Measurement	4	<ul style="list-style-type: none"> • Point on the scale where the object ends is the length of the object • The object has to begin from the 0 mark on the scale and only then we can find out its length • We need to count the points to find out the length, so if the pencil is starting from 1 and ending at 6, it is 6 cm long because there are 6 points – 1, 2, 3, 4, 5 and 6
Fractions	4	<ul style="list-style-type: none"> • Fractions mean dividing things equally • $\frac{1}{3}$ means 1 out of 3 parts, the part need not be equal • 3 and 4 in the fraction $\frac{3}{4}$ represent two different numbers
Perimeter	6	<ul style="list-style-type: none"> • Perimeter is the area of the figure • Area of a rectangle is $l \times b$ whereas its perimeter is $l \times b \times l \times b$ • Perimeter of the triangle with side l is $l \times l \times l$
Algebra	8	<ul style="list-style-type: none"> • Variables are alphabets with fixed numerical value • Two different variables cannot be added • $x + y = xy$; $5x + 5y = 10xy$
Classification of plants and animals	4	<ul style="list-style-type: none"> • Animal is a creature that lives on land and has four legs • Man was once an animal, now he is not • An insect is too small and it can fly and so it cannot be called an animal
Evaporation	4	<ul style="list-style-type: none"> • Water from seas and oceans change into water vapour and go up in the sky where they condense and form clouds. This entire process is called evaporation. • Only water from seas and oceans can evaporate. Water inside a closed room cannot evaporate. • Drying is not the same as evaporation
Shadows	6	<ul style="list-style-type: none"> • Shadows are like dark reflections • A shadow is a dark light • Shadows are part of the object itself
Gravity	8	<ul style="list-style-type: none"> • If you let go a pen on the moon – • it will float away as there is no gravity on moon • it will float where it is as it is too light to fall down and moon's gravity is also weak • it will move towards the Earth because the Earth acts like a stronger magnet
Atoms and molecules	8	<ul style="list-style-type: none"> • When water is heated to form steam, the oxygen and hydrogen atoms separate from the water molecule • An atom as a rule never exists as itself • Steam has atoms and not molecules, and because it is in the gaseous state the atoms move apart

STUDENT INTERVIEWS IN GOVERNMENT SCHOOLS

While student performance data in many assessment studies (ASER 2008, Municipal School Benchmarking Study 2007) show that learning levels in government schools are low, and there are studies aimed at exploring a number of background input factors that influence learning, a well-meaning teacher needs information and strategies that give her the insights to bring about effective student learning. Student interviews address this specific teacher need to explore the students' minds, let her zero-in on the misconceptions and the exact faulty strategies students use to answer the questions. This functions as an excellent window into the students' thought and enables the teacher to target the specific learning issues while designing the remediation for improving learning.

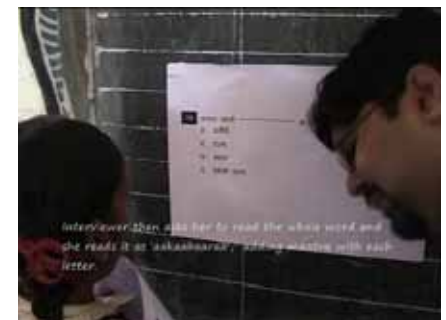
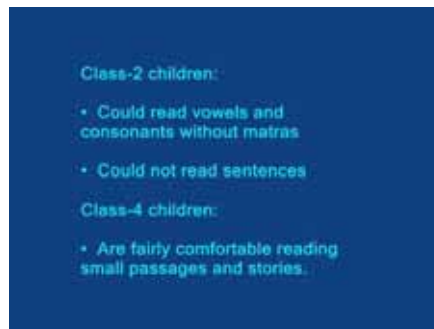
- Students in these schools especially in lower classes have reading difficulty and the concepts and procedures they struggle with are more basic compared to students of private schools
- Many wrong notions and procedures of answering questions are seen from the students in these schools too similar to the private school students.
- Students demonstrate fearlessness and share their reasoning eagerly while answering questions during the interviews. This is seen commonly in both urban and rural schools.



EI researchers start Language interviews on reading with a focus on whether students are able to decode the letters, words and text effectively before proceeding to explore the comprehension and prior notions that may interfere in their reading comprehension. Students in class 2 are often found to be at letter level and are not able to read simple and short sentences, while at class 4 level they start decoding text fairly comfortably. However, it is commonly observed that the reading is accompanied by running the finger on the texts, reading in a monotone, difficulty in conjoint letters and compound words – all of which indicate that acquisition of reading continues to be an issue in primary classes.



The interviewer points out the words "Kurchi" and asks the student to read. The student reads the word as "Kura"

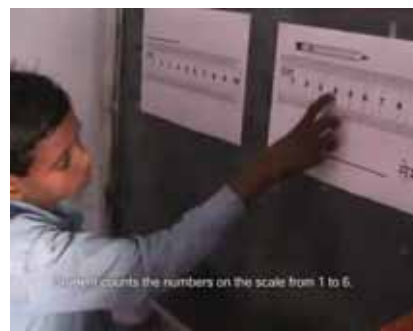


Student reads it as 'aakaabaaraa' adding a maatra with each letter.

Students demonstrate a number of misconceptions and erroneous procedures during the Maths interviews. The difficulties are found to range from reading the question, understanding the mathematical language underlying the question, and then applying what they have learnt. Students in the primary level reveal wrong notions in simple procedures and concepts in topics such as subtraction, multiplication, division, place value, fractions, decimals, measurement, etc.



Student is at the informal stage of measurement and shows length by handspan.



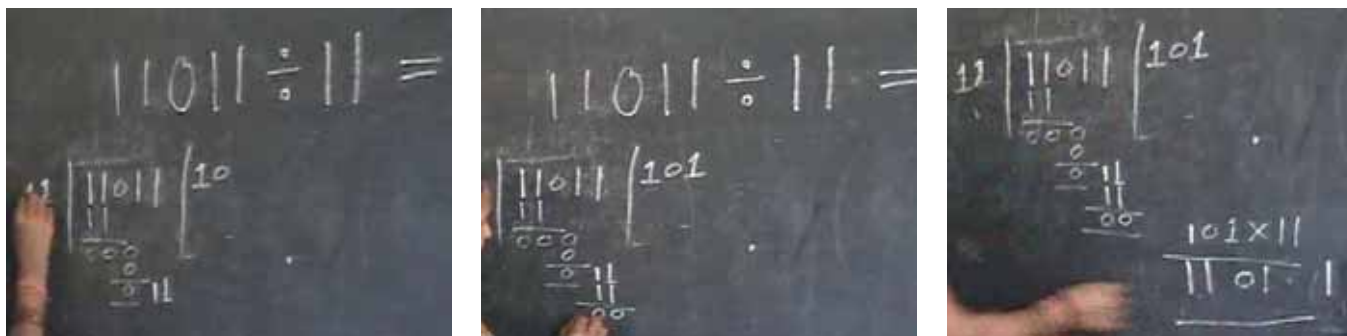
Student counts the units from the starting point till ending point and fails to account for the length of the scale prior to starting point.



A student reads off the unit in the scale at the ending point of the pencil and says that length of pencil changes as it is moved along the scale.

TEACHER INTERVIEWS

When the teacher is asked to answer the questions before or after an interview is carried out in a classroom, there have been cases where the teacher is found to have the same wrong notions as the students, indicating the cause of wrong notions among the students.



Here is a question that was asked to students of class 5. 'Solve: $11011 \div 11$ '. Most of the students gave the answer as 101. The images above show the procedure the teacher used in the classroom to solve the problem. As can be seen, the teacher made an error in the method followed during division.

Teacher interviews when systematically carried out can bring out a number of insights on how teachers think about different concepts. These would aid the policy makers and those in charge of teachers' professional development to design specific training programs that can strengthen the teachers' subject knowledge.

BENEFITS TO THE TEACHER THROUGH STUDENT INTERVIEWS

When students are interviewed, teachers are generally asked to sit behind the class and observe the way interviews are conducted and see how students answer the questions. Most of the time, before the interviews, teachers seem confident about their students and think that their students will answer the questions correctly, with the correct logic. However, the same teachers are surprised to see the kind of wrong notions students have and the various ways in which the students answer the questions during the interviews. *Observing a student interview or conducting it brings it home strongly to the teacher that it is more important to focus on what students learn than on what they teach. This results in a shift in the attitude or approach the teacher takes in the classroom.*

Student interviews also reveal to the teacher the gaps in their own understanding as it allows them to explore and think about a concept in different ways along with the students. This happens when the teacher listens to and explores the student responses, for example a teacher exploring the students' understanding on the gaseous exchange in photosynthesis could realise that the curriculum never approaches photosynthesis and respiration as two processes happening simultaneously in plants, and as a result she herself has not thought through the connections. The teacher could reflect on the connections and ensure that these gaps are filled by her while dealing with either concept in the classroom.

During student interviews teachers realise that many a times wrong strategies in teaching or assessment leads to building or sustaining wrong notions in the students' minds. For example, a teacher may understand that students are not identifying a tilted square as a square because they were always taught and assessed for their recognition of a square only in upright orientation.

Thus apart from understanding student thinking and the errors they make, student interviews strengthen the teacher's own subject knowledge, pedagogical practices and attitude to build their classrooms into places of effective learning.

INTERNATIONAL RESEARCH USING STUDENT INTERVIEWS

Interviewing students is a method used in many different countries and it has given really valuable insights about how students learn. Annenberg Media a unit of the USA based Annenberg foundation does yeoman service to the teacher community in this area. Annenberg foundation funds a wide range of research programs in education and as part of their multimedia resources, the videos are streamed for on-demand viewing through www.learner.org. A few program descriptions are shared below:

1. Can We Believe Our Eyes?



Why is it that students can graduate from MIT and Harvard, yet not know how to solve a simple third-grade problem in science: lighting a light bulb with a battery and wire? Beginning with this startling fact, this program systematically explores many of the assumptions that we hold about learning to show that education is based on a series of myths. Through the example of an experienced teacher, the program takes a hard look at why teaching fails, even when he uses all of the traditional tricks of the trade. The program shows how new research, used by teachers committed to finding solutions to problems, is reshaping what goes on in our nation's schools.

2. Lessons From Thin Air



Just about everyone will agree that trees are made from sunlight, water, and soil the trees suck up from their roots. But the surprising truth is that trees are made from air! Trees are solar-powered machines that convert air into wood. Why is it that, despite the fact that photosynthesis is one of the most widely taught subjects in science, so few people really understand the central idea underlying this system? Starting with this question, program two explores why something taught in school can go unlearned and shows that we often teach without regard to what children actually need to know.

■ SAMPLE TRANSCRIPT OF A STUDENT INTERVIEW

In the table given below, which of the following has been put under the WRONG heading?

	Living	Non living
A. Clouds	Grasshoppers	Clouds
B. Glowworms	Monkeys	Rocks
C. Wheat flour	Wheat flour	Polished marble
D. Polished marble	Glowworms	Rivers

The following discussion occurred between the researcher, Raghav, and another student Kalp in a student interview that was based on the answers given by for the above question in the assessment.

Researcher: Why do you think clouds are alive?

Raghav: When the water in clouds become very heavy, the cloud lets the water go.

Researcher: But, why is it living?

Raghav: Because, the water which evaporates.....when the cloud becomes heavy, it lets the water go.

Kalp: So, it's like the digestive system!

Raghav: Yes.

Kalp: I think the correct answer is C. We eat wheat flour. It's not a living thing.

Raghav: No! wheat flour is a living thing! Because wheat is a plant and plants are living.

Researcher: Raghav, do you know how wheat flour is made? The wheat is crushed and ground in a machine. Do you think it still alive after that?

Kalp: Yes, the wheat is crushed! Do you think it feels anything!? No!

Raghav: How do we know that it feels nothing? It might be feeling something!

What is striking about this conversation is the sophisticated nature of the students' arguments. The interesting part, however, is what these arguments are used for. One of the students, Kalp, argues for the belief that clouds are not living things. The other student, Raghav, is just as convinced that clouds are living things. And in order to justify this belief, he readily argues that wheat flour may be living, even in the face of strong evidence that it is not.

What is the root of Raghav's strong belief that clouds are living things?

The conversation reveals Raghav's conception of clouds. He imagines the cloud to be an entity that 'holds' water (a sort of a 'container'). Now, as he learns about the concepts of evaporation and precipitation, he imagines the water coming into the cloud, and the cloud having to 'let it go'. Because the cloud has to 'let the water go', it must be alive! Raghav's view of a cloud as a 'container' is what is called a 'pre-conception' or prior understanding. His understanding is that water is *inside* the clouds, as opposed to the correct understanding that clouds *are themselves* water. This prior understanding influences his understanding of the new information of evaporation, precipitation and the water cycle resulting in a bizarre belief that clouds are alive!

It is critical for teachers to realise that many of the things that we assume about how children learn are not true. Minds of students are not blank slates. They bring their own ideas to the classroom, many of which may be resistant to change. These ideas are picked up through previous classroom experiences and even outside the controlled environment of the school, through observations, books and the internet, and even through cartoons and television. It is these ideas that teachers should explore and identify using methods like assessment and student interviews. Until their flawed understanding is recognised and challenged, students will continue to acquire new knowledge through this flawed lens; making our classroom lessons less effective.

■ BIBLIOGRAPHY AND REFERENCES

1. Uncovering Student Ideas in Science (Vol. 1) by Page Keeley, Francis Eberle, Lynn Farrin
2. Making Sense of Secondary Science by Rosalind Driver
3. Educational Initiatives (2008), "How do our children think? – A Video Series on Student Misconceptions"
4. Educational Initiatives (2006), "Student Learning in Metro Study"
5. Student interaction videos - <http://www.ei-india.com/post-asset/student-misconceptions/>
6. Pratham (2008) - Annual Status of Education Report
7. Educational Initiatives (2007), "Municipal School Benchmarking Study"
8. www.learner.org

■ ABOUT EI

This is a working paper on the method of student interviews as a tool to understand how students think. Students from private as well as government schools were interviewed on various concepts. This working paper summarises the learnings from the project done in private as well as government schools. Students seem to be having various wrong notions about different things and they seem to be sharing these ideas openly when questioned in an informal way. This method of questioning students can be a powerful tool that can be used in various different ways while teaching.



We are an educational research organization that focuses on learning research through assessments. EI has been started by a group of IIM Ahmedabad alumni with first-hand experience of setting up and running educational institutions. It has been formed with a mission to work towards qualitative improvement in India's educational system and our vision is "A world where children everywhere are 'Learning with Understanding'".

PROJECTS OF EI:

Andhra Pradesh Randomised Evaluation Study (2004 onwards): Done in partnership with Harvard University, Azim Premji Foundation, World Bank and the Government of Andhra Pradesh, this is a longitudinal study across 8-9 years and covers currently 100,000 elementary school kids and measures the impact of various inputs (e.g., block grants, additional teachers) with outcome-based teacher incentives.

Assessment of Student Learning in Sarva Shiksha Abhiyan – RGSM, Chhattisgarh (2008 onwards): The test was developed in Hindi and administered to approximately 3 lakh students in about 1900 schools in 16 districts in Chhattisgarh states. The tests have already been conducted for students of class 3 to 8 for Language and Maths and the report has been submitted to SSA – RGSM, Chhattisgarh.

Municipal School Benchmarking Study (2004-2007): Supported by ICICI Bank, this study assessed learning in 35,000 municipal school students from class 2, 4 and 6 across the 6 biggest towns in each of the states - Gujarat, Andhra Pradesh, Rajasthan, Chhattisgarh and Uttarakhand.

UNICEF Learning Assessment Study for Quality Education (2005-2006): assessed mathematics and language acquisition among primary school children in the UNICEF quality package schools in 13 states of India. The tests were standardised across 9 languages and involved very intricate development cycle involving language experts from all over India.

Teacher Needs Assessment (2008 onwards): is a census study that has been initiated by the Royal Education Council, Government of Bhutan. In this project all teachers of Bhutan are assessed for their general ability, competence in subject knowledge and pedagogical practices.

Student Learning Study (2008-2009): Supported by Google Inc., this study is currently ongoing and assesses student learning in 21 states of India. Nearly 190000 students in classes 4, 6 and 8 are tested for learning in Language and Maths in rural and urban govt. schools.

EI'S PRODUCTS AND LEARNING SOLUTIONS:

ASSET: is an objective-type, multiple-choice test for students of Classes 3 to 10. It is a scientifically designed, skill based assessment developed in India for Indian schools. It assesses students' level of proficiency in the skills and concepts underlying the school syllabus and provides them feedback about their strengths and weaknesses. Know more about ASSET at www.ei-india.com

Mindspark: is a computer based self-learning programme that helps the child improve her skills. It allows each student to follow a learning path that is based on her need. Mindspark is currently available for Maths for classes 1-10 in English version. Mindspark can be accessed at www.mindspark.in.

Rural Mindspark: Hindi version is currently available on demand for some Maths modules. Contact EI to know more about other language versions and modules.

Some Partners / Clients

Google Inc.	Government of Andhra Pradesh	Michael and Susan Dell Foundation
Rajiv Gandhi Shiksha Mission, Chhattisgarh	Royal Government of Bhutan	Suzlon Foundation
WIPRO Applying Thought	World Bank	UNICEF, India

CONTACT DETAILS: Educational Initiatives Pvt. Ltd

Head Office Ahmedabad	Bangalore Office	Delhi Office	Hyderabad Office	Mumbai Office
613-615 JB Towers, Opp. Doordarshan Tower, Drive-in Road, Ahmedabad 380054, INDIA	No.97, 2nd Floor, Robertson Road, Frazer Town, Bangalore-560005 INDIA	3rd Floor, Lakshey Deep Plaza, A-252A, Sant Nagar, East of Kailash, New Delhi-110065 INDIA	Flat No 401/A, Shri S.K.Vihar, H.No:3-4-578/1, Beside Sri Chaitanya College, Narayanaguda, Hyderabad-500029, INDIA	Row House Number 1, Sea Coast 2, (Near Cidco Guest House), Kille Gaothan, Belapur, Navi Mumbai-400614 INDIA
Tel: 079 – 40269696, 40269625	Tel: 080 – 41657715, 64567049, 41237162	Tel: 011-26462264, 40584952	Tel: 040 – 32419534	Tel: 022 - 32686329, 27561430
Fax: 079-26841400				

E-mail us at: assessment@ei-india.com Website: www.ei-india.com

February 2010