The Imaginative Science Teaching Program is another program of:

This Guide designed and compiled by Petra Mikulan.

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Who is the program for?
This program is intended to describe, and provide resources for putting into routine practice in everyday classrooms, a new approach to teaching science. It is firstly designed for students in order that they may learn science in a more satisfying, effective, and meaningful way. It is also designed to help teachers engage students’ imaginations in the processes and details of developing scientific understanding.

What is new about this approach?
The Imaginative Science Teaching Program is distinct because of the ways it uses feelings and images, metaphors and jokes, rhyme and rhythm, stories and wonder, heroes and the exotic, hopes, fears, and passions, hobbies and collecting, and much else in engaging the imaginations of both teachers and learners with developing scientific understanding. We have designing techniques and methods to enable teachers to routinely engage students in learning science efficiently and effectively. Using these techniques for engaging imaginations can make teaching and learning, and developing scientific understanding, more interesting, engaging, and pleasurable for all.

What are the bases of this approach?
It draws on three sources:

1. Vygotsky’s ideas about the imagination and individual development;
2. Practices derived from study of traditional oral cultures;
3. The systematic study of imagination by the Imaginative Education Research Group.

All the knowledge in the science curriculum is a product of someone’s hopes, fears, passions, or ingenuity. If we want students to learn that knowledge in a manner that will make it meaningful and memorable, then we need to bring it to life for them in the context of those hopes, fears, passions, or ingenuity. The great agent that will allow us to achieve this routinely in everyday classrooms is the imagination.
Why imaginative science teaching?

We believe science can be learned in a manner that engages children’s, or adults’, imaginations. This focus on the imagination is not a matter simply of making the task of learning science more entertaining and pleasant—though this is a side-benefit of this approach. Rather the main purpose is to ensure a deeper understanding of science and its uses, increasing the learner’s efficiency and power in understanding science well. The approach described here is designed to show that science can be an extension of, and can enhance, the pleasures and power of our minds. The IST program is designed to show these new ideas at work in the contexts of everyday science teaching in classrooms around the world.

What we intend to show is how we might routinely achieve in the everyday classroom what currently requires rare intuition and energy.
Resources we offer to teachers

We provide materials to help with teaching science to students throughout school and college years. We offer a number of resources useful for imaginative science teaching and learning, including:

- **Innovative ways of using story, metaphor, images, binary opposites, the heroic, play, humour, etc. in practical lesson formats.**

- **Planning frameworks designed to identify and engage emotional and imaginative features of the lessons.**

- **Brief lesson plans showing how individual cognitive tools can directly lead to effective science learning.**

Learning and teaching science can be fun, and this program is seriously dedicated to showing how one can put the fun back in this fundamental of education.
What are the cognitive toolkits of scientific understanding?

The short answer is that cognitive tools are the things that enable our brains to do cultural work. Our brains, like those of any animal, are responsible for enabling us to do bodily and social work. But we have also amassed external symbolic material that constitutes our culture. As we learn features of our cultural inheritance, the brain is provided with the tools that enable it to realize specific capacities. Alone, no one learns to speak, to read and write, or to think scientifically with theoretic abstractions. These human potentials are actualized only by the brain learning to use particular components of our cultural toolkits. Cultural tools become cognitive tools for us when individually we learn to use them. Culture, as it were, programs our brains. For practical purposes, we divide the most effective cognitive tools of scientific understanding into three main sets:
<table>
<thead>
<tr>
<th>Cognitive Tool</th>
<th>Description</th>
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<tbody>
<tr>
<td>Story</td>
<td>One of the most powerful tools for engaging the emotions in learning</td>
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<tr>
<td>Metaphor</td>
<td>Crucial for flexible and creative scientific understanding</td>
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<tr>
<td>Images from words</td>
<td>Generating images in the mind from words is central to engaging the imagination in learning and to developing the imagination</td>
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<tr>
<td>Binary opposites</td>
<td>A powerful organizing tool, useful in initially grasping scientific concepts</td>
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<tr>
<td>Rhyme &amp; rhythm</td>
<td>Potent tools for aiding memory and for establishing emotional meaning and interest</td>
</tr>
<tr>
<td>Jokes &amp; humor</td>
<td>Certain jokes can help make language “visible” and greatly aid awareness and control of language</td>
</tr>
<tr>
<td>Play</td>
<td>Can help students’ develop increasing control over their uses of scientific knowledge</td>
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<tr>
<td>Sense of mystery</td>
<td>Helps students grasp engaging dimensions of the world beyond their routine environment</td>
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<tr>
<td>Sense of wonder</td>
<td>Can capture the imagination in the worlds that science opens up</td>
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<tr>
<td>Extremes &amp; limits</td>
<td>Students develop a fascination with the exotic and extreme, such as, for example, the contents of the Guinness Website of World Records</td>
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<tr>
<td>Sense of the heroic</td>
<td>Gives confidence and enables students to take on, in some degree, the qualities of the heroes with whom they associate</td>
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<tr>
<td>Personalized narratives</td>
<td>Show that all knowledge is a product of someone’s hopes, fears, and passions, and, in doing so, make the world opened by scientific understanding full of rich meanings</td>
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<tr>
<td>Changing contexts</td>
<td>Leads to enlivened attention and considering possibilities for breaking out of conventions and the taken-for-granted</td>
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Some examples:

How is this approach different from other ways of teaching science topics? Let’s look at a couple of examples of how we start differently. You will notice some odd terms—see the website to understand how this approach works and why it is so successful in engaging students’ imaginations.

Cold-blooded vertebrate: The mysterious and amazing eel

- For thousand’s of years the gourmets’ delight—but no pregnant ones: Where are they all coming from?
- A life-cycle weirder than anyone guessed
- Meet the man who spent much of his life tracking down the unexpected birthplace of eels
- The still unsolved mystery of eels’ migration

Biology – Ages 9 to 14.

Opening context:

General orientation: The life cycle and anatomy of this cold-blooded vertebrate may initially seem an unlikely object for one of the most mysterious creatures with one of the weirdest life-cycles on the planet. But the mystery of eels’ origins, the remarkable story of tracing their birthplace, and their strange developments as they float on ocean tides for months and years, makes for a mystery story to equal anything in fiction.

Narrative introduction: Even though eels were a delicacy for the gourmets of ancient Egypt, Greece, and Rome, there was a small problem. No one had ever seen a pregnant eel. Where were they all coming from? It wasn’t until the late 19th century that someone pulled some larvae floating in the Mediterranean onto a boat, put them in a tank of water and noticed after some time that the larvae had turned into elvers—baby eels.

Heroic quality: Persistence and ingenuity. These heroic qualities are represented in our narrative by Johannes Schmidt.

Engaging mental image: The Danish scientist Johannes Schmidt on the decks of various ships criss-crossing the Atlantic from Iceland to the Canary Islands, from North Africa to North America, pulling endless catches aboard and examining their contents in his unrelenting attempt to unravel the mystery of the life-cycle of eels. He began his search in 1904 and continued for twenty years, suspending his voyages reluctantly during the First World War. His unremarked voyages, single-mindedly pursuing knowledge about eels, challenge those of legendary Sinbads or Jasons, and those of Drake, Magellan, and Cook. And what was he doing all those years, braving the Atlantic ocean in all weathers? He was looking for younger and younger eels, elvers, larvae, and tracing them by age in order to locate their breeding grounds.
Butterfly transformations: the astonishing changeling

- from caterpillar to featureless chrysalis to flying flower
- from a static youth of incessant eating, to silent darkness, to astonishing flights across continents and oceans
- the mystery of the monarch butterfly’s incredible 3,000 mile migration, and their built-in “compass”
- the “butterfly bush” brought from the mountains of China 150 years ago

Opening context:

1. General orientation: The transformations that butterflies go through in their life-cycle are among the most dramatic in the animal world. Many animals go through significant changes, but the butterfly seems uniquely to move from one opposite to another constantly; from feasting voraciously to eating nothing to merely sipping nectar; from inhabiting a small space to travelling huge distances; from monochrome dullness to the most colorful creatures.

2. Narrative introduction: If we think of the squirrel and the caterpillar or chrysalis, the squirrel seems by far the most active and energetic, running around energetically almost from birth. But while the early part of the butterfly’s life is static and constrained, that silent dullness is preparation for a freedom of movement the squirrel will never know. The ultimate great freedom of the butterfly to travel hundreds and sometimes thousands of miles is possible only because of the constraint of its earlier forms. We will conclude this brief unit by looking at the relationship between early constraint and freedom in the lives of other creatures, and compare them with the butterfly’s.

Binary opposites: Constraint and freedom

Engaging image:

The images of the imprisoning chrysalis and the free flight of the adult butterfly is perhaps the easiest to use. We can describe the early life of the butterfly egg, the caterpillar, and the chrysalis as preparation for escape from the small space of its early life. The caterpillar does nothing but eat, which hardly seems the way to prepare for flight. But then, quite suddenly, it stops eating. It molts from its skin one last time and waits, perhaps bewildered at what is happening to it, as the skin hardens into a chrysalis where it lies inside, inert, helpless, and cold. How can it be escaping in there? It is certainly changing again. We can see the hardened chrysalis begin to take the imprint of a developing head, thorax, and legs. But whatever is happening, it does not look like an escape from the prison of the chrysalis. Then the cocoon is forced slowly apart. What freedom can the caterpillars expect to achieve once it comes out? But out comes the a trembling creature with crumpled wings. A rush of blood through the frail body and the wings unfurl, and then sway and flap, and its colors glisten. And it can fly, immediately. The frail butterfly can often migrate over a thousand miles.
A part of the novelty of this approach is that it draws on the work of Russian psychologist **Lev Vygotsky** (1896-1934), and extends his “cognitive tools” for use in daily literacy instruction. What are “cognitive tools”? The short answer is that they are features of our minds that shape the ways we make sense of the world around us; the richer the cognitive toolkit we accumulate, the better the sense we make. The particular tools we pick up influence our interpretations of the world around us, just as lenses influence what our eyes see. The lenses or cognitive tools “mediate” how we can see and make sense of things. If we want to understand how and what we can learn, then, we should focus our attention on these cognitive tools. Our educational challenge is how to stimulate, use, and develop these tools to enhance students’ understanding and their literacy skills—and that’s what the ILP aims to show you how to do. Vygotsky’s work suggests a new approach to teaching literacy because of his fundamentally different way of describing how human beings develop intellectually. (For a fuller description visit [http://www.sfu.ca/~egan/Vygotskycogandlit.pdf](http://www.sfu.ca/~egan/Vygotskycogandlit.pdf)).

Another foundation for this approach involves studies of thinking in **traditional oral cultures**. This might seem a second rather unusual place to look to for help with everyday literacy teaching today, but we show what this seemingly indirect route to literacy instruction has to offer. Teachers get a better grasp on how to help people learn literacy by understanding the tools that underlie it and from which it emerged historically and from which it emerges now. Clearly children and adults in the West who come to literacy classes cannot be considered in any simple sense like people who live in oral cultures. For one thing, the environment of the modern non-literate child or adult in the West is full of literacy and its influences. But despite this, many of the “cognitive tools” we find in oral cultures, such as storytelling and rhyming, help us to understand how literacy instruction might be made more imaginatively engaging to students. Even very briefly exploring some of the cognitive tools of oral language will yield a number of practical techniques. (For a more extensive account see “Literacy and the oral foundations of education” at [http://www.hepg.org/her/abstract/476](http://www.hepg.org/her/abstract/476)).

The third foundation is the work of the **Imaginative Education Research Group**. This group came into formation with the beginning of the 21st century, and has quickly developed an international reputation for its innovative, practical, and successful programs. Their focus has been to show how the emotions and imagination of learners have to be engaged for learning to be effective and efficient, and they have shown great versatility in designing techniques and methods for enabling teachers to routinely engage students in these richly evocative ways.
This program in imaginative science and technology is among the newest of the IERG’s initiatives. You can find further material about this general approach, and many more examples of lesson and units plans on science and technology topics and also on all other areas of the curriculum, at http://www.ierg.ca. The third foundation of IST is described in detail in Kieran Egan’s book *The Educated Mind: How cognitive tools shape our understanding* (University of Chicago Press). Early reviews of the book included the following:

"Kieran Egan has one of the most original, penetrating, and capacious minds in education today. This book provides the best introduction to his important body of work." Howard Gardner, author of *Frames of Mind, Multiple Intelligences: The Theory in Practice*, etc. Book cover, hardback; "A carefully argued and readable book . . . Egan proposes a radical change of approach for the whole process of education. . . . There is much in this book to interest and excite those who discuss, research or deliver education." -- Ann Fullick, *New Scientist;* "Almost anyone involved at any level or in any part of the education system will find this a fascinating book to read." -- Dr. Richard Fox, *British Journal of Educational Psychology;* "A new theory of education that is (believe it or not) useful. . . . 'The Educated Mind' is something very new and different." C.J. Driver, *The New York Times Book Review;* "This is really a very exciting book . . . Readers who feel jaded by the output of recent educational thinkers will be refreshed by this book." Oliver Leaman, *The Lecturer;* "Kieran Egan writes with clarity and wit on one of the most crucial issues of our time. The school train, Egan warns us, is lost in a confusion of philosophical dead-end tracks: we need new directions, new signs and signals to help us rethink the journey. In Egan's imaginative portrayal of 'the development of understanding,' he gives us an entirely new map, for immediate use. If we begin by reinventing the teacher as storyteller and recognizing the children as the intuitive poets and dramatists they are, we will be ready to join Egan in his extraordinary vision of sensible schooling available to all." Vivian Paley, author of *Boys and Girls: Superheroes in the Doll Corner, Kwanzaa & Me: A Teacher's Story*, etc. (Book cover.)
Workshops:

Contact us for costs and conditions.

We also provide on-line videoconference sessions, and an on-line mini-course about Imaginative Science Teaching. E-mail us if you would like more information about these.

One of the aims of the IST program is to create a communication network among researchers, practicing education professionals, and others with an interest in science education. If you would like to receive electronic announcements updating you on our work, events, or activities, or to sign up for our newsletter, please contact us.

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Website:
http://ierg.ca/IST/

Watch the website for news about conferences and other presentations. The website also provides opportunities for you to send comments, ask questions, etc.

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An Imaginative Approach to Teaching

By Kieran Egan.
[Translations available in Romanian, Japanese, Indonesian, and Korean.]