*The 6th TRIZ Symposium in Japan, 2010*
*Held by the Japan TRIZ Society, NPO*
*Special Interest Lecture*

# Education with TRIZ:

## For New Perspectives

***Sept. 9 - 11, 2010***
***Kanagawa Institute of Technology***
***(Atsugi, Kanagawa, Japan)***

**Toru Nakagawa**
**(Osaka Gakuin Univ., Japan)**

## Introduction

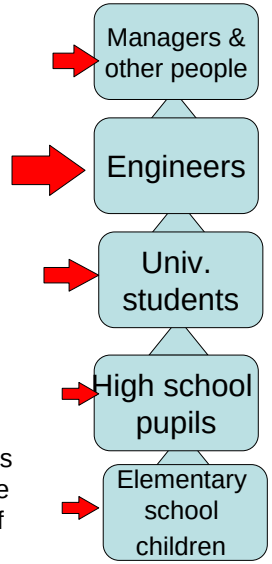
For the purpose of penetration of TRIZ, (the methodology for Creative Problem Solving):

We have been making efforts for penetrating TRIZ mostly in the field of technologies and to the engineers as the main target.

However, it must be necessary and useful to enhance the penetration efforts in the filed of education, both in the higher education and in the middle and elementary educations.

Thus, Japan TRIZ Society has just started the **"Education with TRIZ" Study Group**
(Group Leader: Nakagawa)

So I will Introduce you various examples of activities by myself and others in Japan and overseas, for the purpose of considering the problems and to think of future directions.



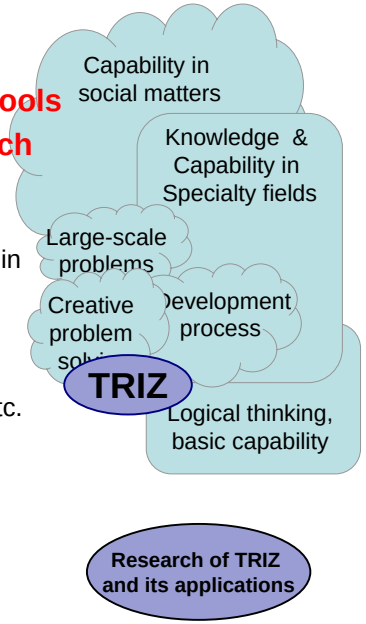

## (A) The First Target:

**At Universities and Graduate Schools**
**TRIZ-based education and research**

Not only teaching TRIZ KB and techniques,
But also we need cultivating students' ability in
creative problem solving,
overall process of technology and product development,
handling large-scale complex problems, etc.

It is also important to combine TRIZ with the specialty education in each department.

Research of the TRIZ methodology and its applications is also necessary.




## (B) The Second Target:

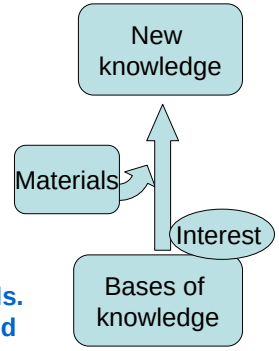
**To the Primary and Secondary Education**
**Introduce creative thinking with TRIZ.**

It is necessary to adapt teaching contents and methods according to pupils' interests and maturity.

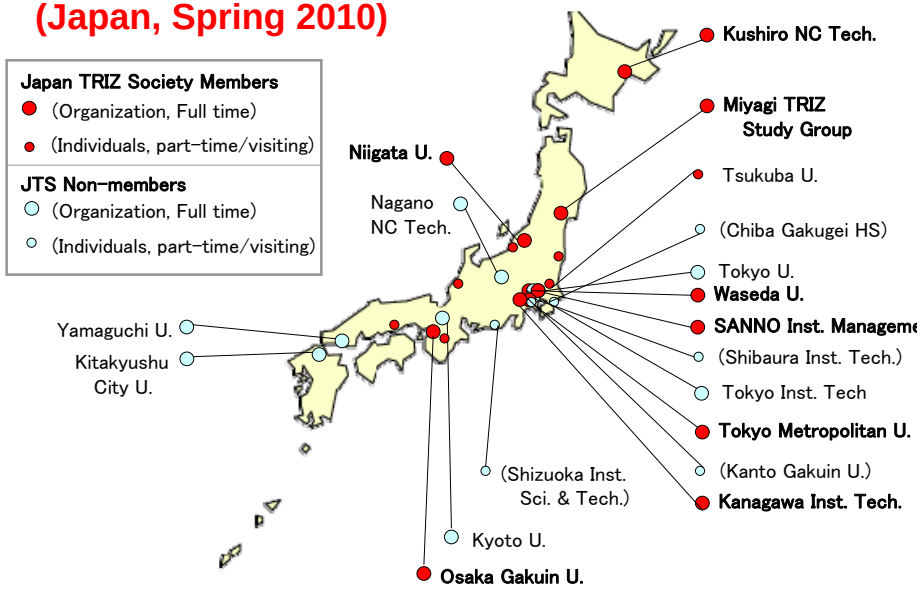
Attracting their interest is especially important, by properly selecting the materials and topics.

Various courses have been developed in Russia, Belarus, etc. We can learn from them.

**There are many and different people having experiences in creativity education at schools. We should better communicate with them and learn from them.**



## TRIZ in Education (Japan, Spring 2010)




## A. Education with TRIZ at Universities and Graduate Schools

It must be useful to teach TRIZ, especially in

Thinking methods for creative problem solving,
Knowledge bases extracted from huge body of science & technology,
and Effective usage of them,

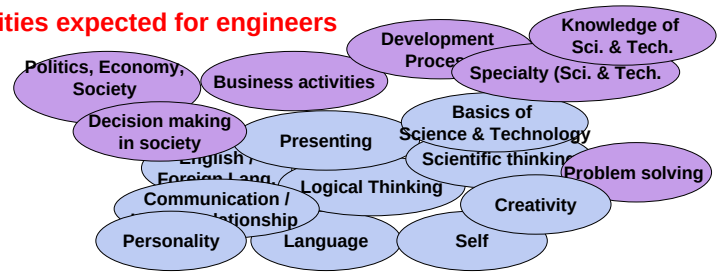
as a part of fundamental education at the universities.

Particularly useful for students in Science & Technologies area.
Can be useful for students in other areas, if properly adjusted.

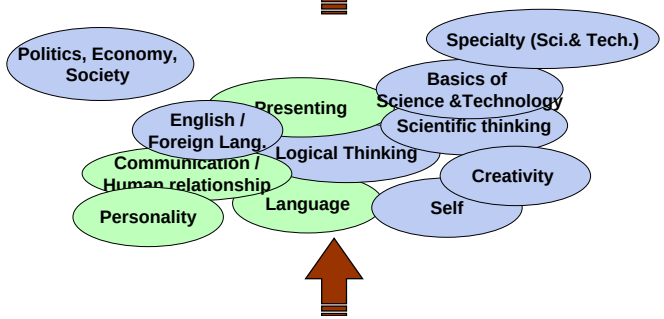
**However, the background knowledge of (undergraduate) studens is much different from that of engineers.**

**--- We need to be careful about such differences.**

### Capabilities expected for engineers




### Capabilities expected for students




## Educating Undergraduate Students:

Students do not have experiences in technology and working in business.
They do not have (at least initially) motivation in the TRIZ related topics.

**Thus we have to teach them step by step from the very basics.**

Basic ways of creative thinking,
Basic concepts of systems, functions, causes & effects,
Basic processes of planning, designing, development, etc.,
Basic mechanisms related to individual technical problems, etc.

For handling a specific technical problem, preparation for these understandings is required.

Hence,
Handling specific technical problems is not easy/appropriate.
Textbooks and Web articles written for engineers are not suitable for students (at least at the initial stage).

**==> It is practical/useful to train the students to solve problems familiar in their lives.**

## Education at the Universities: Various Alternatives

**Number of lectures:**

Usually, 1 course is 90 min. x 15 (= 22. 5 hrs.) ,
How many courses can we use? (Ex. half, one, two, etc.)
==> This makes difference in the contents of the course.

**Position in the curriculum:**

Ex. Common basic class for different departments
Relationship with specialty classes,
Different background knowledge depending on the year of students.

**Style of teaching:**

Lecture, Practice in a large class, Seminar in a small class,
Individual practice (ex. Thesis work), Research project, etc.
==> We should select one or some in combination.

**Selection in contents:**

Necessary to select the essence of TRIZ.

## Ex. A1: "Lecture to Teach TRIZ" in 1 to 3 courses
## TETRIS Project of EU

(G. Cascini, N. Khomenko, et al., ETRIA TFC 2008)
(G. Cascini, Editor: TETRIS TRIZ Handbook, Nov. 2009)

**"Teaching TRIZ at School"**
(Project for establishing a TRIZ Course at High schools, Universities, and Industries)
('Body of Knowledge' of Classical TRIZ is compiled as a textbook.)

TETRIS TRIZ Handbook (Textbook, 280 pages) (distributed free)

1. Fundamentals of Classical TRIZ
2. Laws of Engineering System Evolution
3. Short Review of ARIZ Illustrated by the Analysis of a Real Problem
4. Su-field Analysis and Standard Solutions
5. Techniques to Resolve Contradictions / Resources / Effects

***** It seems necessary to adapt more to students' background knowledge and interests. *****

## Ex. A2: Lecture: "Methodologies of Creative Problem Solving"

Toru Nakagawa (Osaka Gakuin Univ.), Faculty of Informatics,
2nd year, 2nd term, Optional class, Common basics in the Dept.

**(1) Easy Introduction, demonstrated with a few application examples**
**(2) Three main approaches in science & technology:**
Observations => hypotheses; Principles => applications; Problems => solutions
**(3) Finding the problem, and focusing on the core problem**
**(4) What is ideation? Enlightenment and Brainstorming**
**(5) 'Systems'**

**-- Analyzing the Problems --**

**(6) Searching for the root causes**
**(7) Analyzing the system in the aspects of functions and attributes**
**(8) Extra: How to prepare for and write reports (papers)**
**(9) Analyzing the space and time characteristics;**
**and making an image of the ideal (Particles method (or SLP))**

**-- Generating solutions --**

(10) Utilizing knowledge bases: Variety of TRIZ Knowledge Bases
(11) How to break through the barrier?
'Physical Contradiction' and TRIZ 'Separation Principle'
(12) System of solution generation methods: 'USIT Operators'

**-- Summing up the lecture --**

(13) Examples of creatively solving familiar problems
(14) Creative problem solving method with USIT (i.e. Easy TRIZ)
(15) Creative problem solving method with TRIZ
-- Concluding the lecture --

***** Focus on TRIZ/USIT, and covers the whole area of creative problem solving. *****

### Ex. A3: "Creative Design Exercise Class"

**Youtaro Hatamura, Masayuki Nakao, et al. (The Univ. of Tokyo)**
Mechanical Engineering Dept. & Industrial Mechanical Engineering Dept.
A common basis for the departments, 3rd year students.
(Their own methodology, partly incorporating TRIZ)

### Ex. A4: "Introduction to Invention & Ideation Supporting Systems"

**Osamu Katai, Hiroshi Kawakami, Mitsuo Morihisa, et al**. (TRIZ Sympo. 2007)
**Kyoto Univ.,** Faculty of Engineering, Dept. of Physical Engineering
A seminar class of 3rd year students
(Usage of TRIZ software tools and writing a patent specification.)

### Ex. A5: "Product Development Process and TRIZ"

**Yamaguchi Univ. (Shigeru Kasuya,** TRIZ Sympo. 2006)
Exercise of conceptual design of mobile robots. Four 3-member teams.
Surveying needs (with QFD), and problem solving (with TRIZ).
Ex. A robot returning books to the shelves in a library.

***** Approaches suitable and productive for teachers who have experiences at industries. *****

**An Exercise in Nakagawa's Lecture (Ex. A2.)**

## What should we do to improve lecture classes?

**QA:** Concerning to this (or other) lecture class, list up 3 problems you think we should improve.

**QB.** Figure out the 'mechanism' of 'giving a lecture' or 'attending at a lecture'.

**QC.** Make an image of 'Ideal lecture' and figure it out.

**QD.** In order for you to study and understand better, what should we/you do?

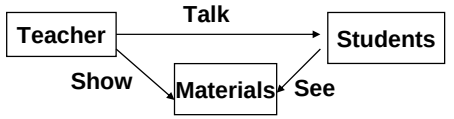
## QA. What are the problems of the lecture class ?

## Problems posed by students (though not explicitly)

- I don't understand what purpose and what use this lecture has.
- I don't understand what Teacher is really saying.
- The lecture is boresome, not interesting.
- The lecture is just given, without chances of asking questions and saying my opinions.
- Various lectures handle widely different topics without much relationship; and hence I cannot follow them.

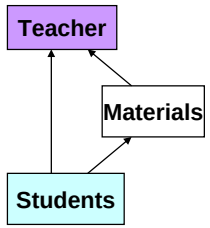
## QB. Illustrate the 'Mechanism' of Lecturing:

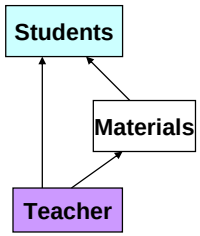
**First, illustrate the skeletal structure among principal components.**

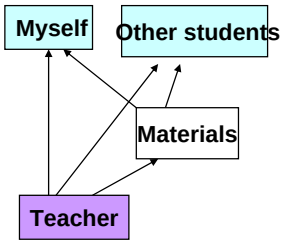



Functional Analysis with USIT

Put the most important component for the purpose of a lecture at the top.
Rearrange other components in the way the upper component is functionally supported by the lower components.
Show the functions between directly contacting components with arrows.



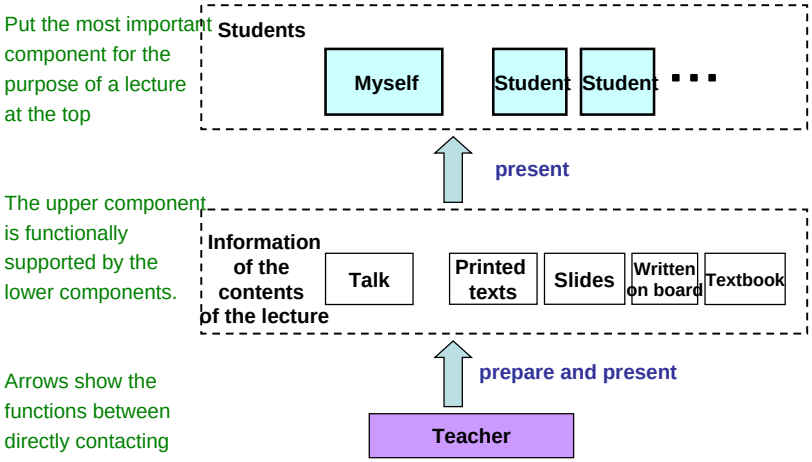



# Illustrate the Functional Relationships of Lecturing.

Put the most important component for the purpose of a lecture at the top

The upper component is functionally supported by the lower components.

Arrows show the functions between directly contacting components.

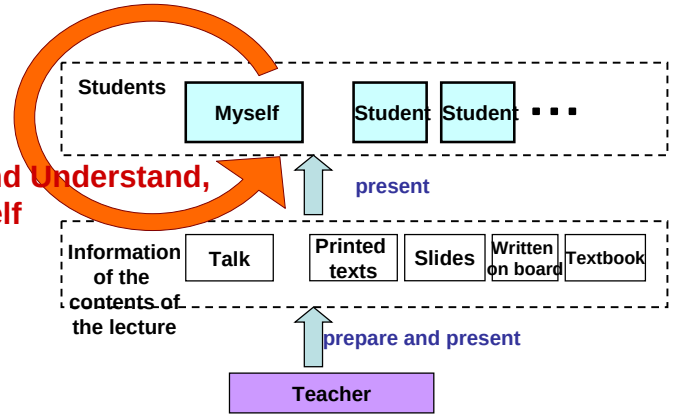



*** However, something WRONG in this slide ??? ***

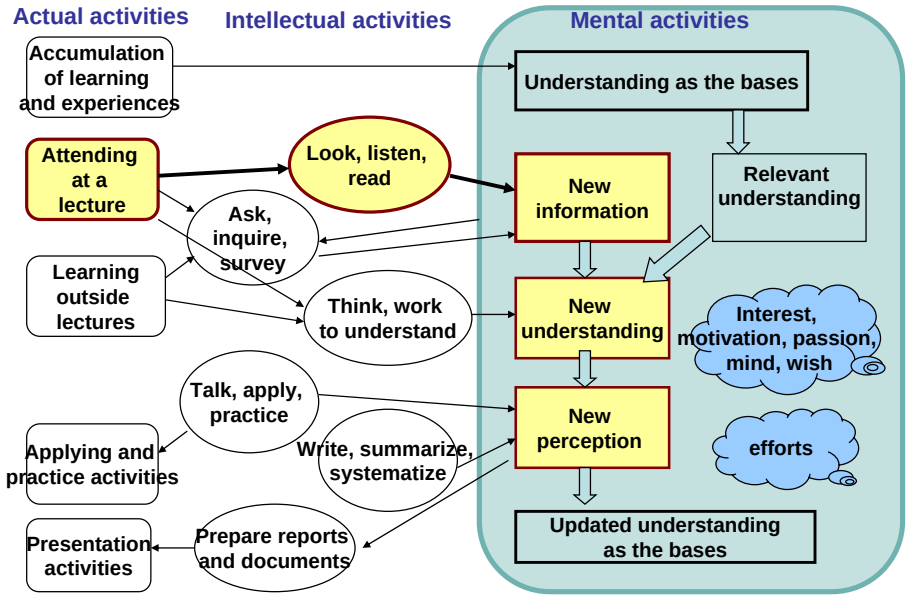
Students (Myself) are only receiving the presented contents.
They are just served, and are not doing anything actively.
No description of students activities of 'learning' and 'understanding'.
(This diagram of lecturing works even if the student is sleeping!)

In the previous diagram, the essential function was missing:

Learn and Understand, for myself




# Illustrate the mental activities of 'Learn and Understand' for myself.




# What should we do, for making lectures/classes better?

The students have to

(and hence the teacher has to support them to)

prepare for the bases of knowledge,

interest, motivation, and concentration,

in order to make the best of 'look, listen, and read',

and also to do intellectual activities of

'thinking, applying, and examining'.

## Ex. A6: Students used TRIZ in their project work.

Masao Ishihama (Kanagawa Inst. Tech.) (TRIZ Sympo 2006)

Formula SAE Project

(Society of Automotive Engineers)

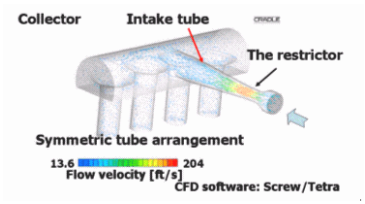
(Held annually in Michigan State, USA.)

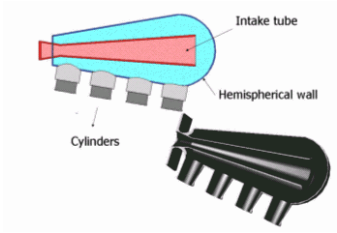
**Improvement of the Air Intake Pipe of the combustion engine:**

**Use of CAE software**

**Experiences of machining**

**Use of TRIZ Contradiction Matrix**




## Ex. A7: Seminar Class (3rd yr.) and Thesis Class

Toru Nakagawa, Osaka Gakuin Univ., Faculty of Informatics

**"Thinking methods for creative problem solving"**

**Seminar Class (3rd year) (1 to 5 students for each year)**

-- Prerequisite of taking Nakagawa's lecture at the 2nd year.
But some students came without taking it.

- Study and making practices of published application examples
- Group practices to solve various problems familiar around us are useful.
  -- Through these practices, problem solving methods TRIZ/USIT are explained.

**Seminar Class for Thesis Work (4th yr., the same members)**

- Continue the group practices of solving familiar problems.
- Each student is requested to find a problem to solve in the thesis work, individually.
- Students present their work by turn and all the members join the discussion.
- Prepare the thesis [with 2 page Extended Abstract]; Presentation of Thesis (1 hour each).

"TRIZ Home Page for Students by Students" (Established Mar. 2006)

***** Students have made several good case studies, even though the quality of theses vary much. *****

**Example: Tsubasa Shimoda, Thesis work (2006)**

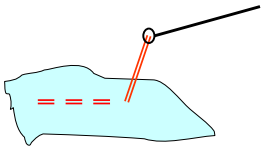
## How to fix a string shorter than the needle at the end of sewing

**Define the Problem:**

**(a) Undesirable effect:** The string is shorter than the needle and prohibit applying the standard way of making a knot.

**(b) Task statement:** Devise methods for fixing the string left shorter than the needle.

**(c) Sketch:**



**(d) Plausible root causes:**

The standard way of making a knot is applicable only when the string left is longer than the needle.

**(e) Minimum set of relevant objects:**

Cloths, string (already sewn), string (left), the needle

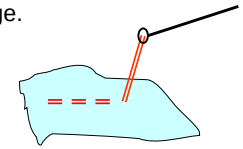
## Problem Analysis (1): Understanding the present system

**(1) Functional analysis: What is the function of the Needle?**

A base for making a loop of the string;
A guide for passing the end of the string through the loop

**(2) Attribute analysis:** Properties taken for granted form the Constraints:

The string does not expand = Its length does not change.
The needle is hard = No change in shape and length.

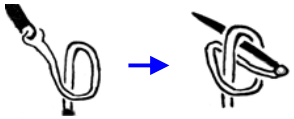


**When any of these constraints is lifted, there appears a novel solution.**

**(3) Analysis of time characteristics:** Processes of sewing:
Solutions at the final stage and solutions at any earlier stage.

**(4) Analysis of space characteristics:** A knot makes the string thick at the end.
Watch out about the topology in making a knot and in the 'hole and string' .

## Several known solutions:



A well-known technique.
Difficult to make the loop of string in the space; need some practices

The hole of the needle has a slit, thus the string can be passed and removed without cutting the loop of the string. (a commercial product)

## Problem Analysis (2) : Understanding the Ideal system

**Ideal arrangement of a sting in space for making a knot**

**It should be nice if we could hold the string in this arrangement in the space.**

## Solution Generation: Generate Ideas and Construct Solutions

Known technique

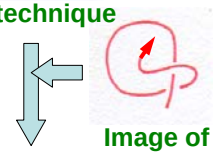
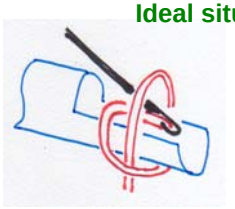
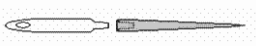


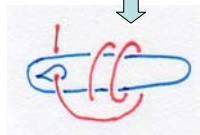
Image of Ideal situation



A novel tool made of a straw

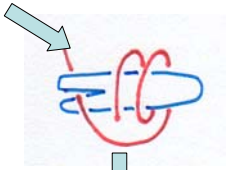


A ridiculous idea



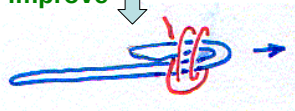
A novel needle specialized for making a knot

improve



improve

improve



## Case Studies of TRIZ/USIT for Solving Familiar Problems

**Nakagawa's Seminar Class at Osaka Gakuin Univ.**

- How to avoid the crashing of stapler needles <=> SLP method
- How to fix a string shorter than the needle <=> USIT full process
- How to Help Recall Passwords <=> Physical contradiction
- How to Prevent Unauthorized Persons from Entering the Auto-locking Door of Apartment Building
  <=> Solving psychological/social and technical problems altogether
- How to Prevent Cords and Cables from Getting Entangled:
  <=> Systematic Classification of Various Solutions

These case studies are easy to understand for students, engineers, and even high school pupils.

*** Good case studies can not be established by students alone; teachers must write papers with full discussions. ***

## Ex. A8: Apply TRIZ in the M. C. and PhD Thesis Works in Various Specialty Fields

(Possibilities: Kanagawa Inst. Tech., The Univ. of Tokyo, etc.)

Mechanical engineering, IT, Chemistry, ・・・

In any field, on any topic,

***** This must be the main target of 'Applying TRIZ in Academia'.**

**But actual results have not been reported yet in Japan.**

**Teacher of the research project should have mastered TRIZ/USIT, and lead the student as 'a tutor with TRIZ'.**

**It is desirable for TRIZ/USIT specialists to cooperate with teachers/students in various fields.**

## Research and Development of the TRIZ Methodology

**At the Master and PhD Courses, to foster TRIZ specialists**

**Ex. A9: INSA Strasbourg (France)**

**Advanced Master in Innovative Design**

(Specialty in TRIZ and OTSM-TRIZ; The only MC Course in the Western World.
(Roland De Guio、Dennis Cavallucci、Nikolai Khomenko、et al.)

**Lectures: Total 413 hours**

Innovation management, Innovation design, TRIZ team management, TRIZ fundamental theory, TRIZ techniques and tools, ARIZ theory & practice, Classical TRIZ and OTSM, Problem Flow Network (PFN) Approach (x3), Applications of PFN.

**Projects of Industrial Practice: 4 months**

***** TRIZ has some research centers in the West, but not so strong yet. *****

**Inside TRIZ consulting firms (Ideation, GEN3, Systematic Innovation, CREAX, etc,)**

**Inside industries (Samsung, Intel, etc. )**

**Few European Universities (INSA Strasbourg, )**

## Ex. A10: Seminar/Workshop without Showing TRIZ Explicitly

T. Nakagawa, Osaka Gakuin Univ., Seminar Class for 2nd yr students

**==> Poster Presentation: Kurumi Nakatani & T. Nakagawa (3rd Day)**

**'Studying the Evolution of Technologies in Familiar Items'**

**Example: A Large Variety of Writing Instruments**

- Show your own favorite Writing Instruments, and explain their good points !
- Visit stationary stores, home-centers, internet, etc. and survey various kinds of Writing Instruments !
- Explain the mechanism of writing/drawing with them !
- Classify the Writing Instruments with the mechanisms !
- Think of Various Usages of Writing Instruments, and classify the usage ! Where (on which), What, and How to write/draw ?
- Tabulate Writing Instruments as classified by the mechanisms and by the usage.
- Why do we have so many different kinds of Writing Instruments ?
- Search for different methods of writing/drawing without using ordinary Writing Instr.
- Think of methods to write/draw the same elements or same things repeatedly.

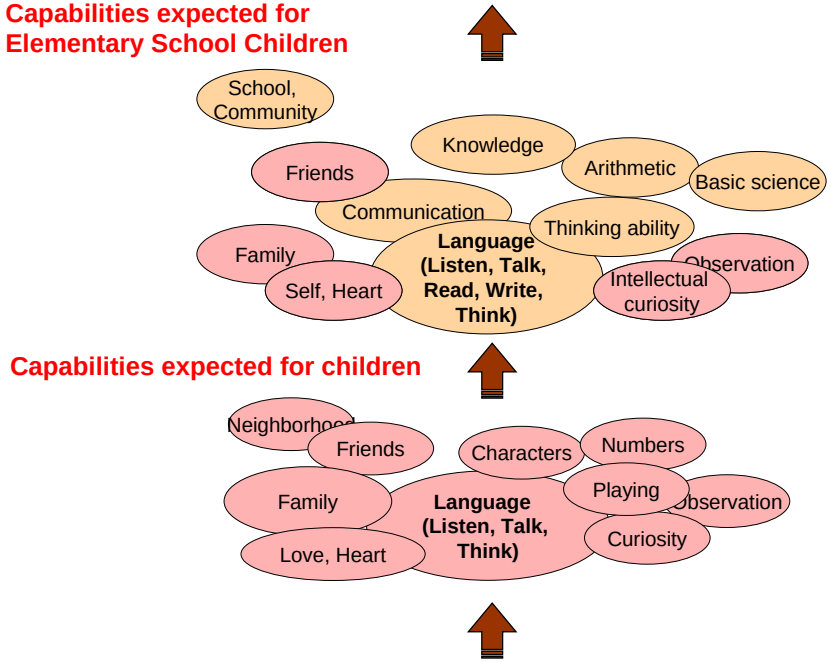
***** This approach can be done even with high school to elementary school children. *****

# B. Education for High School, Middle School, Primary School Children and Penetration in Society

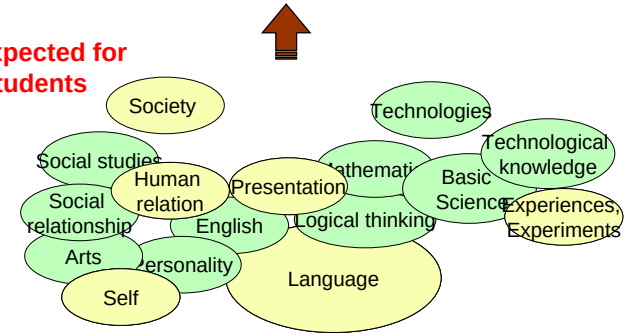
**It is a big task and question how to teach creative thinking to high school students and children.**

**In accordance to the growth of children, we should teach them step by step in the aspects of**

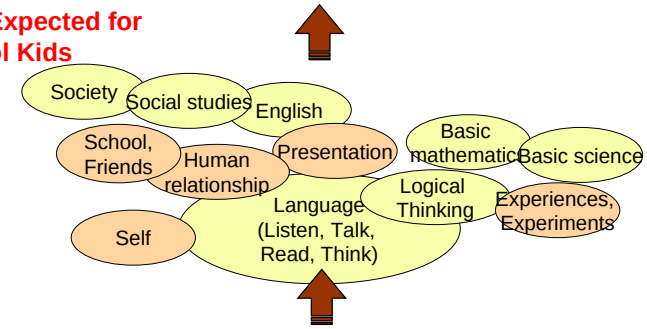
Sensibility, Interest,
Observation capability, Scientific thinking,
Basic understanding of science and technology,
Logical thinking,
Ability of ideation,
Capability of problem solving, etc.



## Capabilities Expected for High School Students




## Capabilities Expected for Middle School Kids



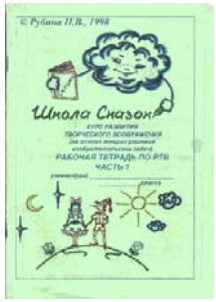

# Ex. B1: Creativity Education for Children

**Active in Russia, Belarus, etc. (Nikolai Khomenko is the leader)**

## CID Course for Children: 'Creative Imagination Development'

Written by Natalia Rubina (1997-1999), English translation. Irina Dolina,
Posted in "TRIZ Home Page in Japan" (2001 - 2002)

For 1st - 3rd yr. Elementary School; Once a week, 1 hour x 15 per semester
Whole set of 12 booklets: Workbooks for children and Guidebooks for teachers




**1st Year: "Fairy Tales School"**

- What does this or that consists of? Where are they located?
- How feels this or that? How seems this or that?
- What can one do and why?
- What was in the past and what will be in the future?

- Fairy Tales from the word "why"
- "Spoiled" Fairy Tales.
- "A Fairy Tale is not true, but there is a hint in it." (Proverbs)


**2nd Year: "Fantasy City"**

- Adventures in Fantasy City: Morphological Box
- Unusual Inhabitants of Fatasy City (Animation Method)
- Magic shop
- Methods of Making Images

- Methods of Solving Problems (Contradictions), Both Cold and Hot (Physical Contradictions)
- "... Sledge, Go Home By Yourself!" (Ideality)
- "Use What Is at Hand, and Don't Look for Anything Else"


**3rd Year: "Planet of Unsolved Mysteries"**

- Methods of Solving Contradictions
- Scheme of Solving Problems

- Modeling with Smart Little People
- Practice Work on Solving Problems

# Scheme of Solving Problems (CID Course for Children) (N. V. Rubina)

**The present problem is:**

If _____

Then (+) _____

But (-) _____

**Articulate the ideal solution:**

_____

**Find the opposite properties:**

_____ should be _____, in order to _____ ,

and should be _____ , in order to _____

**Which resources are there for the solution of this problem?**

_____

**Solution:**

_____

_____

_____

## Ex. B2: Creativity Education for Elementary School Children (Higher grade)

Harumi Ichikawa (Daughter of the late Prof. Kikuya Ichikawa)

### Workshop for Children on Creativity through ET (Equivalent Transformation)

The CAMP Group in Keihanna organized the workshops.
Half-day workshops for children are held continuously on various topics.
H. Ichikawa recently joined this group and started the ET Workshops.

The core concept in ET (by Kikuya Ichikawa) is:
"To find a common essence in different things/phenomena".

Having prepared a large set of picture cards, invite the children to find a common nature/aspect among different things.
Children are requested to tell why he/she think the two pictures are common.

After such an exercise, the children enjoy working to make various things freely by using the materials prepared.

H. Ichikawa says: "I did not have experiences of working for education, I now conduct this workshop smoothly and naturally."

**Anything can become a trigger of new activities.**
**It is nice to have mothers and teachers learned of TRIZ.**

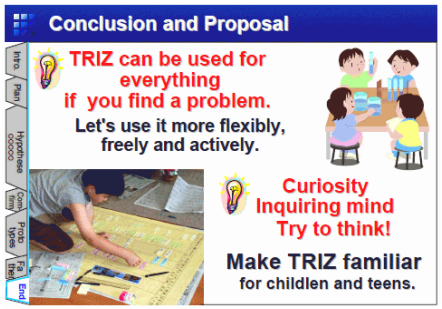
## Ex. B3: Creativity Education for Middle School Kids

Katsuya Miyanishi (Father) - Taichiro and Kai Miyanishi (Sons) (Kanazawa)

### A Summer Homework by Son and Father with TRIZ

"Why Water Striders can stand and slide on the Water?"


Father guided Son to consider various ways for Water Striders to stand and slide on the water surface, and to built toy models.




This suggests the possibility of off-class/club activities at schools or at private organizations.

## Ex. B4: Creativity Education at High Schools

Kouji Harada, Kunio Takahashi (Chiba Gakugei High School) (2002)

Preparation for materials (by teacher) and Web posting (by students)

Materials to study ET and TRIZ Solution Methods

Home Page built by students

An example of problem:
How to save electric power?


Solution:
Using a sensor light

## [Discussion] Possibilities of Creativity Education for Elementary School Children to High School Students

- **If we obtain an occasion, we will certainly make it!**
  **It is essential to make the children get interested in.**
- **Should not try to teach the methods and terms**
  Using real cases, we may choose to apply various ways of thinking, not limited to the TRIZ methods.
- **Approach of mostly using observations, surveys, and discussions:**
  - How to Prevent Cords and Cables from Getting Entangled
  - A large variety of Writing Instruments
  - A variety of nails, and their evolution
  - Variety of tools for picking up/cutting/removing weeds.

**Studying the Evolution of Technology in familiar items**
**==> Will gradually induce idea generation by ourselves**
-- Want to have something applicable to this sort of usage !
-- Have difficulty in doing such and such.
-- There can be a new method like this !

## [Discussion] Necessity of Cooperating with Many Other People

**The TRIZ Community in Japan is very poor yet in the experiences of education of high school students and children.**

**It is necessary to cooperate with various people and organizations who are preceding in the education.**

Japan Creativity Society,
Researchers in the field of education (e.g. Japan Education Engineering Soc.)
Teachers at schools
Voluntary people working for education in communities,

**Let's try various activities in cooperation with these people!**
**Once we have occasions, we can make use of them.**
**Once we contact with young students and children, we can make various trials.**

**Announcement 1:**

## Group Discussion "Education and TRIZ"

### Today after dinner (2nd Day, 19:20 - 21:00) 12F Cafeteria

Coordinator: Toru Nakagawa + Nikolai Khomenko

Language: Mostly in English (Interpreter support: Japanese → English)

Topics: Education and TRIZ at the Universities
Education and TRIZ for children to high school

Penetration of TRIZ to society/community
Understanding of TRIZ in its essence

Speakers: Masao Ishihama, Katsuya Miyanishi, Seiji Watanabe, Mahmoud Karimi,

**Announcement 2:**

## Japan TRIZ Society
## First Meeting of "Education with TRIZ" Study Group

### Tomorrow morning (3rd Day, 9:00 - 9:40) 12F Cafeteria

Coordinator: Group Leader: Toru Nakagawa (Osaka Gakuin Univ.)

Language: Japanese only.

Topics: Reports by each member
Discussion on the future activities of the Study Group

***** If you are interested in the activities, please come and join us.**
**Study Group is open to you all.**