



# **Nurturing the Inventive Spirit**

## **- A Handbook for Teachers**

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**Foreword by Prof. Phua Kok Khoo**  
Chairman, Tan Kah Kee Foundation  
Chairman, Tan Kah Kee Young Inventors' Award Committee

Singapore's vision for the future is to successfully transform itself from a Manufacturing-Based Economy to a Knowledge-Based Economy. This vision is crucial to sustaining the economic growth and prosperity of our small nation against the backdrop of increasing globalization and competition.

Several ingredients are crucial in Singapore's drive to become a Knowledge-Based Economy. One of the key ingredients is the creation and generation of new ideas. Singapore has been relying largely (particularly in the past) on knowledge and technological transfers from multinational corporations and foreign talent from developed countries. In advancing and progressing to a Knowledge-Based Economy, the creation of new ideas and inventions by Singapore's people and institutions is extremely important. This is recognised by the Singapore government, which is stepping up its investments in research and development, as well as expanding its initiatives in developing Singapore into a regional Intellectual Property Hub.

The Tan Kah Kee Young Inventors' Award was set up by the Tan Kah Kee Foundation to encourage and facilitate the above objective. The award serves to foster creative thinking and an innovative spirit among young Singaporeans. It has been 17 years since the Tan Kah Kee Young Inventors' Award was first launched in 1986 and I am pleased to say that the award has been very successful in meeting its objective.

To further improve the quantity and quality of the entries for the award and to empower teachers with a creative space for ideas, we organized the seminar entitled "Nurturing the Inventive Spirit" for teachers. We hope the teachers can benefit from this seminar, and that when they return to school with these new insights, they will continue to nurture an inventive spirit in our young Singaporeans.

## **Foreword by Dr. Low Hwee Boon**

Co-Chairman, Tan Kah Kee Young Inventors' Award Committee

In a global, digital and knowledge-based economy, the best use of knowledge and technology is manifested in its inventions and innovations. The ability to effectively use such knowledge and technology confers on companies and nations a better competitive advantage.

The Tan Kah Kee Foundation has been fostering creative and innovative thinking among young Singaporeans for many years. The Tan Kah Kee Young Inventors' Award was first mooted by Nobel Laureate Professor C.N. Yang in May 1986. Professor Yang, who is Tan Kah Kee Foundation's advisor and mentor, observed that most Asian students, including Singaporean students, were good at academic pursuits but lacked an innovative and inventive spirit. He thus proposed an award for inventions that would encourage people to innovate and invent, which would create economic benefits for society.

Since 2001, the Foundation has initiated and organised the "Forum on Creativity in the Arts, Science and Technology". The Forum was successful in bringing together a number of eminent speakers from both overseas and Singapore to give their views and personal experiences on creativity in their own fields. This year the Foundation has organised a seminar for teachers entitled "Nurturing the Inventive Spirit". The Seminar complements the Forum and provides a platform for teachers to share their experiences in encouraging innovation and invention in school. The Foundation has also compiled a resource book entitled 'Nurturing the Inventive Spirit; A Handbook for Teachers'. We hope that this handbook will be a useful resource for teachers.

Lastly, I want to take this opportunity to congratulate Mr Lim Poh Seng and his committee members for a job well done and also to give special thanks to Prof Rosemary Khoo for her assistance in the editing of the resource book.

# ❧ 1. Introduction ❧

Inventions happen in many ways -- almost as many ways as there are inventors. Many inventions come about because their inventors have a flash of inspiration or “eureka moment”. But many things have been invented by groups of inventors working together. Teamwork allows inventors to put their heads together and brainstorm to find solutions to problems. As the old saying goes, “Two heads are better than one.”

Most inventions are not the work of a single individual or even a single team. They’re the result of tens, sometimes hundreds of people’s work over tens, hundreds or even thousands of years. Each inventor adds a new idea and builds on what has gone before. Borrowing from the past is how people learned to build modern airplanes.

Few inventions happen overnight. Even something as simple as Velcro took eight years to invent. Inventors experiment, make changes and experiment again -- often for years. The urge of invention strikes people of all ages and nationalities.

How does an invention happen? When a child is asked to “invent” a solution to a problem, the child must draw upon previous knowledge, skills, and experience. The child also recognises areas where new learning must be acquired in order to understand or address the problem. Through critical and creative thinking and problem solving, ideas become reality as children create inventive solutions, illustrate their ideas, and make models of their inventions. The inventive thinking project provides children with opportunities to develop and practise higher-order thinking skills.

Throughout the years, many thinking skills programmes or models have sought to describe the essential elements of thinking and/or to develop a systematic approach to teaching thinking skills as part of the school curricula. Although each uses different terminology, each programme or model describes similar elements of either critical or creative thinking, or both. Some of these programmes or models will be reviewed below to show how the inventive thinking project provides an opportunity for children to “experience” most of the elements described.

**Please read the following programmes or models of creative thinking skills in Annex 1:**

- **Alex Osborn -- Brainstorming**
- **Edward de Bono CoRT Thinking Programme**
- **Benjamin Bloom's Model**
- **Calvin Taylor's Model -- Talents Unlimited**
- **Creative Problem Solving Model -- Scott Isaksen and Donald Treffinger**

These examples will show you how critical/creative thinking and problem-solving skills and talents can be applied through the activity of inventing. The inventive thinking project that follows can be used across all disciplines and levels and with all children. It can be integrated with all curricular areas and used as a means of applying the concepts or elements of any thinking skills programme that may be in use in your school.

Children of all ages are talented and creative. This project will give them an opportunity to develop their creative potential and synthesise and apply knowledge and skills by creating an invention or innovation to solve a problem, just as a “real” inventor would.

## ❧ 2. Suggested Activities ❧

### Activity 1: Introducing Inventive Thinking and Brainstorming

#### Step 1: Read stories about inventions.

Identify books in your library or websites in Internet about inventors, invention and creativity. Ask students to read the stories of inventors and their inventions. Older students can locate such information from internet websites themselves. How did these inventors get their ideas? How did they make their ideas a reality?

#### Step 2: Invite a local inventor to give a talk.

Invite a local inventor to speak to your students. For information on some of our local inventors, you may browse through the list of winning entries of the Tan Kah Kee Young Inventors' Award at the Tan Kah Kee Foundation's website ([www.tkk.wspc.com.sg](http://www.tkk.wspc.com.sg)). If not, most of the major companies have a research and development department made up of people who think inventively for a living. Perhaps, you can write to them for assistance.

#### Step 3: Study inventions around us.

Ask the students to look at the things in the classroom or their home that are inventions. All inventions that are patented will have a patent number. You can highlight such items to them. Tell them to check out their home for patented items. Ask the students to compile a list of the inventions they discover and brainstorm on what would improve these inventions.

#### Step 4: Teach students the techniques of brainstorming.

In order to guide students through the inventive process, start with a few preliminary activities dealing with creative thinking to help set the mood. Begin with a brief explanation of brainstorming and a discussion on the rules of brainstorming and let them practise the techniques (see Annex 1).

Note: If your students are already familiar with brainstorming techniques and the creative thinking processes, this step can be skipped.

### Activity 2: Practising the Creative Parts of Inventive Thinking

#### Step 1: Apply Bob Eberle's Scamper technique.

Once your students have become familiar with the techniques of brainstorming and the creative thinking processes, Bob Eberle's **Scamper** technique for brainstorming can be introduced (see Annex 1).

Alternatively, CoRT thinking skills or any thinking tools which students are familiar with can also be applied.

Note: If your students are quite familiar with the **Scamper** technique or the CoRT thinking tools, or any thinking skills taught in school, this step can be skipped.

**Step 2: Think of new uses for an object.**

Bring in any object or use objects around the classroom to do the following exercise. Using the relevant thinking skills, ask the students to list many new uses for a familiar object. You could use a paper plate to begin with, and see how many new uses the students can discover. Make sure to follow the rules for brainstorming in Activity 1.

**Step 3: Create a new ending to a story.**

Using literature, ask your students to create a new ending to a story, change a character or situation within a story, or create a new beginning for the story that would result in the same ending.

**Step 4: Create a new product by combination.**

Put a list of objects on the chalkboard. Ask your students to combine them in different ways to create a new product.

Let the students make their own list of objects. Once they combine several of them, ask them to illustrate the new products and explain why they might be useful.

<b>Activity 3: Practising Inventive Thinking with the Class</b>
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Before your students begin to find their own problems and create unique inventions or innovations to solve them, you can assist them by taking them through the following steps:

**Step 1: Finding the Problem**

Let the class list problems in their own classroom that need solving. Use the “brainstorming” technique from Activity 1. Perhaps your students never have a pencil ready, as it is either missing or broken when it is time to do an assignment. A great brainstorming project would be how to solve that problem.

Select one problem for the class to solve using the following steps:

- Find several problems. Select one to work on.
- Analyse the situation in the problem.
- Think of many, varied, and unusual ways of solving the problem.
- List the possibilities. Be sure to allow even the silliest possible solution, as creative thinking must have a positive, accepting environment in order to flourish.

## **Step 2: Finding a Solution**

Select one or more possible solutions to work on. You may want to divide the class into groups if the class elects to work on several of the ideas.

Improve and refine the idea(s).

Share the results of the solutions to the problem or any class inventions that students come up with.

Solving a “class” problem and creating a “class” invention will help students learn the inventive process and make it easier for them to work on their own invention projects.

## **Activity 4: Developing an Invention Idea**

Now that your students have had an introduction to the inventive process, it is time for them to find a problem and create their own invention to solve it.

### **Step 1: Invention Idea Survey**

Begin by asking your students to conduct a survey. Tell them to interview everyone that they can think of to find out what problems need solutions. What kind of invention, tool, game, device, or idea would be helpful at home, work, or during leisure time? (You can use the “Invention Idea Survey” form in Annex 2.)

### **Step 2: List of Problems**

Ask the students to list the problems that need to be solved.

### **Step 3: Decision-making Process**

Using the list of problems, ask the students to decide which problems would be possible for them to work on by listing the pros and cons for each one. Ask them to predict the outcome or possible solution(s) for each problem. Conversely, ask them to make a decision by selecting one or two problems that provide the best options for an inventive solution. (Duplicate the Form of “Planning and Decision-Making Framework” in Annex 2.)

### **Step 4: An Inventor's Log or Journal**

Tell your students to keep a record of their ideas and work, which will help them develop their invention and protect it when completed. (Sample log sheet in Annex 2)

### **Rules for Authentic Journal Keeping**

- Using a small notebook, make notes each day about the things you do and learn while working on your invention.
- Record your idea and how you got it.
- Write about problems you have and how you solve them.

- Write in ink and do not erase.
- Add sketches and drawings to make things clear.
- List all parts, sources, and costs of materials.
- Sign and date all entries at the time they are made and have them witnessed.

### **Activity 5: Brainstorming for Creative Solutions**

Now that the students have one or two problems to work on, they must take the same steps that they did in solving the class problem in Activity 3.

These steps could be listed on the chalkboard or a chart:

- Analyze the problem(s). Select one to work on.
- Think of many, varied, and unusual ways of solving the problem. List all of the possibilities. Be non-judgmental. Select one or more possible solutions to work on.
- Improve and refine your ideas.

### **Activity 6: Practising the Critical Parts of Inventive Thinking**

Now that your students have some exciting possibilities for their invention projects, they will need to use their critical thinking skills to narrow down the possible alternatives. They can do this by asking themselves the following questions about their inventive idea:

- Is my idea practical?
- Can it be made easily?
- Is it as simple as possible?
- Is it safe?
- Will it cost too much to make or use?
- Is my idea really new?
- Will it withstand use, or will it break easily?
- Is my idea similar to something else?
- Will people really use my invention? (Survey your classmates or the people in your neighbourhood to determine the need or usefulness of your idea – adapt the Invention Idea Survey form.)

## Activity 7: Completing the Invention

When students have an idea that meets most of the above qualifications, they need to plan how they are going to complete their project. The following planning technique will save them a great deal of time and effort:

- Identify the problem and possible solution. Give your invention a name.
- List the materials needed to illustrate your invention and make a model of it. You will need paper, pencil, and crayons or markers to draw your invention. You might use cardboard, paper, clay, wood, plastic, yarn, paper clips, and so forth to make a model. You might also want to use an art book or a book on model-making from your school library.
- List down in order the steps for completing your invention.
- Think of possible problems that might occur. How would you solve them?
- Complete your invention. Ask your parents and teacher to help with the model.

### Remember:

**What** – Describe the problem.

**Materials** – List the materials needed.

**Steps** – List the steps to complete your invention.

**Problems** – Predict the problems that could occur.

## Activity 8: Naming the Invention

An invention can be named in one of the following ways:

1. Using the inventor's name.
2. Using the components or ingredients of the invention.
3. With initials or acronyms.
4. Using word combinations (such as repeated consonant sounds and rhyming words).
5. Using the product's function.

Ask your students to list one or two examples for each category.

## **Activity 9: Optional Marketing Activities**

Students can be very fluent when it comes to listing ingenious names of products in the market. Solicit their suggestions and have them explain what makes each name effective. Each student should generate names for his/her own invention.

### **Developing a Slogan or Jingle**

Have the students define the terms “slogan” and “jingle”. Discuss the purpose of having a slogan.

Your students will be able to recall many slogans and jingles! When a slogan is named, discuss the reasons for its effectiveness. Allow time for thought in which the students can create jingles for their inventions.

### **Creating an Advertisement**

For a crash course in advertising, discuss the visual effect created by a television commercial, magazine, or newspaper advertisement. Collect magazine or newspaper advertisements that are eye-catching – some of the advertisements may be dominated by words and others by pictures that “say it all”. Students also enjoy exploring newspapers and magazines for outstanding advertisements. Have students create magazine advertisements to promote their inventions. (For more advanced students, further lessons on advertising techniques would be appropriate at this point.)

### **Recording a Radio Promo**

A radio promo will add a final touch to a student’s advertising campaign! A promo may include facts about the usefulness of the invention, a clever jingle or song, sound effects, humour – the possibilities are endless. Students may choose to tape record their promos for use during the Invention Convention.

### **Advertising Activity**

Collect 5 - 6 objects and give them new uses. For instance, a toy hoop could be a waist reducer, and some strange-looking kitchen gadget might be a new type of mosquito catcher. Use your imagination! Search everywhere – from the tools in the garage to the kitchen drawer – for fun objects. Divide the class into small groups, and give each group one of the objects to work with. With the object, the group is to give it a catchy name, write a slogan, draw an ad, and record a radio. For variation, collect magazine ads and have the students create new advertising campaigns using a different marketing angle.

### **❧ 3. Parent Involvement ❧**

Projects are often successful when a child receives encouragement from its parents and other caring adults. Once the children have developed their own, original ideas, they should discuss them with their parents. Together they can work on making a model to make the child's idea come to life. Although the making of a model is not necessary, it makes the project more interesting and adds another dimension to the project.

You can involve parents by simply sending a letter home to explain the project and let them know how they may participate. A parent may have invented something which can be shared with the class. (See sample parent's letter in Annex 2 – adapt the letter for how you want your parents to participate)

### **❧ 4. Young Inventors' Day ❧**

Plan a Young Inventors' Day so that your students can be recognised for their inventive thinking. This day should provide opportunities for students to display their inventions and tell the story of how they got their idea and how it works to other students and to parents.

When a student successfully completes a task, it is important that such effort is recognised. All students who participate in the Inventive Thinking Lesson Plans are winners by virtue of this fact.

We have prepared a certificate that can be copied and given to all students who participate and use their inventive thinking skills to create an invention or innovation.

## **❧❧❧ 5. Enrichment: Stories about Inventors ❧❧❧**

Reading stories about great thinkers and inventors will help to motivate your students and enhance their appreciation of the contributions of inventors to our way of life. Thus, keeping a collection of these books in your library about inventors, invention, and creativity will be useful. Try to identify some good websites which provide this information so that older students can browse through themselves.

For the young inventors in our schools, you can refer to “A Compilation of Inventions of Tan Kah Kee Young Inventors’ Award, 1994 – 2003”, published by Tan Kah Kee Foundation.

As students read these stories, they will realise that “inventors” can be male, female, old or young. They are ordinary people who follow through their creative ideas to make their dreams a reality.

## ❧❧❧ 6. Patent, Trademark and Copyright Primer for Students ❧❧❧

Having been inspired by stories about inventors and their inventions, your students should be motivated by now to kick start their brainstorming and ideas generation process. No matter how simple or complex, their ideas may well lead to inventions that benefit society and mankind.

**Intellectual Property (IP)** refers to creations of the human mind. A creative work, an expression or solutions to a problem are all creations of value and intellectual property. Many forms of IP can exist in one invention.

Get your students to look at their portable CD-players. Its unique shape may be protected by a registered design; its CD-playing mechanism may be protected by patents; the name of the CD-player may be registered as a trade mark; and of course the advertising materials for the CD-player may be protected by copyright.

**Intellectual Property Rights (IPRs)** are rights that are put in place to prevent others from exploiting someone's IP without his consent. Common forms of IPRs are **Patents, Registered Trade Marks, Registered Designs and Copyright**. IPRs serve as an incentive by rewarding creators with certain exclusive rights.

IPRs encourage greater creativity and innovation in society because creators, authors, designers, and inventors can have their rights protected and thus reap benefits. Society can also progress upon the generation of new creations and inventions.

The administration and use of each form of IPR is governed by a set of rules, laws, regulations and procedures. You may refer to the annex for details on the common forms of IP.

# **Annex 1: Thinking Programmes/Models**

## **1. Brainstorming**

Introduced by Alex Osborn in his book “Applied Imagination”, brainstorming is the crux of each of the stages of all problem-solving methods. It is an idea-generating technique which can be used to help:

- 1) define what project or problem to work on;
- 2) diagnose problems;
- 3) premeditate a project by coming up with possible solutions; and
- 4) identify possible resistance to proposed solutions.

Brainstorming is a process of spontaneous thinking used by an individual or a group of people to generate numerous alternative ideas while deferring judgment.

### **Rules for Brainstorming**

**No Criticism Allowed:** People tend to automatically evaluate each suggested idea – their own as well as others. Both internal and external criticism are to be avoided while brainstorming. Neither positive nor negative comments are allowed. Either type inhibits the free flow of thought and requires time which interferes with the next rule. Write each spoken idea down as it is given and move on.

**Work for Quantity:** Alex Osborn states that “Quantity breeds quality”. People must experience a “brain drain” (get all the common responses out of the way) before the innovative, creative ideas can surface; therefore, the more ideas people generate, the more likely they will be quality ideas.

**Hitchhiking Welcome:** Hitchhiking occurs when one member's idea produces a similar idea or an enhanced idea in another member. All ideas should be recorded.

**Freewheeling Encouraged:** Outrageous, humorous, and seemingly unimportant ideas should also be recorded.

### **Procedure**

1. In a small or large group select a leader and a recorder (they may be the same person).
2. Define the problem or idea to be brainstormed. Make sure everyone is clear on the topic being explored.
3. Set up the rules for the session. They should include:
  - letting the leader have control.
  - allowing everyone to contribute.
  - ensuring that no one will insult, demean, or evaluate another participant or his/her response.
  - stating that no answer is wrong.
  - recording each answer unless it is a repeat.
  - setting a time limit and stopping when that time is up.

4. Start the brainstorming. Have the leader select members of the group to share their answers. The recorder should write down all responses, if possible so everyone can see them. Make sure not to evaluate or criticise any answers until done brainstorming.
5. Once you have finished brainstorming, go through the results and begin evaluating the responses. Some initial qualities to look for when examining the responses include:
  - looking for any answers that are repeated or similar.
  - grouping like concepts together.
  - eliminating responses that definitely do not fit.
  - After narrowing your list, discuss the remaining responses as a group.

### **Bob Eberle's Scamper technique for brainstorming**

**Substitute** – What else instead? Who else instead? Other ingredients? Other material? Other power? Other place?

**Combine** – How about a blend, an alloy, an ensemble? Combine purposes? Combine appeals?

**Adapt** – What else is like this? What other idea does this suggest? Does past offer a parallel? What could I copy?

**Minify** – Order, form, shape? What to add? More time?

**Magnify** – Greater frequency? Higher? Longer? Thicker?

**Put to other uses** – New ways to use as is? Other uses if modified? Other places to use? Other people to reach?

**Eliminate** – What to subtract? Smaller? Condensed? Miniature? Lower? Shorter? Lighter? Omit? Streamline? Understate?

**Reverse** – Interchange components? Other patterns?

**Rearrange** – Other layouts? Other sequences? Transpose cause and effect? Change pace? Transpose positive and negative? How about opposites? Turn it backward? Turn it upside-down? Reverse roles?

## **2. Edward de Bono CoRT Thinking Programme**

The CoRT Thinking Programme is developed by De Bono to provide a comprehensive programme of lessons for educational use in schools. We can apply a variety of tools from CoRT1 and CoRT4 wherever appropriate to invention. His programme also takes into account the values that people have.

Here are the main tools we might use:

*CoRT 1 is on Breadth.* The specific purpose of this section is to broaden perception so that in any thinking situation we can see beyond the obvious, immediate and egocentric.

- **PMI (Plus, Minus and Interesting)** – an attention-directing method of forcing a thinker to explore a situation before reaching a judgement.
- **CAF (Consider All Factors)** – another attention-directing tool designed to increase the breadth of perception. What are the factors that have to be considered in this matter?
- **APC (Alternatives, Possibilities, Choices)** – another attention-directing tool which, rather than looking ‘forward’ with thinking, looks at ‘parallel’ possibilities.
- **AGO (Aims, Goals, Objectives)** – another attention-directing, perception-broadening tool. This tool is more concerned with the overall purpose or objective of the thinking than a moment-to-moment focus.
- **FIP (First Important Priorities)** – what are the priorities here? Not everything is of equal importance. Some things are much more important than others. Some values are much more important than others.
- **C&S (Consequences and Sequel)** – if thinking is going to result in action of any sort (decisions, choices, plans, initiatives etc.), then that action is going to take place in the future. So there is a need to look at the consequences of that action.
- **OPV (Other People’s Views)** – another attention-directing tool designed to broaden perception. The key questions here are:
  - Who is affected by this thinking (action)?
  - What are the views (thinking) of those affected?

*CoRT 4 is on Creativity.* In CoRT 4 the type of creativity that is developed is the ‘design’ type of creativity. Edward de Bono has called this type of thinking ‘*lateral thinking*’. The processes are put forward as thinking tools which can be applied deliberately and directly in order to produce a result.

- **YES, NO & PO** – PO indicates that an idea is not offered as true, accurate, or the way things are, but in a creative sense, to open up new ideas and new ways of looking at things.
- **Stepping Stone** – is a method for getting out of the channels of thinking formed by experience in order to increase the chances of finding new channels. It can be set up deliberately by saying anything unlikely or outrageous, e.g., to reverse the situation, turn it inside out, upside down, or back to front.
- **Random Input** – the technique involves the deliberate introduction of something that is unconnected with the situation, e.g., a random word. It is held in the same context as the problem to see what new ideas are triggered.
- **Concept Challenge** – involves looking at accepted ideas, things that are taken for granted or adequate ways of doing things, and challenging them. This challenge is not an attempt to prove them wrong but a challenge to their uniqueness.

- **Dominant Idea** – is to recognise an idea which dominates the situation. Once the dominant idea is identified, it becomes much easier to escape its domination and to come up with a new idea.
- **Define the Problem** – a problem may not be what it appears to be at first. An effort to define it exactly may make it easier to solve.
- **Remove Faults** – one way to get an improvement is to pick out all the faults in the existing idea and then try to remove them.
- **Combination** – things which have existed separately can be put together to produce something that has a value greater than the sum of its parts.
- **Requirements** – ideas do not exist in a vacuum but are connected with a situation which has its own requirements. It is useful to be aware of the requirements and to allow them to shape the idea.
- **Evaluation** – means judging an idea to see whether it is going to work.

CoRT 1 covers the basic thinking tools that are useful to all students.

CoRT 4 contains the tools for creativity relevant to the inventive thinking. For example, the two skills “**Stepping Stone**” and “**Random Input**” will help you to generate new inventive ideas, while “**Concept Challenge**” will help you to pick out any concept and challenge to see if it is the only way of doing things. Take a look of the inventions around us. “**Combination**” and “**Remove Faults**” will allow you to modify and improve on the existing inventions. Of course, “**Evaluation**” is concerned not with your creativity of your invention, but with judgment about whether it will work or not.

### 3. Benjamin Bloom's Model

Bloom describes the major areas in the cognitive domain. The information here is drawn from the *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain* (1956).

The taxonomy begins by defining KNOWLEDGE as the remembering of previously learned material. Knowledge, according to Bloom, represents the lowest level of learning outcomes in the cognitive domain. Knowledge is followed by COMPREHENSION, the ability to grasp the meaning of material and goes just beyond the knowledge level. Comprehension is the lowest level of understanding. APPLICATION is the next area in the hierarchy and refers to the ability to use learned material in new and concrete principles and theories. Application requires higher level of understanding than comprehension. In ANALYSIS, the next area of the taxonomy, the learning outcomes require an understanding of both the content and the structural form of material. Next is SYNTHESIS, which refers to the ability to put parts together to form a new whole. Learning outcomes at this level stress creative behaviours with a major emphasis on the formulation of new patterns or structures. The last level of the taxonomy is EVALUATION. Evaluation is concerned with the ability to judge the value of material for a given purpose. The judgments are to be based on definite criteria. Learning outcomes in this area are the highest in the cognitive hierarchy because they incorporate or contain elements of knowledge, comprehension, application, analysis, and synthesis. In addition, they contain conscious value judgments based on clearly defined criteria.

The activity of inventing encourages the four highest levels of learning – application, analysis, synthesis, and evaluation – in addition to knowledge and comprehension.

#### **4. Calvin Taylor's Model – Talents Unlimited**

Calvin Taylor' Model is discussed in a summary chapter by Carol Schlichter in Joseph Renzulli's book entitled *Systems and Models for Developing Programs for the Gifted and Talented* (1986). The Taylor model describes the talent areas as PRODUCTIVE THINKING, COMMUNICATION, PLANNING, DECISION MAKING, and FORECASTING. This work is best known as TALENTS UNLIMITED, a program of the National Diffusion Network of the U.S. Department of Education. The Taylor model incorporates both the critical and creative elements of thinking. Rather than a taxonomy, this is a thinking skills model that describes the essential elements of thinking, beginning with the academic talent and then incorporating the other talent areas, as described in more detail below.

PRODUCTIVE THINKING promotes creative thinking in the Taylor model. It suggests thinking of many ideas, varied ideas, unusual ideas, and adding to those ideas.

COMMUNICATION has six elements which include:

- giving many, varied, single words to describe something;
- giving many, varied, single words to describe feelings;
- thinking of many, varied things that are like another thing in a special way;
- letting others know that you understand how they feel;
- making a network of ideas using many, varied and complete thoughts;
- telling your feelings and needs without using words.

PLANNING requires that students learn to tell:

- what they are going to plan;
- the materials that they will need;
- the steps that they will need to accomplish the task; and
- the problems that might occur.

DECISION MAKING teaches the student to:

- think of the many, varied things that could be done;
- think more carefully about each alternative;
- choose one alternative that they think is best; and
- give many, varied reasons for the choice.

FORECASTING is the last of the five talents and requires students to make many, varied predictions about a situation, examining cause and effect relationships. Every element of the TAYLOR model is used when a child invents.

#### **5. Creative Problem Solving Model**

Creative Problem Solving Model is developed by Scott Isaksen and Donald Treffinger as described in the book *Creative Problem Solving: The Basic Course* (1985) by Isaksen and

Treffinger and published in Buffalo, New York, by Bearly Limited, also describes both critical and creative thinking.

CREATIVE THINKING is described as making and communicating connections to: think of many possibilities; think and experience in various ways and use different points of view; think of new and unusual possibilities; and guide in generating and selecting alternatives. CRITICAL THINKING is described as analyzing and developing possibilities to: compare and contrast many ideas; improve and refine ideas; make effective decisions and judgments; and provide a sound foundation for effective action.

These definitions are used in a six-stage, problem-solving process. A brief description of each of the six stages is as follows:

1. **Mess Finding:** Just what's the mess that needs cleaning up, the situation that demands our attention? We have to identify and acknowledge this first before we can proceed.
2. **Data Finding:** Once the general mess is defined, the next stage involves “taking stock” – unearthing and collecting information, knowledge, facts, feelings, opinions, and thoughts to sort out and clarify your mess more specifically. What do you know about the situation, and what do you still need to know?
3. **Problem Finding:** Now that your data is collected, you need to formulate a “problem statement” that expresses the “heart” of the situation. You must try to put aside the common assumption that you “already know what the problem is” and try to state the problem in such a manner as to invite novel perspectives on it.
4. **Idea Finding:** This is the state in which you brainstorm as many ideas or alternatives as possible for dealing with your problem statement. Don't evaluate your ideas at this point, merely list them as an idea pool from which you'll draw in putting together a variety of solutions to your problem.
5. **Solution Finding:** Now that you have a number of ideas that can serve as possible solutions to your problem, it's time to evaluate them systematically. To do this you have to generate a variety of criteria and select the most important for your problem. Is it cost, expediency, pleasure, time involvement, etc.? In this way, you'll be able to identify and evaluate the relative strengths and weaknesses of possible solutions.
6. **Acceptance Finding:** Having decided upon a solution, it's time to formulate a plan of action to implement your solution. Determine what kind of help you'll need, what obstacles or difficulties might get in the way, and what specific short- and long-term steps you are going to take to rid yourself of that original mess!

## **Annex 2: Sample Forms for Activities**

Sample Forms to Print and Use with the Activities

### **Form 1 – Invention Idea Survey**

One of the best ways to collect ideas for developing an innovation or invention is to take a survey. Make sure you survey a variety of people of all different ages and occupations. The more people you talk to, the more ideas you will get.

#### Activity Form – Invention Idea Survey

What does not work as well as you would like it to work?

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What job(s) would you like to see solved?

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What problem(s) would you like to see solved?

---

---

If you could invent something to make your life easier, what would you invent?

---

---

What is the most annoying problem  
at home?

---

---

at school?

---

---

at work?

---

---

at the airport?

---

---

on the road?

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---

at the supermarket?

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---

at the bank?

---

---

at the shopping center?

---

---

at the \_\_\_\_\_?

---

---

## Form 2 – Planning and Decision-Making Framework

### Activity Form – Planning and Decision-Making Framework

**PROBLEM** – What is the dilemma?

---

---

**ALTERNATIVES** – Generate a list of possibilities.

---

---

**PROS & CONS** – What reasons support and do not support the possibilities?

**PROS:**

---

---

**CONS:**

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---

**CRITERIA** – List the criteria for judging the alternatives.

---

---

**SPECIAL EQUIPMENT** – List all items, such as tape recorder, construction materials, etc., that may be required.

---

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**SOURCES OF INFORMATION** – List the primary and secondary sources of information.

**People:**

---

---

**Books, films, places, etc.:**

---

---

**FINAL PRODUCT** – What form will it take? How will the results be communicated?

---

---

**DECISION** – What is the final decision? Why?

---

---

**RESULTS** – How did the plan work? What modifications, if any, took place?

---

---

**Form 3 – School Invention Application**

Activity Form – School Invention Application

**Name:** \_\_\_\_\_

**School:** \_\_\_\_\_

**Grade:** \_\_\_\_\_

**Advisor:** \_\_\_\_\_

**Inventive Thinking Project Title:**

\_\_\_\_\_

Explain how you got the idea for this invention:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

How does the invention work, and how is it helpful?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

What does the invention look like? Label all of the parts.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## Form 4 – Sample Letter to Parents

### Activity Form – Sample Letter to Parents

**To** : The Parent(s) of \_\_\_\_\_

**From** : \_\_\_\_\_

**Subject** : **Creativity and Imagination**

“Inventive Thinking Project” is a school activity which promotes analytical and creative thinking and problem-solving. Parents can enjoy this project at home with their children by encouraging creative ideas, letting them share ideas with the family, and by assisting them with making models of their inventive ideas.

Our students will be asked to survey you, their friends, and other family members to discover a problem that needs solving. Perhaps the cap is always left off of the toothpaste or your child is always losing sneakers, pencils or mittens. Once the children find problems to solve, they will begin thinking of many ideas that might solve those problems. When they do this, they will be combining many of the skills learned in science, social studies, language, writing, art, library, math, and more.

Thank you for your support in this special and imaginative adventure in learning. You will be receiving more information during the school year.

**Teacher**

\_\_\_\_\_

**Form 5 – Certificate of Recognition for Innovative Achievement**

Activity Form – Positive Comments

**POSITIVE COMMENTS**

**Presenter’s Name :** \_\_\_\_\_

**What I like most about your invention is :**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**“Praise is the best diet for us, after all...” Sydney Smith**

## Form 6 – Young Inventor's Log

### Activity Form – Young Inventor's Log

A log is a diary and a record of your inventive thinking. It should include everything that is related to your project. Every time you write in the log, you should initial and date your entry and also have it signed by a witness. A witness can be anyone who knows what you are working on that day – mum, dad, friend, brother, sister, etc. The list below includes some of the items that might be recorded in your log. You will think of others. Remember, every time you work on your project or just “think” about your idea, you should record it in your inventor's log or notebook.

- **Ideas for Inventions**
- **Problems**
- **Possible Solutions**
- **Plans:**
  1. What am I going to invent?
  2. What steps will I need to take?
  3. What materials will I need? What will the materials cost?
  4. What problems might occur?
  5. How will I present my project?
- **Resources:**
  1. Books
  2. Other references
  3. People
- **Drawings of Possible Solutions**
- **Results of Interviews**
- **Results of Surveys**
- **Others**

### **Annex 3: Proposed Scheme of Work**

S/N	Activity	Time (hour)	Remarks
1	Introducing Inventive Thinking		
	Reading the stories of inventions	1	
	Talk by a local inventor	1	
	Inventions around us	1	
	Brainstorming and the creative thinking processes	1	
2	Practising the Creative Part of Inventive Thinking		
	Scamper technique for brainstorming or equivalent activity	1	
	New uses for an object.	1	
	Creating a new ending to a story	1	
	Creating a new product by combination	1	
3	Practising Inventive Thinking with the Class		
	Finding the Problem	1	
	Finding a Solution	1	
4	Developing an Invention Idea		
	Invention Idea Survey	1	
	List of Problems	0.5	
	Decision-making process	1	
	An Inventor's Log or Journal	0.5	
5	Brainstorming for Creative Solutions	1	
6	Practising the Critical Parts of Inventive Thinking	1	
7	Completing the Invention (individual activity)	2+	
8	Naming the Invention	1	
9	Optional Marketing Activities		
	Developing a slogan or jingle	1	
	Creating an Advertisement	1	
	Recording a Radio Promo	1	
	Advertising Activity	1	
10	Parent Involvement		
11	Young Inventors' Day	3+	
12	Refer students to the IPOS' iperckidz website ( <a href="http://www.iperckidz.gov.sg">http://www.iperckidz.gov.sg</a> ) for first-hand information on Patents, Registered Trade Marks, Registered Designs and Copyright	1	
13	Identify outstanding inventions to be submitted to TKKYIA	2	

## **Annex 4: Tan Kah Kee Young Inventors' Award 2005**

Make a difference with your creativity and innovation. The Tan Kah Kee Young Inventors' Award invites you to take on the challenge of creating scientific and technological breakthroughs. Who knows, your invention could revolutionise our way of life.

Three categories are open for participation – Student Section, Open Section and Defence Science Section.

### **Who Can Take Part**

#### ***Student Section***

1. Students from primary & secondary schools, junior colleges and institutes of technical education (except tertiary students) who are Singapore citizens or permanent residents.
2. Foreign students studying in Singapore at levels equivalent to pre-university or below are welcome to participate.
3. All participants must be aged 18 years and below on the closing date.

#### ***Open Section & Defence Science Section***

1. Singapore citizens or permanent residents (including students from tertiary institutions)
2. Non-Singapore citizens or non-permanent residents who are residing in Singapore are welcome to participate.
3. All participants must be aged 35 years and below on the closing date.
4. All DSTA members are not eligible to participate in the Defence Science Section.

### **Rules and Conditions**

1. Participants may sign up individually or as a team of not more than 3 members.
2. The main criteria for judging are originality, practicality and creativity of the invention. For Defence Science Section, inventions must be relevant to defence and security.
3. Participants are allowed to submit more than one invention. However, each invention must be registered online separately.
4. The submitted entries should neither have won awards in any open competition nor been submitted concurrently to other similar competitions.
5. Entries submitted must be participants' own invention; any form of plagiarism will be rejected.
6. Shortlisted participants will be required to present their inventions to a panel of judges.
7. The judges' decision will be final and no correspondence will be entertained. No award will be made if the entries do not reach acceptable standard.
8. All entries should be submitted through online. All submissions must be true and fully completed. False or incomplete entries will be disqualified or rejected.
9. Closing Date: All entries must be submitted by 31 December 2004.
10. Participants shall bear all costs incurred in submitting the entry. While the participants should prepare prototypes upon submission of their online applications, they are only required to submit the prototypes when their projects are shortlisted. Participants should be able to present their prototypes as and when required by the judging committee.

11. While every care will be exercised in the handling of the entries, the organisers will not be held responsible for any loss or damage.
12. The organisers will not be responsible for any loss of patent rights.
13. Participants are to collect their prototypes within 1 month after the award presentation from the designated place or within 15 days upon receiving of the notice from Tan Kah Kee Foundation Secretariat, whichever is earlier. Otherwise, the organisers reserve the right to dispose the prototypes.
14. The rules and regulations are subject to change without prior notice.

### Prizes

Open Section & Defence Science Section		Student Section	
Gold Award	\$10,000	Gold Award	\$5,000
Silver Award	\$5,000	Silver Award	\$2,000
Merit Award	\$3,000	Merit Award	\$500
Commendation Award	\$1,000	Commendation Award	\$200
		School Award -- Cash awards of \$3,000, \$2,000 and \$1,000 for schools with outstanding participation and submissions.	

\* Non-Singaporean and non-PR will only be given medals and/or certificates for Open and Student sections.

### Registration

Online application through our website [www.tkk.wspc.com.sg](http://www.tkk.wspc.com.sg) from 15 September 2004.

### Closing Date

All applications must be submitted online by **31 December 2004**.

#### **Sponsored By:**

Tan Kah Kee Foundation  
Agency for Science, Technology and Research  
Defence Science and Technology Agency

#### **Supported By:**

Singapore Science Centre

## Annex 5: Common Forms of Intellectual Property (IP) and What They Mean

### Patent

A **patent** is a right given by the Government, to the owner of an **invention**. An invention can be a product or a process that provides a solution to a technical problem.

A patentable invention must meet three criteria:

- The invention has to be **new** or **novel**. See Annex 6 for article on the concept of novelty.
- The invention must involve an **inventive step**. That means that the invention must be something that is not obvious to an expert in the field of the invention.
- The invention must be capable of **industrial application**. This means the invention has to have some form of practical use. Other people must find it useful and be able to use it to achieve a concrete end result.

### Trade Mark

Heard of Nokia, Canon and Adidas? They are examples of **trade marks**. A trade mark is a visible sign used by a trader to help him identify or **distinguish** his goods or services from those of other traders.

® and ™ are common symbols associated with trade marks. ® shows that the mark is a registered trade mark. ™ on the other hand, is a symbol used to show that the mark is used by the company as a trade mark. It does not mean that the mark has been registered.

A registrable trade mark has to be distinctive so that people can tell the difference between your product or service from those of other traders. A trade mark can come in the form of:

- letters,
- words,
- names,
- symbols,
- signatures,
- numerals,
- shapes,
- colours,
- aspects of packaging or
- a combination of any of the above

## Design

**Design** refers to the appearance of objects we see everyday. It protects the shape, configuration, pattern or ornament applied to your students' invention by industrial process. A design can be 2-dimensional or 3-dimensional.

Examples of 3-dimensional designs include shape of toys, electronic equipment, furniture and even food items like ice-cream or cookies. An example of 2-dimensional design is the pattern on a piece of fabric or carpet.

A registrable design must be **new**. New means that the designs must not have existed anywhere else in the world until you have created them. A design is not new if any person other than the designer has knowledge of the design before it has been registered. It is also not new if the design or any article bearing the design is published or sold in Singapore or anywhere else in the world.

A design must also be capable of **industrial reproduction** to be registered. This means that at least 50 copies of each object to which the design has been applied, must be made for sale or hire.

## Copyright

Copyright is a bundle of rights given to creators of **works of expression**. Copyright protection is **automatic** and needs no registration. It exists once the work is created in a material form such as in a recording or in writing.

Copyright is based on **originality**, meaning that there is independent effort in the creation of a work. Let's assume that 2 of your students were to paint a portrait of the same subject (e.g a boat on a river) and both paintings look similar. Both paintings would be considered as individual works (assuming no copying was done from each other) and would be entitled to separate copyright protection.

Copyright helps to protect your students' works such as:

**Literary works:** Books, essays, lyrics of songs, newspaper articles, computer programmes, web-sites

**Dramatic works:** Scripts, dance choreography

**Musical works:** Musical scores

**Artistic works:** Paintings, sculptures, drawings, photographs, buildings

**Published Editions:** Typographical layout, arrangement of newspaper columns and books

**Sound Recordings:** Sound recordings on tape or compact disc

**Films:** Motion pictures on videos, VCDs, DVDs and on films

**Television and Radio broadcasts**

## **Cable Programmes**

### **Performances**

The © symbol indicates that someone has claimed copyright of the work. The symbol will help anyone using the work to know who is claiming copyright and alert him to the claim. If you had not used the © symbol, it does not mean you do not claim copyright or have lost your copyright.

For further other information on IP and IPRs, you (& your students) may also refer to *[www.iperckidz.gov.sg](http://www.iperckidz.gov.sg)*.

## **Annex 6: Have You Disclosed Your Invention or Design?**

### **Keeping things secret - Novelty**

It is a natural impulse to spread the good news when you have developed a great new product – the more publicity the better! It also might appear to make perfect business sense to talk about your great new design or invention in seeking investors. But take care, such actions may cost you your valuable IP.

The invention must be novel in order that it may qualify for a grant of patent. It must therefore be kept a secret until the patent application has been filed. If it has been disclosed anywhere else in the world, it may not be regarded as novel.

Although there are certain specific situations where a disclosure may be disregarded (e.g. in breach of confidence, if displayed in specific international exhibitions etc), in most cases public disclosure is novelty destroying and makes the invention unpatentable. Note though, that different countries have different standards in determining how disclosure would affect the novelty.

Novelty is also a requirement for registered designs. If the design has been registered, or has been published before the date of application of the design registration anywhere in the world, in respect of the same or any other article, the design is considered to have been disclosed and therefore not new or novel. The design is also not new if it differs only in immaterial details, or features, from other designs that are commonly found in trade.

You might think this is all too restrictive – but ignore this and your IP could be lost. Although not all disclosures are novelty destroying, in that it might not reveal the essence of your invention or disclose the design – is it a risk you would care to take? You might be able to get around a potentially novelty destroying disclosure, but it would probably mean greater work for your IP lawyer (and hence possibly greater costs!).

[Extracted from “IP Starter – Your guide to Intellectual Property” available at [www.surftp.gov.sg](http://www.surftp.gov.sg) – IPOS’ one-stop, first-stop portal on IP information & research]

## Acknowledgements

Materials in this resource book are adapted from:

- (1) The Inventive Thinking Curriculum Project  
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- (2) Inventive Thinking Lesson Plans  
Introduction: Lesson plans and activities for teaching inventive thinking  
By Mary Bellis, adapted from materials written by the USPTO
- (3) CoRT Thinking. Teacher's Notes  
By Edward de Bono, Pergamon Press.

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Members of the Tan Kah Kee Young Inventors' Award School Sub-committee:

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