Nurture a Spirit of Innovation: The Young Innovators' Programme

Tan Lian Seng
Oh Chee Wee
River Valley High School
Singapore

ABSTRACT

In the knowledge-based economy of the 21st century, content knowledge can be easily accessed through numerous means especially the internet. Success in this century now lies not in how much a person knows but how he uses the information to constantly innovate and come up with new ideas. The River Valley High School (RVHS) Young Innovators' Programme (YIP) began in 2001 to encourage students to take a keener interest in innovation. The YIP has since developed to become a key programme of the Science and Technology Department. Adopting The Creative Problem Solving Cycle for YIP, RVHS has achieved commendable results in the highly competitive Tan Kah Kee Young Inventors' Award Competition. In this paper, the authors will share the framework, implementation and experience of the YIP.

INTRODUCTION: THE ORIGIN

The need to nurture an innovative spirit

The 21st Century marks the widespread shift of production-based economy to that of the knowledge-based economy. To meet the challenges of the shift, the Economic Development Board of Singapore has identified knowledge, creativity and innovations as the main determinants of long term competitiveness and placed nurturing innovation-driven enterprises as one of the strategies (Economic Development Board, 2008). In this new economy, employability comes not to the hardworking worker who does the right thing, but to the hardworking worker who constantly upgrades, innovates and redefines his role in the workforce (Tan, 2003).

It comes as no surprise that the education of our young is the incubation point of the innovative spirit for the workforce of tomorrow. One of the desired outcomes of education

(Ministry of Education, 1998) is to nurture the innovative and creative spirit of our young charges. The Ministry of Education has also invested resources to support development in this area. With this support, the question now lies in how well we, as educators, nurture the innovative spirit of our students.

Fogler and LeBlanc (Fogler and LeBlanc, 2007) opined that to innovate, one must possess two ingredients, knowledge and creativity. Knowledge is needed as one needs to have the ability to observe and analyse, to correctly identify the real problem and arrive at a feasible solution. Knowledge is needed to understand how things work, to ground our innovations in the realms of possibilities and work within the constraints of available resources and technical feasibility. Creativity enables one to see beyond the usual and conventional. Creativity compels us to work outside the tried and tested. Innovating is then about harnessing the knowledge gained to create new and better solutions through means of Creative Problem Solving. As knowledge is aplenty and easily accessible, the role of the teacher is to guide their students in the knowledge-seeking process and create the right environment and culture for creativity to thrive.

To support the cultivation of knowledge, creativity and innovation in our students, the Science and Technology Department in RVHS has put in place the Young Innovators' Programme (YIP) to nurture the innovative spirit in our students. Since 2001, we have won the School Award for the prestigious Tan Kah Kee Young Inventors Award Competition, an affirmation of our effort at innovation through our YIP.

.

In YIP, we believe that students should display originality in research and demonstrate an ability to apply the principles of science and technology they have learnt to solve real-life

problems. That is to say RVHS students should be able to demonstrate their understanding of the various subjects learnt by applying them in novel situations.

Hence, our YIP seeks to provide learning opportunities to the students to let them "think out of the box". We also consciously seek to engage students in solving multi-disciplinary problems, encouraging them to draw on their learning from different subject disciplines. With this in mind, we have adopted the use of the Teaching for Understanding (TfU) framework as our overarching curricular framework to design the curriculum of YIP. Through this programme, students will develop the necessary Attitudes, Skills and Knowledge (ASK) that will enable them to face the challenges of an innovation-driven world.

In this paper, the authors attempt to capture the School's curriculum effort in nurturing an innovative spirit in students through the YIP.

WHAT IS THE YOUNG INNOVATORS' PROGRAMME (YIP)?

What makes a good product design? It is with this question that we raise our students' awareness of what constitutes a good design process. The YIP seeks to develop students' understanding of the knowledge learnt in different disciplines by creating a curriculum that gives them opportunities to integrate their learning in the innovative process.

Understanding Goals of YIP

The YIP aims to help our students develop an:

1) understanding of the design process that promotes creativity and nurtures our students' interest in innovation,
2) understanding of how knowledge and skills can be used imaginatively and with daring innovation,

3) appreciation of the importance of exploratory learning in various disciplines against a genuine problem,

Through these understanding goals, the YIP develops a series of performances of understanding that seek to create a process-orientated approach to learning and to inspire our students constantly to think of new and innovative ways of solving problems in their daily lives.

ASK in YIP

Choy et. al. (2007) described the centre of the RVIP as the development of "good habits of mind (**A**: Attitudes), critical thinking skills (**S**: Skills) and construction of knowledge (**K**). To this end, the YIP has evolved from a less structured curriculum that centred around problem-seeking and solutions-creation to a process-centred curriculum that seeks to develop the requisite ASK present in a first-class product design and invention.

In the YIP, the students constantly apply the following in the various performances of understanding:

a) Habits of Mind (**A**)

   Our main focus in the habits of mind is for students to behave intelligently under challenging conditions that demand acute observation, perseverance, creativity and craftsmanship. We want them to develop a critical attribute of human intelligence, that is, to have the information and know how to act on it. The whole programme will instil in students a composite of many skills, attitudes and proclivities

b) Critical Thinking Skills (**S**)

   The predominant critical thinking skills are observation, analytical and independent thinking, intellectual perseverance, confidence in reasoning,

generating and assessing solutions and comparing and contrasting ideals with actual practice. These skills are necessary for a problem solver.

c) Construction of Knowledge (**K**)

The students will practise divergent thinking when generating ideas for their identified problem and convergent thinking for choosing the best solution among the generated ideas. Using the design process (Figure 1), students will understand the construction and improvement of ideas in the design process of a product. They will apply their understanding of the various subject areas to solve problems encountered during the problem-solving process.

Through developing these attitudes, skills and an understanding of the design process, the YIP can develop the spirit of innovation and creativity in our students.

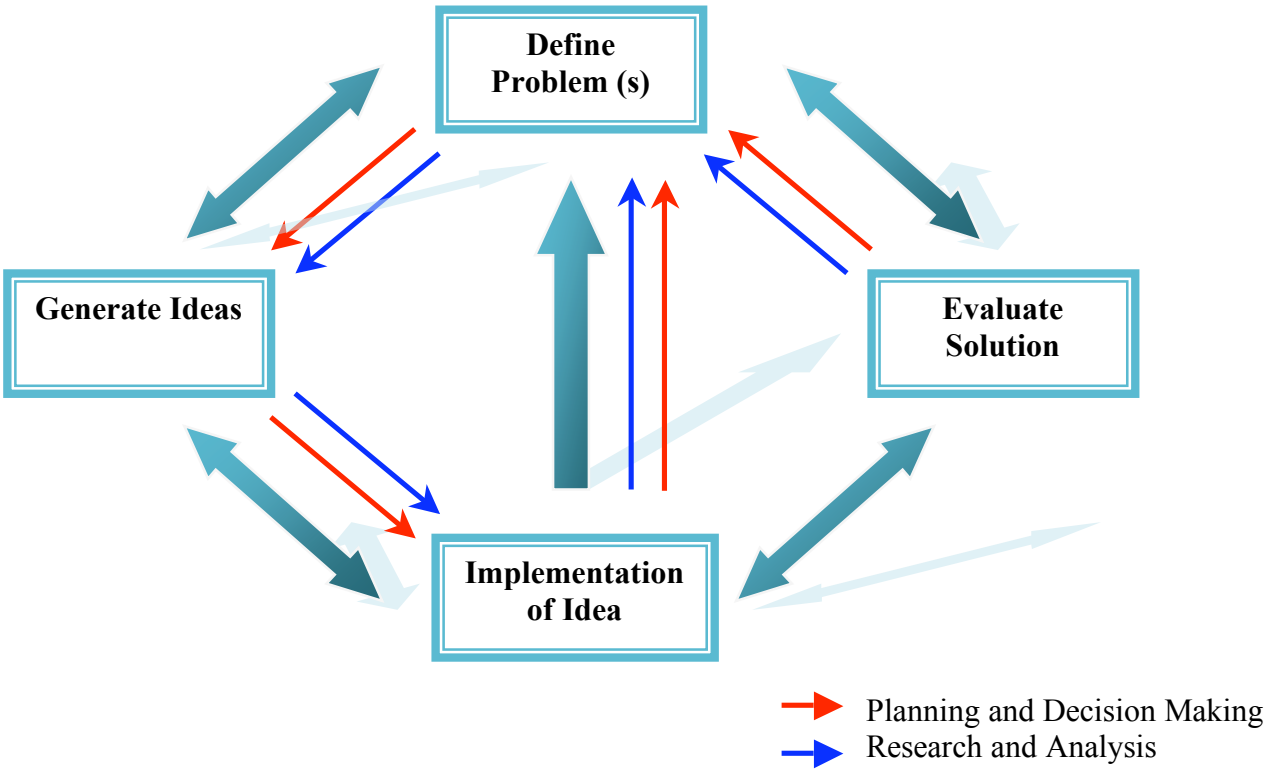

Figure 1: Problem Solving Cycle used in River Valley High School classroom

CID Programme

The CID (Construct, Integrate & Differentiate) Programme aims to promote independent and active learning. It provides our students with opportunities to construct their own learning by integrating knowledge from various disciplines, using modes of inquiry appropriate to the project they are working on. It also strives to engage students in applying the integrated knowledge critically and creatively to real life situations. In the process, it enhances students' attitude and skills to prepare them for the challenges of the future.

This CID programme will take four years to complete and it aims to develop ASK in our students through the use of innovative and engaging lessons. It also equips the students with the necessary attitude, skills and knowledge for project work and independent study.

YIP in CID

In order to look into how best to allow each project group to better process each stage of YIP from brainstorming to product realisation, we see CID as an ideal platform to run YIP as one of their programmes. Not only do the objectives of YIP sit well with those of CID, it offers a more systematic way of assessing process and quality of project work.

With the support of this four-year CID programme, YIP has benefited in two main ways:

1) It has structured time-tabled curriculum time for mentors to meet the students during normal lessons
2) It gives a more structured assessment framework which will help students to meet the requirements of YIP which are in line with those of CID.

The Framework of YIP

The YIP is essentially a programme that brings together a group of students to engage in activities for innovating or inventing a product solution to solve an identified problem. As mentioned in the earlier section, the YIP has matured into a more rigorous design-process-centred curriculum after a few reversions using the TfU framework.

The YIP uses several platforms to engage students in the design process. By providing an authentic learning situation, students undertake performances of understanding that mirror the various stages of the design process. This results in a problem-based learning approach that lends itself naturally to the design process. Hence, the YIP uses the TfU framework to design the curriculum that leverages on the iterative Problem-Based Learning Process (Tan, 2002) and the Creative Problem-Solving Cycle (Fogler and LeBlanc, 2007).

Some of the platforms for the students to demonstrate their understanding of the design process include:

1) Tan Kah Kee Young Inventors' Award

   The Tan Kah Kee Young Inventors' Award was launched in 1986. It is an annual award presented to participants for their display of creativity and innovation. It was initiated by Nobel Prize-Winner, Professor C N Yang, who proposed having this award with the key objective of encouraging students and young people to be engaged in creativity and invention.

2) Odyssey of the Mind

   Odyssey of the Mind is a creative problem-solving competition for students. It provides creative problem-solving opportunities for students and fosters original and

divergent thinking. Students select a problem, create a solution and then bring their solution to compete against other teams'.

3) Creative-Thinking Programme

   This programme is organized in collaboration with Ngee Ann Polytechnic for the schools in the West Zone. The objective of this programme is to nurture students' interest in design and innovation. Through this, students will learn creative thinking techniques, such as divergent thinking and convergent thinking.

4) Toy Design Competition

   This competition provides an avenue for the students to develop their design skills by creating their dream toys. Through this competition, it is hoped that the students will be able to strengthen their problem-solving skills, drawing and presentation skills as well as teamwork, and ultimately, the ability to unleash their creativity and innovation in designing new products for the toy industry.

As can be seen from the structure and framework of the YIP, students are not only given opportunities to develop their understanding of the design process but are also supported by the school and teachers.

The Creative Classroom – The Success Factor

One of the key features in making the Young Innovator's Programme successful is to create an environment or creative classroom for creativity to thrive. In establishing a creative classroom, Ng laid out 5 attributes as seen in Figure 2 (Ng, 2004).

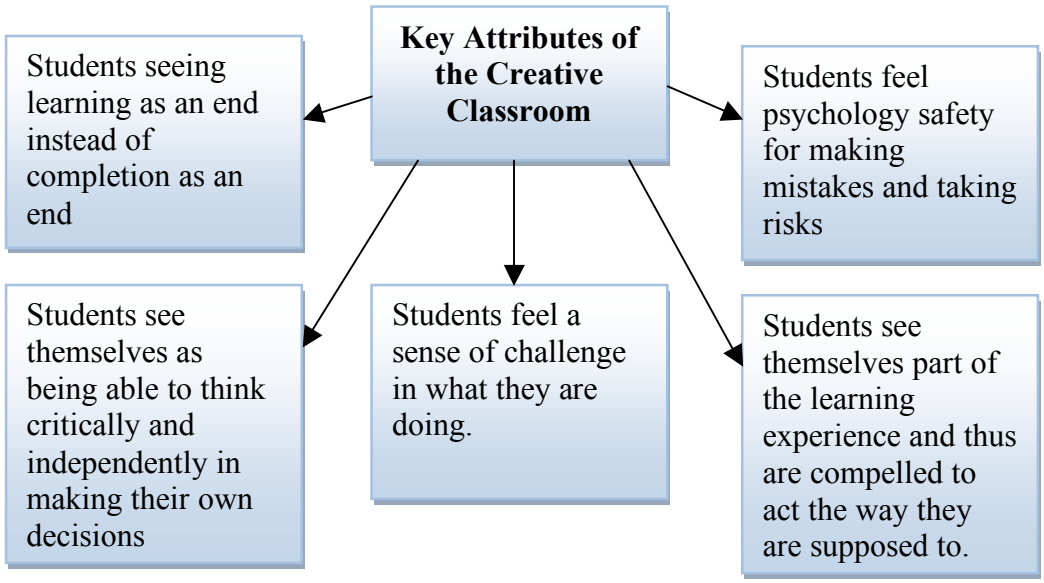

Figure 2 Five Attributes of a Creative

To promote creativity, the YIP has arranged itself in such a way that the 'classroom' contains some of the creative classroom attributes if not all.

The sense of psychological safety enables the students to be more experimental and work outside the norm when it comes to innovation. This is due to the fact that they fear repercussions lest they should fail in their project. This way, students are more willing to take calculated risks in the course of their innovation. They will understand that failing and making mistakes are part and parcel of a successful innovation. In order to make the process of innovating less intimidating and provide space for risk taking, YIP has taken steps to support the students.

As some platforms of the YIP are outside the formal curriculum (such as Toy Design Competition, Creative Thinking Programme), they do not have direct links to the students'

academic grades. However the students are motivated to do well as their achievements and participation are recognised in their co-curricular record.

All successful innovators have within themselves a passion to innovate and put their creative ideas into operation. They derive great satisfaction going through the process of creating a solution which they are passionate about and not just any other solution. In order to encourage this passion, solutions which were unable to meet submission deadline for certain YIP platforms (Eg. TKKYIA) will be allowed to continue for submissions in the following year. In this way, the students need not necessarily see time as a deterrent restricting their innovative solution; students will be able to continue to work on the solutions they had in mind thus sustaining their passion.

To have passion, the students themselves must have interest and show willingness to take on the process on their own. They perceive themselves as active participants and initiators of the innovation process thus these students are very motivated in implementing their solutions. Although the school strongly encourages students to participate in YIP, it is not compulsory and only students who are both willing and able are selected. The YIP platforms also require the students to propose their own problems or at least provide challenging problems to solve. These problems are often authentic and/or close to their hearts and able to sustain their interest and intellectual rigour. Thus, students in the YIP often stay on because they enjoy what they are doing.

Finally, the nature of YIP platforms requires students to work independently. The teacher mentors are not experts and can only offer guidance on the problem-solving approaches. Sometimes, the students develop more knowledge in their area than their teacher mentor.

Moreover, students involved in the YIP take completion of their innovations at their own pace. Students are given the flexibility to arrange meetings with the teacher mentors and workshop assistants at their own pace. Students will be asked to attend mass briefings only when necessary. This enables the students to perceive themselves as independent learners and value the learning process as well rather than simply the end product.

REFLECTIONS ON THE YIP

Teacher Mentors' Reflections

After involvement in the YIP over the last few years, we noted that the students learn to be observant of their surroundings, the needs of people and how things work around them. It expands their knowledge in various disciplines and sharpens their observation skills. It also teaches them to be focused and holistic in their problem-solving strategy and technique.

In essence, the programme meets the objectives of our CID Programme - to construct, to integrate and to differentiate.

Students' Reflections

Through our various interactions with the students, we have had opportunities to observe them at work and we can see how the students have benefited from the YIP Programme.
The following students' reflections clearly show why YIP has been successful:

Tan Yu Chong (2006): Participant in the TKKYIA 2005

"The experience obtained during these activities helped me in solving problems in life. I am also better at handling stress and completing my tasks efficiently. I learnt the art of juggling my activities and schoolwork which many find difficult or impossible. Creativity is also one

aspect that I have developed. I have started to see things from many perspectives and ideas can flow when the need arises."

Luo Jie (2007): Silver Award winner of the TKKYIA 2007

"Of course, it is not easy to think of an idea and work on it. We thought of lots and lots of ideas, but they were rejected one after another. However, we kept thinking and thinking, and suddenly, I thought of a very simple but creative idea. When I got the news that we had won the silver award, I told my team-mate immediately. We screamed in the canteen. Only if you were us, would you know how we felt, so just do it."

Priscilla Lim (2008): Commendation Award winner of the TKKYIA 2008

"The sense of accomplishment upon completing the product was certainly overwhelming. It was extremely rewarding as I have learnt the importance of teamwork and perseverance. We often had to go back to the drawing board in order to complete the projects. The most valuable thing that we have learnt is that a lot of effort has to be put into each and every product that is in the market. A lot of time and effort has to be put into perfecting it, especially in the safety aspects and user friendliness."

Tan Yu Chong (2008): Winner of the Odyssey of the Mind 2008

"The competition has made me realise that every one of us has hidden potential. We should never hold back from going all the way to complete our task. This is because only when we stretch ourselves can we realise our potential."

As can be seen from their reflections, the spirit of perseverance was evident. This habit of mind was carefully honed during the YIP and many of these students can see learning beyond

the usual academic subjects. In the various performances of understanding, they have opportunities to develop the willingness to embrace new challenges, natural curiosity and the love for problem-solving as can be seen from the reflections.

The Way Forward

From 2001 to date, we have continuously improved on our programme and shared our experiences with other schools through events like the Inventors' Week held in the Singapore Science Centre and the West Zone Centre of Excellence for Science and Technology Teachers' Conference 2007. The affirmation we received at the various platforms provides the momentum for us to commit ourselves to nurturing our students so that they can be equipped for the knowledge-based economy.

REFERENCES

1. Tan, O.S. (2003), Problem-based Learning Innovation: Using problems to power learning in the 21st century. Thomson Learning.
2. Ng, A.K. (2004), Liberating the Creative Spirit in Asian Students. Pearson Prentice Hall.
3. H. Scott Fogler (2008), Strategies for Creative Problem Solving (2nd Ed.). Prentice Hall.
4. Choy B.H., Teo S.C. and Yap W.C. (2007) 'RVIP: Reflections on Curriculum Redesign'. Proceedings of the Redesigning Pedagogy: Culture, Knowledge and Understanding Conference, Singapore May 2007.
5. Ministry of Education, Singapore (2008), Desired Outcomes of Education, http://www.moe.edu.sg/education/desired-outcomes/

ANNEX A

PROBLEM SOLVING CYCLE

Table 1 explains the Problem Solving Cycle as well as the Student's actions and Teacher-Mentor's actions during the Cycle.

Round 1 of the Problem Solving Cycle will concentrate on defining a problem to be solved. This problem will be referred to as the **overarching problem**. While solving the overarching problem, minor problems might surface in the iteration of the cycle.

Table 1: The Problem Solving Cycle

Cycle Stage	Description	Student's Action	Teacher-Mentor's Action
Defining the Problem	A typical starting point of the cycle. Here the student will define the overarching problem to be solved.	Student will brainstorm for problems to solve. At this point, accept all problems generated. Student will then analyse the list to select a few problems to work on. Student will then research further into the few problems to find out the REAL problem (the reasons behind having the problem). Student will need to decide on the overarching problem to be solved.	Mentor will coach student on the heuristics needed for analysis, research and selection should the student not be adept in these areas.

	Minor problems that surface during the implementation.	Student will need to analyze and prioritize the problems to be solved for the subsequent iterations.	Mentor will provide guidance on the direction of research and approaches in analyzing problems.
Generating Ideas	Solutions to the problem will be proposed at this stage. Should all solutions be impractical or not feasible, student may revisit the problem to look at it from another perspective.	Student will research into the possible ways for solving the problem. Student will brainstorm for solutions to the proposed problem. Again, accept all ideas generated. Student will evaluate the list of solutions base on factors such as feasibility, practicality and cost. Student will then need to decide which of the solutions to implement. After a decision is made, students will research and implement their solution.	Mentor will provide guidance on the direction of research and approaches. Mentors will often need to walk student through the kind of solutions already available. This is necessary as students often lack knowledge of this.

Implementation of Idea	The proposed solution will be implemented and realized at this stage. Should student face extreme difficulty in implementing it, student may go back to look at other proposed solutions. Students should go through the cycle to resolve any new problems that surface during the implementation of the solution to the overarching problem.	Student will attempt to implement the selected solution. Careful planning has to be made on how the solution can be implemented. Student will need to evaluate the options before deciding whether to continue implementing the solution.	This stage is always filled with technical difficulties. As a teacher mentor, it will be necessary to direct the student on the feasible ways of implementation. Teacher mentor must also remind the student of safety during implementation.
Evaluate the Solution	Once the solution is implemented, it will be evaluated through testing and checking against the problem	Student will test the completed solution for any flaws and make further improvements. Should any flaws exist, student will analyze the problems that	It is important to guide the student on the possible courses of action should the solution

	it attempted to solve. This can also be an alternate starting point where student evaluates an existing solution to identify a problem	constitute the flaws and go through another round of the cycle. Student will check the solution against the overarching problem. Should the solution not solve the problem, student will then revisit the overarching problem and probe deeper into the REAL problem. Sometimes, minor problems appear at this stage. Student needs to define the problems and address them through the cycle.	fail to work or fail to address the overarching problem. The student faces a setback and may need emotional support.