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Introduction

In opening the seventh International Conference on Thinking in Singapore in 1977, Prime Minister Goh Chok Tong outlined topics of increasing importance for countries wishing to become, or remain, competitive in the twenty-first century.

Prime Minister Goh Chok Tong suggested education should be concerned with developing 'thinking schools and a learning nation'. Discussing educational priorities, he suggested it was no longer desirable or essential to study for the sake of obtaining high scores in examinations. What is needed is to inspire students with a passion for learning and an ability to think critically and creatively, rather than simply churning out students who can only do what others have done before them.

Countries around the world share these sentiments and beliefs.

This publication aims to provide teachers in the secondary years of schooling with a valuable and timely resource as they seek to infuse thinking into their content delivery and classroom activity.

At the heart of all teaching are three core components:

Content: *what is taught;*
Process: *how content is delivered;*
Products: *what students are required to do to demonstrate understanding.*

Although teachers have varying degrees of freedom in how they apply each of these three components, modifications in one, two or all three areas may help bring thinking into focus. Planning and programming with a thinking focus requires teachers to be aware of structures and approaches that will provide them with the flexibility to work with these three core elements. This publication seeks to explain what higher-order thinking is, and provide examples of thinking-based activities for secondary mathematics, science and technology classes.

Section 1

Planning Models and Frameworks

Many different structures have been used to create a diverse range of teaching and learning activities in this publication. Some, like Bloom's Taxonomy, will be familiar to most teachers. Others, such as the Infusion Matrix, will be new to many.

The purpose of this section is to provide a very brief overview of some of the models and frameworks used to create the activities included in this book. For more information concerning specific models, see the bibliography.

Blank pro-formas for each model introduced have also been included.

Infusing Higher-Order Thinking

Working with Content, Process and Product

In a recent publication, Gross, Sleap and Pretorius (1999) outline the importance of modifying content, process and products to meet the learning needs of gifted students.

The increased emphasis placed on thinking as an integral component of curriculum delivery for all students, however, means all teachers – not just those working with gifted students – are turning their attention to these core components of teaching and learning.

To bring higher-order thinking to the forefront of learning activities for students, teachers in every faculty will need to consider these three core components of the curriculum – content (what is taught), process (how content is delivered) and product (what the student is required to do to in order to demonstrate understanding).

Content

The content of the curriculum comprises the ideas, concepts and information presented to students. To bring higher-order thinking into focus, make this content more complex, abstract and varied. Teachers may also consider selecting a range of strategies in their own planning and programming, from curriculum models and management tools such as:

- Bloom's Taxonomy;
- The Infusion Matrix;
- Structures that enable self-selection and self-pacing, such as Gardner's Multiple Intelligences, learning centres, individual study plans;
- The Divergent Questioning Model.

Modifying content may also see teachers encouraging the use of:

- A range of sources of information including study based on student interests;
- Email to communicate with experts in their field of study;
- A wide range of graphic organisers.

Process

The process or methodology is the way in which the content is presented to students. This includes the type of questions asked and the mental and physical activities expected of them. The teacher may modify the level of thinking required, the pace of teaching and the type of approach used.

Teachers may choose from a range of curriculum models and management strategies in planning and programming, to address processes such as:

- Models for meta-cognitive processing and a range of options for different learning styles;
- Gardner's Multiple Intelligences (Interpersonal);
- Directed thinking;
- Open-ended questioning techniques, such as open or closed questioning and the Question Matrix;
- Higher levels of Bloom's Taxonomy (Infusion Matrix);
- Divergent and creative thinking processes;
- A conference-based assessment approach.

Modifying processes may also see teachers encouraging the use of:

- A range of methods of thinking, feeling and learning to accommodate different interests and learning styles;
- Strategies to determine prior knowledge;
- Problem-solving approaches to issues;
- Inductive reasoning and discovery learning;
- Different forms of presentation, journals and learning logs;
- Self-management strategies, such as contracts, learning centres, negotiated curriculum, resource-based learning and computer-aided instruction;
- Student choice within learning experiences and topics;
- Computer-aided instruction (especially multimedia) to assist learning.

Product

As with content and process, the importance of developing and applying higher-order thinking skills is paramount in the presentation of any product. It is important that, where possible, these products address a real problem or concern rather than simple summations of content. Equally, the presentation of these products should be to a 'real' audience that is able to professionally evaluate the work.

Teachers may also consider the following in modifying products:

• Giving students the choice of products within guidelines;

• Using complex problems with a range of solutions;

• Using different problem-solving models such as creative problem-solving and future problem-solving;

• Teaching information skills (defining, questioning, accessing, analysing, utilising and evaluating information);

• Using a range of appropriate audiences, such as peers, other classes, teachers, experts and organisations appropriate to the task;

• Providing web publishing as an option.

Modifying products may also see teachers encouraging the use of:

• Databases and spreadsheets;

• Graphic organisers, tables, charts and multimedia presentations;

• A range of product options from Gardner's Multiple Intelligences;

• Predetermined criteria for evaluation that is relevant to the task.