PYP Thinking Skills Project

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Student Thinking and Learning in the PYP Transdisciplinary Framework

Case Studies from PYP Schools

by

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Part 1 Overview

1 Background, Purpose and Structure of the Final Report

1.1.1 Background, Purpose and Scope of the Report

The focus for this report is on the transdisciplinary framework of the IB's Primary Years Programme (PYP), specifically how the transdisciplinary skills framework can advance deep learning and thinking for PYP learners aged 3-12 years of age. Using a mixture of theoretical analyses, literature review and empirical findings from PYP case study schools, the report will address the following research questions:

- What is the relationship between deep learning and thinking and, specifically, the role of thinking in deeper learning? What are the views of PYP case study schools on this question?
- What kinds of teaching promote skillful thinking and deep learning and how are they best organized? What are the current practices in PYP case study schools?
- How are progressions in thinking represented at various levels (in the research literature, in national curricula)? How are students' thinking progressions defined in PYP school-based practice?

The research team recognize that they are not beginning from scratch with regard to interrogating the PYP curriculum and that they have already submitted a literature review, and an audit and evaluation of PYP with regard to developing and assessing thinking skills, and made recommendations to the IB (Swartz & McGuinness, 2014a, 2014b). The data for those previous reports were confined to desk-based research whose purpose was to address: (1) the current state of the art with regard to identifying important and teachable kinds of thinking, how they can *be taught,* and how they can *be assessed*, primarily through the literature review; and (2) how the three IB programmes aligned with that picture, based on an audit of IB guidance materials. During that work, An Integrated Research and Practice Informed Framework for Developing and Assessing Thinking Skills and Related Constructs (see Appendix 1) was created and recommendations were made to the IB with regard to the position of teaching and assessing thinking across the three programmes. In summary, we noted how well placed the PYP transdisciplinary curriculum was to advance students' thinking skills, and our recommendations pointed to how IB guidance for the PYP could be strengthened. Specifically, we noted (1) the need to be more explicit in how thinking is articulated as a curriculum objective; (2) the need for thinking strategies to be made more explicit, more visible to children, and thus more

learnable; and (3) the need to help PYP schools and teachers create more specific assessment criteria and assessment strategies related to thinking.

The current report builds on those previous reports in several ways. First, the research lens is extended: (1) to examine more closely the relationship between thinking and learning – specifically the role that thinking plays (or interplays) in creating deep learning, however that is defined, and (2) to look at how progressions or developmental continua in thinking might be best articulated. As the project developed we recognized that these were two very different pieces of work. Surprisingly, they draw on two different research literatures and we had not reviewed the progression literature in the previous reports to any great extent. For that reason, we are structuring the current report into several different parts, see below for outline of the structure of the report.

Second, an important limitation of the previous work was the absence of any contact with IB schools or direct information about what PYP teachers were doing in classrooms, beyond the examples we had accessed from the IB website. Using a case study methodology, this current research allows us to collect information directly from PYP schools about the school's specific approach, beliefs and practices and includes interviews with PYP co-ordinators and teachers, as well as opportunities to discuss some video lessons with teachers.

1.2 Distinctive Features of the PYP Transdisciplinary Curriculum related to learning and thinking

What follows is a brief overview of the distinctive features of the PYP, drawn from the IB's own guidance materials. The PYP curriculum framework includes the following essential elements.

Table 1 Essential Elements of the PYP written curriculum (PYP Making it Happen 2009, p. 10)

Knowledge	Significant, relevant content that we wish the students to explore and know about, taking into consideration their prior experience and understanding.
Concepts	Powerful ideas, which have relevance to the subject areas but also transcend them, that students must explore and re-explore in order to develop a coherent, in-depth understanding.
Skills	Those capabilities that the students need to demonstrate to succeed in a changing, challenging world, which may be disciplinary or transdisciplinary in nature.
Attitudes	Dispositions that are expressions of fundamental values, beliefs and feelings about learning, the environment and people.

Action	Demonstrations of deeper learning in responsible behavior through responsible action; a manifestation in practice of the other essential elements.

Working with an inquiry pedagogical approach, the PYP curriculum framework is designed to achieve the learning goals of international-mindedness embedded in the IB Learner Profile – learners as inquirers, knowledgeable, thinkers, communicators, principled, open-minded, caring, risk-takers, balanced, and reflective.

Thinking skills is one of five skill-sets within the PYP transdisciplinary skills element and their description is derived largely from Blooms' taxonomy with some additional kinds of thinking included – dialectical thought and metacognition. The other skill-sets are Social Skills, Communication Skills, Self-Management Skills, and Research Skills.

Table 2 Thinking Skills as part of the PYP Transdisciplinary Skills Framework (PYP Making it Happen, 2009, p. 21)

PYP Transdisciplinary Skills	Thinking Skills
Acquisition of Knowledge	Gaining specific facts, ideas, vocabulary, remembering in a similar form.
Comprehension	Grasping meaning from learning material; communicating and interpreting learning.
Application	Making use of previously acquired knowledge in practical or new ways.
Analysis	Taking knowledge or ideas apart; separating into component parts; seeing relationships; finding unique characteristics.
Synthesis	Combining parts to create wholes; creating, designing, developing and innovating.
Evaluation	Making judgements or decisions based on chosen criteria; standards and conditions.
Dialectical thought	Thinking about two or more different points of view at the same time; understanding those points of view; being able to construct an argument for each point of view, based on knowledge of the other (s); realizing that other people can also take one's own point of view.
Metacognition	Analyzing one's own and others' thought processes; thinking about how one thinks and how one learns.

Importantly, the PYP is characterized as a concept-driven curriculum, with the role of key concepts being to deepen understanding by having students re-visit the key concepts across units of inquiry,

and across the years, in order to appreciate how they transcend subject boundaries. Key concepts thus are intended to act as a meta-framework and help to increase conceptual coherence across the curriculum, both in the programme of inquiries and in subject specific teaching. The key concepts identified for the PYP are **Form, Function, Causation, Change, Connection, Perspective, Responsibility and Reflection.** Key concepts are very well developed in the PYP documentation and a lot of learning seems to depend on them. For example, it is claimed that "A concept-driven curriculum helps the learner to construct meaning through improved critical thinking and the transfer of knowledge". These key concepts are exemplified in each of the PYP scope and sequence subject guides and they are the only transdisciplinary element to be illustrated in this way.

However, the main transdisciplinary thrust of the PYP framework with regard to knowledge is accomplished through the transdisciplinary themes, central ideas and lines of inquiry within each unit of inquiry. Six inquiries are completed by the students each year (4 in the early years) and these are timetabled alongside teaching in specific subjects which follow either the IB scope and sequence or a nationally or locally prescribed curriculum. The main pedagogical approach – inquiry – is deliberately intended to create opportunities for thinking and deep learning.

Table 3 The process of inquiry within the PYP curriculum framework (PYP Making it Happen, 2009, p. 29)

What does an inquiry look like?
Inquiry, interpreted in the broadest sense, is the process initiated by the students or the teacher that moves the students from their current level of understanding to a new and deeper level of understanding. This can mean: • Exploring, wondering and questioning • Experimenting and playing with possibilities • Making connections between previous learning and current learning • Making predictions and acting purposefully to see what happens • Collecting data and reporting findings • Clarifying existing ideas and reappraising perceptions of events • Deepening understanding through the application of a concept • Making and testing theories • Researching and seeking information • Taking and defending a position • Solving problems in a variety of ways

So, despite the Thinking Skills element being labelled 'thinking', there are clearly several other essential curriculum elements, as well as the pedagogical approach, that are designed to promote thinking and deep learning. The complexity of this should be borne in mind throughout the report.

1.3 Structure of the Report

The report is structured into five parts.

Part 1, which includes this preliminary section, goes on to position the concepts of deeper learning and thinking into a wider landscape of educational discussions about the role of 21st century skills in curriculum design and learning. It introduces the concept of *adaptive competence* as an important educational goal for effective learning, rehearses some of the findings from our previous review of the literature on teaching thinking, and links key ingredients for effective learning with parallel ingredients for effective thinking, in an effort to understand more fully the relationship between effective learning and effective thinking.

Part 2 includes an overview of research design, methodology and data collection. Then, the case study schools are introduced through pen portraits.

Part 3 delves deeper into some of the research questions (Research Questions 1 and 2), examining more closely the role of thinking in deep learning. In order to bring these discussions closer to classroom practice, we have used classroom vignettes to make their meaning clearer. The findings from the Case Studies related to the first two research questions are then reported and considered in relation to themes from the research literature.

Part 4 focuses on the issue of progression in thinking (Research Question 3). Some important distinctions are made between the scale and scope of different types of progression, and examples of the different types from the research literature and from national curricula are examined. The findings for the Case Studies related to this research question are then reported.

Finally, Part 5 makes recommendations.

2 Deeper Learning and Thinking: The Wider Landscape

2.1 Deeper Learning and 2lst century skills

At the beginning of this report we would like to situate the issues raised by the research questions into the wider and ongoing educational discourses about the nature of learning, deeper learning and 21st century skills.

For many years, what students learn in schools has been critiqued, particularly in developed countries, as leading only to a superficial understanding of curriculum topics (e.g., Bransford et al., 1999; Pellegrino & Hilton, 2012). This level of understanding is perhaps sufficient to pass tests or examinations but not sufficiently robust to be applied beyond the school context in which the learning occurred. Students' understanding, it is argued, is fragile, consisting of isolated and overly specific concepts without sufficient generality. Students can learn to solve problems when they are presented in predictable ways but not when they are encountered in less predictable and messy real world environments (e.g., Perkins, 2014).

A general response to this has been to argue for the school curriculum to be broadened to include what are called 21st century skills as educational goals. Such skill-sets normally encompass both cognitive and non-cognitive skills – cognitive skills such as critical thinking and creativity, interpersonal skills such as collaboration and negotiation, as well as more personal skills such as self-management and being capable of acting autonomously (e.g., OECD Key Competences (2005), https://www.oecd.org/pisa/35070367.pdf; National Research Council Workshop, 2011) Proponents of this view (which include the current authors) argue that these are the types of learning that will endure and be helpful to learners in later life and work. Yet critiques of this approach say that the traditional goal of schooling is to give students access to established bodies of knowledge and ways of knowing associated with disciplinary knowledge or school subjects. They argue that mastering these areas of learning still remains important educational goals even at primary school level.

In the past 10 years, several important research/policy/practice publications have appeared that attempt to make connections between these contrasting points of view about curriculum priorities and what is important for school learning. The terms 'deep learning ' (Fullan & Langworthy, 2014), 'deeper learning '(Hubermann et al., 2014; Pellegrino & Hilton, 2012), and initiatives such as New Pedagogies for Deep Learning (http://npdl.global/) have begun to appear, and even the claim that this shift in terminology represents a more significant change and a new synthesis between what were previously considered two opposing approaches (e.g., Bellanca, 2015).

For example, a Committee of the US National Research Council was charged with Defining Deeper Learning and 2lst Century Skills, drawing on existing educational and pedagogical research (Pellegrino & Hilton, 2012). Having reviewed the 21st century skills literature and linking it to what constitutes growing expertise in a variety of knowledge domains (e.g., typical school subjects such as science, mathematics and history), they concluded:

> "the link between deeper learning and 21st century competencies lies in the classic concept of transfer— the ability to use prior learning to support new learning or problem-solving in culturally relevant contexts. We define deeper learning not as a product but as processing — both within individual minds and through social interactions in a community — and 21st century competencies as the learning outcomes of this processing in the form of transferable knowledge and skills that result." (Chapter 4, p. 74)

The key point in this definition is the recognition of 21st century skills as a potential vehicle for transfer of learning.

Another portrait of deeper learning has grown from an initiative of the William and Flora Hewlett Foundation in the US (Hubermann et al., 2014; Bitter et al., 2014). Drawing on a range of research and interviews with experts, they concluded that deeper learning consists of six dimensions which have collectively become the focus of a national project to promote deeper learning in schools: These are:

- Mastery of core academic content;
- Critical thinking and problem-solving;
- Effective communication;
- Ability to work collaboratively;
- Learning how to learn;
- Academic mind-sets.

Chow (2010), the Director of the Education Program at the Foundation, argues that these are "a set of skills and competences that reinforce one another and together promote rigorous and deeper learning". The key point here is that these dimensions focus more on the role of 2lst century skills in furthering the mastery of core academic content, revealing a question as to the primary goals for teaching 2lst century skills – for promoting mastery of core curriculum content or toward transfer and lifelong learning, or both!

In the following sections we will examine more closely the research conclusions from these two research traditions - one where learning is the primary focus and the other where thinking is the primary focus – to see in what ways they complement one another.

2.2 Becoming a More Effective Learner: Perspectives from Research on Learning

For this section, we rely on the consistent pattern of conclusions to emerge from substantial reviews of the research literature over the past 15 years. These research reviews have been conducted with a specific focus on educational practice: the US National Research Council's *How People Learn* (Bransford, Brown & Cocking, 1999) and subsequent related publications, *How Students Learn: History, Mathematics, and Science in the classroom* (Donovan & Bransford, 2005); the International Academy of Education's *How Children Learn* (Vosniadou, 2001); and the OECD's *The Nature of Learning: Using Research to Inspire Practice* (Dumont, Istance & Benavides, 2010), particularly the chapter in that volume by de Corte on *Historical Developments in the Understanding of Learning*. These publications do not use the term 'deep' learning, preferring the terms 'effective learning' or 'productive' learning. Towards the end of this Section 2 we will make comments on these terminological distinctions.

The conclusions from these research syntheses about what constitutes effective learning draws extensively on the notion of "adaptive expertise" – an idea which has become very influential in understanding how flexible (or not) prior learning is in response to new learning challenges. The term can be traced back to Hatano (1990) who drew a distinction between routine expertise and what he called "adaptive expertise"', when he observed, for example, two types of Japanese sushi experts; one excels following a fixed recipe, creating wonderful flavours and textures with a specific recipe, while the other is more flexible and more adaptable to external demands, can improvise and use alternative ingredients and so on. The idea of adaptive expertise has fed into a more general concept called "adaptive competence" which is best represented in the OECD's research synthesis by de Corte and his colleagues (de Corte, 2010), although the roots of the idea can be traced to the extensive US National Research Council report, *How People Learn* (Bransford et al., 1999, p.33). de Corte now considers that adaptive competence should be considered as the ultimate goal of education. Adaptive competence is defined as "the ability to apply meaningfully-learned knowledge and skills flexibly and creatively in new situations" (de Corte, 2010, p 47) as opposed to routine expertise which is comprised of being able to complete typical school tasks competently but without much understanding. The key

adjective here is 'adaptive', indicating a readiness and an ability to successfully respond to changing contexts and future learning challenges – what transfer of learning usually implies.

Building on this body of research, de Corte and his colleagues outline the key ingredients of adaptive competence, see Table 4 taken directly from de Corte (2010, p. 47). Note that acquiring adaptive competence means learning much more than would be traditionally expected of even well mastered subject knowledge and subject skills – the well-organised and flexibly accessible domain specific knowledge referenced in the first row in Table 4. It also means the learners become well practised in using a repertoire of what are termed heuristics or thinking strategies. While these might first be encountered and learned in specific contexts, they have the potential to be more generally applicable across contexts, hence their heuristic value. The other three ingredients recognize the importance of newer forms of learning – knowledge about how to learn, how to organize and manage oneself as a learner, underpinned by positive beliefs about oneself as a learner and about the to-be-learned material. The dynamic integration of these ingredients creates adaptive competence, according to this view. The picture of learning presented here is in sharp contrast to the more minimalist meanings of learning-as-remembering, or even learning-as- understanding, that are often portrayed in earlier theories of learning.

De Corte also argues that to become an effective learner, learners should be made explicitly aware of these components as educational goals, and that learning environments and classroom practices should be designed to achieve them (de Corte & Masui, 2004). We will have more to say about how to do this in later sections of the report.

Table 4 Key Ingredients of Adaptive Competence (verbatim from de Corte, 2010, p 47)	
Well organised and flexible knowledge	Well-organised and flexibly accessible domain-specific knowledge bases involving the facts, symbols, concepts and rules that constitute the contents of a subject-matter field(s) *or any to-be-learned material.*
Heuristic methods	Heuristic methods, i.e., search strategies for problem analysis and transformation (e.g. , decomposing a problem into sub-goals, making a graphic representation of a problem) which do not guarantee but significantly increase the probability of finding the correct solution through a systematic approach to the task.
Metacognitive knowledge	Meta-cognitive knowledge, involving, on the one hand, knowledge about one's cognitive functioning or 'meta-cognitive knowledge" (e.g., believing that one's cognitive potential can be developed through learning and effort); and, on the other hand, knowledge about one's motivation and

	emotions that can be actively used to improve learning (e.g. ,becoming aware of one's fear of failure in mathematics).
Self-regulatory skills	Self-regulatory skills, regulating one's cognitive processes/activities ("meta-cognitive skills" or "cognitive self-regulation", e.g. ,planning and monitoring one's problem-solving processes); and skills regulating one's volitional processes/activities ("motivational self-regulation", e.g., maintaining attention and motivation to solve a given problem).
Positive beliefs	Positive beliefs about oneself as a learner in general and in a particular subject (or contexts), about the classroom or other context in which learning takes place, and about the more specific content within the domain, *or any to-be-learned material.*

2.3 Becoming a More Effective Thinker: Perspectives from Research on Teaching Thinking

For this section we will draw primarily on the analysis and conclusions from our previous review of the research/practice literature on developing and assessing thinking (Swartz and McGuinness, 2014a Report Part 1, all references to Sections below refer to this report). Although several theoretical perspectives were identified in the literature, there is agreement that at least these three ingredients are important for effective thinking and thus should become explicit teaching objectives for any thinking curriculum:

Important Thinking Skills: The first key ingredient is to identify important thinking processes or thinking skills and explicitly make these the objectives for instruction (Section 2.1). While acknowledging the dominant influence of Bloom's taxonomy of educational objectives (and more recent modifications), we argued that it was not sufficient just to name different kinds/types of thinking (e.g., analysis, evaluation, prediction), important though they are. Helping students to become more effective thinkers demands that they get to know more about what it means, not just to analyse, but to analyse **more skillfully** (Section 2.3). We pointed to Swartz and colleagues' models of skillful thinking as useful guides for helping students to do this. For example, how to use guiding questions to prompt students to think more skillfully about parts and wholes: What is the whole object? What are the parts of the object? What would happen if the part was missing? What is the function of the part? What is the relationship between the parts and the whole, how do they work together (See Section 4.2)? We also argued that the types of thinking described in Bloom's taxonomy need to be expanded to include important types of 'thinking-for-action' such as problem-solving and decision-making (Section 2.2 and Appendix I in this Report). Creating thinking maps with students,

and using thinking organizers such as graphic organizers and thinking routines that highlight the mental moves needed for more skillful thinking have lots of advantages for classroom teachers, making thinking more visible, more teachable and thus more assessable (Sections 4.2, 4.3 and 4.4).

Thinking Dispositions: Recognizing that simply having the ability to think is not sufficient for effective thinking, the literature points to the importance of a range of other learner attributes or dispositions to support thinking, ensuring that a person has the 'will to think well' in addition to the 'skill'. In *How We Think* (1933), after advocating that we teach students strategies for what he called "reflective thinking" (in 21st century terms, critical thinking), John Dewey said "You can teach students how to think reflectively, but if they don't care about doing this, they won't". Examples of such dispositions include being open-minded, wanting to seek out the truth, seeking clarity, respecting alternative perspectives, being curious, being adventurous in thinking, persevering and so on. Various frameworks for thinking dispositions and how teachers might go about cultivating them are outlined (Sections 2.5 and 4.7).

Metacognitive Thinking: Becoming an effective thinker involves exerting some degree of strategic control over one's own thinking, involving a range of so-called metacognitive skills (Section 2.4). This means effective thinkers need to have some knowledge about thinking and thinking strategies, be aware of their own thinking, as well as having the ability to plan and adjust their thinking in the face of new challenges. Being able to do this on a regular basis without external prompting from others means that these metacognitive processes have been internalised and effective thinking thus becomes self-regulating (Section 4.5.2). Achieving this level of metacognitive thinking is very important in promoting the likely transfer of previously successful thinking skills and strategies to new situations (Section 4.5.3). There is a growing body of evidence that demonstrate the power of metacognitive strategies for learning in general and for teaching thinking (Section 2.4).

As well as pointing to the importance of these key ingredients as curriculum objectives, the review pointed to the importance of adopting certain classroom practices that would help to realise the these objectives – strategies for making thinking more visible in the classroom, the importance of dialogue and talking about thinking, collaborative thinking, how to adopt a metacognitive perspective in the classroom, how to teach for transfer, and generally how to create the classroom conditions to foster a culture of thinking (Section 4, Principles and Practices for Teaching Thinking).

Table 5 presents an overview of the final position articulated in the previous reports about teaching thinking.

Table 5 Key Ingredients for Teaching Effective Thinking (adapted from Swartz and McGuinness, 2014a)		
Thinking Objectives	**Teaching**	
Thinking Skills	**Principles**	**Practices**
	Advance deep thinking challenges through infusing thinking into curricular topics and units.	Design lessons, units and inquiries that explicitly focus on thinking as an objective. Give students something challenging to think about, more than routine tasks.
	Make thinking organizers explicit.	Teach explicit thinking organizers/strategies in the classroom, graphic organizers, thinking routines. Prompt the students to make the thinking that results from their use visible and public.
	Engage students in collaborative thinking to ensure joint meaning making, interaction, and dialogue.	Use collaborative groups, arrange the classroom to facilitate interaction, develop a thinking language, support sustained dialogue about thinking.
Thinking Dispositions	Cultivate thinking dispositions and habits of mind.	Make explicit the behaviors associated with thinking dispositions. Create classroom norms and expectations about thoughtfulness and the habitual use of thinking strategies.
Metacognitive Thinking	Prompt students to adopt a strong metacognitive perspective. Teach for transfer of the skillful thinking	Teach students explicit strategies to plan, monitor and evaluate their thinking skills and thinking dispositions. Give students time to do this. Explicitly teach to facilitate the transfer of learned thinking procedures to other curricular and non-curricular contexts.
Culture of Thinking	Generalize the approach from thinking classrooms across all grades in the school.	Prioritize teachers' professional development and teachers' planning time.

2.4 Connecting Effective Learning and Effective Thinking: Key Ingredients

Table 6 shows the relationship between the key ingredients for effective learning, summarised by the Adaptive Competence Model, and the key ingredients for effective thinking arising from the previous literature review on developing thinking by Swartz and McGuinness – a Thinking-Based Learning Model. There is strong agreement between the two sets of ingredients, and certainly no suggestion of either/or.

Table 6 Connecting Research-Informed Models of Effective Learning and Effective Thinking

Effective Learning Adaptive Competence Model (de Corte and others)	**Effective Thinking Thinking-Based Learning Model (Swartz and McGuinness)**
Well organised flexible knowledge	Infusion –Thinking infused into curricular topics
Heuristics	Thinking processes/ skills
Metacognitive knowledge Self-regulatory skill	Metacognitive thinking and self-regulation
Positive beliefs	Thinking dispositions Culture of thinking

While the Adaptive Competence Model has articulated building flexible knowledge structures – perhaps not surprising because of the emphasis in that literature on learning school subjects – the Thinking Model provides more detail about a range of thinking skills (heuristics), especially with regard to teaching approaches. Both models recognise the importance of metacognitive knowledge, metacognitive thinking, and self-regulation as components of effective learning and thinking, and their potential role in facilitating transfer of prior learning (of any kind, including thinking) to new situations. Both models acknowledge that other psychosocial learner attributes (dispositional, motivational, volitional) also play an important role in becoming an effective learner and thinker, although they are characterized slightly differently – in terms of positive beliefs in the Adaptive Competence Model, and in terms of dispositions in the Thinking-Based Learning Model, which also looks more to the social contexts in which learning takes place through the idea of a thinking culture.

Returning to the first research question about the relationship between deep/deeper learning and thinking, the conclusions from the research literature indicate that deeper learning includes the

capacity to use the complex set of 21lst century skills as outlined in Table 6 and conversely, being competent in the use of those skills implies a deeper form of learning. We shall return to this relationship in Section 5 and analyze it more closely.

Part 2 Research Methodology

3 Research Questions, Design and Methodology

3.1 Research Questions and General Approach

Essentially the research questions were categorized into those that were addressed through desk-based research (e.g., further literature review, interrogation of concepts, re-examination of PYP curriculum materials, etc.) and those that were pursued through the empirical research with PYP schools and teachers, as outlined in Table 7.

Table 7 Overview of Research Questions

Q	Research Questions: Desk-based	Research Questions: School-based
1	**What is the relationship between learning and thinking and, specifically, the role of thinking in deeper learning?**	
	How might **thinking** be described in relationship to **learning** and **understanding** from a research perspective? How might we best define thinking (learning/ understanding) described as 'deep'? How can we demystify the term 'deep' and make it more meaningful (and manageable) to teachers?	How do PYP schools define the terms and describe / define the relationship between thinking and learning?
2	**What kinds of teaching promote skillful thinking and deep learning and how is it best organised?**	
	What kinds of teaching promote deep thinking / understanding? How can teaching that stimulates students' development of deep thinking skills be structured? What are some of the effective teaching strategies' that encourage and support the development of deep thinking skills?	How specific are PYP schools with articulating thinking objectives? What devices do PYP schools use to articulate these objectives? What are the hooks they use to position them in the transdisciplinary PYP framework? What is the current practice in PYP schools in promoting thinking and deep learning?
3	**How are progressions in thinking represented at various levels - in research literature, in national curricula?**	

	How are students' thinking progressions defined in the research literature? How are thinking progressions represented in current national /school-based primary (elementary) curricular in various contexts across the globe?	How are students' thinking progressions defined in PYP school-based practice?

3.2 Strategic Decisions on Research Design and Methods

At the outset of the project, several strategic decisions were made about the general research approach.

- That a case study methodology would be adopted rather than, for example, a survey method. It was recognized that rich up-close information about individual cases would best yield the depth of information needed to address the research questions.
- While interviews with key school personnel would form the primary research data, these data would be collected electronically through Skype or similar software. It was not possible to make face-to-face visits to the case study schools within the limits of the budget or timeline, and electronic collection of data seemed most cost effective.
- That, where possible, lesson videos would be included as the basis for interviews with PYP teachers in order to focus those interviews as close as possible to teaching practices in the classroom. This decision presented both ethical and logistical challenges as the project proceeded.
- That the case studies would be conducted in schools where the language of instruction was English. As the majority of IB schools teach through English, this did not prove to be a significant source of bias in recruiting schools, though it will be borne in mind when interpreting the findings.

3.3 Case Study Approach

It is important to note that a case study approach is a research methodology, designed primarily to probe deeply into single cases or collections of cases, with the purpose of creating rich data sets – the primary focus of which is to illuminate crucial issues rather than to permit generalisations about common practice. Thus, case study methodology cannot provide a quantitative summary of PYP classroom practices with regard to teaching thinking and assessing thinking and related questions about deep learning and thinking. For this study, the principle of maximum variation between cases was adopted as an approach to the selection of cases.

An important question that is usually posed with regards to case study methodology is the identification of what the unit (or case) is in the study. For the purposes of this research the unit was considered at two levels: at the level of the school, and at the level of the individual teacher. At the school level, the case was informed by contextual school information, interviews with key personnel, stimulated recall interviews with the video lessons (see below), and other relevant artefacts/documents forwarded by members of the school to the research team. For the teacher level, the focus was on the individual teacher's pedagogical beliefs and actions with regard to teaching/assessing thinking, and the primary source of evidence was from the videos and stimulated recall interviews (see below). In research design terminology, this method is called an embedded multiple case study design (Yin, 2014). Table 8 gives an overview of the types of information that will be sought from each school, the source of the information and the method of collecting the data.

Table 8 Overview of Data Collection

Type of information	**Source of information**	**Method of collecting data**
Contextual information about the school, some biographical information about teacher qualifications, and experience	School principal, website, teachers	Questionnaire, largely factual information, background teacher questionnaires re their own qualifications and some factual information about the classes that they teach
Curriculum design; general school approach to teaching thinking; views on the relationship between thinking and learning; assessment and progression in thinking	PYP curriculum co-ordinator	On-line interview, plus additional documents forwarded electronically (e.g., inquiry planners, rubrics, and other artefacts)
Classroom practice, focus on how thinking is taught in the context of a specific inquiry, inquiry planning, pedagogical thinking, classroom practices, assessment and progression in thinking	Two /three teachers per school to cover a range of classes, including early years if relevant	Video of classroom practice (to be completed by the teacher and forwarded to the research team) Stimulated recall interview to probe pedagogical thinking Example of inquiry and lesson plan that was the basis for the stimulated recall interview

Examples of students' work	We have some examples of students' work – but not at the level of detail that was originally planned, so this component of the data collection will not be part of the formal analysis

As can be seen from the table, a three layered-approach to data collection was adopted, shifting from general school-level information (from the principal and/or PYP curriculum co-ordinator) through richer data collected from videos of teachers' classroom practice, plus interviews, and then finally to examples of students' work. Unfortunately, although we have some examples of student work, we were not able to collect sufficient numbers to allow for meaningful interpretation across schools.

3.4 Ethical Approval

The research proposal was ethically scrutinized and approved by an independent ethics review organization, Chesapeake IRB, who provides such services for multi-center United States projects (Protocol Number PRO00014254), see Appendix 6.2 for ethics documentation. The main ethical issues raised by the project were consent – from the School Principals, from the participating teachers from each school, and from the parents of the children in the classes who were video-recorded. The other main issue was confidentiality of the participants. The names of the case schools, teachers and children are known only to the research team and will not be identified in this report or in any conference presentations or publications connected with the project. It should be noted that the recorded videos will be viewed only by the research team and will not be used for other purposes (e.g., conference presentations, training). If the case study schools themselves wish to identify their participation in the project to any other audience, they are free to do so.

3.5 Identifying and Recruiting the Case Study Schools

There are 1226 PYP schools across the world available for sampling and they are distributed across IBO defined geographical regions in the following way: The Americas (including Canada, USA, Central America and South America), 651 schools; Africa, Europe, Middle East; 245 schools; Asia/Pacific (including Far East, Australia, New Zealand), 330 (numbers taken from IB Annual Review for 2014). For the case study, the intention was to select NINE schools, three from each region. A purposive sampling strategy was adopted to maximise the likely variation between the schools. The inclusion criteria for selected schools were the following: (1) distributed across the three IB geographical areas; (2) teaching through the medium of English (most IB schools have English as the medium of instruction); (3) privately funded as well as state funded and the plan was to include 5 privately funded schools and 4 state funded); (4) PYP experienced schools (more than 10 years as an accredited

programme vs relatively new to PYP schools (less than 10 years as an accredited programme; (5) inclusion of at least three schools who teach early years, 3-5 year olds (not all PYP schools teach this younger age group); (6) within the above criteria, the intention was to identify at least two schools who we know to have a SPECIFIC interest in teaching thinking, beyond the general expectation of the PYP programme (to maximise variation). These school details are readily available from the IB Find a School website http://www.ibo.org/en/programmes/find-an-ib-school/.

Following these criteria, 27 schools were randomly selected from the IB World Schools website – anticipating that not all schools would be willing to participate. School principals were approached through email with an introductory letter, inviting participation and explaining what was involved in the project. It quickly became clear that this approach was not going to yield sufficient numbers of schools within the timeframe. Sometimes school principals and/or PYP co-ordinators were willing to participate but the perceived workload involved, especially with regard to forwarding the video lessons and the associated ethics requirements (parental opt-in for each child in the video), proved a barrier to participation. Thus, the number of schools randomly selected and approached was increased substantially, involving delays in progressing the data collection. In the long run, seven schools agreed to participate for at least some aspect of the data collection. The sample schools are distributed over three IB geographical areas (two schools in the Americas, including South America; three schools in Asia Pacific, and two schools in Africa, Europe and Middle East). Four sample schools are privately funded and three are state funded. Three schools teach early years, and schools range in the length of time they have been teaching the PYP. Two of these schools were approached specifically because of their known experience in teaching thinking. So, despite the challenges, the sample does adequately meet the initial selection criteria. The research team wish to acknowledge the generous and enthusiastic co-operation that they received from these schools both in terms of the substantive research data but also for their patience as the technical challenges of collecting the data electronically were addressed.

Table 9 summarises the main characteristics of the case study schools. Rather than just numbering the schools (e.g., School 1, School 2), each participating school has been given the name of a flower as a pseudonym (e.g., Daffodil School, Sunflower School) and the teachers in the schools have been given new names, where the initial letter of the name is the same as the initial letter of the school name, for example, Dorothy, Diana and Della teach at Daffodil School, Sophie teaches at Sunflower school and so on. This method will help the reader to keep track of references to the same school or the same teachers throughout the reporting stage

Table 9 Characteristics of Case Study Schools, with Pseudonyms					
School Name	**Interviews with**	**Region**	**Funding**	**Following a national or**	**Selection method**

				state curriculum	
Daffodil School	Dorothy PYP coordinator Teachers (with video lessons): Diana Age group 3-4 years Della Age group 6-7 years	Africa, Europe and the Middle East	Private	No	Approached because of previously *known* specific interest in teaching thinking
Lotus School	Laura PYP coordinator Teachers (with video lessons): Lynda Age group 4-5 years Lottie Age group 6-7 years Lucy Age group 9-10 years Louise Age group 10-11 years	Americas	Private	Yes, but with minimal requirements	Approached because of previously *known* specific interest in teaching thinking
Sunflower School	Sophie PYP coordinator	Americas	Public	Yes	Random
Tulip School	Teresa PYP coordinator Teachers (with video lessons): Tracey Age group 6-7 years Trisha Age group 10-11 years	Asia-Pacific	Private	No	Random
Orchid School	Oliver PYP Coordinator	Asia Pacific	Public	Yes	Random
Magnolia School	Michelle PYP coordinator Teachers (with video lessons): Mollie Age group 6-7 years Martine Age group 10-11 years	Africa, Europe and the Middle East	Private	No	Random
Carnation School	Carla PYP coordinator	Asia Pacific	Public	No	Random

3.6 Data Collection

All data were submitted electronically through a secure Dropbox dedicated to the project.

***For Schools Principals**:* A pro-forma written questionnaire collected contextual information about the schools, see Appendix C.

***For PYP Co-ordinators**:* A pro-forma questionnaire collected biographical details from the PYP co-ordinators, and details of their qualifications, experience and professional development, see Appendix C.

Semi-structured interviews (approximately 60 minutes) were conducted through on-line video using Skype. The interviews were recorded using additional recording software, called Snagit. Coordinators were given a preview of the general questions a few days before the interviews. The preview questions were:

- What is involved in being a PYP co-ordinator?
- What are your general views about how thinking develops in the PYP curriculum?
- How does the transdisciplinary skills framework get linked into planning the inquiries? More specifically, how does thinking skills get linked in?
- Does your school have expectations about how the students' thinking should develop over time (over a year, across the primary school years?)
- Does the school have an approach to the assessment of the PYP transdisciplinary skills? Specifically, how do you approach the assessment of the thinking skills elements?

The full interview protocol and how the interview questions relate to the research questions is in Appendix D. Questions were not followed rigidly and when specific issues emerged they were followed up with additional questions. Also, any further clarifications were sought through email. Interviews were transcribed verbatim and the transcripts formed the primary dataset for the subsequent analyses and interpretation. Co-ordinators also forwarded examples of any planning documents, assessment rubrics or children's work that were relevant to the interview questions. Seven PYP coordinators' interviews were completed.

***For Classroom Teachers**:* A pro-forma questionnaire collected biographical details from the teachers, and details of their qualifications, experience and professional development, Appendix C.

Examples of relevant PYP inquiry unit planners or similar planning documents that were relevant to the video lesson were forwarded to the research team by the teachers.

A two part interview was conducted online through Skype and recorded using Snagit.

The first part of the interview consisted of general questions, and a preview of the questions were sent to the teachers a few days before the interview.

- How do you plan an inquiry? How do you relate the PYP transdisciplinary skills framework to an inquiry - we are particularly interested in the thinking skills that are in that framework?
- What teaching methods do you use to help students improve their learning, particularly to help them improve their thinking skills?
- What is your general approach to assessment and to finding out if/how the children's learning is improving?
- What kinds of responses do you expect from the children in your classroom that would reassure you that they are thinking well – or at least beginning to improve ……..?

The full interview protocol and how the interview questions relate to the research questions is in Appendix D.

Video Lessons: Teachers were asked to video record a lesson from one of their on-going PYP inquiries during their normal teaching duties (30-40 minutes), and then forward the video to the research team. The lesson videos were viewed by one member of the research team (the interviewer) and segments were identified for the interview discussion. The video was then viewed jointly by the interviewer and teacher during their on-line video interview. Reflections from teachers were elicited on different aspects of their recorded interactions with students as they were watching the video. This data collection method is called a stimulated recall interview (Calderhead, 1981; Lyle, 2003). It is particularly useful for probing 'teachers thinking and pedagogical decision-making '

The questions, while viewing the video followed the style recommended for stimulated recall interviewing, included ones such as:

- Tell me what you were trying to achieve in this part of the lesson?
- What were you noticing about the students?
- How were the students responding?
- Did any student reactions cause you to act differently than you had planned?
- Do you remember what were you thinking in this moment?

However, during this stage of the interview much of the teacher questioning related to events that were specific to a lesson.

The recorded teacher interviews were transcribed verbatim and the transcripts formed the basis for the data analysis and interpretation while the video lessons provided the specific context.

3.7 Analytical Approach

Consistent with case study methodology on triangulation, several sources of information were available in order to build a picture of how thinking and deep learning was defined by PYP schools (Research Question 1), how teaching thinking in PYP classrooms was approached and practiced (Research Question 2) and how learning progressions for thinking were defined and handled (Research Question 3). As well as the contextual information about the school, and the co-ordinators' and teachers' biographical data, the main source of data was the verbatim transcripts from the on-line interviews. Other sources of written data such as the inquiry planners and any other written documents (e.g., rubrics) were used to create a rich picture of how the case study school approached thinking skills in the PYP curriculum.

Each member of the research team familiarised themselves with the interview transcripts and related case study materials. Codes were identified related to the specific questions on how links were made between thinking and learning, the use of specific thinking approaches and the reasons why, the role of inquiry and the use of PYP planner, classroom practices (triangulated through video lessons), assessment practices and views/practices on progression. Data were summarised for each case study at the level of school, mainly through the PYP coordinator interviews, and then at the level of the individual classroom teachers (through the interviews, inquiry planners and video lessons). Overarching themes were then identified at the level of the case study. Cross-case study descriptions and comparisons were then made in relation to the research questions. Finally, case study school approaches were evaluated in the light of key ingredients identified as important for promoting for both effective thinking and effective learning

4 Pen Portraits of the Case Study Schools

This section introduces the reader to each case study school. Each school is briefly described, together with the amount of data from the school that was available for analysis and interpretation. The school's main approach to teaching thinking and related issues is also factually described. Efforts have been made to maintain the anonymity of each school, through the use of pseudonyms, and limited information about location.

4.1 Daffodil School

The school was approached to participate because of previously known interest and activity in teaching thinking. This is a private international school, located in the IB region of Africa, Europe and the Middle East. The enrolment is 270 children, from mainly professional, business and international backgrounds, with diverse mother tongues. The school is not obliged to follow a national curriculum. It offers the three core IB programmes and has great depth of experience with the PYP from 3-12 year olds. Interviews were conducted with the PYP co-ordinator and with two teachers about their video lessons. Substantial additional material was forwarded about the school's approach to the PYP, and the teachers forwarded their lesson planners and other supporting materials about their lessons. A distinctive feature was that the school follows a genuinely child-led inquiry approach. This was illustrated in the video lessons that were forwarded to the research team, where the children were observed working in groups on their own inquiries. The school has adopted the Harvard Project Zero approach to teaching thinking, drawing extensively on the ideas and resources from Cultures of Thinking, Teaching for Understanding, and Making Thinking Visible. Extensive professional learning opportunities related to this approach are annually available for the teachers in the school.

4.2 Lotus School

The school was approached to participate because of previously known interest and activity in teaching thinking. This is a private international school, located in the IB region of the Americas. The enrolment is 900 children, coming from a mixture of professional, business and international backgrounds. The dominant mother tongue is a Latin language and the language of instruction is bilingual. The national curriculum requirements are minimal. The school offers the three core IB programmes as well as the careers-related programme. While it has a long history with IB programmes, the involvement with PYP is more recent, within the past 5 or 6 years, and includes children from 3-12 years of age. Interviews were conducted with the PYP co-ordinator and with four teachers about their video lessons. The teaching observed in the videos was a mixture of teacher-led

activities and student-led group work. The PYP coordinator has a long history of professional involvement with the Harvard Project Zero approach to teaching thinking, Cultures of Thinking, Teaching for Understanding, and Making Thinking Visible. More recently, the school has extended its approach to include Thinking-Based Learning, from the Centre for Teaching Thinking in Boston. The school is working to integrate these varied approaches, which also include elements of Philosophy for Children and Habits of Mind. Extensive professional learning is available to the teachers through workshops and coaching opportunities.

4.3 Sunflower School

The school responded to the open call to participate in the project. This is a public school located in the IB region of the Americas. The enrolment is 560 students, coming from mixed cultural, socio-economic and linguistic backgrounds. The dominant mother tongue is English. The school hosts a special needs unit for deaf and hard-of-hearing for their geographical area. The national curriculum requirements are extensive, with external assessment demands. The school has been teaching the PYP programme for the past 5 or 6 years but it does not extend to 3-5 year olds. It does not offer any other IB programme. Only the PYP coordinator was available for interview because of time constraints on the teachers during that period of the year. However, additional relevant information was forwarded to the research team about the school's approach to teaching thinking. The school explained that the key concepts in the PYP curriculum are their main approach to teaching thinking, including the use of Bloom's taxonomy. More specifically, they draw on a range of resources such as graphic organizers and commercially available materials such as Thinking Maps. For annual teacher observations, they use an externally designed evaluation instrument that includes indicators of pedagogical strategies for teaching thinking, including such things as teachers' questioning skills, and if/how they promote thinking and problem-solving skills with their children in the classroom. They have a strong social and emotional learning programme that incorporates the IB Learner Profile Attributes and the PYP Attitudes.

4.4 Tulip School

The school responded to the open call to participate in the project. It is a private international school located in the Asia-Pacific IB geographical region. The enrolment is 200 students, coming from diverse cultural, linguistic and mostly from affluent backgrounds, although they preserve a small number of places for children from more deprived backgrounds. There are no national curriculum requirements but they do make comparisons to national and international benchmarks for maths and language development. The school teaches the IB Diploma Programme as well as the PYP from 3-12 years old

for the past 7 years. Interviews were conducted with the PYP co-ordinator and with two teachers about their video lessons. Substantial additional material was forwarded about the school approach to the PYP, and the teachers forwarded their lesson planners and other supporting materials about their lessons. The teaching observed in the videos was a mixture of teacher-led activities and student-led group work. The school explained that it was drawn to the PYP because of the concept-driven nature of the curriculum and the inquiry methodology as a means for promoting children's thinking. A range of tools were mentioned to help them with their thinking skills work – de Bono's Hats, Bloom's Taxonomy, graphic organizers, mind-maps, prior-knowledge assessments, etc. Specific mention was made of Kath Murdoch's approach to inquiry. The school also has a special focus on building leadership qualities in their students. Teachers participate in a range of professional learning activities both locally and in regional cluster groups. They mentioned the pressures of staff turnover and the need to constantly renew professional development.

4.5 Orchid School

The school responded to the open call to participate in the project. It is located in the Asia-Pacific IB geographical region. The enrolment is 780 students, coming from a mid-high socio-economic background. The dominant mother tongue is English, at about 90%. The school follows a national curriculum which includes explicit expectations about the development of thinking. The school has been teaching the PYP for 10 years, but the school does not teach 3-5 year olds. No other IB programme is taught in the school. Only the PYP coordinator was available for interview because of time constraints on the teachers during that period of the year. The coordinator explained that curriculum planning regarding thinking skills was driven mainly by the key concepts and the central idea, together with a focus on the inquiry methodology, mentioning Kath Murdoch's approach. The school does not adopt a specific approach to teaching thinking, drawing on a range of tools and resources such as thinking templates, reflection questions, and learning intentions. The school is currently exploring the use of Visible Thinking Routines and Habits of Mind.

4.6 Magnolia School

The school responded to the open call to participate in the project. It is a private international school located in the IB region of Africa, Europe and the Middle East. The enrolment is 780 students, coming from mainly high-income backgrounds. There are 170 nationalities represented in the school. While English is the dominant mother tongue, 15 other mother tongue classes are held in the Junior School. They are not obliged to follow a national curriculum though they use external benchmarks of various kinds. The school offers the three IB core programmes and has been teaching the PYP for 12 years,

including early years. Interviews were conducted with the PYP co-ordinator and with two teachers about their video lessons. Substantial additional material was forwarded about the school approach to the PYP, and the teachers forwarded their lesson planners and other supporting materials about their lessons. The teaching observed in the videos was a mixture of teacher-led activities and student-led group work. The school explained that they did not prioritize thinking skills over any other skill-set from the transdisciplinary skills framework. They had prioritized the concept-based curriculum, mentioning Lyn Erikson's approach, and believed that the key concepts were the main driver for developing thinking skills. They also made extensive use of Bloom's Taxonomy. Some teachers in the school had completed an online course on Visible Thinking Routines, and there was evidence of their use in the classroom. A range of professional learning opportunities is available to the teachers in the school.

4.7 Carnation School

The school responded to the open call to participate in the project. It is a public school located in the IB region of Asia-Pacific. The school has been opened for only five years and has an enrolment of 1700 students, with over 50 different nationalities represented. Their backgrounds are largely middle class but with a significant number from low income families. They follow a national curriculum which includes explicit expectations about how thinking should develop. The school has been teaching the PYP for just four years, including to 3-5 year olds. No other IB programme is taught in the school. Only the PYP coordinator could be interviewed because of time constraints on completing the research project, and she forwarded other relevant documentation to the research team. The PYP coordinator was a very experienced PYP teacher, having taught the PYP for over 20 years. She explained that, with such a quick expansion in numbers, her main challenge was to induct new teachers into the PYP curriculum and the school had invested considerably in having senior teachers in a coaching role across the school. With regards to developing an approach to teaching, the teachers had examined ideas about age-related progression in thinking and what that would look like, greatly helped by the thinking continuum which was available in their state curriculum. With an outside consultant, they are currently exploring strategies such as Teaching for Understanding, Thinking Routines and Habits of Mind, but that is at an early stage. An important priority for the school is building leadership capacity.

Part 3 The Role of Thinking in Deep Learning

5 The Role of Thinking in Deep Learning: Ingredients and Classroom Approaches

5.1 Introduction

In this section we return to some issues that were raised in Section 2 but we shift focus from the theory and research to address the second and more practical research question:

What kinds of teaching promote deep learning and how is it best organised in the PYP?

Specifically:

- What kinds of teaching promote deep thinking / understanding?
- How can teaching that stimulates students' development of deep thinking skills be structured?
- What are some of the effective teaching strategies that encourage and support the development of deep thinking skills?

Building on the consensus viewpoint achieved in the Section 2 with regard to the key ingredients for **e**ffective learning and the role of effective thinking in this process, we aim now to focus on the latter, fine tune its details, and ask:

What key teaching processes need to be activated or promoted in the classroom with regard to thinking in order to progress a learner along this pathway to deep learning?.

Here is a quick review of what we sketched in Section 2. There we draw on the findings primarily from the learning research tradition. For example, de Corte (2010, 2011/12) identified a basic list of research-informed processes that are likely to be present in a true or effective learning episode. The list includes such key processes as: (1) the learning is **constructed**, (2) the learning is **self-regulated**, (3) the learning is **situated** in a specific context, and (4) effective learning **is also collaborative**. Together, this set of ingredients in effective learning is abbreviated as **CSSC**.

This is consistent with and informed by the set of competencies that make an episode of CSSC happen: the Adaptive Competence Model. Put together, we get a picture of the mechanisms of what we have been calling the process of deep learning, yielding deep learning as a product. And this view of learning as both process and product is well-understood in the learning literature today.

In this section we will build on our previous work and discuss what can be drawn out of the teaching thinking research tradition as well as the practices of classroom teachers who have translated these ideas into practice insofar as it relates to the role of thinking in deep learning and as it applies to

learning in the PYP. Our primary objective is to create a more complete picture of the key classroom processes to achieve effective learning through effective thinking. We will do this through a brief analytical commentary for each of the key ingredients of good thinking that we have identified but especially through using vignettes from classroom practice that vividly illustrate how the processes can unfold in moment-by-moment interchanges between teachers and students in classrooms.

Here is an extended list of key learning processes, including those identified in the CSSC model, insofar as they depend on the use of effective thinking activities.

Effective thinking activities contribute to deep learning through ensuring that the learning:

- Is *constructed* from relevant prior knowledge and relevant new information ;
- Includes the products of the use of thinking skills, or, to be more precise, *the use of skillful thinking*;
- Depends on the activation of *positive thinking dispositions* and *positive beliefs about one's thinking ability*;
- Grows out of *collaborative thinking;*
- Is *monitored by metacognitive processes*;
- Is based on *self-regulated thinking*.

5.2 The Role of Thinking in Constructing an Understanding of Something

There is now a general consensus that learning is a constructive process where **connections of some kind** are made between what the learner already knows – prior knowledge – and the to-be-learned material. And this is likely to be true irrespective of whether instruction is guided, as in more teacher-led instruction, or more open, as in the case of the PYP inquiry methodologies. The crux is in the phrase "connections of some kind".

Let's think of an example of how knowledge and understanding might be constructed through connections with prior knowledge. Imagine that we are watching a political celebration of some kind and trying to relate it to something that we already know. We recognize it as a celebration because of the behavior of the people involved - applause, smiling faces, joviality, cheers and so on. Interpreting something we are seeing as a celebration because of the demeanor of the people involves a simple and straightforward example of constructed understanding. It comes from a stored knowledge base arising from past experience or past learning. We do this sort of thing every day of our lives, and it clearly shows how this sort of mental activity is flexible and can adapt to new

information. We may never have seen a political celebration after an election before, yet we are able to recognize it, as it has some features in common with what we already know about events that we have categorized as celebrations.

But suppose we've never seen anything like this before – it all looks like strange behavior. We really don't have an immediately accessible knowledge base to help us make sense of what we are seeing. What can we do?

Well, there are some techniques that we learn and often use. For example, we can ask someone what is happening. Those people are all smiling. They are applauding and cheering when that one person on the podium says something. What's going on? Alternatively, if there is not another person around to ask, we can investigate it, if we really want to find out, and if we have already developed a good sense of curiosity about things we don't really understand. So we begin to ask questions about what is going on: What are they really doing? What is this thing called? Maybe we can go to the internet, or find some books about what people do when they are really happy, or in what circumstances might they behave like that in groups and crowds? We are still asking some questions, but now they prompt an investigation or inquiry, that perhaps we have learned how to do in school. And maybe we find pictures that are similar to, among other things, political celebrations. Now we can interpret what we see and, if correct, we have learned something about the world. Notice the "if correct" here. That should give us a hint that something more is needed if the construction/interpretation we develop is to come up to our standards as being a ***correct*** interpretation of the world. The something more is, of course, some form of critical thinking.

We have just elaborated the basic idea behind constructed learning: that knowledge and understanding are a function not only of becoming aware of something or remembering something, but connecting an item (an object, event, state of affairs) observed or remembered with other stored ideas and bits of knowledge. These connections can be derived primarily from past experience and past learning, and/or they can arise from newly discovered information through investigation or inquiry, sparked by our own curiosity and by our ability to ask questions on our own or prompted by others, such as teachers or other learners. ***The mechanism of these connections is analogical or relational thinking, enhanced by the way we conceptualize the item.***

Let's think about this in three stages. (1) The first stage is the identification of the item encountered (through observation, memory). This usually means that the person encountering the new item has some basic categorical knowledge derived from their school learning such as: "Someone picking fruit", "a contested election", "a suspension bridge". Construction depends on ***conceptualizing*** the item in a way that enables the learner to search in his or her memory, either prompted or on his/her own, for

other similar things that fall under the same concept that the learner might know something about. So the primary condition of construction depends on the to-be-learned item falling into some categories that the learner already knows something about. (2) The second stage is that the learner makes this connection, either prompted or on their own. (3) Then, in stage three, the process of construction is completed when the to-be-learned material 'inherits' some of the features of the stored information that leads to a new interpretation that the learner might not have previously considered . Here is an example from an upper primary grade school classroom which includes techniques by the teacher to prompt these three stages.

Vignette #1ª.

Teacher guiding a constructed learning process through the first two stages

In comparing and contrasting two leaders during the American Civil War in the 1860s, Abraham Lincoln and Frederick Douglass, students usually discover, through prompted reading, two important similarities about these men when they were children: they taught themselves how to read and write (Douglass, who was a slave in the South at that time under great risk because what he did was illegal), and they both "escaped" from the poverty of their youth through their own initiative. The students also discover that their mothers died when they were very young. These students are acquiring easy basic knowledge by using a specific furnished knowledge base that they understand in what they are reading.

This third piece of information – that their mothers died when they were young -- seems initially to be rather less momentous to these students than the other two pieces of information. However, when someone reports to the class that they found this similarity between them, the teacher stops the articulation of similarities and says to the class: "Hmm, when a person's mother dies that doesn't just involve someone's death and the loss of someone you used to talk to and play with, a common occurrence at that time. What does someone lose when they lose a mother?" Students responded with things like "Well, mothers take care of their kids. That's what they lose". The teacher then says: "How do children who lose their mothers compensate for this. Have you had any experience with this sort of thing?" Notice the direct guide to think about the past experiences of the students." Some responses pay off. One student says: "Oh yes. That happened to a girl who lives down the street. And she didn't have a father. So she went to live with her grandmother." Other students tell similar stories, mostly about relatives who adopted the child when the father was gone. "What else do children sometimes do?" One student responded after a few moments of thought. "Oh, I

knew a boy whose mother died, but who was in a big family, and his father worked a lot. Well he learned how to take care of himself." Others remembered something similar.

That's an example of a teacher guiding students to make a connection between what they are learning about using basic categories that they have already learned and that might apply to children the age of Lincoln and Douglass in their early years. This may be something stored in their long term memories representing their past experience, perhaps with their own mothers. That's step two of constructing an understanding of something you are learning about.

Step three is often quick and straightforward, prompted by the teacher saying "So what does that tell you about Lincoln and Douglass?" Here's the rest of the Vignette.

Vignette #1b

Teacher guiding a constructed learning process through the third stage

So what do you think about Lincoln and Douglass? Three students said almost the same thing. From one of them: "Oh. I see. They didn't have anyone to tell them to learn to read. They both did this on their own. And they were both born very poor. They must have figured out how to get jobs, and earn enough money to not be poor anymore." In fact, as they find out more about Lincoln and Douglass, they discover that Lincoln went to college, went to Law School, and became a lawyer, and he did this on his own initiative. And Douglass ran away from the plantation he was on as a slave and used the complicated resources of the "underground" railroad to escape to the north where he got himself a job on a newspaper. "So what does all of this tell you about these two men?" Students mention taking charge of things, perseverance, determination, able to make plans and follow them, and many others.

That's a simple and straightforward example of constructing an understanding of something by connecting it with some stored knowledge a person has. The teacher uses relevant prompting and extended questions to help students make these connections. She also relies on the active involvement of the students to engage and respond to her questions, confirming that the process of construction is an active process.

Notice, we have not yet called this "learning". Learning is a success word. And the construction so far may not be correct, as we commented earlier. Maybe Lincoln's and Douglass' mothers were not so caring, or were abusive. Then what the children constructed would be a misinterpretation. Just constructing an understanding in this way may not yet yield true learning. We turn now to what that 'extra' something might be that will justify the claim that this has yielded real learning.

5.3 Deep Learning is based on engaging in Processes of Skillful Thinking

Sometimes the word "thinking '"is used to focus on the *product* of thinking ("What were you thinking that we could do this afternoon?", "What questions do you have about the trip the family will be making tomorrow?"). And often words of praise about thinking like "Good thinking!" are offered about such thinking products. "Thinking", though, is also used to signify a *process*. Process responses are answers to the more colloquial "How did you figure that out?" or "How did you get that answer?"

While answers to both types of questions are important, it is this second meaning -- thinking-as-process -- that is at the heart of the claim that thinking achieves deep learning. Because of this teachers need to develop good instructional techniques to prompt students to identify and articulate what these thinking processes are, and to use and practice them, with the recognition that good ***product*** responses often depend on the use of effective thinking ***processes*.**

Elaborating those practices has been the main emphasis of members of the community of concerned thinkers who have focused on ***how to do good thinking***, characterized as the kind of thinking that can save us from making mistakes and can lead to truth. While this enterprise really dates back to Socrates, it was Aristotle who first tried to set down "rules" and strategies for thinking (Aristotle use of the term "thinking" is usually translated as "reasoning") that were supposed to help us avoid drawing incorrect conclusions from what we were thinking about. And while some who have tackled this question about good thinking – thinking that avoids errors and yields truth – have followed Aristotle and focused primarily on deductive logic and mathematics, trying to develop strict proof procedures that students can learn, others have recognized that much of the important thinking that we do in our lives does ***not*** involve deductive proof, is non quantitative, and hence does not revolve around determining whether arguments are valid, either formally or informally -- the main domain of logic. These other important contexts involve decision making, problem solving, finding out what caused something, predicting, sequencing things, ranking them, etc. Even such commonplace types of thinking like comparing and contrasting fall into this group. The question is: how can we do these kinds of thinking well so that they lead to ideas and conclusions that we can count on as likely to be correct. [1]

[1] As an important aside, the development and use of "the scientific method" is a clear example of this when the question falls into the domain of the natural sciences, has to do with cause and effect, and there is no clear answer to as yet. The objective is the same: follow this method faithfully and you will be able to provide an answer to your question that is well-founded and it would be reasonable to accept.

Benjamin Bloom is usually credited as the originator who tried to put the kinds of questions that require different types of careful thinking into broad categories – those, in fact, incorporated into the set of thinking objectives in the IB. However, in our previous reports we have argued that there is a need to go beyond Bloom's type of classification and to draw on more recent traditions that help us with more specific ways to respond to questions like "What should I do?", "Is there a less routine and more creative way of getting the result we need?", "How does the internet work?' and "What caused that plane crash?". Since the 1950s we find contributions by Edward de Bono, Reuven Feuerstein, Robert Ennis, and Paul Torrance (see Swartz & McGuinness 2014a, Report 1), trying to answer questions like these that involve proposing more finely tuned strategies for effective thinking that align more closely to the ideas we have explored about deep learning, inquiry, and the role of thinking in validating our ideas as real learning. These all fall into the realm of "heuristic" strategies that play such an important role in the Adaptive Competence Model from the psychological learning research literature that we have articulated in Section 2. This is the way that thinking skills – or to be more precise, "thinking skillfully" – contributes to making the process of learning effective.

The idea here is that, for maximum learning power, the thinking skill activities that contribute should be rendered into adaptive and flexible strategies that students can learn, adapt, and then, with practice, self-regulate and internalize. This maps onto what has been the overall picture of the effective teaching of thinking that we review in our previous report (Swartz and McGuinness, 2014a)

So what is the challenge that this brings to teachers? The challenge for teachers is:

- to help students develop important challenging questions, the answers to which depend on the use of skillful thinking;
- to be more explicit about what is involved in thinking effectively as they work with students to articulate such plans;
- to develop and use supporting organizers like written renderings of these strategies, and the use of special graphic organizers to help students download their thoughts as they move through a particular thinking strategy; and
- to provide opportunities for students to share and interact with other students about their ideas.

These methods will scaffold thinking processes so that students can make more connections as described above, or can create new connections that prompt them to ask additional questions, to seek new evidence and so on, as they are advancing their thinking. This approach is articulated as one of the key ingredients of both the Adaptive Competence Model and the effective thinking model we articulated in our earlier work. But now we are suggesting that describing plans that we may adopt

for good thinking in any domain as 'heuristics' – as flexible plans that have the same objective but may vary depending on the specific situations we as thinkers are in – illuminates how to develop workable thinking plans with our students (Swartz & Perkins, *Teaching Thinking, Issues and Approaches*, 1989, Ch. 5; "The Nine Basics of Teaching Thinking"; Swartz, et al, *Thinking-Based Learning*, 2007). These heuristics can first be scaffolded into learning activities by the teacher and then, with the scaffolding gradually removed, they can become internalized through practice by the students who know how to adapt them to specific circumstances, and then used regularly through the process of self-guidance and self-regulation in circumstances calling for appropriate types of skillful thinking. Let's see what this can mean in classroom terms.

VIGNETTE # 2

Teacher guiding young students through a process of analysis to deepen their learning about habitats.

A *teacher of 6 and 7-year olds wants to start to help her students develop skill at analysis, one of the types for "higher-order thinking" identified by Benjamin Bloom. She realized, though, that there are many types of analysis that need to be taught: for example, sequencing, classification, and comparing/contrasting. But she focused her attention on one aspect of how analysis is defined in the PYP Thinking Skills framework, as separating a whole thing into component parts. For example, students often study things that have clear components that they need to learn about, like the parts of the human body. Quickly she realized that the parts of speech, the parts of a story, or the parts of the government of their countries, are all other examples in which students learn about their parts, with the ultimate objective being the student's ability to explain how the parts of something work together to enable the whole object to do what it does.*

But in thinking about this she realized that when this happens in classrooms students are usually only asked what the parts are to check to see if they have learned what the teacher is teaching them. For her objective about developing skill at analysis, though, naming the parts is not sufficient. So how can a teacher enable students to answer the more challenging question, namely, how do the parts work together to enable the whole to do what it does? She therefore worked with her students to develop a thinking strategy to make parts-whole thinking more skillful, directed at students being able to answer this kind of question about how the parts work together as a whole.

"What is this?" she asked her students as she held up her hand. "Your hand", many of them said. "OK. We all know that. Now look at this. ***What do you see?****" She then uses her hand to pick up a pencil and write something on a piece of paper, then she smooths the fabric of her dress, and then she points to the clock and says "Look. It is 10:00. We have another 45 minutes left to this class." "****What do you think I am doing?****" Some students describe what she is doing. She then asks: When you look at my hand doing all of these things* ***what does that make you wonder?*** *Many students ask: "How does your hand work so that you can do those things?"*

But now she says: "So look at it and tell me what the parts are." Immediately 12 students raised their hands. She says, "Each of you tell me one part, and don't repeat what someone else has said." "Your thumb" the first student said. She wrote that on the board. "The skin", another said, and "Your finger nails" said another. She wrote those. One student said "Your fingerprints". She wrote that too. "Good. You've noticed these parts, and remembered what they are called. That's the usual way teachers check up on what you have learned when you are studying something important that has parts. But is that enough to answer your question about how my hand works? " Students are puzzled, but many say "No". "So what else would you want to find out about these parts besides their names?" After a few moments of silence one student said "Well, why do we have finger nails? I know we can scratch things, but is there any other reason? What do finger nails do for us?" The teacher said "Let's hold on to interesting questions like this for a moment, but let's make this a question about any part in general. What I want us to do is to identify the questions in general that we think are important to ask and answer about any parts of a whole, and I will write them on the board. Then maybe we can figure out what you want to know about the fingernails and about my hand." So she wrote: "What are the parts?", then under it "What do the parts do?", and asked: "Anything else? One student said: "How do these parts connect so that we can do things with our whole hand? Do all of them connect, some of them for some things, but not others? I am really curious about that. I wondered that back when you did those things with your hand." She summarized this and wrote it. "Anything else?" After some silence a student said: "What will happen if a part is missing?" She writes that too. "Now let me put these questions in order and we will try them out. She writes the following on the board in big letters:

FINDING PARTS-WHOLE RELATIONSHIPS SKILLFULLY

- *What is the whole object?*
- *What are the parts of the object?*
- *Let's think about each part and ask, what would happen if it was missing?*

- *So what does each part do when it is there?*
- *How do all the parts work together so that the object can do what it does?*

She comments that question 4 is sometimes asked using the word "function".

> *"The reason I wrote this on the board is because we've been studying different kinds of habitats for various animals. I've made a picture of one of those habitats, a forest habitat. She then posts the picture on the wall." Let's use skillful parts/whole thinking to figure out how this forest habitat could have continued to be a home for animals for hundreds and hundreds of years?"*

This teacher now has the students work in groups, record their ideas in writing using a special graphic organizer, and then report back to the class for class discussion and to see if they can combine results. "That was really good thinking" she said to the class when the activity was completed.

This, we believe, gives us a good model for what a teacher can do with regard to all of the different kinds of important thinking. It involves the use of a special thinking prompt, called a "Thinking Routine" (Ritchhart et al., 2011) designed to generate the focus question(s) ("*See, Think, and Wonder*"), and then a "Thinking Strategy Map" (Swartz, et al, 2007) to help students learn to use a special thinking strategy to answer these questions by doing a specific kind of thinking skillfully (*Skillful Parts-Whole Thinking*). In this case the application of skillful-parts whole thinking to the curriculum is in gaining a detailed understanding of how an ecosystem works.

5.4 Regularly Thinking for Deep Learning Depends on Activating Positive Thinking Dispositions and Positive Beliefs

In ***How We Think*** John Dewey (1933) said that students may learn how to think well, and with skill, but if they don't care about thinking well they probably won't. There is general agreement in the research literature that deep learning goes far beyond the acquisition of bodies of knowledge, no matter how well constructed, or even the practice of skillful thinking. This is because we don't consider someone a deep learner if they don't practice the techniques that go into deep learning regularly and when needed. What stands behind this is not a skill but an attitude – they ***care*** about learning and engage in it ***to "really understand things",*** or simply, to ***"get it right"***. These attitudes are often called "***Thinking Dispositions***", after an early article by Robert Ennis (Ennis, 1962) in which he argued that teaching good thinking needs to involve more than just a cluster of abilities, it needs to encompass the development of a number of important dispositions that prompt us to do skillful thinking when we perceive it is needed.

While some have argued that there are many thinking dispositions that we need to help students develop (Costa & Kallick, 2014), most mainstream researchers on teaching critical thinking usually produce a short list of these dispositions as the basic ones, for example: *Finding the truth, Being Understood by Others, Being Open-Minded to Other Points of View,* and *Being Understood by Others*, (Ennis, 1962, 1987, 1996; Tishman, Jay & Perkins, 1993).

Let's be careful here. Dispositions are not new and mysterious things that we now have to work with students to develop. We teach young children how to brush their teeth. But knowing how to do that, and doing it well, is not our objective. We want students to do it *regularly and habitually*-- to develop the habit of doing it. How do we do that? Well, certainly practice is one of the instructional ingredients, like we get students to do for anything we want them to develop the habit of doing: using the correct tenses when they use verbs, adding to get correct results, etc. We also try to help them recognize situations in which these things are called for – are appropriate. Well, that may be a function *of varied* practice, maybe more. But we also want to help them realize that doing these things *is a good idea – to want to do them*. This introduces an emotive component to the disposition to do these things. And, of course, our congratulations when they do all of this will contribute to its success, especially when it is hard.

Thinking dispositions are also dispositions to do specific things well – in this case specific kinds of thinking. They have been discussed considerably in mainstream literature about teaching thinking (Tishman, Jay & Perkins, 1993; Ennis, 1962, 1987, 1996). Let's use the example of skillful parts-whole thinking. Our objective is to help students learn how to do that so that they can explain how something operates, but we also want them to do it when they perceive that it is needed – when they really want to understand something this way – not like a robot, but because they want to get it right. And it is this desire that is the motivator – the driver -- to do this kind of thinking well. So how do we teach that?

We also need to mention another important factor identified in the literature on effective learning. If someone wants to find the truth but believes that he or she can't, it is likely that they won't try. So along with these thinking dispositions, *positive beliefs and positive mindsets* by students that they can accomplish good thinking need to be developed. Repeated practice and praise for effort rather than ability (Dweck, 2006) are often cited as two complementary techniques that can help students develop these beliefs.

These psycho-social attitudes towards thinking and learning are well represented as objectives in the PYP curriculum, through the IB Learner Profile as well as through the PYP Attitudes. But how can we help students develop these special thinking dispositions? In the Vignette below there is an example

of a teacher trying to help students develop one of the important thinking dispositions, being open-minded, one identified throughout the IB curriculum.

Vignette # 3

The students in this 6th grade class have just concluded a decision making activity in which they have worked together in groups of three to decide the best energy source for their region. They have brainstormed many options, determined what they need to find out about an option to decide if it is best for their region (e.g., cost, safety, impact on the environment), compared the results, and decided which energy source they would recommend. Hence they have followed a fairly standard strategy for skillful decision making.

At this point in the lesson they have just made their decisions and the teacher has said that she would like them to write a careful recommendation to the government about this, using a special thinking-to-writing template that she gave them. But first, she recognizes that not all groups are recommending the same energy source. So she asks them to work together in teams of two and explain to each other why they are recommending the energy source their group thinks is best. She wants them to use the structure they have learned for hearing and understanding other points of view, and also ***listen with respect to their partners****. But, she also says, she wants them to be* ***open-minded****, an attitude that they have been working on with regard to other ideas. This involves, she reminds them,* ***listening to others with respect,*** *being able to explain their point of view,* ***but also being willing to change your minds if they find that their partners have uncovered information that they have missed and it speaks convincingly against their choice.*** *She tells them that some people find this very hard and want to define being open-minded as involving just understanding others' point of view, yet always sticking to their own. But she explains that people she considers to be truly open-minded are able to accept other points of view themselves if there is good reason. She writes these characteristics of being open minded on the white board.*

After the activity she asks if any of the students have changed their minds based on this discussion, and some of them say yes. She asks them to explain why to the class. But she also wants them to discuss whether they think being open minded in this way is a good thing, and if so why, if not why not.

This teacher has used a simple and straightforward technique to help students develop a specific attitude or disposition towards their thinking: being open-minded. You see in this vignette the teacher helping students identify the attitude, explaining why it is a good attitude to develop, and then giving

the students practice in engaging in the behavior that manifests this attitude, all peppered with positive reinforcement.

5.5 Deep Learning and Thinking is Metacognitive

As we noted earlier, metacognition, sometimes called 'thinking about thinking' in classroom contexts, is widely recognized as one of the key ingredients for becoming a productive learner. And indeed monitoring the many processes that go into good learning can well yield ***learning how to learn*** in a more effective way. As a process, thinking about how we are managing the many processes that go into learning is bound to contribute to effective learning, just as monitoring how we are playing the violin, or playing tennis, can yield some oversight that is bound to contribute to making us better violinists or tennis players. But notice here that we are the ones who are monitoring how we are doing these things, not the teacher. So we count metacognition as a key learner-oriented ingredient for effective learning. For now, let us consider ***monitoring our thinking*** as a sub-class of the kind of monitoring we do when we are learning how to learn, applying to the processes of thinking we are describing in this section.

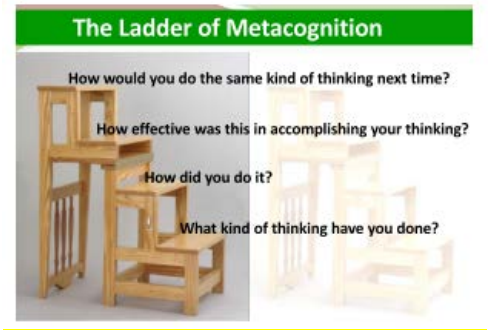
While the term "metacognition" is very broad with regard to the multiplicity of ways that we can think about things, there is agreement that there are five component processes that represent an effective strategy to achieve our objectives of monitoring our thinking (Swartz & McGuinness, 2014a, Sections 2.1 and 4.5 for a more extensive treatment). They start by (1) identifying and describing the task, (2) judging whether the thinking process is working to accomplish what they are trying to accomplish, (3) either affirming the process for future use, or rejecting it so that they don't make the same mistake again, (4) revising the process to make it better if it is causing trouble, and (5) planning how to do it next time using these revisions so that they do it better. And even though they are monitoring their own thinking, the teacher often prompts them to discuss their ideas within their groups so that they may reap the benefits of some of the other students in making the thinking task they are monitoring work well. When things haven't gone so well – students got stuck, or found the ingredients of the thinking process confusing - simple suggestions like taking more time, asking others how to do what they are doing, to reordering the steps of a strategy they are trying, and replacing one of the steps with a different one that may get them the same results more easily.

We have deliberately described this in general terms to emphasize that monitoring our thinking processes, whether they involve trying to respond to the prompts when they use thinking routines, or determining whether a specific conclusion about the cause of some historical event can be drawn from the facts that they have collected about the event, is like monitoring and trying to make more

effective any process we engage in. For example, a football player may monitor how he behaves when he receives a pass when his team is moving towards the goal. He missed because a player from the opposite team who was on his right who he didn't see blocked his kick. What he was doing seemed to be hindering the goal. How can he change his tactics so that if he watches the players on his right he doesn't ignore his left? He thinks if he shifts his body about 30 degrees towards the goal he will be able to easily see what is on one side – the important side, the side he is kicking towards. Maybe that will work. So he plans to try it next time he is in the same position. That's what thinking about thinking is like.

Teachers sometimes find the concept of metacognition very abstract and a difficult one to make accessible to students. So it is important that they work with students to create prompting questions or a plan for skillful metacognitive thinking in the same way as we have suggested for skillful parts-whole thinking, skillful problem solving, skillful decision-making and so on. Teachers often make use of what they call 'the ladder of metacognition', which includes questions with an increasing level of detail, evaluation and planning for next time: What kind of thinking are you doing? How are you doing it – what steps are you taking? Is this a good way to do this kind of thinking? How will you do it next time? When the image of a ladder is superimposed on these questions it makes it much more accessible to their students, even 3, 4, and 5 year olds. Here is a classroom image of this "Ladder of Metacognition".

Figure 1 The Ladder of Metacognition



Vignette # 4

A teacher prompting students to 'think about their thinking' in order to improve it

The students in a 5th grade class have just done some project work in which they have worked on a case study of a town experiencing some pollution of their drinking water due to the dumping of waste from a paper mill that provides the majority of the paper available for paper products in the region. They have used a straight forward problem-solving strategy in which they generate a number of possible solutions, and then consider their consequences, and after comparing the results solution by solution, they make a recommendation about what they think the best way to handle this would be. They work in collaborative thinking groups, and share their results with the whole class to see if the class can agree on a common solution. They explicitly agree to discuss together in pairs any differences in proposed solutions that they have come up with, listening to each other with respect and with an open mind and ready to change their minds if their partner reveals that his/her team uncovered some relevant information that the first student missed.

This is a somewhat complicated process and the teacher notices that there is not much agreement in the class. She tells them that this is acceptable – people sometimes disagree – as long as they can explain why they accept their solution as the best. But she is troubled. So she asks them to stop thinking about their solutions and think about how they went about this task – think about the thinking moves that they made. She says "Let's start at the beginning. What were we trying to do? What kind of thinking did we all do and how they did it, wanting to make sure that they are all "on the same page" with the task.

They all acknowledge that they have been trying to do problem solving, and following the simple strategy outlined above. Then she asks them to discuss with each other whether they think this way of approaching problem solving worked; did it yield a solution that they had

some confidence in. This is where most of the students said no. When she asked why she got a clear response: The groups were working on different problems. For example, one group took the problem to be: "How can the community get the paper company to stop dumping its waste where it leeches into the water". One of their solutions was to fine the company and close it down. But another group took the problem to be: "How can we keep the paper company from polluting while at the same time providing adequate paper for the community", and another was "How can the community assure that they drink pure water?" Then one of the students said: ***"Let's all start from the same place. Let's make our first step to agree what the problem is that we are going to try to solve."*** *So the class, and the teacher, agreed to change the problem solving plan and* ***put in a step on defining the problem at the beginning.*** *The teacher hadn't realized that this had happened in the class and fully agreed that they should make this change in the strategy for problem solving to make it work better. And it did!*

This is an example of how productive a good episode of metacognitive thinking can be in producing a more effective strategy for good problem solving. It is a model for any thinking process that students are trying to do according to a pre-conceived plan.

5.6 Thinking for Deep Learning is Self-Regulating

In the previous vignette, the students were prompted by the teacher's questions to look back over the approach they had adopted to solving the problem. But of course, the ultimate aim for deep learning and thinking is that the student should be able to adopt these metacognitive strategies for self-improvement automatically and become more independent in exercising these abilities. It is a great accomplishment when this happens. And when it happens the thinking that the students are doing becomes "self-regulating". And of course many of the other strategies that the students use trying to achieve effective learning need to become self-regulating as well. Then they have not only learned how to learn effectively, they do this whenever they need to find out something new that they don't know about. The capacity for metacognitive thinking is a core process for this kind of self-regulation. And, of course, the goal of every educator is that their students not only learn this, but that they do it for the rest of their lives.

So how can teachers bring students to this point? Self-regulated learning - and in particular self-regulated thinking - refers to a process by which students become more adept at ***managing their own learning and thinking processes in the pursuit of learning and thinking goals.*** So let us focus on thinking. What does self-regulated thinking mean?

Usually we think of self-regulation simplistically. You are driving your car and someone stops short in front of you. Nobody tells you want to do. Rather, you reduce your speed and turn your wheel so that you can go around the other car. Then you go back to your regular driving. Well, that not just a natural reaction to a sudden problem. It is an accomplishment. When you were learning to drive you couldn't do that. You just slammed on the brakes so that your instructor, who was in the front seat, hit his head on the windshield. No airbags then. But he smiled and said "Let me show you". And he did. He set up a mock situation like that one, told you when to push gently on the brakes, and he guided your hand in turning the wheel at the same time. He told you to practice that in an empty parking lot by putting a pile of old clothes where the car in front would have been. And you practiced it, first with him telling you what to do, then just told you about turning the wheel, then nothing during, but after he said: do you think that you turned your car out too far? You said yes, so he put some tape on the steering wheel to guide you. Then, after you tried it many more times, you did it right again and again, and without anyone telling you. That's how we learn to regulate ourselves.

Transpose this to asking and answering one of the "thinking routines" like "See, Think, and Wonder". When? How? There will be teacher guidance first, then you will get it and it will become natural. Or to developing one of the follow-up strategies to help you answer the question, "I wonder what caused the Titanic to hit the iceberg?" You've learned that question sets your objective: no guessing, I want to really find out. How? This takes us beyond the use of thinking-routines, which help you lay out specific ideas and develop important questions. But now you need to answer these questions.

You've learned and used a strategy for this that guides you to come up with possibilities (you've learned that these are sometimes called "Hypotheses"). Then you develop a plan for what you will look for that will give you enough information to be able to say, "Fog was probably not the cause?" or "High speed and the belief that nothing could sink the Titanic" probably was. Then you search for facts that will give you enough evidence to say yes, or no, to these possible causes. And you've learned how to decide if the evidence is enough. You have practiced this so now you feel confident that you can do it and do it well. Then you advance an answer to the question, what is the likely cause of the Titanic hitting the iceberg... And if someone asks you why, you are prepared to explain all the evidence that you found. You are guiding yourself in a process that you have learned through previous teacher guidance and then practice, first with the teacher, then without, until you feel pretty confident that your response – your conclusion about the Titanic – is first-rate acceptable. You have learned how to manage the thinking process on your own – to self-manage. That is a key ingredient that can lead you to more effective learning about what caused something to happen. Self-regulated thinking is a complex mix of cognitive, emotional and motivational processes.

Here is a Vignette drawn from the psychological literature about the route to self-regulation by the students of an effective reading strategy (drawn from Palinscar and Brown, 1984)

Vignette # 5

The teacher is guiding students to self-regulate their reading comprehension

To foster fifth graders' competence in reading comprehension a teacher decides – in line with the new standards for language teaching -- to teach four reading strategies: activating prior knowledge, clarifying difficult words, making a schematic representation of the text, and formulating the main idea of the text. The teacher's aim is not only that the students can execute these strategies but also that they will themselves be able to regulate their use, i.e., that they will autonomously and spontaneously apply the strategies whenever appropriate.

In the initial stage of learning a strategy, the teacher models extensively in front of the class how the strategy works and how it has to be applied. Thereafter, the strategy is practiced in a discussion format with the whole class using short texts. In this stage, the strategy use is still mainly regulated by the teacher through asking questions such as "Are there any difficult words in the text?" but the students who are learning the strategies have to execute the strategies themselves.

In the next phase the students – now split into small groups of three or four – are given the opportunity to apply the strategies under the guidance of the teacher. This takes place in the form of dialogues during which the members in each group take turns in leading the discussion: the students take responsibility not only for executing but for regulating the strategies. The teacher remains available to give support and help as far as is necessary, but focuses on stimulating discussion with questions and prompting the students to reflect on and discuss the use of the strategy.

Notice how there is an active use of prompted metacognitive strategies as an overlay on this practice: students are asked constantly to monitor, reflect on, and even make appropriate changes in the way they are using this strategy themselves. All of these ingredients go into building the competence in the self-management of learning.

5.7 Thinking for Deep Learning is Collaborative

In the last 30 years or so there has been a shift in our understanding about the nature of learning away from the view that learning is an individual activity toward recognizing that learning, at its best, is social. We learn from others as well as developing ideas ourselves. We learn from teachers, but also from TV, from newspapers, from our neighbours, etc. This, too, is argued to be an essential component in effective learning.

There are lots of reasons why a dominant theme in education over the past thirty years has been to structure the classroom in the primary grades to promote students ***working together in collaborative groups***. Learning to divide a task for work by a team, promoting active learning, and students listening to each other as a model for better social interaction outside school are often quoted as main reasons. This has now become commonplace in many schools, utilizing many techniques promoted by proponents of collaborative learning in their writings and workshops (see Swartz & McGuinness, 2014a, Section 4.6 for a summary).

But there is a deeper reason connected with the concept of effective learning that we have articulated. It is simply that real learning needs to aim at not just a monolithic body of knowledge, but everything important that we, as a society, or as a sub group in society, claim to know about something. This certainly may make the quest for effective learning relative to grade level and age, but it also makes it an ongoing process. But more important, that means that we need to acknowledge that what we think we know about something may be in disagreement with what others think they know. The road to effective learning may be a bumpy road. We especially need to be careful not to count as learning only ideas about which there is social consensus, even amongst reliable and honest people. We suggested earlier that the adjective “effective” as applied to “learning” carries with it a normative connotation: what we include in learning should not be just guesses but rather items that are defensibly maintained to be correct or true. If we accept things that are false that does not count as learning (though, of course, finding out that they are false may well be something that we learn). If someone thinks that they have learned that Napoleon defeated Wellington at Waterloo they are wrong, because the consensus is that that battle did not turn out that way. So all learning must be considered as social in that sense, even including disagreements about what the truth is.

This is where the need for the practice of good thinking comes in. Good thinking needs to be the determiner of what we accept as true, hence what we have learned.

Perhaps we can best explain this by going back to what we said earlier: We learn things from others, for example on TV. Well, we need to be extremely careful here. Not everything we hear discussed on

TV is reliable, and while our neighbours are nice people, sometimes they accept rumours as fact, and we need to be careful with them too, but in a nice way. We need a filter in the way we learn from others. So we need to learn to think critically about social learning as with other contexts for learning.

What does this mean in the context of teachers and students in classrooms? From classroom observations around the world (e.g., Alexander, 2000), we know that the dominant mode of interaction in classrooms tend to be monologic – that means that most of the classroom talk is initiated by teachers, with brief answers from students, followed by minimum teacher feedback. This is sometimes called the IRF – initiation-response-feedback – mode of classroom interaction. While this is certainly a form of interaction, it is a minimalist form. Teachers do most of the talking and the amount of student talk is not sufficient to give teachers many clues about how the students are thinking, or indeed give the students much opportunity to construct their understandings in the way we described as being constructed in the section on deep learning. In fact this is a factor that contributes to students relying on simple memory to give teachers back in tests what they have told the students so that they will get a good grade. And to make it easy many of these tests are simple multiple-choice tests. A few pencil strokes is all students need to do to show that they understand something – not much writing is needed.

So students in more and more classrooms work in cooperative or collaborative ***groups***, usually of between 2 and 6 students. And the activity of the groups is prompted not only by teacher- led talk but by a teacher posing questions for the students to try to answer or a challenge by the teacher to find out about something. Hence, as we remarked, one of the main characteristics of these groups is that the students are engaged in "active" learning.

But active learning, in this sense, is not the main objective of such group work. Active learning could happen in regular classrooms that are not divided into groups. For example, a teacher could pepper the class time with questions or challenges that the students can respond to individually. When students work from tablets, and not just text books, teachers can pose somewhat complex challenges that lead students to explore a range of things on their tablets that may not be accessible while they are sitting at their desks with just their textbooks. Still, while this learning is active, it is not collaborative.

Rather, while working in groups, students are supposed to work by ***collaborating*** in the learning process as they engage in active learning, e.g., in answering the teacher's questions, or being prompted to raise such questions themselves – for example being prompted by teachers using such prompts as "What do you see, what does that make you think, and what, again, does that make you wonder" – one of the "Thinking Routines" derived from the project called "Visible Thinking".

But we need to be more precise here. "Collaboration" is a very general term. A group of three students can collaborate, for example, by having one student record what individual members are saying, another student give a report of what has been recorded, and another student be a moderator in the sense that he or she needs to make sure that all of the students get a chance to contribute their ideas to the final product – the report. Indeed, these are key structural components of group work promoted by many group-work theorists (Johnson & Johnson, 1994).

But working together in this way may not yield much depth of learning on the part of any of the students. Indeed, in some groups each of the students work on their own to meet the challenge of the teacher, then the recorder records each of their ideas, and the spokesperson reports this. This omits a key factor that is often mentioned as one of the objectives of collaborative work, ***interaction*** between the students. But even this term does not capture the key objective of such group work, which is more than just combining the ideas of the members of the group. Interactive learning implies that as the student put their ideas together they do more to achieve a deeper learning outcome than just knowing what each member says. This can take two forms.

The first of these involves the process of ***dividing a task and having the students each work on a different component of a larger task***. For example, suppose the teacher prompts the students to explain how an automobile assembly line works in an automobile factory (or suppose that is one of the things that they all wonder in responding to what they see – a photo or a video of an automobile assembly line -- by raising questions). Well, maybe one student's task is to focus on the raw materials for the manufacture of automobiles: where do they come from and how do they get to the factory. Another student's task is to describe how the raw materials are manufactured to become a component of an automobile, another student finds out how they are put together, and the final student finds out how the completed automobile gets to the automobile showroom. This could involve a lot of research about these processes and, when put together, yield an account that no one student could have accomplished in the time he or she spent on a specific component. And each student will be learning something from the other students that yields a richer and deeper understanding than just what he or she has learned about one of the components on the process.

But while this is a common ***collaborative learning process*** and it involves some interaction, it is not the model of collaborative interaction that carries with it the richest type of interactive learning that we engage in when we think of learning as a social phenomenon. That is where the students may all be researching the same thing and they come back with different views of what they have been researching, some of which conflict. Many educators view this as an important way that collaborative group work can mirror what happens in the "real" world outside the classroom. This **is usually**

motivated by the desire to find out what is true and an attitude of - and respect for -- views and thinking of others*.** It contrasts with the attitude that what I think is right and while others disagree, they are wrong, or, "they are entitled to their opinion, and I am to mine, and never the twain shall meet." The collaborative ingredient here that is suggested as a counter to this attitude involves both ***dialogue, in the sense of talking together, but also ***dialectic –*** that is, students challenging each other with competing ideas through engagement in careful and skillful thinking, especially critical thinking. The example in this Vignette is a good clear example of this.

Vignette # 6

The students are learning about types of energy needed in our society every day, like electricity, and the sources of such energy. They explore different sources of information, including the class text book, about how electricity, for example, is generated through nuclear, or solar, sources. But then the teacher gives them a challenge: Let's work together, think about, and then try to recommend what we think is the best energy source for our region. These students have already developed, with the teacher, and worked with in their reading and writing in earlier years, a thinking strategy for skillful decision making. It includes such features as developing a list of clear options, predicting consequences, both pro and con, of each option, checking on whether some of these consequences are more important than others and adjusting their weight, and then comparing the options to recommend the best one based on these elaborate consequence sets. And when they choose what they think is the best they need to be prepared to explain why.

Well now they have developed a rich and long list of options through group brainstorming, and the teacher has commented on these and written them on the board as a class list. The list includes commonplace options like burning coal and hydroelectric projects, as well as some creative ideas (lightening, gravity, animal power). Now they must explore the consequences of each for their communities. So the teacher has broken them into collaborative groups of four students each, and has randomly assigned options to each, saying to them "It is as important in your decision-making to find out that an option is not a good one as to find out that it is the best". She then asks them to consider what they would want to find out about an option to determine whether it was a good one for their community. Once again they brainstorm, clearly drawing from prior knowledge and past experience. They list things like: cost, availability, effect on the environment, etc. But where can they go from here.

This teacher models some planning with one of the groups for the whole class to see. She goes to the group that is working in energy from solar sources and asks them: "How many of you know how much a solar panel costs?" None of them do. So how can you find out? One student says, "Go to the internet." She says, yes, but suppose you didn't have access to the internet. Is there some other way?" Another student says: "Well, I suppose that I could look around my neighbourhood and see if there are any solar panels on the homes of one of my neighbours. Then I could go and knock on the door", another student says "I'd look in the yellow pages of the phone book to see if there is a company that makes them and I would call them", etc. The teacher then says, "OK" and she points to student #1, and says "I'm going to give you all a week to get information about the consequences of your option in the categories you listed, cost, availability, etc. So you be the internet person", then to student # 2, "You look for places that make or sell them", etc. When you return next week I want you to share what you have found and try to come up with ***what the group thinks is the most reliable information about the consequences.***

She then adds some pointers: "Be careful about bias on the part of the people you get your information from, or simply misinformation. Use the strategy we developed to figure out ***how likely it is that each source you get information from is reliable****. Remember, that is a key critical thinking skill and if you say that the information is likely to be reliable you should be ready to explain why, using the criteria we developed for judging the reliability of a source of information. So I want you to compare your results from different sources and if there is a conflict, ask whether the source is reliable, and see if you can reach agreement on how to respond to the factual questions you raised about energy sources to help you get information on the basis of which you could decide which you thought the best option was. And remember – you need to reach agreement, though you may agree that there is disagreement and none of the sources you consider is really reliable. Maybe one of them will make money if people believe him, another has been accused of bias before, etc.*

Then, you can focus overall on the predictions of consequences of using one energy source or another, identify the information you have gathered and that you all judge to be reliable, and compare these options to judge what you think should be the dominant source of energy for us, and write your results. I will ask for a report from each group that I will want your spokesperson in each group to write on a large matrix that I will put in the front of the classroom so that we can all share the results of each group."

It is in the spirit of collaboration directed at yielding the best possible reflective synthesis of the thinking of each member of a group that we find an effort towards interaction and collaborative thinking most clearly represented. And the role of skillful thinking here is clear and necessary.

5.8 Thinking for Deep Learning Grows Even Deeper in Thinking Classrooms

There is a second important way in which the social nature of learning can be exploited in the interests of deeper learning and thinking. That is to transition from small group work to making the whole classroom a community of thinkers and learners. Ritchhart and his colleagues (Ritchhart, Church, & Morrison, 2011) articulate this vision very well in their book, called *Visible Thinking,* where they describe the factors that they consider contribute to creating a culture of thinking in a classroom. Here are the eight factors: ***Environment, Routines, Interactions, Language, Modeling, Time, Expectations, and Opportunities***. The idea here is that a combination of structural and environmental factors need to combine with the teacher engaging in a number of other techniques to initially prompt student thinking with each other in a classroom (not just within small collaborative groups), and then guide their collective thinking.

Vignette # 7.1

The teacher and students contribute to a culture of thinking in the classroom

For example, the students may be reading about, and may have seen a video shown by the teacher about, a newly discovered and almost whole fossilized animal at a large fossil site in Africa dating back 100,000 years. To prompt some focused thinking the teacher may ***suggest that this is an opportunity for the students to think carefully*** *about this fossil, and to facilitate this she asks them to all* ***focus on a specific thinking prompt,*** *one that is called "See, Think, and Wonder". This and others like it have been called "Thinking Routines" (Ritchhart, Church, and Morrison, 2011); short prompts that draw out specific thoughts of the students. This will initially structure their thinking focus.*

So first, the teacher will ask them to ***interact, in groups of four,*** *and talk about what each of them sees when they look at the fossil.* ***She gives them time*** *to discuss what they see, commonly called Wait Time (as in Assessment for Learning approaches), so that they can articulate what they think they see. Then the teacher asks each group to share their responses with the whole class. She writes the variety of responses on the board. They vary from "Bones of a dead animal" to "A fossil of a monkey from many years ago."*

Notice how this activity very quickly prompts connections with prior knowledge that the students use to interpret what they see.

> *She then asks them to do the same in responding to the second prompt in this triad, "Think". "What does all this make you think?" she asks. This time* ***she models what some responses might be.*** *She says that this makes her think that there were probably many such similar animals around at this time, not just this one, as well as many other kinds of animals. She says that she thinks that because of what she already knows about animals living in this time period - that there were many species. She suggests that they try to* ***continue to connect what they are seeing with things that they already know*** *about fossils. She makes this explicit by giving a category description to the fossil, and a challenge: "What does seeing this and knowing that this is a fossil that dates from 100,000 years ago" make* ***you*** *think?*
>
> *Again, she gives the students time to think – and discuss – their thoughts in their groups. Once again, she asks for reports, but this time asks one student to record these on the board. "Now let's ask what all of this makes you wonder?" After discussion the students list many questions now – one main objective of prompting them with this specific thinking routine. And they discuss them in their groups, report a selection to the class, and a student recorder writes them on the white board as well so that the students can download them to their iPads. Some of these questions were: "What caused the death of these animals?", "Does this fossil show any changes in this animal compared to similar fossils from earlier periods and later periods?" "Does this fossil tell us anything about human beings?" "How many other fossils were found at this site?"*

Notice the dynamic here. This is thinking that is going on in the whole classroom, but it is not yet the classroom thinking together. So while there is already a climate of thinking in the classroom, it is lodged in the small groups. The reporting is just reporting, with no prompted activity by the teacher to get the whole classroom interacting.

The teacher now continues.

> *In each group, why don't you select one of these questions and see if you can answer it by* ***searching for information on the internet and using some of the types of skillful thinking that you have recently learned. For example, if you work on the cause question, make sure you use the strategy you learned for skillful causal explanation. Develop a list of possible causes and then see if you can find enough evidence to sort out which possibility is the likely one. Or if you are working on how this compares to other fossils use the extended version***

of compare and contrast in which you draw conclusions about what you are comparing and contrasting that you think are justified by the important similarities and differences.

Notice how the teacher has now shifted away from the use of thinking routines to prompt students to come up with ideas and questions developed out of connections with prior knowledge and experience, and has prompted them to use ***strategies for skillful thinking*** **that are designed to lead them to defensible judgments that reflect the use of critical thinking processes** (Swartz, Costa, et al, 2008). She continues:

"I'm going to ask you to work together in teams, and I will ask each team to work on a different question. When you have completed your work I will ask each group to report to the whole class."

As we interpret this vignette we are struck by how these two thinking techniques can prompt careful extended thinking in many classrooms yielding well-thought-out ideas, just as we remarked that teachers shifting to a questioning or challenge style, and accepting responses from individual students, or, better, collaborative groups, fosters a great willingness for students to expose and share their ideas. But while these students all have an opportunity to interact in the classroom by asking questions, we are struck by the absence of any system of structured dialogue, dialectical discussion, or debate as a necessary ingredient in such classrooms. That is, extended critical thinking has not been integrated into this classroom activity. How can that be structured into a classroom that has a base of this kind of culture of thinking as a norm?

Vignette # 7.2

A teacher guides students to engage in dialogical thinking in the classroom

The students in a 5th grade classroom have been watching a video of a real case of cyber bullying via the internet. A lot of details are given in this case study – about the situation, the school, the individuals involved, etc. ***The teacher stops the video short of what the outcome was and poses the question: if you know who is doing the bullying and it is a friend of yours what would be the best thing to do?*** *This is a decision-making challenge, and the students have been practicing skillful decision making in a number of their classes. She says to them:* ***use the strategy for skillful decision making to think this through.*** *The teacher guides them to* ***develop a number of options*** *working together in their groups using standard brainstorming. She records these on the whiteboard. The teacher assigns each group a different option and gives them the task of figuring out* ***what the pro and con consequences of each option would likely be*** *based on what is in the video, any relevant background*

knowledge that they have, and any additional information they can find about the school and the community. Based on this they are to ***judge whether this option would be a good one and worth considering seriously****. This is a high motivation activity for these students who know of similar cases of bullying in their own school. They use a graphic organizer to write their considered results in their group – what they think the consequences might be, what evidence they have found and what it shows about the likelihood of the consequences, and even how important the consequences would be and why.*

The teacher then asks each group to write side by side on the white board their pro and con list, with an indication of how likely they think the consequences would be and how important they think the consequences are on the board side by side so that each students in the class can each consider them, compare them, and decide which they think is the best option. *If they have questions about a pro and con list for the group that recorded it the teacher gives them time to discuss this with the group openly in class. When they decide on what they think the best option is, the teacher reminds them that they should be prepared to explain why.*

Will the students all agree on what should be done? In activities like this they usually don't. So the teacher sets up ***dialogue groups between groups of two students each in the class who disagree*** *and gives them the following instructions: "****Explain to each other*** *why you think your option is best. But when you do this* ***listen to your partner with respect and take what he or she says seriously****. And* ***have an open mind.*** *Maybe your partner has discovered something that you missed. If that happens and you want to change your mind, it is ok to do so. Or you may still not agree. In either case be prepared to explain to anyone who asks why. And "****treat each other with respect – you both have worked hard and have done some honest thinking, so even if you disagree respect what your partner says as another point of view****."*

This exemplifies one way that this teacher has tried to make her classroom not only a classroom where thinking is going on, but a classroom in which the students all try to find out what the best thing to do is and if we disagree, we ***have an open mind, dialogue with each other***, ***listen to each other***, and ***see if we can reach agreement***. If so, fine – but we should be able to explain why: what we have learned that made a difference. If not, we ***respect each other and acknowledge that each represents a different point of view,*** one of the key IB objectives***.*** In this vignette a third focal point for researchers on teaching thinking has been used: the explicit prompting of one of the important ***Habits of Mind*** developed in the work of Costa and Kallick (Costa and Kallick, 2002; Swartz, Costa, Kallick, et al, 2008). The specific "habit of mind" emphasized in this vignette is ***listening with understanding and empathy***.

The objective here is to give students a model of how to live in a world in which we all learn from each other but respect differences that remain after such a social dialogue. We may want to call this a Level 2 Thinking Classroom, in contrast to thinking classrooms, like those represented in Vignette #1, that have students interacting in various ways regarding what they are thinking, but stop short of engaging them in dialogical thinking, with the goal of exploring as fully as they can what the most likely truth is about what they are thinking about. This model of a thinking classroom, and its rationale, has appeared in one important strand in the community of researchers about teaching thinking (e.g., Mercer & Littlejohn, 2007; Wegerif, 2011). This is also reflected in one of the basic attitudes that IB promotes for the PYP: *respecting other points of view.* But note, in these examples students are not being taught to respect ***any point of view***, but only those that can be supported with reasons and have resulted from careful thinking themselves.

5.9 Concluding Comments about Teaching Thinking

We have identified six different but complementary ways that different aspects of thinking can play a role in enhancing learning in the PYP. We have also tried to give readers of this report ideas about instructional techniques that teachers can use to help students develop proficiency and competence in these, and how they complement each other. These are all essential in maximizing the power of the route taken in the PYP to achieve the special PYP learning objectives.

While every ingredient in this picture is mentioned or alluded to in the IB guidance materials about the PYP there is no comprehensive picture of how these ingredients either fit together conceptually or can be played out in the classroom. Hence our sense is that IB coordinators and PYP teachers have tried to fill in this picture with what they can find that they think speaks to some of these ideas. We hope that, from the point of view of classroom instruction, we have succeeded in giving you a more detailed, comprehensive, and coherent picture of what thinking instruction might look like that fills in this extremely important aspect of the way the PYP provides an education of the highest quality to its students.

Before we analyze the results of the interviews we wish to add a few clarifying details about some of the materials that may be mentioned in these interviews. As we commented in our earlier work (Swartz & McGuinness, 2014a, Report 1), there are a number of different approaches to teaching thinking, each providing ways of structuring thinking processes to foster some aspect of good thinking. To mention the major ones: **Edward de Bono's *CORT Programme*** (de Bono, 1986) promotes many short and specific strategies to use to organize specific episodes of thinking and is also associated with the ***Six Hats*** (de Bono, 1985).

The ***Visible Thinking Programme*** (Ritchhart et al, 2011) promotes the use of short "Thinking Routines" to foster good thinking, used primarily to prompt making connections to prior knowledge and develop questions to be answered about specific and important content issues. This program also endorses and develops procedures for creating a culture of thinking in the classroom.

The "***Philosophy for Children***" programme (Lipman et al. 1980) promotes, among other things, raising philosophical questions about our world, and uses informal logic to guide one's thinking about these philosophical issues, creating a community of inquiry.

The ***Thinking-Based Learning Programme*** (Swartz, Costa, et al, 2008; Swartz, 2008) promotes the development and use of strategies for skillful uses of various forms of everyday thinking encompassing analysis, creative thinking, critical thinking, and the broader processes of decision making and problem solving, and promotes using these to think deeply about important curricular content.

The ***Habits of Mind*** programme (Costa & Kallick, 2014) in which 16 "habits" of thinking that good thinkers use are identified and developed, promotes that everyone should use these to enhance their thinking. Examples are listening to others with respect, thinking interactively, and making use of all of the senses in observing things.

Each of these programmes uses their own language, and promotes different strategies as effective thinking processes. And while they seem like competitors in the field, in fact, they all can provide ideas and techniques that can be used to fill out some of the picture of the role of teaching thinking that we have presented to you, or as models of similar activities designed by teachers for their own classroom.

Once again we wish to emphasize that good thinking is not just one thing, it comes in different varieties depending on what the thinking is about and what its objective is. For example, is the thinking directed at identifying important questions about a topic that can guide an inquiry? Is it directed at helping students develop better decision making skills than we ordinarily use? Is it directed at coming up with a new and creative way of doing something? Is it directed at how we can learn to guide ourselves in good thinking? We know that some of the traditional categories of thinking reflect the distinctions between these questions: critical thinking, creative thinking, analysis, for example, as do the Bloom categories.

So our first caution, which we will apply to some of our results, is that some of the differences from school to school may not be based on competing suggestions about what makes for good thinking, it may reflect these (and perhaps other) different and complementary objectives.

Our second caution has to do with vocabulary. Hidden in vocabulary differences from one programme to another may well be a commonality of objectives and thinking strategies.

In our analysis of the results of our interviews we will be especially sensitive to these two cautions.

6 Findings from the Case Studies: Deep Learning, Research Question 1

6.1 Introduction

Research Question 1

How do PYP schools define the terms and describe / define the relationship between thinking and learning?

This section will report and interpret the views and practices of PYP case study schools addressing Research Question 1, through the information gathered from the interviews/follow-up emails with PYP coordinators and from interviews with teachers in the context of their video lessons. The interview questions relevant to the research questions were:

What is your interpretation of the meaning of deep learning?

From your perspective, how does the use of thinking skills enhance/promote deep learning?

Themes from the interviewee responses to these questions were identified and will be interpreted in the light of our earlier analysis from the research literature on key ingredients for effective learning and the role of thinking in promoting it.

6.2 How do PYP coordinators and teachers interpret the meaning of deep learning and its relationship to thinking?

The email responses from the PYP coordinators provided the most complete evidence on this question, as the coordinators had some time to reflect on it and to gather their thoughts. In general, the coordinators had rich, well-articulated and highly personalised understandings of what they meant by deep learning, and their understandings were clearly influenced by their experience with the different elements of the PYP transdisciplinary framework. Some of the most dominant themes they mentioned were:

Beyond memorisation: Coordinator Oliver from Orchid School had this to say

> *"In my opinion, deep learning is learning beyond the facts…….More than just students memorising and reciting information …….conceptual understandings as opposed to just knowledge retention".*

The idea of 'going beyond' was also evident in coordinator Dorothy from Daffodil School who explained:

> *"From my own perspective I would use the term 'deep learning' when referring to something that we have dug into in order to understand the many facets of a topic. This would be in contrast to 'superficial or surface learning' that happens when we skim over something in a cursory fashion."*

During a more general discussion about the benefits of a PYP curriculum, another co-ordinator, Teresa from Tulip School, drew a distinction between children who had experienced the PYP curriculum as "*making connections with everyday learning*" compared to children from other schools who may "*think like a rote learner or are very robotic".*

Conceptual understanding and big ideas also emerged as associated with deep learning, for example, in her interview, co-ordinator Carla from Carnation School used Bloom's taxonomy as a way of articulating her understanding of deep learning:

> *"I suppose we'd look at that as the depth of understanding and we'd probably even look at Bloom's framework …..So, you know, how well can they describe, can they explain, can they analyse, can they evaluate. What level of understanding do the students have, that is probably what I'd think about rather than having a superficial understanding just at a knowledge level and being able to tell you."*

When discussing deep learning as a goal of the PYP curriculum, coordinator Laura from Lotus School explained:

> *"Our real goal is to teach students to identify what is essential; we want them to identify what are the big ideas"*

She elaborated on how important it was for students to gain an understanding of "*generalizations*" and "*theories*".

The **durability of deep learning** was a distinctive feature for many of the respondents. Coordinator Michelle from Magnolia Schools said:

> *"….it means learning that endures, rather than that which is forgotten. In order for learning to endure and to lead to understanding, there needs to be connection to, and building upon, what students already know. That is the basis of the constructivist approach to learning which is the bedrock of the PYP."*

During her interview, Teacher Louise from Lotus School summed up the idea of deep learning as always being with you in the following way:

> *"*I *think that deep learning is something that you're basically going to keep with you for the rest of your life, whether you think about it every day or not, doesn't matter. Like deep learning is something that you carry around with you in your baggage of content and knowledge and when you need it, it's going to be there to help you….."*

The importance of **transfer of learning** was raised many times as a key characteristic of deep learning, co-ordinator Teresa from Tulip School was very clear about this:

> *"When we talk about deep learning, what we are actually referring to is the child's ability to transfer their conceptual knowledge from one subject focus, to another or real life situation"*

Several respondents began to articulate the **role of thinking in the development of deep learning and transfer.** For example, coordinator Dorothy from Daffodil School, summarised it like this:

> *"I believe that if we select worthwhile content, take time to explore it deeply, and make our process explicit (using thinking routines or other means), students can see, value and internalise that learning process. Students can then independently use that approach in and outside of the classroom. If the goal is transfer we need to teach students how to think deeply so that they can experience deep learning about any topic in life*."

A similar view was expressed by co-ordinator Michelle from Magnolia School:

> "*Higher levels of thinking are needed both in developing understanding and for application in new contexts than is needed for regurgitation of what has been learnt. Developing these higher level thinking skills will enable students to understand and apply new areas of learning much more easily."*

And by co-ordinator Oliver from Orchid School, who also introduced **the importance of metacognitive awareness in the process of deep learning**:

> *"Thinking Skills I think provide the necessary scaffolds for deep learning to occur. I think experience is engaging and critical, but to really cement learning we need to be aware of it. Students need to understand the purpose, learning goals, the way something has been learned etc. and thinking skills really do go hand in hand with this. "*

Co-ordinator Oliver was also the only respondent to mention an **emotional component to deep learning**, referring to it as creating a "*deep emotional shift in the person*"

The more **transformative effects of deep learning** were also captured in coordinator Teresa from Tulip School's elaboration of the meaning of deep learning:

> *"Through deep learning they (the students) also gain an indispensable sense of knowledge, skills and attitudes such as self- directed learning, collaboration, effective communication etc."*

6.3 Summary of key characteristics of deep learning and thinking

The PYP promotes a style of constructivist learning, based on making certain "transdisciplinary themes" and their exploration via a set of important "key concepts" using inquiry methods, as the key learning goals. Everyone interviewed not only showed a clear understanding of this but a firm commitment to its superiority over standard disciplinary learning, which tends to result in more fragmented learning and memory-based rote learning.

The interviewees clearly recognised that learning needed to have a degree of permanency if it was considered to be worthwhile, but also a degree of flexibility to allow it to be useful across a range of situations. In other words, if learning is to be called deep then it must be transferable. Several respondents appreciated the crucial role that higher-level and effective thinking would have in making learning deep and thus more transferable. Some interviewees also captured the more metacognitive aspects of learning such as becoming aware of the process in order to make it deeper. There was also a hint that there was more to deep learning than pure cognition – that deep learning could also invoke the emotions, and could have wide ranging effects on how we presented and managed ourselves to the world.

Although these features were not expressed by each respondent, collectively they bear a strong resemblance to contemporary views on learning as captured in the idea of adaptive competence that we discussed in Section 2 of this report – that deep learning is transferable, involves strong conceptual understanding, needs thinking plans and devices to make it deep, is metacognitive, has some non-cognitive as well as cognitive components, and requires some degree of self-management. Their views on learning were certainly not minimalist.

7 Findings from the Case Studies: Teaching Thinking, Research Question 2a

Research Question 2a

How specific are PYP schools with articulating thinking objectives? What devices do PYP schools use to articulate these objectives? What are the hooks they use to position them in the transdisciplinary PYP framework?

7.1 Some preliminary comments on learning objectives in the PYP

The PYP curriculum differs from traditional primary curricula in that it is structured around a rich set of important *transdisciplinary key concepts and themes* mandated to be the basis for the learning objectives of the PYP. So it is not perhaps surprising that these elements are a high priority in the PYP case study schools' planning and practices.

What emerged in many interviews was that this focus on conceptual understanding is what is special about the learning objectives of the PYP.

> "*PYP is very, is concept based."* (Co-ordinator Michelle from Magnolia School)
>
> *"The PYP is an inquiry-based approach to the understanding of big overarching concepts"* (Coordinator Dorothy from Daffodil School)
>
> *"That has been the one way that we have been able to collaborate and interact with every unit planner, by doing the key concepts. So if kindergarten was working on causation, music can easily also be also talking about causation in music or in physical education, or in any of the English as second language classes. So that's really, that's been our central thread……. "(*Coordinator Sophie from Sunflower School)
>
> **"….***and I can see that this is a great framework, great framework where the kids really get to have a conceptual understanding about things. They really get to make these great generalisations when they address the central idea. They can develop all these wonderful skills as well…."* (Coordinator Laura from Lotus School)

And even if this dominant view was not captured in a specific statement, it was evident across a wide range of other documents, particularly in the unit planners. Having acknowledged that, we turn now to the more specific research questions as to if/how PYP case study schools position thinking as a curriculum objective and related questions.

7.2 Thinking as a specific PYP objective - devices and hooks?

Information on these research questions was collected mainly in response to the following interview questions:

What are your general views about how thinking develops in the PYP curriculum?

In your view, what are the main issues that emerge when linking thinking skills into the inquiries?

From the interviews it emerged that the case study schools differed in the degree to which they prioritized thinking as an explicit curriculum objective, and whether it was given specific instructional attention above and beyond the other PYP transdisciplinary skills. Perhaps not surprisingly, the two case study schools that were selected into the study because of their known practices with regard to teaching thinking (Daffodil and Lotus Schools) were different from the schools that were randomly selected. But even those two schools were different from one another in their approaches.

While all of the coordinators agreed that thinking was key to deeper forms of learning (though not alone – together with other skills and techniques, like having the students work collaboratively), when it came to details, no common conception, device or 'hook' of how this was to be accomplished emerged.

For example, some coordinators said that **more sophisticated thinking was carried along with the exploration of the PYP key concepts**:

> *"as teachers we're thinking of it more from the conceptual basis rather than approaching it from the thinking skills basis. I think we're probably not doing that so much."* (Coordinator Michelle from Magnolia School)

And she went on to say:

> *"…we had quite a focus on concept based learning and I think it was only then that we began to get to grips with the key concepts and how they are useful for driving the students' thinking."* (Coordinator Michelle from Magnolia School)

Other coordinators explained how **the key concepts provided the cross-curricular coherence:**

> *"That has been the one way that we have been able to collaborate and interact with every unit planner, by doing the key concepts. So if kindergarten was working on causation, music can easily also be also talking about causation in music or in physical education, or in any of the English as second language classes. So that's really, that's been our central thread……. "*(Coordinator Sophie from Sunflower School)

> *"And the concepts and, sometimes the central idea, sort of drive the planning***."** (Coordinator Oliver from Orchid School)

When discussing how she introduces new teachers into the elements of the PYP framework, another coordinator said:

> *"……building the conceptual knowledge, we've tried to come at that first, and then the next step is how do we link thinking with that."* (Coordinator Carla from Carnation School)

For some schools, the **pedagogical inquiry model was dominant in their approach to thinking**, both in a general way and specifically:

> *"in our school plan……. to make sure that we don't just view an inquiry as a unit of inquiry that you do in a term, and that's it……. rather it's a way that you teach…….. whether you're gaining facts or learning words or applying something or evaluating or thinking about your own thinking……"* (Coordinator Oliver from Orchid School)

And referring to stages in a specific model of inquiry (Kathy Murdock's model) and how they can link to the different types of Bloom-like thinking:

> *"those stages, they (the teachers) do try and match some of those thinking skills up to those stages. For example, if the students are finding out, they are learning specific facts or remembering something, you know, or if they're going further or taking action, they might be analysing or synthesising something. So that's where the thinking skills start to become important……"* (Coordinator Oliver from Orchid School*)*

Another coordinator linked the **inquiry methodology and interactive nature of the teaching that followed, as the important vehicle for developing thinking skills:**

> *"….we look to facilitate inquiry in the class and the thinking skills. Apart from that, I think it's more of the interaction that the students have in terms of the guiding questions that the way teachers facilitate in the classroom. Also, the questions that the students come up with, there is a lot of peer interaction and peer learning happening, so we have, for example, we have students asking a question…. the other two will say okay, he has asked a question, let me have a go at it."* (Coordinator Teresa from Tulip School)

Several schools referred to the **use of well-known published resources and tools to support thinking,**

> **"***We have a general set of thinking tools and thinking routines and resources as …..the Y-charts and the Lotus diagrams, the Affinity diagrams, Swat analysis, the Harvard Thinking Routines as well……the 5 W's, things like little traffic lights, so a lot structures that you know, some more formal than others……. "(*Coordinator Oliver from Orchid School)

> "*About five years ago one of our instructional coaches…….was a certified Thinking Maps trainer. Thinking Maps is a whole series of thinking processes and organisers that help take your thoughts and put them on paper. Teachers say……. let's use this in the classroom and they describe it and they use that for (developing) thinking. Or we use the double bubble map when we're comparing or we'll use a cause and effect map. So, the teachers have really bought into this thinking and are helping the kids organise their thoughts before going on to writing or research or whatever we're doing."* (Coordinator Sophie from Sunflower School)

> **"***This year we formalised it a little bit more in that every year level is to focus on embedding Habits of Mind, and mind mapping into their classes. We're trying to use the Habits of Mind to link with the attitudes a little bit just in order to give the teachers another language to use and examples that may, I suppose, embellish some of those things a little bit. (*Coordinator Carla from Carnation School)

And she continued:

> "*Then we came up with a simple framework just in terms of tools that would be expected to be taught at a particular year level. So that, as they're moving up the school, there is, I suppose, a grab bag of tools that can be used that don't have to be retaught every time."*

Two schools had **embraced thinking skills within the PYP framework in a more comprehensive way**.

Daffodil School had adopted a comprehensive approach developed at **Harvard's Project Zero,** including Teaching for Understanding, Cultures of Thinking, Visible Thinking and Thinking Routines, as the main way of ensuring that thinking enhanced deep learning through the PYP concepts.

> *"…we have found both the Teaching for Understanding framework and the Culture of Thinking projects, from Project Zero at Harvard Graduate School of Education, have provided us with approaches to thinking and learning that have deepened the classroom experience for both students and teachers."* (Coordinator Dorothy from Daffodil School)

> *"For us, we say that the Culture of Thinking approach and the PYP inquiry approach fit hand-in-glove. They both support each other. As students learn to follow the inquiry cycle – (look carefully, wonder, ask questions, inquire, reflect, draw some conclusions but also ask more questions and possibly begin the cycle again) they learn to inquire collaboratively, sometimes using the thinking routines, sometimes not. Students learn how to 'think together' to reach a common goal. In so doing they develop the thinking skills that the PYP value and the thinking dispositions that we value within a Culture of Thinking*."(Coordinator Dorothy from Daffodil School)

While Lotus School also adopted many of the features of the Harvard Zero Project, including Visible Thinking and Thinking Routines, they had recently added the approach developed by Swartz called Thinking-Based Learning (TBL). In TBL, organized and explicit patterns of questioning prompt various kinds of thinking, like decision-making, comparing and contrasting, and problem-solving, so that students can begin to exercise these types of thinking *with skill*. Thus thinking skillfully is used to deepen students' learning about inquiry themes or to further explore the learning opportunities in the key concepts – where the thinking drives the understanding of the key concepts rather than the other way. This is sometimes called the infusion approach to teaching thinking. Coordinator Laura from Lotus School reports how they have integrated Thinking-Based Learning with Thinking Routines,

> *"….we work on curriculum mapping……we put into that document everything that's going to happen in those four or five weeks; I mean all the contents that are going to be addressed from the different curriculum areas and also what skills we're going to develop, what is our central idea, which are the concepts that are going to be developed in every course……. we have a big scope, even in there we also have, for example, what special things we're going to do about thinking, how we're going to work in TBL or Thinking Routines – it's in that mapping."*

And she goes on to say

> "*….and after writing that in the planner, in the PYP planner, we have another small document that we call the Arc of Learning (referring to a document sent electronically to the research team)."*
>
> *"So here, we take this specific learning experience and we detail the curriculum objective and the thinking objective."*
>
> *"So at the end of the class the teacher goes back and checks those objectives and then the teacher returns to the central idea to see how the learning experience in the whole, both the curriculum objective and the thinking skill objectives, have driven them to understand a little bit more about the central idea."*

However, despite these differences, there is one principle that all but one of the coordinators stressed explicitly, that thinking, in whatever way students were engaging in it in PYP learning, was not an instructional objective in the PYP, but rather a "tool", a "means", or a "vehicle" for enhancing the achievement of other PYP learning objectives, that is deep conceptual learning employing one or more of the PYP transdisciplinary themes and key concepts. Basically, these coordinators were saying that whatever students were taught and learned with regard to thinking, and how thinking was to be employed, this was there only as means to achieve deep PYP concept learning, **and not a** PYP learning objective in and of itself.

Lotus School stood out as different, having recently introduced the use of "Thinking-Based Learning" in which learning how to do various kinds of thinking like decision-making and problem-solving skillfully had been introduced and prioritized as an important transdisciplinary skill objective justified in its own right for improving the thinking of students in the variety of contexts in which it serves as an organized process leading to a conclusion or to an action, and not just as a means to deepen PYP concept learning. This school also successfully integrates this approach with a variety of others including Thinking Routines and Habits of Mind in what appears to be a seamless curriculum and pedagogical approach.

8 Findings from the Case Studies: Teaching Thinking, Research Question 2b

Research Question 2b

What is the current practice in PYP schools in promoting thinking and deep learning?

8.1 Introduction

To answer this question we draw primarily from the interviews with the teachers about their video lessons, rather than from the coordinators whose voices tended to be more prominent in the previous sections. Ten video lesson interviews were available for analysis, from four different schools. Two of those schools, Daffodil School (2 teachers) and Lotus School (4 teachers) had adopted specific programmes for teaching thinking, while the other two schools, Magnolia School (2 teachers) and Tulip School (2 teachers) were using a variety of different tools and techniques. In this section we will overview the teachers' classroom practices, with examples, and identify key common features, making observations about the challenges that children might encounter when learning to think well.

These are the general interview questions that are most relevant to this research question. The interview questions were customised for individual teachers, depending on the specifics of the video lesson.

How do thinking skills get linked to planning an inquiry? How does that work?

Do you adopt any specific approach to the development of thinking?

What other teaching methods do you normally use to provoke your children's thinking?

What kinds of thinking do your students find challenging?

8.2 A variety of approaches

Similar to the findings from the previous section, when we examined more closely how teaching was planned and taught in specific classrooms, we also found a variety of approaches.

8.2.1 Inquiry-based: The first point is to remember that the PYP follows an **inquiry based** approach and all of the approaches adopted by the teachers were within that inquiry context. In fact, several teachers specifically mentioned the inquiry process itself as an important provocation for the students' thinking, referring to several authors whose work on inquiry they drew upon, John Dewey,

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Kathy Short (USA) and Cath Murdoch (Australia). One of the teachers, Della from Daffodil School, spoke strongly about how important it was to "go with the children" in any inquiry approach:

> "…*that's a really, really big thing for me, that I plan a lot of inquiries with the children that have really come from them"*

And that was illustrated in her maths lesson on fractions, where children worked independently in groups to create a box of ingredients to match a specific food recipe, following an interest that the children themselves expressed in creating 'recipe boxes', shown recently on a local TV series. Several teachers raised the issue of how difficult it is for teachers to 'let go', especially if they had been trained in more didactic teaching methods, or if that was the cultural norm in other local schools.

8.2.2 Priorities for Planning: All teachers referred to the PYP Unit Planner as the main tool for linking thinking skills to the planning of their inquiries, and the teachers forwarded their planners to the research team to help explain more clearly how they did that. How specific their focus was on any particular thinking skill depended on the degree to which thinking had been identified as an explicit objective in their school, as discussed in the previous section. For the most part, teachers included a selection of thinking skills that were considered to be relevant in that unit, alongside the other transdisciplinary skills, like social skills, research skills, communication skills. But these thinking skills were more likely to be developed through immersion in the activities related to the lines of inquiry rather than being explicitly taught.

However, the teachers from Lotus School – where thinking had been explicitly identified as an objective - had created an additional document to help them elaborate on their thinking objectives as the inquiry unfolded. This document, which they called the Arc of Learning, specified what thinking skills (e.g., contrast, decision-making, classification) and what thinking routines (e.g., see-think-wonder, circle of viewpoints, think-puzzle-explore) would be used to advance the understanding of the transdisciplinary theme and/or key concept through the series of lessons and specific lines of inquiry that made up the whole unit. For example, teacher Lucy from Lotus School explained about her planner;

> *"… we have a thing that we call Arc of Learning, which is a kind of annex to the PYP planner, we place all the thinking routines, and the skills that relate to TBL (Thinking-Based Learning), we place them at the bottom of the planner. So, if we are doing a thinking routine, we will be specific on the name of the routine, and what will be the nature of the thinking skill that we are working on……we have it at the end of the planner, like an attachment."*

This type of planning was practiced by all the teachers across the school and the results were clearly present in the lesson videos from the teachers we observed. Teacher Lucy elaborated:

> "*We no longer focus only on the concept, or the content, we are making it a bit more thinking-based – that is what we want them learn."*

Each lesson then was designed around a content objective and a thinking objective which they called 'the target' which is illustrated in each lesson through a graphic like a dartboard. These can be clearly seen at the beginning of each lesson. In explaining the importance of the target, teacher Louise says:

> *"… our target – we put our curriculum content along with the thinking that we are going to do in that specific lesson. So that they are aware of what we are doing and how we are working …..we can start… even throughout the lesson, we can do metacognition – asking, so what are we doing here and how are we doing it, you know, what is the process?"*

In contrast, Teacher Martine from Magnolia School, where the focus was primarily on driving the thinking through key concepts, explains how she matched up the key concept with her goal for thinking for her video lesson:

> *"…the unit lent itself really nicely to dialectical thought because we were looking at perspective as our concept, and so that was perfect, so that was easy to fit in, and then, as well, we will include some evaluation through reflection"*

Her video lesson demonstrated how this planning worked out in practice and provoked her students to think deeply about the topic under consideration.

Clearly, what is prioritized as a curriculum objective for the PYP determines how the units are planned, what is taught and how it is taught.

8.2.3 Specific Approaches and Mixed Approaches: The teachers in Lotus School were following several different approaches. They had begun their professional journey with **Visible Thinking, Thinking Routines and Cultures of Thinking.** More recently, they had adopted **Thinking-Based Learning (TBL),** but they also had a history of using **Habits of Mind** as well as some of the questioning and discussion methods from **Philosophy for Children**. These latter approaches were specifically used to develop the PYP attitudes rather than for thinking skills. We were particularly interested in the teachers' views and practices on how these combinations, particularly Thinking Routines and Thinking-Based Learning, worked out in the classroom during a lesson.

From the teachers' responses to direct questions about these combinations, they did not see a problem and indeed, described the potential benefits of both approaches.

Teacher Louise from Lotus School described her experience:

> *"I think they support one another more than anything…..because the process of a Thinking Routine is not so long…compared to a TBL lesson, so that you can actually incorporate at least one or two thinking routines throughout the TBL lesson, which in the end helps children develop the lesson in a better way. "*

She went on to describe an example of how the routine Think-Pair-Share enhanced a TBL lesson on parts-whole skillful thinking, through facilitating the children's discussion in pairs.

Another Lotus School teacher, Lottie, explained how she used the Zoom-In Thinking Routine to prompt her students to find evidence in relation to skillful prediction during a TBL lesson.

Lynda, the early years teacher from Lotus, who was very experienced with Thinking Routines made an additional comment:

> "*… you might be teaching a full TBL lesson, but in the moment you can use some other tools, like introducing some thinking routines just to start the thinking – or you can combine - not even the ones you already planned but (in response to) what's happening in the classroom."*

Our observations from the video lessons confirmed that combining these approaches worked well in the hands of teachers who were reasonably experienced in both approaches.

In Daffodil School, **Visible Thinking, Thinking Routines** and developing **a Culture of Thinking** were the main theoretical influences on the thinking related classroom practices. (This school had also developed extensive processes for observing and documenting children's thinking which will be described in a later section, see Section 12.3). With regard to Thinking Routines, teacher Della said

> "*…this is a really big part of how I teach and the kind of language I use …… I don't necessarily have certain thinking routines that I always use, I try to use different ones and to make them my own"*

She went on to describe how the routine See-Think-Wonder could be adapted to Hear-Think- Wonder or Listen-Think-Wonder or Feel-Think-Wonder, thus linking the development of thinking with learning about the senses, and emotions.

In relation to developing Thinking Routines with very young children, Diana from Daffodil School, who taught 3-4 year olds in a bilingual setting, said:

> "*… at the age of children that I am dealing with, even understanding that they are asking a question is very hard for some of them. I'm trying to get them to see the difference between when we look at something and when we talk about it – some of things that we say are things that we see and some of the things we say are things that we think"*

She saw her work as preparing her children for the Thinking Routines they will encounter when they move to the next stage (pre-K in her school). She described using a modified version of the What's Inside Routine through peeling an onion, and moving then to ask the children what they see in pictures and what is behind the picture (meanings and what the picture represents).

Thinking Routines were also a feature of classroom practice in Magnolia school, where teacher Mollie taught a video lesson using the Thinking Routine, See-Think-Wonder. Their school had some on-line training in this approach, though the practice was not widespread. She said she chose it for her video lesson because it was a preparation for a lesson on observational drawings, and that it fitted well.

For their video lesson design, the teachers in Tulip School followed closely **Bloom's Taxonomy**, using it to guide their students' thinking through different phases of a lesson, from acquiring knowledge,

through checking understanding, to application, and later evaluation. For example, teacher Trisha said:

> "*specifically, for this lesson, what I have done is I have used the Bloom's taxonomy"*

Teacher Tracey from the same school explained that:

> "*at different parts of the lesson I have tried to incorporate different thinking skills……at the very beginning my main idea was to focus on vocabulary, to focus on acquiring knowledge. As the lesson went on, we went onto grasping the meaning or comprehending what was happening, then application*."

Both teachers went on to describe that they also used a variety of other thinking tools to help their students' thinking. Teacher Trisha explained how she uses **de Bono's Six Hats** to prompt children to generate the pros and cons in relation to a situation (e.g., investment in technology), asking children to put on the different coloured hats depending on which mode of thinking they are in - the yellow hat for positives, the black hat for negatives and so on. She describes how she uses the Six Hats also during Circle Time to help children express their feelings.

Teacher Trisha from Tulip School makes extensive use of **Mind-Maps,** explaining:

> **"***at the very beginning when I make a mind map, it helps the children see how much they know. As they go along and when we make conclusions towards the end of an inquiry, it helps the children see how much they have learned. So, that's why I think mind maps help. "*

In the lesson video, she demonstrated how mind maps were used with smaller groups of students, and then how the results of the smaller groups were combined to show a bigger understanding of the topic for the whole class.

8.3 Key characteristics across approaches and tools

Despite the differences between the approaches that the schools adopted and the variety of thinking 'tools' that they used, there are some common features. Further questioning of the teachers about the other methods that they used to provoke thinking enabled us to see a more complete picture of what the teachers were doing in their classrooms to help their students to be better thinkers. Here are some of the more common practices:

Questioning and Prompting Students to Think: When teachers were asked additional questions about what methods they used to stimulate thinking, a common response was, not surprisingly, the importance of questions. Teachers responded about questions with many different phrases:

> "*questions are so key*" (Mollie from Magnolia School),

> "*I try very hard to turn things into questions….rather than giving an affirmative answer or a negative answer, to turn it into a question, let the child figure it out for himself or herself*." (Martine from Magnolia School)
>
> "*even understanding that they are asking a question is hard for them*" (Diana from Daffodil School with reference to 3-4 year olds)

Prompting thinking towards more skillful thinking is central to the TBL approach, for example, using prompts for skillful parts-whole thinking such as: What are the names of the parts? What would happen if that part was missing? Then what is the function of the part? How do the parts fit together to work as a whole? Many of the Thinking Routines are phrased as questions: What makes you say that? or have questions implied, Think (What do you think?)– Puzzle (What puzzles you about this?) – Explore (How might you explore it?), See (What do you see?) – Think (What does it make you think about?) – Wonder(What does it make you wonder about?). Teachers who had this repertoire of thinking prompts at their fingertips appreciated their power for promoting children's thinking.

Using Thinking Organizers: Many of the examples that the teachers gave in the interviews can be classed as thinking organizers – methods to help students create more meaningful patterns to their thinking. Some of these organizers organize the **products** of thinking, like mind-maps, while others organize the **processes** of thinking like the TBL prompt questions, or graphic organizers, or the thinking routines.

In the interviews, teachers described an array of **visual** organizers that they used in their classrooms. For example, teachers from Lotus School had created a library of visual tools to support the children's thinking – cut-out keys of different colours for each of the thinking routines so they would be readily recognised through repeated use and across grades; cut-out magnifying glasses for the key concepts to remind students what the 'bigger' concept was behind a learning activity.

Teacher Lucy from Lotus School explains:

> "*we use them since they were in Pre-K. So they are aware of the thinking routines as well. We use them, we have these keys, and we go and open their minds with the keys, and each thinking routine has a colour, so the kids, even if they can't read, they know that the red one is giving wonder, or the blue one is CSI……when they get to first grade, they really knowthe routine. It is a routine, it's not something we do sporadically*."

Teacher Della from Daffodil explained her use of '**giant post-it notes**" to record children's thinking, and modified her approach depending on the size of the group:

> "*I've learnt over the years that it's great to do things on big posters when you're working in groups, if you work on A3, you can copy it and then each child has a copy for themselves…….So I use the big, kind of giant graphic organizer for maybe a mini lesson but*

> *try to do more on A3 sheets and have lots of children working together in partners or groups so that they can get their thinking down*."

During Della's video lesson, while the children were working in small groups on their investigation about fractions, they were spontaneously creating a big class poster of **Powerful Thinking Words**, such as "evidence", "discovery", "organise", "curiosity", "concentrate", "persevere". These were words that came up in their inquiry discussions. They had developed an awareness of what an important thinking word might be and rushed to add a new one to the class poster, pointing out to the rest of the class that they had just put a new powerful thinking word on the poster (even if the bigger words were not quite correctly spelt!)

Prompting Metacognitive Thinking: In the interviews the teachers recognised the importance of metacognitive thinking, though it was sometime referred to a general way as 'getting them to reflect'. The teachers in Lotus School made extensive use of the 'target' (the graphic device they used to illustrate the content/thinking objectives for the lesson) as tool to prompt metacognitive thinking, Teacher Louise said:

> "*They can go back to the target and know what we are going to be talking about and what we are going to be doing. Sometimes, they even have questions, even before we start – which is good for me*"

> "*when we do our lessons we always try to go back to our thinking moves, so that the kids know exactly what it is and what kind of thinking it is that we are developing*;"

Lottie from Lotus School

> "*We use making thinking visible, which is displaying all the learning processes on the wall, in a way that the kids can tell their own story. Then they can go back, over time, to their own thinking, to see how the process of thinking developed through the whole unit"*

With regard to making the thinking processes more visible, several Lotus School teachers used the phrase "*the walls that talk*" referring to their practice of making thinking and learning processes accessible for metacognitive evaluation through visual displays and visual artefacts of various kinds. Metacognition was raised several times as being challenging for some students, particularly younger ones and second language learners. Some teachers were not daunted by this, saying that "we just walk them through the steps" (early years' teacher Lynda from Lotus School). Nevertheless, making the thinking visible remained a challenge for some teachers, especially when it came to assessing the thinking, rather than prompting metacognitive reflection. We shall return to this issue in Section 12, on assessment and progression in thinking, where we will also describe how Daffodil School has developed a strategy for documenting thinking.

Group work and collaborative thinking: All the video lessons that we observed included some form of groupwork, group discussion, or collaborative working on tasks. Teachers spoke enthusiastically about the benefits of group work, and many reported thinking deeply about how they arranged their groups – friendship groups, mixed ability groups, mixed language groups in terms of mother tongue, and, indeed, how membership of groups changed over the course of the school year.

For example, Martine from Magnolia School who taught 10 and 11 year-olds operated a complex system for creating groups, giving students some freedom of choice as well as prompting them to become more aware of the need for different members in a group depending on the task, and about group composition. She explained:

> "*From day one, I let them choose their seats, and arrange the classroom the way they want to. About every two weeks we rearrange the classroom and the idea is that they sit there thinking about how do I work with others? Who complements me? Who doesn't? Maybe for this certain unit I need these people and I didn't need them in the last unit. So really looking at how we collaborate. Then also I encourage them to try new people. So, if you haven't worked with this person before, why don't you give it a go for two weeks? It's only two weeks*"

For her younger children (3 and 4 year-olds), Diana from Daffodil school stressed the importance of learning to participate in a group as a first step. She noted:

> "*…..develop it slowly, we start with very short circle times, it builds up, and more and more I am inviting the children in to try and, you know, build themselves into the conversation. The ones who used to be just the listeners will now be a bit more proactive in the group, while others will need to sit and try to listen. It's not easy for them, but I think it is important that by the end of the year they do understand that that's an expectation for them."*

Even with older children, teachers reported strategies for managing their students' participating and contributions to class or group discussions. Again, Martine from Magnolia School explained her strategy using a jar of popsicle sticks with the students' names on them which she kept on her desk to monitor individual students' contributions to discussions:

> *"I have a jar of popsicle sticks that sits on my desk and I have each of their names written on it. So I try to refer back to that because I do find myself falling into the trap of kids with their hands up."*

And she continues:

> *"especially when we are doing debates – not like a class conversation – but when we are actually debating like in Socratic type seminar circles, I find that my quieter students will take a back seat and not talk, so we will use the talking stick and once you've had it three times you're done, so the onus is then on the others to contribute"*

8.4 Summary

We summarize these results described in Section 8 as pointing to the awareness of all the teachers and coordinators of the need and importance of creating specific thinking activities for students to enhance their special PYP learning objectives. But from the teacher interviews and video lessons, what makes the biggest difference in the approaches to thinking adopted by teachers is whether their school has identified thinking as a key priority or an explicit curriculum objective, or whether it is considered important- but no more important- than any other of the transdisciplinary skills. This difference feeds into how units are planned and how they are taught.

Where thinking is prioritized, the schools largely adopt a more programmatic approach to teaching thinking, with one school adopting several different programmes for different purposes. These schools have expended considerable time, effort and resource into developing their teachers' professional competence with regard to teaching thinking.

That said, all teachers report a mixture of effective approaches to teaching thinking, showing some features in common with the key ingredients for deep learning and thinking as outlined in Section 5.

9 Concluding Comments to Part 3

In Part 3 (Sections 5, 6, 7 and 8), we have tried to do two important things.

We have tried to present a coherent view of the different thinking-related ingredients that are needed to realize the full potential in achieving the learning objectives of the PYP, and we have matched that with the perceptions of both coordinators and teachers in a selection of PYP case study schools about the role of thinking in their classrooms as they try to achieve these learning objectives.

In doing the first of these, we have drawn on the latest learning-related and thinking-related research (Section 5) and connected this with the latest ideas about classroom practice that can realize these objectives. And in the second we have drawn upon extensive interviews and supporting material provided by both teachers and coordinators in a cluster PYP schools worldwide, selected to give a wide variation in school background variables.

As we have documented in Sections 6, 7, and 8 of Part 3, there are a multiplicity of practices related to how to bring thinking activities to bear on the fundamental content goals of the PYP. On the up side, we have found that almost all of the coordinators and teachers recognize the importance of introducing special thinking activities into the PYP learning process to supplement the broad inquiry learning approach used in the PYP. But this has led to a wide variety of practices, some developed in depth, some not. The degree to which thinking activities have been developed and used in a school seemed to be a function of the degree to which a school treats teaching thinking as a learning objective.

Nonetheless, we found that almost all the teachers and coordinators that we interviewed had significant things that they could share with other PYP teachers. This all points to the opportunity for some cross-fertilization from school to school and teacher to teacher, set in the broader context of the kind of coordinated and integrated framework for teaching thinking in the PYP that we have presented. We have developed a series of recommendations to the IB about all of this that we include in the final section of this report.

Part 4 Progression in Thinking

10 Progression in Thinking: Research Perspectives

10.1 The Context

We now shift to address Research Question 3:

How are students' thinking progressions defined in the research literature? (Section 10)

How are thinking progressions represented in current national/school-based primary (elementary) curricula in various contexts across the globe? (Section 11)

How are students' thinking progressions defined in PYP school-based practice? (Section 12)

While the PYP guidance on the transdisciplinary curriculum articulates in some detail the different kinds of curriculum elements (see Table 1), has clear views about the nature of learning (constructivist), and about the nature of teaching through inquiry approaches, it is virtually silent on what expectations PYP schools might have about how transdisciplinary skills learning progresses, or might be progressed, within a unit of inquiry, across units of inquiry or across the primary school years. In contrast, scope and sequence is outlined for the subject areas (e.g., language, mathematics, social studies) and age-related expectations about learning outcomes are summarized for these learning areas but not for the transdisciplinary skills.

In our previous reports we called for a greater alignment between thinking curriculum objectives, pedagogical practices to promote thinking, and practices to assess thinking. Explicitly including thinking as a learning outcome across any curriculum raises several questions about the nature of thinking and its development: For example:

- What does it mean to say that a learner's thinking has developed – what does growth in thinking look like?
- Can we create developmental continua that would help teachers promote and advance a learner's quality of thinking – over a short time span (e.g., a unit of inquiry), or a full school year, or over the primary school grades?

- What performance standards can be reasonably expected from students at any specific stage in their educational history, for example, at different age/grade levels in a primary curriculum? Is this a sensible question to ask?

In the previous report, these questions were not directly addressed. In this section we will examine possible answers to these questions as they are currently being considered in the research and policy/practice domains and then report the views, experiences and practices of the PYP case study schools on related questions. Research Question 3 is thus the main focus for the next sections.

10.2 Progression: What Does It Look Like for Thinking?

In this section we distinguish between two different types of progression map. The focus for the first type is formative assessment and we will call that *a developmental continuum*. The second type describes expectations about thinking across the school years, and we will call this an *age-related thinking progression.* The use of terminology in the literature is not consistent, with the terms *developmental continuum*, *thinking progressions*, *thinking continuum* and *progress maps* being used to describe both types of progressions. Nevertheless, it is recognised that progress maps differ in their grain – some zooming in on specific developments over a short time space, and some zooming out to cover a wider developmental span. To capture this distinction, and for the purposes of clarity in the report, we will adopt the terminology as outlined at the beginning.

A dictionary meaning of the word 'progression' refers to the process of developing over time, with some continuity or connection implied between what went before and what comes later. When we talk about progress in thinking, teachers are likely to ask "What does that look like?" But that question might be too general to answer in a helpful way for teachers. If we ask a more specific question like "What does a specific type of thinking, for example, problem-solving, look like when it is performed at different levels of competence", then the question becomes more manageable. It implies that we have some underlying model of competent problem-solving and can distinguish a less competent performance from a more competent one. The answer then becomes more similar to developing criterion-referenced rubrics that teachers may already be using for other learning domains such as reading or writing.

Criterion-referenced assessment invites us to specify any performance (including thinking) at different levels of competence from 'beginner' to 'expert', at different levels of proficiency or whatever it is called. These rubrics are normally used summatively to assess current levels of performance on a task. But if the same rubric is used formatively, in an assessment FOR learning context, then the different levels of proficiency indicate a growth pattern for that type of thinking –a progress map –

which can be used as the next steps or direction of development for that child's learning. Then the progress map becomes both an instructional goal and a set of success criteria for assessing achievement. This type of progress map will be called *a developmental continuum* as its focus is probably specific to a curriculum task or unit of inquiry and, if used formatively, the time frame for development will be probably short – within a unit of inquiry or over several units of inquiry. Then a follow-up question about progress is the degree to which the learner can achieve the expected level of performance with some prompting (scaffolding in the Vygotsky sense) or whether they are fully competent and can demonstrate the expected level of performance autonomously on a familiar task and /or on a novel task. These are all relevant dimensions of progression related to self-regulation and the ability to transfer their level of competence outside the context in which it was initially developed and success demonstrated.

Table 10 shows an example of a possible developmental continuum for problem-solving, ranging across four levels of performance from 'novice' to 'exceeds expectations'. Note that this model of problem-solving only goes as far as thinking about the problem, generating possible solutions and their likely effectiveness. This example does not cover the phase of actually implementing a solution – this would require another set of problem-solving skills, including planning, managing resources, keeping on track towards the goal, as well as evaluating whether the chosen solution does actually solve the problem.

Table 10 Example of a developmental continuum for problem-solving

Standard _____ **Criteria**	**Novice**	**In progress**	**Meets expectations**	**Exceeds expectations**
Identifies, clarifies and begins to represent the problem	Needs prompting to recognize that there is a problem	Recognizes there could be a problem but vague about the possible reasons why	Understands the reasons for the problem and builds a general picture	Recognizes the nature of the problem, the underlying reasons, and the extent of the problem and builds an accurate model (representation) of the problem
Asks questions, collects information and checks out the representation of the problem	Takes given information for granted, needs to be prompted to collect more information	Asks relevant questions, collects information some of which is incomplete or inaccurate, is unsystematic in approach, needs some help	Asks relevant questions, collects accurate and complete information, spots and eliminates some irrelevant information	Collects accurate, complete and relevant information, using a systematic method, checks the model
Suggests possible solutions	Makes vague suggestions about any methods to solve the problem	Suggests one plausible method to solve the problem, but tends to rush ahead to apply that solution, needs prompting to hold back	Suggests two or three appropriate but fairly obvious methods that might solve the problem	Suggests four or more methods with some evidence of creativity to solve problem, modifies and/or combines different methods
Predicts consequences of likely solutions and evaluates their likely effectiveness	Shows little evidence of looking ahead and using reasoning skills to evaluate effectiveness of solutions	Begins to look ahead and to see the likely consequences of one or two methods, makes some attempt to evaluate their likely effectiveness	Predicts likely consequences and evaluates the effectiveness of all of the solutions, shows some understanding of the problem-solving process, able to make some adjustments	Predicts likely consequences, evaluates the effectiveness of all the solutions, reflects on the implications, demonstrates in-depth understanding of problem-solving process, self-corrects and looks towards improvement

Then there is another focus for the question “What does progress in thinking look like?” in the context of appropriate expectations for competent thinking across the primary school years (and beyond).

What are the expectations about competent levels of thinking for early years children, lower primary schools and upper primary school? The focus for this question invites us to have a more general model of growing competence, drawing on knowledge of children's growing cognitive capacities, their learning and teaching contexts, as well as taking into account the demands of the to-be-learned curriculum material. The answer to this question may seem, at first sight, to be more similar to the age-related expectations for subject areas that are already described in the PYP guidance for the subject areas. But a word of caution. We will need to be clear what the underlying model of competence is for progress in thinking across a wider time span, one that recognises both the growing cognitive capacities of children as well as takes into account their learning and engagement with an array of different knowledge and skills across any primary curriculum – their growing knowledge base.

Let's label this type of progression in thinking, "age-related progression in thinking", because of the longer time span and cross-curriculum perspective involved, compared to the more specific and time limited focus of developmental continuum described in the earlier paragraph. In the later sections we will illustrate and critique ideas of progression that are captured in both types of progress maps. But before that, we will turn to the theoretical and research literature to critically examine the ideas about growth and progression in thinking that have been proposed.

10.3 Theoretical and Research Perspectives on Progression in Thinking

In this section we will identify broad perspectives on how cognitive growth can be conceptualized. The perspectives are drawn from cognitive developmental psychology, from educational theory and taxonomies of learning objectives, from research on how expertise develops in specific domains, as well as drawing on more general discussions of learning progressions.

10.3.1 Progression in thinking: Linear models of 'pure' thinking

Perhaps the most dominant idea about progression in thinking involves the idea of a shift in the 'type' of thinking from a more simple or elementary type to a more advanced or complex type. The most obvious theory that springs to mind from cognitive developmental psychology is probably Piaget's stage-like model of children's thinking. Piaget formulated a continuum of logical operational thinking, moving from sensory-motor thinking in infancy, to pre-operational thinking in early childhood, then through concrete operational thinking in middle childhood, to formal operational thinking in adolescence and adulthood. Several decades of empirical research have cautioned us about the validity of this sequence as a basis for considering universal growth in children's thinking, and even Piaget himself acknowledged a range of variability over different domains. Nevertheless, there

remains the view that it might still be of some value. However, Goswami, an eminent British developmental psychologist, provides an alternative perspective. She summarized the state of current knowledge on children's learning and reasoning for the Cambridge Primary Review Trust which was a major review of research to inform the primary curriculum in England, and concluded:

> *"Children think and reason largely in the same way as adults, but they lack experience, and are still developing the ability to think about their own thinking and learning (meta-cognition) and to regulate their own behavior and interactions. They need diverse experiences in the classroom to help them develop these self-reflective and self-regulatory skills."* (Goswami, 2015, Cambridge Primary Review Trust, Research Briefing 3)

She goes on to explain that what distinguishes children's performance from adults' performance is prior knowledge (the amount, and organisation of knowledge, available for retrieval from their long-term memories) as well as a their capacity to self-regulate – for example, their ability to hold items of information in their working memories, to attend to information without distraction, and to inhibit impulsive responses. She notes that:

> *"Learning in classrooms can be enhanced by developing metacognitive strategies, self-reflection and inhibitory control in children These skills can be taught"*. (Goswami, 2015, Cambridge Primary Review Trust, Research Briefing 3)

However, many of these research conclusions are not based on curriculum learning in classroom settings. So there still remains the challenge of how to make what-is-to-be-learned-from-instruction accessible to children so that they can build up their knowledge base on which to exercise their powerful reasoning powers. Hence, it continues to be important to use learning materials and contexts that are meaningful to children, that link to their prior knowledge, to limit the number of items/dimensions of information presented to them so that their working memories are not overloaded, and to devise methods to develop their metacognitive strategies helping them to plan and to inhibit distracting responses. According to Goswami, these are the more likely constraints on children's ability to think rather than their powers of reasoning per se. (See Section 5, Vignette#4 for an example of a teacher prompting the development of metacognitive awareness and metacognitive strategies.)

The other dominant model about progression in the educational literature is Bloom's original work (1956) and subsequent revisions of his taxonomy. While the original purpose of Bloom's taxonomy was as a classification system for educational outcomes, it does imply a hierarchy and is often interpreted as a continuum from lower-order thinking to higher-order thinking, as if a learner needs

to be able to memorise before they are able to analyse, evaluate, or synthesise. There is no evidence in the cognitive developmental literature that children's memory strategies develop **before** their reasoning powers, and indeed both seem to be dependent on the development of metacognitive strategies (Goswami, 2008). In the case of Bloom, if the linear sequence from 'remembering' to 'understanding' to 'analysing'….. is taken as developmental continuum, teachers may fail to see that these cognitive processes are much more likely to interact with one another, for example, with analysing helping to deepen understanding which in turn is likely to make the material more memorable and thus more immediately retrievable to a learner for synthesis or making remote connections.

In terms of planning for teaching and expectations, both of these highly influential models, Piaget and Bloom, can lead to a serious underestimation of children's intellectual capacities. This is particularly true for younger children, when teachers may fail to challenge and stretch younger children's thinking because they think that remembering must be more important in the early years over so-called higher-order thinking which should be left for later primary grades or secondary school (or even for higher education). This is not to forget the importance of developing children's prior knowledge, but to recognise that bodies of knowledge in long term memory can be created through a variety of different cognitive processes.

10.3.2 Progression in thinking: Knowing and thinking

Another model for progression in thinking comes from research on the differences between expert and novices in specific knowledge and performance domains, such as mathematics, science, history and sports. The main insight from this research tradition points to the importance of developing ways of thinking in a specific domain as well as knowledge and concepts: for example, knowing that seeking evidence for a history project is likely to mean finding corroboration from another source, whereas seeking evidence in science is more likely to mean testing an experimental hypothesis. While many of the research examples come from students' learning in secondary education, post-secondary and even professional contexts rather than with primary school children, there are emerging patterns showing general characteristics of growing competence and expertise that are useful in describing an underlying model of competence that may have application in the primary grades and even for early years children. Bransford et al., (1996, 2005), in their summary of the current state of knowledge about how students learn, identified the following general characteristics of emerging expertise (paraphrased from the executive summary):

- Expertise develops from an initial novice stage, through intermediate stages to a more advanced stage across several dimensions simultaneously and progress can be variable across those dimensions (e.g., in mathematics and language competence studied at the same time). In other words, progress is messy. It takes effort, time and practice to stabilise into consistent patterns of performance.
- Expertise results from changes in learners' knowledge structures, their problem-solving and reasoning strategies as well as their capacity for metacognition and self-regulation.
- Experts have more integrated knowledge structures whereas novices' knowledge structures are more fragmented, pointing to the importance for future learning of prior knowledge and practice at constructing understandings by making connections between present experience and prior knowledge.
- Experts tend to recognise patterns and make connections compared to novices who focus more on isolated facts.
- Within their long-term memories, experts tend to have stored the links between concepts and the conditions under which they might be applied (condition-action links), thus making it easier for them to apply their knowledge. For novices, the links between the stored knowledge and the conditions for applying it are more distant.
- When confronted with a new problem experts tend to build up an understanding of what the problem is about rather than immediately trying to suggest solutions, compared to novices who rush for solutions and then have to backtrack to get a better understanding of the problem.
- Experts have a better capacity for self-regulation and self-monitoring than novices, for planning ahead, apportioning time, explaining to themselves in order to improve their understanding, noting failure to understand and activating background knowledge.
- Nevertheless, experts have varying levels of flexibility in their approaches to new problems, they can sometimes be blinded by their existing knowledge and not be able to transfer their competence outside of their domain. The absence of flexibility in some forms of expert thinking has led to a distinction being made between more routine forms of expertise and what Hartanto (1990) called adaptive expertise. As we have pointed out earlier in Section 2, the concept of adaptive expertise had fed into the Adaptive Competence Model that we referenced in Sections 2 and 5.

Compared to the pure thinking perspective on progression, the expertise viewpoint emphases the interaction between growth in knowledge structures and their organisation (not just amount), and the influence that has on reasoning and problem-solving, which echoes what we said in Section 5 about the important role of thinking in developing deeper forms of learning. Again the growth in metacognition and self-regulation emerges as important.

10.3.3 Progression in thinking: Insights from research on learning progressions

The term progression in learning covers a much wider range of learnings than is the focus for this report. Nevertheless, we will draw on that body of knowledge and current educational practice and see how helpful it might be in grasping some of the fundamental requirements for a thinking progression.

Research and educational interest in learning progression have been motivated by dissatisfactions expressed about standards-based grade level descriptions of what students need to learn at each grade. These have often been critiqued as no more than descriptions of collections of 'bits of knowledge and skills' without much coherence about how they fit together, how their learning might progress within a grade and how the learning builds up from grade to grade. In contrast, learning progressions are seen as growth in a complex mix of learners' knowledge, conceptual understanding and ways of thinking (thinking skills) in a specific area of learning (the research has mostly been in mathematics, science and reading). Learning progressions have been defined as "descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate a topic over a broad span of time……*they are crucially dependent on instructional practices if they are to occur"* (Duschl, Schweingruber & Shouse, 2007).

Borrowing an analogy from a paper written to make research on learning progressions more accessible to educational practitioners (Achieve, 2015), it is suggested that learning progressions can be described as formations of stepping stones across a river. One side of the river is where the learner is currently standing and represents the current level of the learner's competence in the domain; the other side is the desired learning goal and the level of competence that the learner wants to achieve. The stepping stone analogy outlines an array of possible stones that can be used to move the learner towards the learning goal. Individuals may have a unique travel path to reach the goal, but the learning progression illuminates those pathways and helps the teacher to understand better how students can find their way to their learning goal. Learning progressions help teachers identify commonly travelled pathways. Thus learning progressions provide very important tools for teachers

to give formative feedback to students and that is why they have assumed such significance in **"**assessment for learning**"** approaches.

The following are some key points from the learning progression literature. They can certainly inform any content curriculum structure but from our point of view right now they have relevance for likely thinking progressions (extracted from Achieve, 2015; Duschl et al, 2007; Hermitage, no date; Metz, 2009).

- Learning progressions provide an opportunity to create a curriculum model more coherent than a collection of bits of knowledge and skills, showing continuity between earlier and later stages.
- Learning progressions need an anchor point and an exit point, as well as intermediate points but, following the stepping stones analogy, the pathway between these points need not be linear.
- Learning progressions involve progress along multiple dimensions. Progress along these dimensions may not be consistent or even. At the individual level, progression can seem quite 'wobbly'.
- Learning progressions may prompt us to rethink what is meant by developmentally appropriate learning, pointing out that what children are able to achieve may be crucially dependent on what they have been given the opportunity to learn.
- Learning progressions are not the same as teaching sequences, though they should help teachers design teaching sequences and assessment tasks.
- Learning progressions should be empirically derived from research and observation on how students acquire competence. Currently, the research gaps are very large and learning progressions are a mix of research and professional judgement about what constitutes progress.
- Learning progressions come in different 'grain' sizes – some zooming in on specific competences in a context over a short time span, and some zooming out on progression, for example, across the grade levels. (This point has already been made at the beginning of Section 9.)

10.3.4 Key points from theoretical and research perspectives on progression in thinking

Section 10.3 has ranged widely across several different areas of research and educational practice. These are the key points that we consider are likely to be relevant as we go forward.

- Despite the dominance of linear models of cognitive development, the range of evidence suggests that progress in school-related thinking may not be as linear as the traditional cognitive models such as Piaget and Bloom may have suggested, or been interpreted as suggesting.
- Development in children's thinking is likely to depend on changes in their broad cognitive capacities such as metacognition and self-regulation as much as their precise reasoning powers, and both of these types of cognition can be taught to young children, as illustrated in Section 5, Vignette #4 and #5.
- Often what distinguishes adult thinking from children's thinking is the wealth of their prior knowledge as well as their metacognitive and self-regulatory capacities.
- Progress in children's thinking can be conceived as the development of adaptive competence – not dissimilar to the development of the type of adaptive expertise seen in experts who become accomplished in specific knowledge or performance domains. In Section 5 we illustrated how this adaptive competence can be prompted and enhanced through instructional practices that focus on the role of thinking to deepen learning.
- The educational usefulness of thinking progress maps are exactly the same as the benefits attributed to learning progression more generally – they provide a thread whereby teachers can build on what has gone before and prompt what is likely to come next; they help teachers observe how learners are progressing and give appropriate feedback; as well as developing a bigger picture with regard to the development of broader 2lst century skills – thinking, working with others, learning to learn, clear communication, and so on. These broader learning goals do not usually feature much in age-related expectations or grade descriptions.

11 Thinking Progress Maps: Examples

The positioning of 21st century skills as important goals for education has led to renewed research activity around the assessment of thinking skills, as one among several other skills such as communication, collaboration, and digital literacy. For the purposes of this section, we have selected two examples from the research/development literature that are relevant to answering the question 'what does progression in thinking look like'. Both examples make suggestions about a developmental continuum that might be useful for formative assessment purposes but none speak to the issue of age-stage related progression across the school years. For that type of progress map, we turn to two examples of curriculum authorities who have identified thinking as one of the broader learning goals in their national/state curricula, and have developed progress maps or thinking continuum to help schools and teachers 'know what it looks like", to plan appropriate teaching, and to devise assessment strategies to evaluate students' achievements in the light of these newer forms of curriculum learning and so on.

11.1 Examples of Developmental Continua for Thinking from Research and Development

The first point to make is there are many published teaching resources available that include examples of developmental continuum, and are used by teachers and school systems. For example, Greenstein (2012) includes a wealth of examples of rubrics that can be used as developmental continua for a range of 2lst century skills, including thinking. While these are extremely useful, they have been created based entirely on teachers' professional judgements and it is not always clear what models of competence underpin the developmental continuum and/or the consistency between different versions. For this reason, the examples selected for illustration in this section are more research-informed, deriving from different theories of thinking, although trialled and evaluated by teachers in classrooms.

11.1.1 Example 1: A developmental continuum for collaborative problem-solving from ATC21s (2009-2012)

A developmental continuum related to collaborative problem-solving has emerged from the international research and development project called Assessment and Teaching of 21St Century Skills (ATC21s). This project was an international research and classroom-based collaboration to devise and trial assessments for a range of 2lst century skills http://www.atc21s.org/. The project focussed particularly on collaborative problem-solving in the context of solving complex problems presented as

interactive computer-based tasks. Collaborative problem-solving was defined as a complex skill combining both cognitive skills and social skills, see Figure 2.

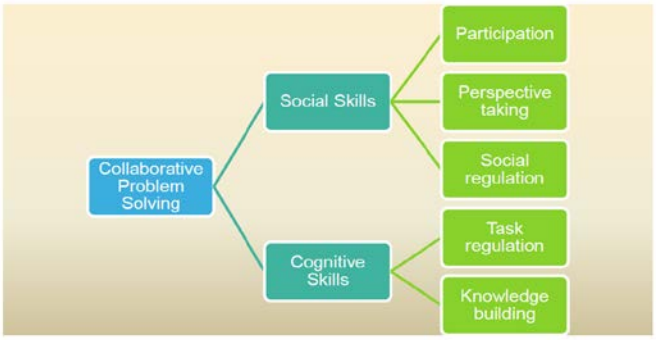


Figure 2 Model of Collaborative Problem Solving

An example of the developmental progression associated with this model is reproduced in Table 11 to give some indication of what criteria are being used and how they are conceptualised as developing from a less competent performance to the most competent performance, Level A to Level F. Note that the progression is quite complex as it is proceeding along two dimensions simultaneously, the cognitive process of solving the problem and the collaboration nature of the task (distinguished by italics in Table 11). It should be noted that the progressions from this strand of work are *empirical* progressions derived from trialling online problem-solving tasks with students in classroom settings.

http://www.atc21s.org/uploads/3/7/0/0/37007163/collaborative_problem_solving_emprical_progressions_v1.1.pdf

This research has led to the creation of online modules for teachers at the Graduate School of Education, University of Melbourne, to develop their understanding of collaborative problem-solving, the notion of developmental continua and how they can be used in classrooms for formative assessment purposes, available from http://www.atc21s.org/professional-development-modules.html

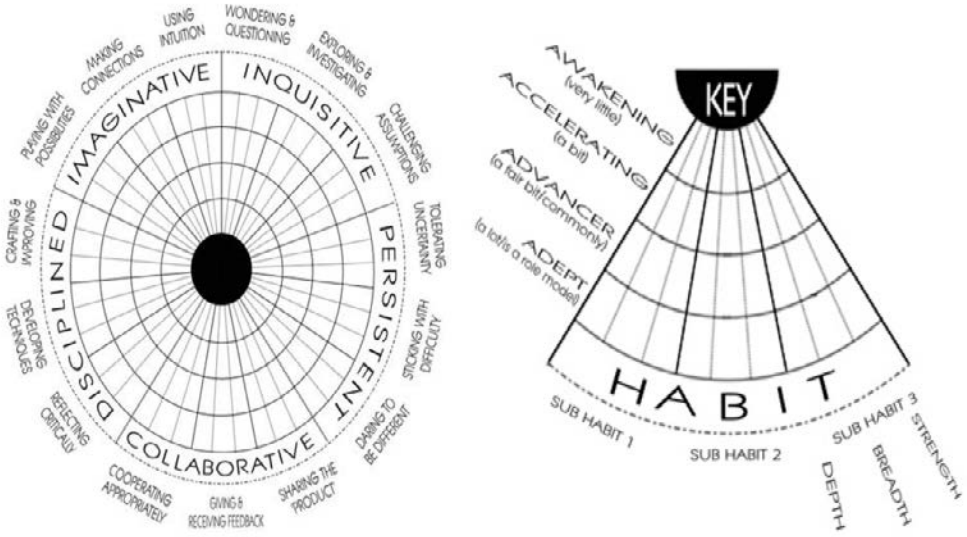
Table 11 A Developmental Continuum for Collaborative Problem-solving, incorporating both cognitive skills and social skills, (from Empirical Progressions link at http://www.atc21s.org/).		
Level	**Level Title**	**Level Description (*italics* draw attention to the collaborative aspect)**
F	Strategic approach to problem via collaborative process	*The student works collaboratively through the problem-solving process and assumes group responsibility for the success of the collaborative problem-solving tasks.* The student works through the problem efficiently and systematically using only relevant resources. *They tailor communication, incorporate feedback from their partner and resolve conflicts*
E	Efficient working partnership	The student's actions appear to be well thought out, planned and purposeful. They identify consequences of their actions and use prior knowledge to plan their strategies and set goals. Students can adapt their original thought processes in light of new information. *The student initiates interactions and responds to their partner's contributions but may not resolve differences.*
D	Cooperative planning	At this level, the student perseveres in attempting to complete the task and *they appear committed to solving the problem together. They share resources* and the student recognises patterns across pieces of information. They explore the task systematically, make plans and set focused goals. *Students have an awareness of their partner's performance on the tasks and can comment on their own performance*. Students at this level can complete simple tasks successfully.
C	Awareness of partner and directed effort	*The student recognises their partner's role and the importance of working together to solve the problem. They realise they do not have all the necessary information and begin to share resources and information with their partner. They report their own activities and help their partner to understand the task.*
B	Investigating the problem	The student actively participates in familiar tasks but largely independently. *Interaction with their partner is limited only to when it is necessary for completing a task*. The student tests out theories to solve the problem, using only available information and setting very broad goals.
A	Independent inefficient exploration	*The student explores the problem independently only communicating with their partner at the beginning of a task*. Their approach is unsystematic and focussing only on isolated pieces of information resulting in a lack of progress through the task.

Note how this speaks to some of the issues raised in Section 5 about how teachers can make collaborative groups really collaborative.

11.1.2 Example 2 A developmental continuum the Creative Dispositions for OECD project (2013)

This developmental continuum was produced as a prototype to be trialled in schools for usefulness as a formative assessment tool and for its usability and the clarity of the language being used (Lucas, Claxton & Spencer, 2013). It was commissioned by the OECD's Centre for Educational Research and Innovation (CERI) in 2011. From an extensive review of the research literature, consultations with practitioners and an expert panel, the authors constructed what they called the Five Creative Dispositions Model, consisting of *inquisitiveness*, *being persistent*, *being imaginative*, *working collaboratively*, and *being disciplined*. Each of the five creative dispositions has sub-domains (e.g., *inquisitiveness* was broken into: *wondering and questioning*; *exploring and investigating*; and *challenging assumptions*) resulting in 15 sub-domains which was quite complex. However, the pictorial representation of the model made it considerably easier for teachers to use. For the trial in schools, the model was presented to the teachers as a wheel with each domain/subdomain being represented as spokes in the wheel. Teacher were then invited to rate the children's dispositions along a four point scale ranging from Awakening (very little) through to Adept (a lot/is a role model), see Figure 3. In order to arrive at a judgement on the four point scale, the teacher was asked to decide, for each sub-domain or habit, if the child showed the disposition: strongly; in breadth (over a range of contexts); and with depth (subsequently called confidence).

Figure 3 Developmental Continua for the Five Creative Dispositions Model



From the initial trials in schools, teachers reported that they were able to use it and that it captured important dimensions of children's creative dispositions and creative behaviors. Without commenting on the details of the model, we think that the pictorial representation offers possibilities for how the PYP transdisciplinary skills, PYP attitudes or IB Learner Profile Attributes could be presented in a more holistic way for teachers and students. Again it should be noted that this continuum does not claim to be an age-related progression tool but should be used for formative assessment across a shorter time span.

11.2 Examples of Age-Related Thinking Progression Maps from National/ State Curricula

As a response to 2lst century learning challenges, many nations/states/school systems are now concerned to explicitly include broader learning goals related to critical and creative thinking, problem-solving, and communication in their curriculum frameworks. The broader learning goals are usually conceived in terms of cross-curricular or overarching goals that go beyond traditional subject knowledge and skills. They are variously referred to as key competences or competencies, key skills, personal capacities, personal capabilities, thinking skills, or some combination. They have been classified as falling into three categories – cognitive, interpersonal, and intrapersonal, and some frameworks tend also to include the new literacies such as digital literacies, as well as a wide range of other important goals for education, such as ethical understanding, civic awareness and so on. While some countries (e.g., New Zealand) have simply identified a range of such key competencies, other nations/states have created age/grade-related progression maps outlining expected milestones.

11.2.1 Example 1: Northern Ireland Curriculum Thinking Skills and Personal Capabilities Framework

The Northern Ireland curriculum includes a Thinking Skills and Personal Capabilities Framework, which became a statutory requirement in 2007 for all school children from age 4 to 14 years of age who attend schools in Northern Ireland. One of the research team (Carol McGuinness) was involved in its development. The Framework consists of five strands**: Managing Information; Thinking, Problem-Solving and Decision-Making; Being Creative; Working with Others; and Self-Management**. These strands are very similar to those included in the PYP Transdisciplinary Framework. Full details are available at http://www.nicurriculum.org.uk/docs/skills_and_capabilities/training/TSPC-Guidance-KS12.pdf

The pedagogical approach advised by the Curriculum Council was that the thinking skills were to be *explicitly* taught using the infusion methodology as illustrated in Section 5 of this report, and considerable resources were created and made available to Northern Ireland Schools through the council's website (see Gallagher et al., 2012 for a comparison of how these types of frameworks were launched in Northern Ireland, compared to New Zealand and Israel). Guidance on metacognitive thinking is included in these resources.

Progress maps were designed from Foundation Phase (early years); to Key Stage 1 (lower primary); to Key Stage 2 (upper primary), to Key Stage 3 (lower secondary). Table 12 shows in some detail how the progression is laid out for the **Thinking, Problem-Solving and Decision-Making** strand, which can be broken into **Analysis, Critical Thinking, Problem-Solving and Decision-Making**. **Creative Thinking** in the Framework belongs to the **Being Creative** Strand. Note how the same types of thinking are repeated at each stage but with increasing depth/breath reflecting the changing curricular demands and more extensive knowledge bases acquired as the learners move through the primary grades. Even the younger children are expected to engage with all the different types of thinking in a skillful way. The progression model assumes that, at each stage, children are expected to be supported/scaffolded at the beginning of the stage but then achieve a level of self-regulation before shifting to the next stage, where they are likely to encounter more complex curricular demands and may well require additional scaffolding, before they achieve a new state of self-regulation and so on. The important point is that self-regulation is a spiralling goal throughout the stages of primary schooling and not something to be achieved only at the end of the primary grades, as might be expected in a more linear developmental model. Note in the final column that there are suggestions about the likely thinking skill lessons that would advance the students' thinking in appropriate ways.

This is NOT an empirical progression but rather one that is informed by general principles to be found in the research literature, rather than a progression which has been empirically validated.

Full details are available at

http://www.nicurriculum.org.uk/docs/skills_and_capabilities/training/TSPC-Guidance-KS12.pdf

Age-related progress maps for all fives strands of the NI Framework can also be found at this web address.

Table 12 Northern Ireland Curriculum: Thinking, Problem-solving and Decision Making Progress Map

The purpose of this strand is to engage pupils in active learning, so they can go beyond the mere recall of factual information and the routine application of procedures. Pupils need to be explicitly prompted to engage with a range of different kinds of thinking in a range of contexts so that they can deepen their understanding of curricular topics, be more critical of evidence, think more flexibly, be able to solve problems and make reasoned judgements and decisions rather than jumping to immediate conclusions. As they progress, pupils will become more adept at managing their own learning, transferring their use of thinking skills across the curriculum as well as into their everyday lives.

Type of Thinking	**From Foundation Stage 4-6 years (2 grades)**	**To Key Stage 1 6-8 years (2 grades)**	**To Key Stage 2 8-11 years (3 grades)**	**To Key Stage 3 11-14 years (3 grades)**	**Likely Thinking Skills/Lesson Plans**
(Building prior knowledge **)** **ANALYSIS** Seeing patterns and relationships	Makes close observations and provides descriptions of what they notice Structures experiences and stories Identifies parts and wholes Sequences and orders events and information Begins to sort, group and classify information, objects and events, noting similarities and differences	Shows understanding by organizing and summarizing information Identifies parts and wholes Sequences, orders and ranks along different dimensions Identifies similarities and differences, makes comparisons, and makes connections	Uses memory strategies to deepen understanding and comprehension and builds knowledge bases Identifies and orders patterns through a range of strategies - parts/whole analysis, grouping, classifying and reclassifying	Generates deep interpretations and new ideas through comparing and contrasting and using other strategies	Parts/whole Sequencing Ranking Compare and contrast Classification

Pointers for Progression: From describing patterns/characteristics to explaining relationships, then interrelationships between a number of variables/factors. Developing a desire to explore the parts and functions of things, to seek connections and explanations with the purpose of deepening understanding of curricular topics.					
CRITICAL THINKING Developing lines of reasoning Examining evidence	Makes simple predictions and sees possibilities Gives reasons and explains them	Begins to test predictions and looks for evidence Explains methods, reasons, choices	Makes and tests predictions, examines evidence, makes links between cause and effect Discriminates between fact and opinion Questions reliability of evidence	Develops an argument and decides if conclusions support an idea Poses questions about reliability of evidence and reaching conclusions Spots biases and errors in arguments Draws generalizations	Reasons and Conclusions Making predictions Cause and effect Reliability of evidence Fact and opinion Examining bias Developing an argument Sampling and generalization
Pointers for Progression: From giving reasons/opinions, to explaining reasons/opinions to addressing counter-arguments. From making predictions and finding evidence, to identifying causes, to explaining them, weighing them up and offering valid conclusions. Developing an ability to weigh and assess reasons, to build complex conceptualisations. Developing an alertness for the need for evidence and to demand justification.					
CRITICAL THINKING Seeing multiple perspectives	Explains own point of view	Sees more than one point of view	Understands and explores more than one point of view	Seeks out and critically analyses a range of viewpoints and interpretations	Circle of viewpoints Debates Weighing up the pros and cons of different viewpoints Examining common ground Reconciling points of view

Pointers for Progression: From showing awareness of another perspective, to empathising with different viewpoints, to weighing up viewpoints and gaining insight as to why they are held, critically analysing them and drawing own conclusions. Developing the tendency to explore, value and evaluate alternative views, being open-minded.					
PROBLEM-SOLVING DECISION-MAKING Solving Problems Making Decisions	Sees possibilities/ options and follows up the consequences	Is systematic and works through the stages in a task Suggests solutions to problems and tries them out Generates options and makes decisions	Clarifies the nature of the problem or the decision Tries alternative problem solutions and approaches Evaluates solutions and sees what worked Examines options and weighs pros and cons	Clarifies and builds up a representation of the problem/decision context Predicts consequences Examines pros and cons, and evaluates outcomes Uses a range of problem-solving methods and evaluate solutions Refines and modifies methods and ideas Evaluates and reflects on outcomes	Problem-solving Identifying the problem to be solved Generating possible solutions Making predictions about likely consequences different solutions Weighing up the pros and cons of alternatives Recognizing real world constraints Planning and implementing proposed solutions in real time Decision-Making Identifying why the decision needs to be made Generating possible options Making predictions about the likely consequences of different options Weighing up pros and cos Deciding on a course of action Reviewing short-term and long term consequences of decisions
Pointers for Progression: From accepting the problems as already defined towards clarifying what the problem is, and building a better representation of the problem. Moving toward more systematic methods of decision-making/problem-solving to include a wider range of options/possible solutions. Developing the ability to generate and evaluate multiple options and solutions, to create, refine and modify solutions.					

11.2.2 Example 2 Victoria (Australia) Curriculum Thinking Framework

In 2013, Australia adopted a cross-curricular **General Capabilities Framework**, with seven capabilities, including Critical and Creative Thinking. The other six are Literacy, Numeracy, ICT Competence, Ethical Behaviour, Personal and Social Competence, and Intercultural Understanding. Learning continua have been developed to map the essential skills and capabilities expected at particular points in school from Foundation to Level 10 in the Australian school system. The implementation of this framework is at a very early stage.

http://www.australiancurriculum.edu.au/generalcapabilities/critical-and-creative-thinking/introduction/introduction

Each Australian state is mandated to adopt the framework but it can be customized at the state level, especially by those states that previously had a Thinking Framework, e.g., the State of Victoria. For these reasons, we have chosen to use the new Victorian Curriculum Thinking Continuum as an example, as it does have some distinctive features, see below.

Three strands have been identified as the basis for the continuum: **Questions and Possibilities** (covering information-seeking and generative/creative thinking); Reasoning (critical thinking); and **Metacognition (**defined largely as reflection and learning strategies**).** Thinking continua (age-related progress maps) have been mapped for these strands from Foundation to Level 10, see Table 13 below. Note that the progress maps contain both descriptions of types of thinking (inductive, deductive) as well as tools for thinking (e.g., visualisation, note-taking) which could cause some confusion.

A distinctive feature of this framework is that '**achievement standards'** for thinking have been articulated for particular points across the all grades. Overall, it is not clear what the model of thinking competence that underpins this thinking continuum is, or the research base that has informed its development. It certainly is not an empirical progression, as far as we can find out, though that is not surprising for age-related progression maps of this kind. Nevertheless, it does illustrate what a fully developed age-related progression map with associated achievement standards might eventually look like.

Table 13 Victorian Curriculum: Critical and Creative Thinking: Foundation-Level 10

http://victoriancurriculum.vcaa.vic.edu.au/critical-and-creative-thinking/introduction/rationale-and-aims

Foundation to Level 2	Levels 3 and 4	Levels 5 and 6	Levels 7 and 8	Levels 9 and 10
Questions and Possibilities				
Identify, describe and use different kinds of question stems to gather information and ideas	Construct and use open and closed questions for different purposes	Examine how different kinds of questions can be used to identify and clarify information, ideas and possibilities	Consider how to approach and use questions that have different elements, including factual, temporal and conceptual elements	Investigate the characteristics of effective questions in different contexts to examine information and test possibilities
Consider personal reactions to situations or problems and how these reactions may influence thinking	Explore reactions to a given situation or problem and consider the effect of pre-established preferences	Experiment with alternative ideas and actions by setting preconceptions to one side	Suspend judgements temporarily and consider how preconceptions may limit ideas and alternatives	Suspend judgements to allow new possibilities to emerge and investigate how this can broaden ideas and solutions
Make simple modifications to known ideas and routine solutions to generate some different ideas and possibilities	Investigate different techniques to sort facts and extend known ideas to generate novel and imaginative ideas	Identify and form links and patterns from multiple information sources to generate non-routine ideas and possibilities	Synthesise information from multiple sources and use lateral thinking techniques to draw parallels between known and new solutions and ideas when creating original proposals and artefacts	Challenge previously held assumptions and create new links, proposals and artefacts by investigating ideas that provoke shifts in perspectives and cross boundaries to generate ideas and solutions
Reasoning				
Examine words that show reasons and words that show conclusions	Examine and use the structure of a basic argument, with an aim, reasons and conclusion to present a point of view	Investigate common reasoning errors including contradiction and inconsistency, and the influence of context	Examine common reasoning errors including circular arguments and cause and effect fallacies	Examine a range of rhetorical devices and reasoning errors, including false dichotomies and begging the question
Compare and contrast information and ideas in own and others reasoning	Distinguish between main and peripheral ideas in own and others information and points of view	Consider the importance of giving reasons and evidence and how the strength of these can be evaluated	Investigate the difference between a description, an explanation and a correlation and scepticism about cause and effect	Examine how to identify and analyse suppressed premises and assumptions

Consider how reasons and examples are used to support a point of view and illustrate meaning	Investigate why and when the consequences of a point of view should be considered	Consider when analogies might be used in expressing a point of view and how they should be expressed and evaluated	Investigate when counter examples might be used in expressing a point of view	Investigate the nature and use of counter examples structured as arguments
	Identify and use 'If, then…' and 'what if…' reasoning	Examine the difference between valid and sound arguments and between inductive and deductive reasoning, and their degrees of certainty	Consider how to settle matters of fact and matters of value and the degree of confidence in the conclusions	Consider ambiguity and equivocation and how they affect the strength of arguments
	Explore distinctions when organising and sorting information and ideas from a range of sources	Explore what a criterion is, different kinds of criteria, and how to select appropriate criteria for the purposes of filtering information and ideas	Examine how to select appropriate criteria and how criteria are used in clarifying and challenging arguments and ideas	Investigate use of additional or refined criteria when application of original criteria does not produce a clear conclusion
Meta-Cognition				
Consider ways to express and describe thinking activity, including the expression of feelings about learning, both to others and self	Consider concrete and pictorial models to facilitate thinking, including a range of visualisation strategies	Investigate thinking processes using visual models and language strategies	Consider a range of strategies to represent ideas and explain and justify thinking processes to others	Critically examine their own and others thinking processes and discuss factors that influence thinking, including cognitive biases
Explore some learning strategies, including planning, repetition, rewording, memorisation, and use of mnemonics	Examine an increased range of learning strategies, including visualisation, note-taking, peer instruction and incubation, and reflect on how these can be applied to different tasks to reach a goal	Examine learning strategies, including constructing analogies, visualising ideas, summarising and paraphrasing information and reflect on the application of these strategies in different situations	Examine a range of learning strategies and how to select strategies that best meet the requirements of a task	Investigate how the use of a range of learning strategies can be monitored, evaluated and re-directed as necessary
Investigate ways to problem-solve, using egocentric and experiential language	Investigate a range of problem-solving strategies, including brainstorming, identifying, comparing and selecting	Investigate how ideas and problems can be disaggregated into smaller elements or ideas, how criteria can be used to	Consider how problems can be segmented into discrete stages, new knowledge synthesised during problem-solving and criteria used	Investigate the kind of criteria that can be used to rationally evaluate the quality of ideas and proposals,

	options, and developing and testing hypotheses	identify gaps in existing knowledge, and assess and test ideas and proposals	to assess emerging ideas and proposals	including the qualities of viability and workability
Achievement Standard				
By the end of Level 2, students use and give examples of different kinds of questions. Students generate ideas that are new to them and make choices after considering personal preferences. Students identify words that indicate components of a point of view. They use reasons and examples for different purposes. Students express and describe thinking activity. They practice some learning strategies. Students demonstrate and articulate some problem-solving approaches.	By the end of Level 4, students explain how to construct open and closed questions and use them for different purposes. Students select and apply techniques to generate a range of ideas that extend how problems are solved. Students describe and structure arguments with clearly identified aims, premises and conclusions. They use and explain a range of strategies to develop their arguments. They identify the need to make distinctions and apply strategies to make these. Students use concrete and pictorial models to facilitate thinking, including a range of visualisation strategies. They practice and apply an increased range of learning strategies, including visualisation, note-taking, peer instruction and incubation. Students select and apply a range of problem-solving strategies.	By the end of Level 6, students apply questioning as a tool to focus or expand thinking. They use appropriate techniques to copy, borrow and compare aspects of existing solutions in order to identify relationships and apply these to new situations. Students distinguish between valid and sound arguments and between deductive and inductive reasoning. They explain how reasons and evidence can be evaluated. They explain and apply basic techniques to construct valid arguments and test the strength of arguments. Students represent thinking processes using visual models and language. They practice and apply learning strategies, including constructing analogies, visualising ideas, summarising and paraphrasing information. Students disaggregate ideas and problems into smaller elements or ideas, develop criteria to assess and test thinking, and	By the end of Level 8, students prioritise the elements of a question and justify their selection. Students demonstrate flexibility in thinking by using a range of techniques in order to repurpose existing ideas or solutions to meet needs in new contexts. Students explain different ways to settle matters of fact and matters of value and issues concerned with these. They explain and apply a range of techniques to test the strength of arguments. Students use a range of strategies to represent ideas and explain and justify thinking processes to others. They evaluate the effectiveness of a range of learning strategies and select strategies that best meet the requirements of a task. Students independently segment problems into discrete stages, synthesise new knowledge at intermediate stages during problem-solving and develop and apply criteria to assess ideas, proposals and emerging thinking.	By the end of Level 10, students construct and evaluate questions, including their own, for their effectiveness. They demonstrate a willingness to shift their perspective when generating ideas, resulting in new ways of perceiving solutions. Students structure complex valid arguments. They explain and apply a range of techniques to test validity within and between arguments. Students identify, articulate, analyse and reflect on their own and others thinking processes. They use, monitor, evaluate and redirect as necessary a range of learning strategies. Students develop, justify and refine criteria to evaluate the quality of ideas, proposals and thinking processes.

		identify and seek out new relevant information as required.		

11.3 Key Points about Examples of Progress Maps

Section 10 has ranged across a variety of sources to identify different kinds of progress maps which have been created for different purposes, and with varying degrees of theoretical and research underpinnings. Key points of relevance for the PYP review are:

- Although there are many progress maps for different types of thinking available in the educational literature, very few are based on explicit and/or research–informed models of growing competence in thinking, or have been empirically validated. At best, they are first approximations or a first step. As indicated earlier, this is also true for learning progressions in other domains. This is not to deny their usefulness but only to admit that considerable research and development work on thinking progressions remains to be completed.
- We pointed to examples of research informed developmental continua on problem solving and on creative thinking dispositions, which shows that the research/practice thinking communities recognize that there is a big gap to be filled here.
- There is certainly an opportunity for the PYP to be more proactive in articulating expected progress in different modes of thinking related to even the current PYP Thinking Skills Framework, to help PYP teachers have a clearer understanding of what progression in thinking looks like, at least for formative assessment purposes.
- As broader learning goals, such as thinking skills, gain prominence in national/state curricula, curriculum authorities are beginning to create age/grade-related thinking progressions. For the most part, these currently exist as guides for teachers to prompt them to design more thinking-focused teaching activities and to create expectations and 'pictures of progress' for schools and teachers as they go about designing relevant assessment activities, which is probably the best description of the intentions behind the Northern Ireland Thinking Skills and Personal Capabilities Framework. But, in addition, the Victorian Curriculum Thinking Curriculum has gone one step further and includes an explicit statement about expected achievement standards at various grades at school.
- The PYP, with its worldwide network of schools following a common curriculum framework, may be in a unique position to begin to develop age/grade-related expectations about the development of thinking which would put it at the frontiers of development in this domain.

12 Findings from the Case Studies: Progression, Research Question 3

12. 1 Introduction

This section will report and interpret the views and practices of PYP case study schools through the information gleaned from the interviews with PYP coordinators and teachers as well as from the documentary evidence about progress maps, continua or other assessment tools that were electronically forwarded to the research team.

Essentially, two domains of questions in the interview schedule elicited information about progression in thinking. The first was a direct question: "*Does your school have expectations about how the students' thinking should develop over time? For example, in lower primary classes vs upper primary, with younger children vs older children ……..* ?" Answers to this question will be interpreted in the light of issues outlined earlier with regard to progression in thinking over the primary school years in **age-related progress maps.** The second line of questioning that elicited information on progression came from questions about th*e assessment of thinking skills, asking teachers what improvements they expect in children's thinking within a unit of inquiry or a school years, and what assessment strategies or tools they might use to give feedback to students.* Answers to this question were interpreted in the light of issues outlined with regard to **developmental continuum** and their use in formative assessment.

12.2 Age-related Progress Maps: Views and Practices

There were different understandings expressed about nature of these kinds of progress maps, as well as some degree of caution about the implications of creating them. The main question from the case study schools was: '*What would progression of this kind look like*"? Only two schools reported creating such documents, one was a public school where a thinking skills framework was about to become mandatory, and a continuum related to various dimensions of thinking had been created at the level of the state curriculum (Carnation School). The other school was a private school selected as a case study school because of its ongoing development work related to thinking skills (Lotus School). These progress maps will be described in more detail later. Whether documented or not, PYP coordinators and teachers held implicit views about the likely nature of progression in thinking, ranging from linear progression models not unlike a Bloom-type sequence to models that were more spiral and multidimensional. While there may not have been documents outlining these expectations,

these implicit views and expectations influenced the teachers' planning, as well as their teaching and assessment practices.

A Cautious Welcome: Schools who were not currently engaged in this kind of mapping welcomed the possibility, even if they were not yet clear about what it would look like. For example, PYP Coordinator Teresa from Tulip School, readily acknowledged that they do not have 'thinking-by- itself' expectations in any of their curriculum overviews, thought she would be interested in exploring this further. This school did make extensive use of rubrics for self-assessment and the teachers were clearly familiar with continua and could see their value in other domains, such as writing.

> "*We do have a curriculum overview for the subject areas and we look at how we can build and facilitate thinking in these areas. But, as opposed to just thinking by itself, no, we haven't done that so far. But we would look at working on it because it's interesting just to see what are the expectations, keeping age groups in mind. "*

And while Daffodil School had a very well developed philosophy about teaching thinking, and comprehensive classroom practices related to thinking routines and cultures of thinking, they had not worked up progress maps of this kind. Their PYP coordinator Dorothy said:

> *"And the answer to that (question) really is no, we don't. What we have not developed, we have not put into place, is any continuum of development of thinking skills. We have not created that. And that isn't to say that it wouldn't be interesting to have that. But we just haven't gone that far. "*

Magnolia School had been doing developmental work on key concepts and had put a lot of their recent professional learning effort in that direction rather than focus directly on thinking skills. Their PYP coordinator Michelle explained:

> *"…..we don't have any written document to track those thinking skills …….what does synthesis look like at different age groups. No, we definitely don't have anything like that. You know, it's a bit hard to know what it would be like."*

By the end of the interview, when asked what additional guidance she would like from the IB on any topic, and referring back to the earlier part of the interview about age-related expectations, she concluded:

> "*I think it would be really helpful to have a framework, even if it were just a suggested one, that we could then adapt…….that really is like a continuum of approaches to learning."*

PYP coordinator Oliver from Orchid School was the only one to articulate the possible disadvantages of these kinds of maps, worried about the underlying model of progression that they might encapsulate and that they might encourage a tick-box approach to children's learning, in conflict with the more holistic, inquiry-based approach.

> *"my only comment is that, you know, thinking is really challenging and sometimes it doesn't fit into nice little boxes and a sequential sort of pattern ……..we've got to be careful what we ask for because we may not like what we get. So, you know, I'd hate to get to (a situation where), you have to do this and then this and this and then this type of thinking. "*

What does it look like? When the coordinators and teachers began to elaborate on their views about progression it became clear that their implicit idea was that growth in thinking did not follow a linear path. It could be characterised "**Not really linear – more like repeating- but** ….", coordinator Oliver from Orchid School, who was worried about the implied linearity of progress maps, went on to say:

> *"…if you're a grade 1 and you're studying the community and people who help us, you may use (a certain kind of) thinking. But if you're in year 6 and you're studying about sustainability and pollution or whatever, you may need to do that kind of thinking again. So it's not just a done once – check – it's constantly revisited……"*

Coordinator Michelle from Magnolia School also struggled with the same idea of whether a linear view from lower to higher-order thinking implied in the Bloom-like PYP thinking skills framework was appropriate.

> "*Sometimes I think - something like making inferences you know - and some people say, "Oh that's a higher level thinking skill," but I taught early childhood and I know they can make inferences ……., because often they're doing that higher thinking, like they're doing metacognition, they're thinking about their thinking but at an easy level. I don't know how you would describe what that would look like."*

Coordinator Laura from Lotus School, who were already involved in some age/grade-related mapping of thinking, was more confident she knew what is looked like, even if she would like to understand it in more detail. She said:

> *"One of the things that we know is that everything can have a junior version, so we work on this junior version……..we know what the thinking skills are but we relate them to the stage of maturity of the classes that we have here, of the different ages. So that's what we're doing right now but it would be a good idea to see exactly how it might work in more detail……."*

But there were still concerns that some forms of thinking are more appropriate for the older children. Teacher Martine who teaches 10-11 year olds in Magnolia School, explains how curriculum planning contains implicit views about thinking progression. She says:

> *"We have a curriculum map for the year level and so that helps us look at what we're planning for the year. I guess, within there, we are thinking about, well, when they come to us they're really fourth graders and so we're not going to start with metacognition and dialectical thought. We're going to start with just, you know, how do you find knowledge and how do you comprehend it? I think that, in that sense, when we are planning we are thinking about that progression of the students as well. So, you know, we're going to meet them here, start here, and by the end of the year we're going to push them all the way to this."*

A similar view is expressed by teacher Trisha from Tulip School when she describes her expectations for younger children's thinking compared to the older children that she teaches:

> **"…..***so whatever we have taught them (referring to the younger children), they usually come up with the same thing. But where I am teaching, at the age group of ten and eleven, is where they're moving from childhood to adulthood and this is when they have a major change in their feelings, their emotions, the way of thinking or their perspectives. This phase is when we want them to do the critical thinking and put up their own opinion and give reasons. So this is a little different from what an age group of two or three year olds would do……"*

More generally, coordinator Carla from Carnation School explains how having a progression map for thinking – a thinking continuum as she calls it – in their state curriculum has helped her teachers understand in a more developmental way about what thinking looks like across the primary school years, with the potential to shape their planning and classroom practice. She explains:

> "I *think because they look at thinking processes on a continuum through the (name of state) curriculum, it's now helping teachers have a better understanding of what it may look like at a particular age level, which then informs their planning, and goes ok, if it's got to look like this, then I need to be looking at teaching this, or providing these resources, or having this kind of discussion. So I think, in some ways, it has actually helped our teachers a lot."*

The language to talk about thinking needs to be age-appropriate: One issue that was raised by several co-ordinators and teachers related to progression, was how important it was to get the language for talking about thinking right, in the sense of making the opportunities for thinking in more sophisticated ways (however defined) more accessible to children of different ages. Although, Daffodil school did not have a document outlining age-related expectations about thinking, it had many ideas of age-related progression implied in the school's practices. For example, coordinator Dorothy from Daffodil School said:

> "*We certainly use some of the PYP language when talking about thinking skills in the classroom – certainly by Grade 4 and 5 we want students to understand these terms. But we modify it in the lower grades especially in Early Years.* "

Dorothy forwarded this grid electronically to show how they modified the PYP thinking skills language for younger children (Table 14).

Table 14 Modification of PYP language for younger children in Daffodil School	
Acquisition of	Learning new knowledge

Comprehension	developing an understanding (so that students understand the on-going and ever changing nature of our understanding)
Application	taking action to apply our learning
Analysis	looking at the parts and wholes of a situation/object
Synthesis	making connections and bringing ideas together
Evaluation	drawing conclusions and making decisions
Dialectical thought	being open-minded to different perspectives and points of view
Metacognition	thinking about how one thinks and learns

Referring specifically to the issue of language and thinking routines with younger children, Dorothy went on to say:

> "*…that's very important of course for all of the early years' classes. The routines, some of them (the teachers) use the routines but they have to modify the language and the steps that they take, of course."*

The word 'metacognition', as well as the process of 'thinking about thinking', was raised several times as presenting a likely challenge for teachers and students. Teacher Lottie, in Lotus school, who teaches 9 and 10 year-olds, makes this comment about metacognition and how she makes the language for talking about thinking more accessible so that children know more directly what it is they need to think about. For clarity when reading the quotation – in this class, a type of thinking is identified as part of the objective of the lesson and is called the target. She says:

> *"Metacognition itself is a big word ……not that they're not able to understand it, but I don't like to overcomplicate things for my kids…..I know I'm doing a little bit of metacognition there with them (referring to the video) but I'm using language they're already familiar with, I'm using language that was in the objective. I'm going back to the objective and this is the reason why the target is so useful and so important."*

She also made reference to children who are not being taught in their mother tongue.

> *"But if I start using big words, that they might not be able to understand in their language, let alone in English, it's just not going to happen, you know. So I think that's the main reason why metacognition is sometimes so hard for them, because we have this big question with big words and it's like, okay, say it again but in a way I can understand. You can see it in their faces, you know, they got like a question mark face, like what? No, I don't like to see that on my kids."*

So even if the growth model is one of revisiting different types of thinking in new, and presumably more demanding, contexts across the primary years, there is still a challenge in making the language of thinking accessible to children of different ages and linguistic backgrounds.

Self-regulation as a key feature of what progression looks like: Two case study schools had worked on creating age/grade-related progress maps. They were very different from one another in their content. One was more specifically about thinking skills or thinking moves (Appendix E) while the focus for the other was the development of a disposition for thinking independently (Appendix F). The key common feature was that the underlying model of growing competency was from a performance that was highly supported or scaffolded, towards increasing autonomy in the performance, from other-regulation to self-regulation.

Example 1: Lotus School has worked with Thinking Routines and Thinking Moves from Project Zero's Visible Thinking programme. In their book, *Making Thinking Visible*, Ritchhart et al. (2011) have grouped Thinking Routines/Thinking Moves into pairs showing the type of thinking (the Thinking Move) that might be best prompted by a specific Thinking Routine. For example, See-Think-Wonder is paired with Description-Inference-Wonder; I-Used-to-Think is paired with Reflection and Metacognition; and Circle of Viewpoints is paired with Perspective-Taking.

Then these Routine/Move pairs are grouped into a bigger organizational sequence for promoting understanding and thinking, from Routines for **Introducing and Exploring Ideas**, to Routines for **Synthesising and Organising Ideas** to Routines for **Digging Deeper into Ideas**. Lotus School has used this organizational sequence to phase the introduction of thinking routines and the expected thinking moves across the age grades. In the very early years, the expected thinking moves are in the category of **Introducing and Exploring Ideas**, and additional routines/moves are added as the children progress throughout the grades. While this appears as a very linear sequence, the suggested progression is more complex. For example, there are also expectations that routines/ moves that were introduced earlier should continue to be practiced but with greater independence (moving from **introducing** to **supporting** to **automatic**). The important point is that, at the end of the primary grades, the children are expected to be able to have achieved at some level of proficiency across all the different types of thinking moves. Technically, this is more like a planning for teaching document (it is called scope and sequence), rather than a progress map about children's thinking. Nevertheless, it has some features of progress maps, such as an underlying model of competency which is multidimensional, as well as a strong perspective on self-regulation.

This scope and sequence document is very alive in the practices of the teachers at Lotus School. When asking teacher Lucy from Lotus School how she approaches the assessment of thinking, she explained how it is used for both formative and summative assessment.

> "*We have a scope and sequence of the thinking skills that we require for students starting pre-K up to grade 5. What we do is write comments, formatively of course, whenever they are doing an exercise or something, we would write how their thinking is going on, based on the scope that we have. So it's like, are they achieving it or in the process of doing it? And then, whenever it's a summative assessment, we try to do one of these things as part of the summative assessment."*

See also Appendix I for an example of a scope and sequence document for thinking skills from the Thinking-based Learning perspective.

Example 2: The second example comes from Carnation School where the teachers had been working on the question "What does progress in thinking look like?" Their ideas of progression had been influenced by the thinking continuum of their state curriculum, and they extended that model to some of the attitudes/learner attributes of the PYP programme. They began to work on a developmental continuum for Thinking and Acting Independently. PYP coordinator Carla explains:

> *"We've definitely started to look at doing a similar thing with the attitudes, from the Primary Programme. So, because again, teachers are asking, "What does independence look like for a Prep child, or for a year two child, or for a year four child?" This year the staff worked on putting a document together that was just very, very simple in terms of the kinds of things that they would be looking for (at each stage), with the idea that they'll review it next year."*

And she goes on to describe the likely benefits of having this kind of progress map and how it could be used by the teachers.

> *"If these are our expectations at this year level…….then we can see that this child is actually working beyond that – at this point – because they are showing these behaviors. Not that we want to assess the students on their attitudes or even the learner profile in some ways because it can be very subjective. But it gave them something to think about in terms of, you know, looking at the work habits and the social capabilities of particular children in comparison to others.*

Appendix F shows the full details of the progress map created by the teachers. Not surprisingly because of the disposition being described – independence – the model of progression is from being other regulated, and from being prompted by the teacher, to becoming more proactive in asking questions, seeking help and feedback, setting goals and so on. Note also that progress is envisaged as happening across multiple dispositional and behavioral dimensions, such as being curious and seeking information, asking questions and building up the knowledge base, participating in roles and taking on responsibilities, seeking and using feedback, and setting goals. (A cautionary note – because

the time line for developing independence is stretched across the full primary school years, the expectations for younger children might result in over dependency rather than creating agency).

12.3 Developmental Continua for Formative Assessment: Views and Practices

In the earlier section, we drew a distinction between age-related progression and the idea of using a developmental continuum as a guide for formative assessment with a shorter time focus. The key characteristic of this kind of map is that it captures an underlying model of growing competency of the thinking in question, and articulates different levels of competency, from least to most competent. Different terms are used to describe this growth – becoming more competent, increased proficiency, becoming more skillful.

Checklists and Rating Scales – not Progress Maps: If schools had not identified thinking as a curriculum objective and were not very explicit about thinking in their instructional practices, then it is not likely that they would have developed progress maps of this kind. And, for the most part, that was true for the case study schools, with one exception. Lotus School had begun development work on these kinds of maps, and we include some examples of their work below. Rather, schools tended to have developed checklists or ratings scales for indicators of good thinking or related dispositions, that teachers used to assess children's learning, or that the children used for self-assessment. These checklists and ratings often contributed to feedback conversations with the children or were included for reflection in portfolios. In that sense they were part of the school's assessment for learning philosophy.

For example, in Daffodil School, teachers rated the children annually across the transdisciplinary skills using a frequency scale – *rarely, sometimes, usually, consistently* – on behavior indicators that showed positive dispositions for good thinking, such as "*Plans for and carries out activities effectively*", "*Shares own ideas considerately*", " *Works cooperatively with others"*.

Lotus School had developed a checklist for children's self-assessment: "*I am thinking and understanding when I: Look closely and describe details**;** Explain ideas by putting thoughts into words and giving details; Give reasons for my explanations; Make connections; Listen to and think about the ideas of others; Know the main idea; Wonder and ask questions; Think beyond my first idea or answer*."

Tulip School had a teacher assessment set of criteria for summative assessment that included three skills headings – research and presentation skills, thinking skills, and communication skills. The criteria under thinking skills were: "*The child exhibits a thorough understanding of the central idea/lines of inquiry on the task assigned. The child is able to apply the knowledge to independently answer the question. The child is able to organize thoughts and make connections to the central idea/lines of*

inquiry." Feedback to the children on these criteria was shown through three smiley faces – happy, neutral and sad. In addition, evidence **for** assessment criteria related to thinking progression were often evident in writing continua which were normally well developed in schools.

The challenge of making thinking more visible: Several coordinators acknowledged the challenges they faced when assessing thinking. They concluded that teachers need to have a clearer understanding so that they know what to look for as evidence of better quality thinking. For example, Carla from Carnation School said how important teachers' understanding was, she explained:

> *"…….just teachers' understanding what it means. So, how do you assess something that you're not quite sure exactly what it should look like, or what your own understanding of it is*?"

When considering the other pressures on teachers' time, coordinator Oliver from Orchid School said:

> *"…the thinking stuff, you know, you've got to work a bit harder to see that, ……..it's often more about having a conversation with a child …….So, yeah, one of the challenges is the actual visibility of it, and the time within the week to get through it ."*

Teacher Della from Daffodil School who taught 6 and 7 year-olds, explained that, through observation and questioning the children about what strategies they had use, she had created records of children's responses as evidence of their thinking. She said:

> *"I would really talk to the children as they're working and, maybe, make notes on a grid where I have all the children's' names, (asking them) are you showing evidence, what proof is there, what strategies did you use to do this piece of writing. So I definitely ask the children to make their thinking explicit and they know, for example, with say mathematics that it's not just the answer that's important……* **"**

Teacher Diana, also from Daffodil School, who teaches 3 and 4 year-olds, explained how she designed tasks that were increasing complex so that she could clearly observe how her young children were responding and developing. In the context of her lesson, she explained:

> **"..***as part of a series of activities that I have been doing with the children as the year has gone on, where we've done this data handling activity, in a circle. I've been trying to develop the activities so that the children's thinking and the children's choice-making is becoming increasingly complex and the demands that I am making of them are increasingly more demanding.*
>
> *So I'm looking at their ability to function as part of a group and that is a progression. I'm looking at their ability to understand the activity and to accurately engage with it. I'm looking at their ability to listen to what the other children are doing and their ability to communicate effectively within the whole class. As I said before, these activities are planned so that they demand an increasing level of complexity with regards to the children's understanding of whatever the activity might be*."

And Teacher Mollie from Magnolia School, explained her strategy of using something like a mind-map for pre- and post-assessments to see how the children's understanding and thinking had developed – a strategy that was used by several other teachers as well. Mollie explained:

> *"I am looking for a change, I'm looking for a comparison of, I suppose, before and after, so, for example, this particular unit, at the beginning of the unit, we do just a very simple graphic organiser …..(goes on to explain in more detail) ……and they can, you know, write and it's just all boxes with places for a picture and little bit of text. But it's really interesting doing the same assessment at the end of the unit of inquiry and to see how much more, you know they're have lot broader and a lot deeper understanding about how plants are important, as a result of the Unit of Inquiry."*

Since becoming involved with the Thinking-based Learning approach, coordinator Laura from Lotus School explained how they now make the criteria for more skillful thinking visible through co-constructing a thinking map in a familiar and simple context so that the criteria for doing good thinking are clear to the students before they embark on their curriculum topic or inquiry.

> **"***We always tell our students the criteria that makes good thinking beforehand…….*
>
> *"I mean, you introduce the skills and you just try to develop them through the different questions from the thinking map (in a familiar context). But once they do that, we tell them 'Okay, this is what we are looking for…….'"*

Laura explained how they are helping teachers to become more skilled at looking at students' work and finding evidence of thinking, using a protocol called Looking at Students' Work (LASW) from the Cultures of Thinking Approach. She says:

> "…..*when assessing skills precisely, what we do most of the time is – we look, we have these protocols, we get together and we just use the protocol call LASW, Looking At Students Work*"

The LASW protocol involves an agreed set of steps at a professional learning meeting between a group of teachers to help the 'presenting teacher' gain a deeper understanding about the qualities of a student's work so that the teacher is more equipped to give feedback to the student.

> "…..*she will go back to the student and she would have more tools and be more empowered to talk to the students and just see how can she move her students forward – so that's what we do."*

Clearly, teachers have devised a variety of strategies for responding to the challenge of making thinking more visible, which is a prior condition for collecting evidence about the current state of the child's performance before even considering the creation of progress maps for formative assessment.

The role of documentation: Another theme to emerge as important for making the thinking more visible and thus available for assessment was the role of documentation. The term 'documentation' is used by the Harvard's Making Thinking Visible approach in a very specific way as having a role in formative assessment. For example, it is noted on their website: "*Through documentation of students' thinking and learning, we develop our own understanding of how thinking processes develop and how we can best support them. In this sense, documentation is not just a reflective examination but also a prospective one as it shapes the design of future learning situa*tions." http://www.visiblethinkingpz.org/VisibleThinking_html_files/02_GettingStarted/02d_StartingDoc.html

In particular, Daffodil School is very committed to this approach and have formally adopted it as part of their assessment policy to document progress within a unit of inquiry. Coordinator Dorothy described some examples of what is documented: for example, reflective commentaries on learning activities in student portfolios:

> "*We ask students to reflect on and explain their thinking about different learning activities within each unit of inquiry. These reflections are saved as part of each student's portfolio of work. In March we expect students to be able to lead their student-led conferences with their parents and teacher, either in English or their mother tongue."*

Dorothy goes on to explain how teachers use blogs for documenting what has been happening in a unit of inquiry:

> "*…we all have a blog, and every teacher will write down or document what's been going in that week with pictures, and the children might write something as well. But what we're trying to encourage teachers to do is to document the pedagogical side of it. Why are we doing what we're doing?"*

Diana, the early years' teacher from the same school says how she keeps track of the children's progress and how she communicates this to the children's parents on an ongoing basis, using an e-portfolio called Storypark.

> **"***I have an observational record, which I keep for each child, which is like my book that I keep beside me and I jot things down there. We use a learning story format for feedback to parents, using photographs and text, and that's pretty much a complete record.*
>
> *"What happens is we take the photographs and put them into a story format, which we share immediately with the parents, we publish it and share it immediately with the parents. So we have a dialogue going all the time and the bank of photographs and stories that we have of each child is a very good record of where they are and how they're progressing."*

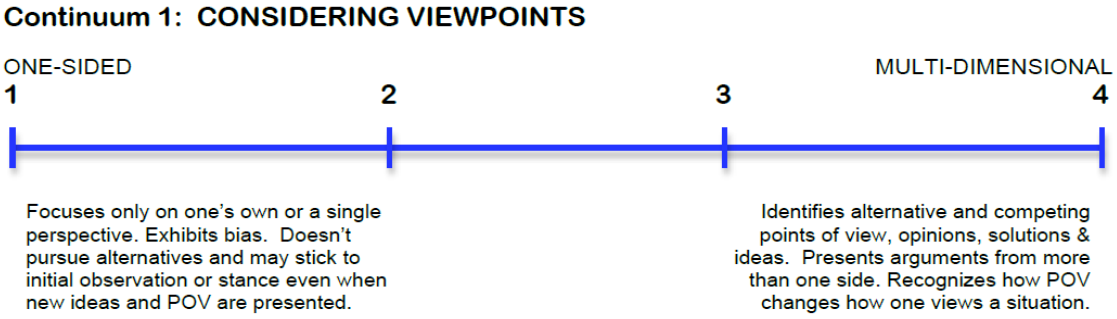
Coordinator Laura from Lotus School who adopts a very explicit approach to teaching thinking mentions that they make reference to children's progress in thinking skills in the report cards that are sent to parents, albeit not in a very detailed way**.**

> *"…within our report card, the one that we show to our parents, there is always a record, we just say how the child is developing their skills but not in a very specific way. Really it's something that we would like just to go further in really recording thinking skills."*

More generally, there were several comments about the increased use of digital portfolios and how they were likely to facilitate the development of transdisciplinary skills, in terms of reflections on learning, recording of progress and reporting.

Examples of Progress Maps: As mentioned earlier, we were only able to uncover examples of developmental continua in one of our case study schools. Lotus School, who were working with several different thinking approaches including both Thinking Routines and Thinking-Based Learning, has worked on developmental continua for several Thinking Routines, and were working on a similar approach with the thinking skills from Thinking-Based Learning. (For illustrative purposes, Appendix G shows examples of developmental continua from schools which are not in this study.)

They began with a continuum for the Thinking Routines that had been developed by the Harvard Cultures of Thinking/Making Thinking Visible group, see below for the example of the Thinking Routines, Considering Viewpoints. Note that this example identifies two levels of performance – the lowest level and the highest level but with no intermediate steps. Very useful as a first attempt but not very specific with regards to helping a student know how to move on – the jump is too big.



Lotus School had elaborated on this continuum to articulate more explicitly FOUR levels of performance from least competent (one-sided) to most competent (multi-dimensional or multiple perspectives), see Table 15 below. See also a similar articulation for the thinking moves associated with two other Thinking Routines.

Table 15 Examples of more detailed Developmental Continua for Thinking Routines from Lotus School				
Thinking Move or Routine	4	3	2	1
Considering Viewpoints	Presents arguments from more than one side. Recognises how Point of View changes how one views a situation	Identifies alternative and competing points of view, opinions, solutions and ideas	Doesn't pursue alternatives and may stick to initial observations or stance even when new ideas and points of view are presented	Focuses only on one's own or single perspective
Describing what's there	Attends to details, sees hidden, obscure and missing aspect, identifies pattern	Generates possible interpretations without having to definitively name them	Fails to look deeply, confuses interpretation and observation	Recognises only the most salient aspects, qualities or objects
Building Explanations	Proposes tentative theories and explanations that are refined and modified as new evidence presents itself, remains open	May stick to refuted ideas because they are one's own	Accepts simple explanations quickly without probing	Doesn't look for evidence, support or alternatives

12.4 Concluding Comments on Thinking Progression Practices in the Case Study Schools

As we noted earlier, the state of the science of characterizing progression in thinking and related assessment is not yet fully developed, so it is not surprising that individual schools, school systems and curriculum authorities have often struggled to create theoretically sound and/or empirically robust progression maps for use in schools.

While we found many good attempts by the teachers in the case study schools to create a variety of strategies for assessing thinking (checklists, rating scales, portfolios), for the most part , these attempts were not underpinned by any well-articulated model of what progression in thinking might look like. The PYP schools that were making some progress on this track were drawing from specific

thinking approaches, or from external curriculum authorities, rather than directly from PYP guidance materials. From our interviews with coordinators and teachers, they could do with some more explicit guidance from IB about this.

Our own view is that any such developments with regard to characterizing progressions and/or creating progress maps should be preceded by the creation of a specific PYP framework for teaching thinking. The final section elaborates on this point and makes recommendations.

Part 5 Recommendations

13 Recommendations

Preliminary Comments

The track that the IB guidance material takes teachers and schools on, to facilitate the important type of learning the PYP promotes, is consistent with the dominant themes, both in spirit and in detail, in the contemporary research literature about learning and thinking. But it is not yet specific enough to guide coordinators and teachers to the dominant ways that this research translates in successful classroom teaching today.

We applaud the fact that the IB has undertaken to have the initial review of their approach to thinking set in the context of the way teaching thinking is being treated today, and then to engage in this second review which focuses on the way that teaching thinking is being interpreted by IB schools. As of now, teachers and school IB coordinators in our case study schools show that they value the importance of bringing more specific thinking activities into their schools and classrooms. But many of them are not sure how to do this. So they have tended to search the field of teaching thinking and bring back a variety of different practices, some more firmly adopted by all the teachers in the PYP programme, some more fragmentary in both school and classroom. Hence our sense is that often classroom teaching in the PYP does not yet realize its full potential as a powerful context for early years/primary grade students to engage in the most effective learning. We are happy to say, though, that in our judgment this is remediable, and we make a series of suggestions below about how the PYP may realize this potential more fully, without compromising any of its basic principles or require more time in the school year.

The key findings from this report have confirmed many of the conclusions that we reached from our previous audit of the IB guidance documents for PYP schools (Swartz & McGuinness, 2014b). Moreover, the findings from the Case Study Schools have significantly deepened our understanding and provided us with detailed examples of how PYP schools approach teaching thinking, how they relate thinking to deep learning, and what expectations they hold about how thinking progresses and how they might assess that. This is the basis for our recommendations, mindful that our case study methodology is designed to illuminate important issues and cannot represent all PYP schools. There will certainly be PYP schools who adopt other approaches that we have not captured in our sample. Nevertheless, the consistency of the appearance of certain patterns, we feel, is sufficient for our study to raise some important key issues which, when addressed, will be helpful to all PYP schools achieving the basic objectives that IB has for the PYP.

Recommendation #1

One main issue we would like to raise with IB is the extent to which it wants to prioritize effective thinking as a curriculum objective. This would mean giving it the same status as the mastery and use of the key concepts in the PYP curriculum. This would change the way thinking is handled in PYP lesson and unit planning, and give the message that good thinking is not just about the issues dealt within a specific unit of inquiry - important though that is. Rather, elevating thinking as an explicit curriculum objective, in a manner similar to key concepts, would show that, in the value system of the IB, becoming a good thinker is sufficiently important to articulate a set of thinking-related objectives and ask that they be addressed in all PYP planning.

There are three main reasons for this. The first is that we have demonstrated the intimate connection between doing certain kinds of thinking well in bringing about truly effective learning, based on the latest, and most widely accepted research-based, conceptualization of effective learning (Section 2, Section 5). To maximize this we have shown that, at almost every important step along the way, certain types of activities involving specific thinking processes are what bring about the desired results.

The second reason is that this is evident in the specific learning framework, the concept-based curriculum that the IB has established to define the route to effective learning in the PYP. Consider the role of key concepts like “cause”, “function”, etc. in this process. Yes, understanding the cause of a social revolution enriches and deepens our understanding of the revolution, as does the function of social media in making the revolution succeed. But, to really get at the cause, and not just guess, and to really grasp the function of social media, and not just say that they were important, good careful thinking is required. And, we anticipate that the IB does not want such thinking used just in the relation to a specific topic in a specific PYP inquiry, but wants students to learn to ask this question about cause, and be able to figure out what the real cause was, of anything they encounter like this for the rest of their lives.

The third reason is independent of the value of good thinking in the learning activities of the PYP. It has to do with the value of good thinking in the lives of our students outside school, both when they are going to school and after. Where the questions they learn to raise and the processes they use to answer these questions perhaps has most effect in their lives outside of school is in their decision making and problem solving. The importance of students learning how to think through decisions and solve problems, and developing the disposition to do these when they are needed, in translating good ideas into good action is obvious. This, in itself, is an argument that should justify any school to make teaching skillful thinking a key objective in the school.

For all of these reasons we urge the IB to take this recommendation and elevate good thinking, in all its forms, to become a key objective of the PYP. We have found that a school that does this and starts with 3 and 4 year-olds, and reinforces this with varied practice regularly, will have a group of students who will have internalized these processes by the time they get to age 8 or 9. Good thinking then becomes as natural as speaking their language well. To us this means that good thinking has the same status as good reading and writing and all should be considered gateways to deep learning and good living.

We make the following recommendations on the assumption that the IB does elevate good thinking as a key objective in the PYP.

Recommendation #2

The different elements of the PYP Transdisciplinary Framework are presented in a fragmented way – themes, concepts, skills, attitudes, learner attributes. These elements are all presented as lists, leaving implicit how they are likely to interact, or which ones might be more important than others. If the different elements of good thinking are added to these lists teachers may, also, not be sure how they fit in. Some of the coordinators commented that their teachers were having a hard time trying to fit the pieces together already without the addition of thinking skills as a priority, for example. We will not speak to this issue but will address ways that we think the IB can avoid its recurrence if thinking is brought up front as an important curricular objective.

We recognize that ways to put these ingredients together may quite legitimately vary depending on the learning objective(s), and certainly from grade level to grade level. But when thinking is added, it will be important to give classroom teachers some guidance in the kinds of connections that can be made with the various ingredients in the thinking programme. For example, suppose that students are not only exploring the French Revolution, but have been guided by the teachers to probe one of the key concepts with regard to the revolution – to ask what caused it to happen the way it did? The inquiry models used by many schools can set a context for students trying to answer this question. But are there any thinking strategies that can be used to help students reach defensible conclusions about this?

Well, one of the important types of critical thinking has to do with finding out what caused something, as we mentioned in Recommendation 1. To do this with skill involves a strategy that focuses the students to develop a range of possible causes, and then guides them to search for evidence that will lead them to what the most likely cause is. This kind of exploration, and the understanding that

results, is one of the goals of the IB and, when students achieve this goal, their understanding of the French revolution will become enriched and will deepen. But, if teachers are unfamiliar with the way they can create a thinking activity like this for their students in this context, this opportunity may be lost.

We recommend, therefore, that the IB either creates or utilizes what we include in this report -- a diagrammatic framework showing how the ingredients in a thinking curriculum fit together, as we have described it, and then relate it to the ingredients in the present PYP instructional framework: basically, *to create a framework for teaching thinking in the PYP*. We also recommend that the IB make available to all PYP schools the conceptual material that fleshes out such a framework: a set of published resources that can inform teachers of the details of this new thinking-oriented framework. We suggest that our two reports be included.

Recommendation # 3

We are all aware of the research that shows that reading about new approaches to classroom instruction alone has minimal effects on classroom change. But there is now research that shows that a well-structured teacher-training programme can dramatically increase the implementation of new ideas in school classrooms. We note from our interviewing that some of the schools we spoke to, in fact, have identified specific thinking-related programmes, and have worked out ways of either bringing such teacher-training programmes to their schools, or bringing their teachers to sites where such programmes were taking place, or doing some online training. And we noted that in some of these schools, teachers were implementing what they were learning with frequency and in coordination with their colleagues.

On the other hand, we also noted that while all of the teachers we interviewed took the idea of bringing thinking activities into their classrooms, many were left on their own to find activities that they thought might work. In some of these classrooms we noted that the teachers were satisfied that they had found thinking activities that “worked”, others were not so confident about what they were doing. In a few cases where the teachers described problems that they had, we could see immediately what could have been done vis a vis the thinking activity to ensure that it achieved the thinking objective more successfully, and we remarked that if these teachers had attended a workshop on teaching skillful thinking they would have found this out for themselves.

Hence we recommend that IB provide a series of robust teacher-development workshops on teaching thinking in the PYP as we have conceptualized it in this report. By "robust" we mean that this programme should, at the least, contain a coaching component in which coaching on classroom implementation is provided to individual teachers, or to groups. This is the kind of teacher-training programme that the major research on teacher-development has shown is maximally effective.

A word of caution. We have noted that some programmes designed to bring thinking into classrooms specialize in only one or two aspects of the whole that we have outlined in Section 5. What we would emphasize is that, however the IB puts together these workshop opportunities, they be constructed to address all SIX of the key ingredients (Section 2, Section 5) that we identified as a coherent programme specifically tailored to the objectives of the PYP in which the different ingredients complement each other. For example, teaching students to use thinking routines should not be presented as a competing alternative to teaching them how to engage in skillful thinking, but rather as two components in a larger enterprise that complement each other.

Recommendation # 4

Some IB coordinators and teachers, recognizing that there may be more to teaching thinking than they currently practice, have said that they would like to find out what other PYP schools are doing to meet the challenge of bringing an emphasis on thinking into their schools. And, indeed, it is our perception that there are some fine examples already in these schools of ways of emphasizing one or more of the six focal points we identified in Section 5. We recommend that the IB establish a special network of IB schools in which teachers can contribute videos on line of thinking-based lessons or classroom activities with an explanation of the lesson objectives and any special features, perhaps slotted into one of the 6 categories we have identified.

We also suggest that the IB set up regional conferences on thinking in a PYP context in which teachers could demonstrate some of these lessons and activities and discuss together, how they work, and how they might be either adapted to other contexts, or enriched. For example, some teachers have adapted a technique for translating good thinking into good writing not developed in an IB context, for use in a specific PYP instructional context revolving around one of the important transdisciplinary themes, and have tried it in some middle and upper primary students. Something special like this, with a distinctly PYP cast to it, that does not appear in the literature on teaching thinking, but can be made available to other teachers in this way, can spread from school to school and enrich many more students than if this teacher wrote an article about it.

Recommendation # 5

Without explicit models or even schematic expectations of how specific types of thinking might develop in school classrooms, it is difficult for schools to create developmental thinking continua or progress maps for either specific tasks or for age-related expectations. Among other things this can have an impact on the way teachers sequence their instruction and how they emphasize the thinking processes that students are learning to engage in. However doing this successfully presupposes that a framework for teaching thinking of the sort that we have previously discussed has been adopted, is in play in some PYP schools, and teachers have mastered instructional techniques that they judge make their work with thinking skills effective. But more than that, the way that such a framework plays itself out in a PYP school needs to be monitored and the results recorded. Any realistic expectation that students will progress in their thinking according to certain patterns, or in specific ways, with and without support, needs to be based on the reality of the classroom and not just on our ideas of what we think students can do.

Hence we recommend that IB make this an active and ongoing research project in all PYP schools, with an on-site manager organizing this in each school, and a central coordinator with a research team collecting the data, evaluating it, and making recommendations of expected progressions in thinking by grade level. We suggest that at least two years be devoted to this project.

As was indicated in Sections 10 and 11, there is no firmly accepted set of expectations that can serve as the basis of a viable and reliable guidance and assessment programme with regard to growth in skill at thinking. If the changes we recommend are made in the instructional framework of the PYP with regard to the various aspects of thinking we have identified, we see the potential for the IB setting realistic standards for the development of thinking abilities not only in PYP schools, but in the broader community of schools that have committed themselves to teaching students to be good thinkers. That would certainly be viewed as a contribution by the community of teaching thinking scholars and practitioners.

Bibliography

Achieve (2015). *The role of learning progressions in competency-based pathways*. Downloaded http://www.achieve.org/files/Achieve-LearningProgressionsinCBP.pdf

Alexander, R. (2001). *Culture and pedagogy: International comparisons in Primary Education*. London: Wiley-Blackwell.

Anderson, L.W, & Krathwohl, D.R. (Eds.), (2001*). A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives*. New York: Addison Wesley Longman.

Assessment and Teaching of 2lst Century Skills – International project *http://www.atc21s.org*

Barron, B., & Darling-Hammond, L. (2010). Prospects and challenges for inquiry-based approaches to learning. In H. Dumont, D. Istance, & F. Benavides, (Eds.) (2010). *The nature of learning: Using research to inspire practice*, (pp 199- 216). Paris: OECD Publishing, Centre for Educational Research and Innovation.

Bellanca, J. (2015). *Deeper learning: Beyond 21lst century skills.* Bloomington, In: Solution Tree Press.

Bitter, C., Taylor, J., Zeiser, K.L., & Rickles, J. (2014). *Providing opportunities for deeper learning, (2nd report).* Washington: American Institute for Research.

Blatchford, P., Kutnick, P., Baines, E., & Galton, M. (2003). Toward a social pedagogy of classroom group work. *International Journal of Educational Research, 39* (1–2), 153-172.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain*. New York, NY: David McKay.

Bransford, J., Stevens, R., Schwartz, D., Meltzoff, A. N., Pea, R., Roschelle, J., Vye, N., Kuhl, P. K., Bell, P., Barron, B., Reeves, B., & Sabelli, N. (2006). Learning theories and education: Toward a decade of synergy. In P. Alexander & P. Winne (Eds.), *Handbook of Educational Psychology* (2nd ed., pp. 209-244). Mahwah, NJ: Erlbaum.

Brookhart, S. M. (2010). *How to assess higher-order thinking skills in your classroom*. Alexandria, VA: ASCD.

Calderhead, J. (1981). Stimulated recall: A method for research on teaching. *British Journal of Educational Psychology, 51*, 211-217.

Carr, M., & Claxton, G. (2002). Tracking the development of learning dispositions. *Assessment in Education: Principles, Policy & Practice, 9*(1), 9-37.

Chow, B. (2010). *The quest for deeper learning*. Education Week, Oct 6.

Cook, R., Weaving, H., & Gordon, J. (2012). Key competence development in school: education in Europe: KeyCoNet's review of the literature: a summary. *Brussels, Belgium: European Schoolnet. Estratto da http://keyconet. eun. org/c/document_library/get_file*

Costa, A.L., & Kallick, B. (2014). *Dispositions: Reframing teaching and learning*. Thousand Oaks, CA: Corwin.

de Bono, E. (1985). *Six hats thinking*. Boston, MA: Little, Brown and Co.

de Bono, E. (1986). *CoRT (Cognitive Research Trust) program.* Elmsford, NY: Pergamon Press, Inc.

de Corte, E. (2003). Transfer as the productive use of acquired knowledge, skills, and motivations. *Current Directions in Psychological Science*, 12(4), 142-146.

de Corte, E. (2011). Constructive, self-regulated, situated, and collaborative learning: An approach for the acquisition of adaptive competence. *Journal of Education*, 192(2/3), 33-47.

de Corte, E. (2010). Historical developments in the understanding of learning. In H. Dumont, D. Istance, & F. Benavides, (Eds.) (2010). *The nature of learning: Using research to inspire practice,* (pp. 35-60). Paris: OECD Publishing, Centre for Educational Research and Innovation.

de Corte, E., & Masui, C. (2007). The CLIA-model: A framework for designing powerful learning environments for thinking and problem solving. *European Journal of Psychology of Education*, XIX, 365-384.

Dewey, J. (1933). *How we think*. Boston, MA: D.C. Heath & Co.

Dumont, H., Istance, D., & Benavides, F. (2010). *The nature of learning: Using research to inspire practice*. Paris: OECD Publishing, Centre for Educational Research and Innovation.

Dumont, H., Istance, D., & Benavides, F. (2012). *The nature of learning: Using research to inspire practice – A Practitioner Guide*. Paris: OECD Publishing, Centre for Educational Research and Innovation. (Prepared by Jennifer Groff).

Duschl, R., Schweingruber, H.A., & Shouse, A. (2007). *Taking science to school: Learning and teaching in grades K-8.* Washington, DC: National Academy Press.

Duschl, R., Maeng, S., & Sezen, A. (2011). Learning progressions and teaching sequences: a review and analysis. *Studies in Science Education*, 47(2), 123-182.

Dweck, C. (2006). *Mindsets: How to fulfil your potential*. New York: Ballantine Books.

Ennis, R. H. (1962). A concept of critical thinking. *Harvard Educational Review, 32*(1), 81-111.

Ennis, R. H. (1987). A taxonomy of critical thinking dispositions and abilities. In J. Baron, & R. Sternberg (Eds.), *Teaching thinking skills: Theory and practice.* (pp. 9-26). New York: WH Freeman/Times Books/Henry Holt & Co.

Ennis, R. H. (1996). Critical thinking dispositions: Their nature and assessability. *Informal Logic, 18*(2).

Ennis, R. (2009). Critical thinking: A streamlined conception. *Teaching Philosophy, 14*(1), 5-24.

Erickson, H. Lynn (2002). *Concept-based curriculum and Instruction: Teaching beyond the facts.* Thousand Oaks, CA: Corwin Press.

Flavell, J.H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34(10), 906-911.

Fullan, M., & Langworthy, M. (2014). *A rich seam: How new pedagogies find deep Learning.* London: Pearson.

Gallagher, C., Hipkins, R., & Zohar, A. (2012). Positioning thinking within national curriculum and assessment systems: Perspectives from Israel, New Zealand and Northern Ireland. *Thinking Skills and Creativity, 7*(2), 134-143.

Goswami, U. (2015). *Children's cognitive development and learning*, (CPRT Survey 3). York: Cambridge Primary Review.

Hatano, G. (1990). The nature of everyday science: a brief introduction. *British Journal of Developmental Psychology,* 8, 245-250.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* London: Routledge.

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. London: Routledge.

Hermitage, M. (no date). *Learning progressions: Supporting instruction and formative assessment.* The Council of State School Officers, downloaded from https://www.cse.ucla.edu/products/misc/cse_heritage_learning.pdf

Hipkins, R., Bolstad, R. & Johnson, C. (2015). *Exploring new metrics for education 3.0.* Wellington: New Zealand Council for Educational Research.

Howe, C., & Abdin, M. (2013). Classroom dialogue: a systematic review across four decades of research. *Cambridge Journal of Education,* 43(3):325-356.

Huberman, M., Bitter, C., Anthony, J., & O'Day, J. (2014). *The shape of deeper learning: Strategies, structures and cultures in Deeper Learning Network High Schools, lst Report.* Washington, DC: American Institute for Research.

Hyerle, D. (2008). *Visual tools for transforming information into knowledge*. Thousand Oaks, CA: Corwin.

Greenstein, L. (2012). *Assessing 2lst century skills: A guide to evaluating mastery and authentic Learning.* London: Corwin (A Sage Company)

Johnson, D., & Johnson, R. (1994). *Learning together and alone, cooperative, competitive, and individualistic learning*. Needham Heights, MA: Prentice-Hall.

Joyce, B. & Showers, B. (1996). The evolution of peer coaching. *Educational Leadership*, 53(6), 12-16.

Katona, G. (1940). *Organizing and memorizing: Studies in the psychology of learning and teaching.* New York: Columbia University Press.

Kuhn, D. (2000). Metacognitive development. *Current Directions in Psychological Science, 9*(5), 178-181.

Lipman, M., Sharp, A. M., & Oscanyan, F. S. (1980). *Philosophy in the classroom*. Philadelphia, PA: Temple University Press.

Lucas, B., & Claxton, G. (2010). *New kinds of smart: How the science of learnable intelligence is changing education*. Maidenhead, UK: McGraw-Hill International.

Lucas, B., Glaxton, G., & Spencer, E. (2013). *Progression in student creativity in school: First steps towards new forms of formative assessments*. OECD Education Working Papers, No. 86, OECD Publishing.

Lyle, J. (2003). Stimulated recall: A report on its use in naturalistic research. *British Educational Research Journal, 29(6)*, 861-878.

Mayer, R.E. (2011). *Applying the science of learning*. London: Pearson.

Metz, K. (2009). Rethinking what is "developmentally appropriate" from a learning progression perspective: The power and the challenge. *Review of Science, Mathematics and ICT Education*, 3(1), 5-22.

McGuinness, C. (1993). Teaching thinking: New signs for theories of cognition. *Educational Psychology*, 13(3 & 4), 305-316.

McGuinness, C. (1999). *From Thinking Skills to Thinking Classrooms: A Review and Evaluation of Approaches to Developing Pupils' Thinking.* Norwich: HMSO. (DfEE Research Report No. 115).

McGuinness, C. (2005). Teaching thinking: Theory and practice. *British Journal of Educational Psychology*, Monograph Series II, 3, 107-127.

McGuinness, C., & Nisbet, J. (1991). Teaching thinking in Europe. *British Journal of Educational Psychology, 61*(2), 174-186.

Mercer, N., & Dawes, L. (2014). The study of talk between teachers and students, from the 1970s until the 2010s. *Oxford Review of Education*, 40 (4):430-445.

Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking: A sociocultural approach*. Abingdon, Oxon: Routledge.

National Research Council (2011a). *Assessing 21st century skills: Summary of a workshop.* J.A. Koenig, Rapporteur. Committee on the Assessment of 21st Century Skills. Board of Testing and Assessment, Division of Behavioural Sciences and Education. Washington, DC: The National Academies Press.

New Pedagogies for Deep Learning http://npdl.global/

OECD (2004*). Problem-solving for Tomorrow's World: First Measures of Cross-curricular Competences for PISA 2003*. Paris: OECD.

Palinscar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring. *Cognition and Instruction*, 1(2), 117-175.

Pellegrino, J.W., & Hilton, M.L. (Eds.) (2012). *Education for life and work: Developing transferable knowledge and skills for the 21st Century.* (Chapter 5 Perspectives on deeper learning) Washington, DC: National Academy Press.

Perkins, D. N., Jay, E., & Tishman, S. (1993). Beyond abilities: A dispositional theory of thinking. *Merrill-Palmer Quarterly, 39(1)*, 1-21.

Perkins, D. (1998). What is understanding? In Stone-Wiske, M. (Ed), *Teaching for understanding: Linking research with practice.* San Francisco, CA: Jossey-Bass.

Perkins, D.N. (2014). *FutureWise: Educating our children for a changing world.* San Francisco, CA: Jossey-Bass.

Perkins, D.N. (2009). Making learning whole: How seven principles of teaching can transform education. San Francisco, CA: Jossey-Bass.

Perkins, D., Tishman, S., Ritchhart, R., Donis, K., & Andrade, A. (2000). Intelligence in the wild: A dispositional view of intellectual traits. *Educational Psychology Review, 12*(3), 269-293.

Perkins, D. N., & Salomon, G. (2012). Knowledge to go: A motivational and dispositional view of transfer. *Educational Psychologist, 47*(3), 248-258.

Ritchhart, R., Church, M., & Morrison, K. (2011). *Making thinking visible: How to promote engagement, understanding, and independence for all Learners*. San Francisco, CA: Wiley.

Rychen, D. S., & Salganik, L. H. (2003). *Final report: Key competencies for a successful life and a well-functioning society.* Göttingen, Germany: Hogrefe and Huber.

Soland, J. et al., (2013). Measuring 21st century competences: Guidance for educators. Rand and The Asia Society. Available at http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjN2sulvaXOAhWmL8AKHXDiC_YQFggcMAA&url=http%3A%2F%2Fasiasociety.org%2Ffiles%2Frand-1012report.pdf&usg=AFQjCNEwMHXe_734_qp6MFHJSkM2pmoiLw&sig2=F6F8fce-JTiOD5aLFROjNQ&bvm=bv.128617741,d.bGg

Swartz, R., & Perkins, D. (1989). *Teaching Thinking: Issues and Approaches*. Pacific Grove, CA: Midwest Publications.

Swartz, R.J., & Parks, D. (1994). *Infusing the Teaching of Critical and Creative Thinking in Elementary Instruction.* Pacific Grove, CA: Critical Thinking Books & Software.

Swartz, R.J., Fischer, S.D., & Parks, S. (1998). *Infusing the Teaching of Critical and Creative Thinking into Secondary Science.* Pacific Grove, CA: Critical Thinking Books & Software.

Swartz, R.J., Larissey, J., & Kiser, M. A. (2000a). *Teaching Critical and Creative Thinking in Language Arts*. Grade 1 & 2. Pacific Grove, CA: Critical Thinking Books & Software.

Swartz, R.J., Whipple, T., BLaisdell, G., & Kiser, M. A. (2000b). *Teaching Critical and Creative Thinking in Language Arts*. Grade 3 & 4. Pacific Grove, CA: Critical Thinking Books & Software.

Swartz, R., Kiser, M. A., & Reagan, R. (2000c). *Teaching Critical and Creative Thinking in Language Arts.* Grade 5 & 6. Pacific Grove, CA: Critical Thinking Books & Software.

Swartz, R. J., Costa, A., Kallick, B., Beyer, B., & Reagan, R. (2007). *Thinking-based Learning: Activating Students' Potential*. Norwood, MA: Christopher-Gordon Publishers.

Swartz, R. & McGuinness, C. (2014a). *Developing and Assessing Thinking Skills: The International Baccalaureate Project. Final Report Part 1: Literature Review and Evaluation Framework*. The Hague: International Baccalaureate Organisation.

Swartz, R. & McGuinness, C. (2014b). *Developing and Assessing Thinking Skills: The International Baccalaureate Project. Final Report Part 2: Evaluation of the Current IB Programmes*. The Hague: International Baccalaureate Organisation.

Tishman, S., Jay, E., & Perkins, D. N. (1993). Teaching thinking dispositions: From transmission to enculturation. *Theory into Practice, 32*(3), 147-153.

Tishman, S., Perkins, D., & Jay, E. (1995). *The thinking classroom: Learning and teaching in a culture of thinking.* Boston, MA: Allyn & Bacon.

Trickey, S., & Topping, K. J. (2004). Philosophy for children: A systematic review. *Research Papers in Education, 19*(3), 365-380.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press. (translated and abridged edition).

Wegerif, R. (2011). Towards a dialogic theory of how children learn to think. *Thinking Skills and Creativity, 6*(3), 179-190.

Vosniadou, S. (2001). *How children learn*. International Academy of Education. Available at http://www.ibe.unesco.org/

Yin, R.K. (2014). *Case study research: Design and methods*. (Fifth Edition). Thousand Oaks, CA: Sage Publications.

Appendices

Appendix A Integrated Framework from Previous IB Reports

An Integrated Research and Practice Informed Framework for Developing and Assessing Thinking Skills and Related Constructs				
Thinking Objectives	**Teaching**		**Assessment**	
	Principles	**Practices**	**Principles**	**Practices**
Thinking Skills Metacognitive Thinking Thinking Dispositions	Make thinking organisers explicit Advance deep thinking challenges Engage students in collaborative thinking to ensure joint meaning making, interaction, and dialogue Prompt students to adopt a strong metacognitive perspective Teach for transfer of the skillful thinking being learned Cultivate thinking dispositions and habit and minds Generalise the approach from thinking classrooms across all grades in the school	Teach explicit thinking organisers/strategies in the classroom, graphic organisers, thinking routines Give students something challenging to think about, more than routine tasks Prompt the students to make the thinking that results from their use visible and public Use collaborative groups, arrange the classroom to facilitate interaction, develop a thinking language, support sustained dialogue about thinking Teach students explicit strategies to plan, monitor and evaluate their thinking skills and thinking dispositions. Give time to do this Explicitly teaching to facilitate the transfer of learned thinking procedures to other curricular and non-curricular contexts Create classroom norms and expectations about thoughtfulness and the habitual use of thinking strategies Prioritise teachers' professional development and teachers' planning time	Align teaching and assessment practices with thinking objectives in the classroom. Be specific about the performance criteria and standards expected for the use of same Thinking Skills Metacognition Thinking Dispositions Adopt assessment for learning principles	Prompt student performances that display the use of thinking skills, habits of mind, and the efficacy of thinking dispositions. Design assessment rubrics and ratings that incorporate Specific criteria Appropriate standards Next steps Growth patterns Share the criteria and standards with students Give feedback and identify next steps Use self and peer assessment to communicate and share standards, promote assessment literacy re thinking objectives

Appendix B Ethics documents for schools and consent forms

PYP Thinking Skills Project
Funded by the IB

c/o School of Psychology
Queens University Belfast
Belfast
BT9 5BN
Northern Ireland
October 13, 2016
Contact email: l.sproule@qub.ac.uk

Dear Principal

Case Studies of PYP classroom practices to develop children's thinking

We are a research team who has been commissioned by the International Baccalaureate (IB) to explore how their Primary Years Programme (PYP) schools use the transdisciplinary framework and the PYP inquiries to help the students develop their skills in thinking and learning. The research will consist of nine case studies of PYP schools from around the world. We are inviting your school to participate as one of those case studies. The findings from the project are intended to contribute to the on-going IB review of the PYP.

Case studies are being drawn from PYP schools that teach through the medium of English, that are located in different parts of the world, that are funded differently (public schools vs privately funded schools) and whose teachers have had various length of experience teaching the PYP. Within those categories, your school has been randomly selected to be invited to take part.

The study will conform to the highest ethical standards with regard to anonymity, informed consent and data protection, as explained in the attached document (ethics and ethical oversight). You are free to refuse the invitation, or to withdraw if you begin and then change your mind, without suffering any adverse consequences.

What is the project about?

Essentially we want to find out about the different ways that PYP schools approach the development of children's thinking skills, how they use the transdisciplinary framework to plan the PYP enquires, how teachers organise their classroom practices, and how they assess the learning outcomes related to thinking. Each case study will be based on interviews with two or three teachers discussing these themes online with a member of the research team (using Skype, or similar software), as well as reflecting on a video of a lesson they have taught related to an inquiry. More details may be found in the Next Steps document attached.

Members of the research team have considerable experience both as educational researchers and as teacher developers on pedagogy and thinking skills and we have conducted previous research for the

IB on these topics[2]. Based on our previous experience, we expect that the school and the teachers will benefit from engaging in professional dialogue with the research team about their teaching, even though it is confined to on-line discussions. Unfortunately, time constraints and the level of funding for the project do not permit us to visit each of the case study schools in person.

Feedback and reporting

You will receive a summary of the research findings and we will be glad to answer any further questions you may have.

Signaling your interest in participation

If you and your staff are interested in participating, please return the expression-of-interest form below to Dr Liz Sproule, who will be the main contact person for the project. If you have any questions to ask or want further clarifications before deciding, please do not hesitate to contact Liz at the email address.

We very much hope that your school will participate and look forward to working with you on this project.

Yours sincerely



Dr Robert Swartz
Director: Centre for Teaching Thinking, USA

Professor Carol McGuinness
School of Education
Queen's University Belfast

Dr Liz Sproule
Visiting Research Fellow,
School of Psychology,
Queen's University Belfast
(Project coordinator and First point of contact)

Expression-of-interest form

I AM interested in _____ school participating in the IB Thinking Skills Study.

I am NOT interested in _____ school participating in the IB Thinking Skills Study.

Signed _____ (principal)

Please forward to l.sproule@qub.ac.uk

[2] http://www.ibo.org/globalassets/publications/ib-research/continuum/student-thinking-skills-report-part-1.pdf
http://www.ibo.org/globalassets/publications/ib-research/continuum/student-thinking-skills-report-part-2.pdf

Next steps in the PYP Thinking Skills Project: Procedure for the case study

If you decide that your school is interested in participating, then the next step is to give your formal written permission by completing and returning the consent form we will send on receipt of your expression of interest in the project. It is important that you read the ethics document carefully before you do so.

Then we will ask you for the contact details for the person who has the main responsibility for curriculum coordination, the PYP coordinator, and 2/3 teachers who have expressed interest — one who teaches a lower primary class, one who teaches an upper primary class, and, if your school enrolls early years children (3-5 year olds), then we would like to contact one of those teachers as well. These members of staff must consent freely with no expectation of adverse consequences if they do not wish to take part. Once you have their verbal agreement, and we have their contact details, we will send them written information and a consent form.

All our interactions with members of your staff will be completed on-line, either through Skype (or some other web-conferencing software) or by email.

For the teachers, we will be asking them about their general approach to developing children's learning and thinking and to send us at least one example of their inquiry plans. We will also be asking them to video one of their lessons related to an ongoing PYP inquiry (about 30-40 minutes video will be sufficient) and send it to us. After we and the teacher have had a few days to become familiar with the video, a member of the research team will jointly view it on- line with the teacher as the basis for discussion of how the teacher planned the lesson, why it was planned that way, whether it worked in the way she intended and so on. This interview will then be transcribed so that we may further analyze the teacher's responses.

In order to complete the video, each teacher will need to obtain written consent from the children's parents or guardians and, in the case of the children 7 years of age and over, the written assent of the children themselves. Children under seven years can give verbal consent after the teacher explains what is going to happen.

When we receive the each teacher's own consent form, we will then forward to him/her the information letters with consent forms for parents, guardians, and children. If the parents' or guardians' first language is not English, teachers may be able to interpret the study for them. Also, we will provide a 'script' for the teachers to explain to children what the purpose of the video is and to put them at their ease. Anonymity, data protection and ethical oversight are explained in the attached ethics document.

We recognise that asking teachers to video their own classes can be stressful but we want to emphasise that the purpose of the video is to provide a concrete situation to stimulate discussion with the research team about teaching practices, classroom organisation and teacher/student interactions. From a research point of view it is much more productive to have a specific example of a lesson as a basis for a discussion about pedagogy, rather than just to talk about it in general terms. The teachers' professional insights will make an important contribution to the study.

It should be emphasised again that the video will be viewed only by the teacher and members of the research team. It will not be available to anyone else, not even to yourself as school principal, unless the teacher wishes to share it. It will be destroyed at the end of the research project.

In order to provide some information about the assessment aspect of the project, we will ask teachers to give us some anonymised examples of their students' work and a short commentary explaining how they assess it (only for those children who complete written work).

Overall, we estimate that we are asking for 4-5 hours of each teacher's time — making the video, plus preparation for interview (1.5 - 2 hours); online interview (1 hour), general preparation, plus consent forms (1 hour).

We will need only 1 hour interview with the PYP curriculum coordinator.

Finally, we will need to collect information about your school, numbers enrolled, background of students (including language background), number of teachers, their qualifications and length of experience, staff-student ratio and so on. We will do this via survey questionnaire and we hope that this kind of information will be readily available within the school and therefore will not require too much time to complete.

PYP Thinking Skills Project Case Studies: School Principal consent form

I have read the attached Next Steps (procedure) and ethics documents which explain the research about International Baccalaureate PYP case studies.

I understand that the letter is asking me to give my consent to (please print name of school) _____ school taking part in the study.

I understand that the school's PYP coordinator will be interviewed by the research team online about their role and their work.

I understand that two or three teachers will be asked to record one of their lessons and discuss it with the research team online and that they will be asked to comment on assessment of two students' work.

I understand that the information collected for the case studies will be kept securely by the research team during the course of the project and then destroyed at the end of the project.

I understand that teachers are being asked to destroy their copies of the video lesson so that they are not used for purposes other than for this research project.

I understand that participation is voluntary and that I, as principal, am free to withdraw my consent to the school taking part at any time.

I understand that this research will be published in a report but that no names of people or schools will appear in it.

I undertake to facilitate the procedures detailed in the procedure document for gaining consent from parents, guardians, and children and to ensure that the videos are destroyed at the end of the study.

Please tick one of the following boxes to indicate whether or not you give permission for the research.

☐ I AGREE to give permission for the above research

☐ I DO NOT AGREE to give permission for the above research

Signature: _____ Date:_____

Please print surname_____

PYP coordinator and teacher email contact details

PYP Coordinator (who may also be one of the teachers) _____

Teacher 1 _____
Teacher 2 _____
Teacher 3 (early years teacher if applicable) _____

IB Thinking Skills Project PYP case studies: PYP coordinator consent form

I have read the attached Next Steps (procedure) and ethics documents which explain the research about International Baccalaureate PYP case studies.

I understand that the letter is asking me to participate in an online interview.

I understand that the information collected for the case studies will be kept securely by the research team during the course of the project and then destroyed at the end of the project.

I understand that participation is voluntary and that I am free to withdraw my consent.

I understand that this research will be published in a report but that no names of people or schools will appear in it.

I undertake to facilitate the procedures detailed in the procedure document for gaining consent from parents and children.

Please tick one of the following boxes to indicate whether or not you agree to taking part.

☐ I AGREE to take part in the above research

☐ I DO NOT AGREE to take part in the above research

Signature: _____ Date:_____

Please print surname_____

We need to know the following information for practical reasons related to our discussions

What time of day is convenient for you to take part in the discussion? (It need not be during the school day)?_____

Do you know how many hours you are behind or in front of Greenwich Mean Time? ____ hours in front/behind.

IB Thinking Skills Project PYP case studies: Teacher consent form

I have read the attached Next Steps (procedure) and ethics documents which explain the research about International Baccalaureate PYP case studies.

I understand that the letter is asking me to participate in an online interview.

I understand that the letter is asking me to video record one of my lessons and discuss it with the research team online.

I understand that I will be asked to comment on assessment of two students' work.

I understand that the information collected for the case studies will be kept securely by the research team during the course of the project and then destroyed by them at the end of the project.

I understand that participation is voluntary and that I am free to withdraw my consent.

I understand that this research will be published in a report but that no names of people or schools will appear in it.

I undertake to follow the procedures detailed in the ethics and procedure documents for gaining consent from parents and children and to destroy the videos at the conclusion of the study.

Please tick one of the following boxes to indicate whether or not you agree to taking part.

☐ I AGREE to take part in the above research

☐ I DO NOT AGREE to take part in the above research

Signature: _____ Date:_____

Please print surname_____

We need to know the following information for practical reasons related to our discussions

Do you have good IT support or alternatively, do you feel confident using IT? (If not, we will help)

_____

What time of day is convenient for you to take part in the discussion? (It need not be during the school day)?_____

Do you know how many hours you are behind or in front of Greenwich Mean Time? _____ hours in front/behind.

What is the nature of the inquiry you will be video recording?

_____

_____

Information Leaflet for Parents: IB Thinking Skills Project case studies

We are approaching you to ask permission for your child to participate in an educational research study as described below. Before you decide, we would like you to understand why this research is being done and how it will involve your child.

Please read this sheet carefully. If you have any questions, there are contact details at the end of this sheet. Talk to other parents, the teachers in the school or the school principal about the study if you wish.

What is the purpose of the study?

The purpose of the study is to see how PYP schools and teachers across the world help their students to develop skills in learning and thinking, which are important elements of the Primary Years Programme in the school which your child attends.

Why was my child's school selected?

Nine case study schools from those who follow the IB's Primary Years Programme were selected. Schools had to meet certain criteria – to be from different geographical areas (as defined by the IB), to teach through the medium of English, to be either privately or publicly funded, and to have different years of experience running the PYP in their schools. When those criteria were filled, then schools were randomly selected.

What is involved in the research?

Each case study will be based on interviews with up to four teachers from the school, discussing themes related to planning, teaching, and assessing how students develop learning and thinking skills. The interviews will be conducted online via Skype with a member of the research team. For those interviews, the teachers will be asked to video one of their lessons and to send it to the research team as the basis for discussion. They will also be asked about their assessment practices, by commenting on a few anonymized examples of their students' work.

General information about the background of students in the schools, the qualifications and experience of the teachers will also be collected.

Why have I been approached?

You have been approached because your child is in one of the classes that will be videoed. The video will consist of a normal lesson as part of one of the PYP inquiries or projects. No additional or new teaching activity will be introduced. The purpose of the video is to get an overall impression of the class as the basis for the interview with the teacher. It will not focus on any individual child.

Does my child have to take part?

Your child's participation and your agreement is completely voluntary, with no adverse consequences for either of you if you refuse to participate. Also, even if you agree, each child will be asked individually if they wish participate. If, at any point, your child wishes to withdraw from the video element of the study, then they can do so without giving a reason.

What about data protection?

Videos will be encrypted and securely forwarded to the research team. They will be destroyed at the end of the study. They will not be used for reasons other than as the basis for discussion during the teacher interviews.

What are the possible disadvantages and risks of taking part?

The research does not involve any new or additional teaching activity beyond what the children will be experiencing regularly in their classrooms. There is a slight risk of children being uncomfortable with being videoed. They will be reassured that they can withdraw from this at any time without giving a reason. Teachers will be particularly alert to this possibility and will accommodate any child who does not wish to continue.

What are the possible benefits?

The main benefit is that findings from the research will contribute to the ongoing development and improvement of the PYP in all IB schools. Specifically, the teachers in your child's school will have an opportunity to engage and benefit from professional dialogue about teaching and learning in the PYP context.

Will taking part be confidential?

Case study schools will be anonymized in any subsequent reports and publications, and all efforts will be made to disguise any characteristics that might make the schools recognizable. In particular, although the research is funded by IB, the research team works independently and the IB will receive only the anonymized reports and will not know the identity of the case study schools.

Specifically, only the research team and the relevant teacher in the school will view the video lesson. It will not be viewed by other members of the school.

Who is organising and funding the research?

The research is commissioned and funded be the International Baccalaureate Organisation. The research team consists of a group of experienced educational researchers and professional developers: Emeritus Professor Robert Swartz, Director, Centre for Teaching Thinking, Boston, USA; Professor Carol McGuinness and Dr Liz Sproule from Queen's University Belfast, Northern Ireland. This team have completed previous work on development and assessing thinking skills for the IB.

Who has reviewed the research?

The research proposal has been ethically reviewed and approved by an organization, Chesapeake IRB, who provides such services for multi-center United States projects, and thus it conforms to the highest ethical standards. If you wish to reassure yourself, you may examine Chesapeake IRB[3] at the link in the footnote.

How do I signal whether I agree or disagree?

Please fill in the attached consent form and return it to your child's class teacher as soon as possible. If you do not wish your child to take part, you are free to refuse.

Further Information and Contact details: If the teacher cannot answer any questions you might have, you may email Dr Liz Sproule at L.Sproule@qub.ac.uk.

[3] Chesapeake IRB website link:
https://www.cirbi.net/CIRBI/Rooms/DisplayPages/LayoutInitial?Container=com.webridge.entity.Entity%5BOID%5BAC482809EC03C442A46F2C8EEC4D75D3%5D%5D

IB Thinking Skills Project PYP case studies: Parent consent form

I have read the Information Leaflet which explains the research about International Baccalaureate PYP case studies.

I understand that I am being asked to allow my child to be video-recorded during one of his or her normal lessons.

I understand that I am being asked to allow that video to be shared with the research team for the purposes of an online discussion with the teacher about teaching and learning.

I understand that the letter is asking me to allow a copy of my child's school work, with the child's name removed, to be shared with the research team as an example of teacher assessment, if my child's work is selected by the teacher for that purpose.

I understand that the information collected for the case studies will be kept securely by the research team during the course of the project and then destroyed at the end of the project.

I understand that this research will be published in a report but that no names of people or schools will appear in that report.

I understand that participation is voluntary and that I am free to withdraw my consent at any time.

I understand that my child must also give consent and is free to refuse even if I have consented.

Please tick **one** of the following boxes to indicate whether or not you agree to your child taking part.

☐ I AGREE to take part in the above research

☐ I DO NOT AGREE to take part in the above research

Signature: _____ Date:_____

Please print your surname_____

Please print the name of your child _____

Information and consent form for the children

Teaching students how to learn and think well

Would you like to be part of this project?

Hi there,

Bob, Carol and I are a research team who have been asked by the International Baccalaureate Organisation (that's the organisation that approves what you learn in your school) to find out what happens in your classes when you are learning to improve your skills, to think and to be better at learning. We are writing to you to invite you to be part of the project.

What is the project about?

Your teacher has agreed to talk to us about how she plans your lessons and teaches you in your classes. To help us discuss these things in more detail, she has agreed to video one of your lessons and to send it to us, so that we can talk about what she does in more detail. Our team will look at the video with your teacher so that she can explain to us how your class works. She has also agreed to show us some of the class work that you do in your class. In order to this, you need to agree to allow us to video you in your class, and to look at your work. We are also asking your parents or guardians for their agreement. So you cannot take part unless your parents or guardians agree as well. However, you do have a say and this is what this letter is asking you about.

Why was your school selected?

We have chosen NINE schools across the world who are part of the IB family of schools. In order to give every school a fair chance to be included, we put the names into a hat and picked them out at random. Well, before that we decided that we could only work with schools who taught through English. Then we had to make sure that sufficient numbers of schools from different parts of the world were included, and that schools with students from different backgrounds were also included. Your school came up as one that met all these different requirements. That is why we have asked your school to work with us in the research project.

Do you have to agree to take part?

You are completely free to choose whether you agree to take part or not. If you decide not to take part, nothing nasty will happen to you. Also, even if you do decide to be take part in the video now, if you are not too keen on the day of the video, you can also say that you don't want to do it.

What will happen if you do agree to take part?

Your teacher will video one or two lessons in your classroom. These lessons are just part of your ordinary school work. You will not be asked to do any kind of new work for the project. The teacher will show you the camera and answer any questions you have. He or she will check if it is alright to video you, as part of thewhole class. The teacher is not allowed to video you if you have not agreed and, even if you did previously agree, you can say that now you don't really want to.

As we cannot visit all the schools around the world, your teacher will send us the video and we will look at it online with your teacher to discuss the details. For example, we will ask your teacher what she/he wanted you to learn and how the lesson worked.

We will also ask your teacher to send us some examples of the classroom work the students write for the teacher. We only want to see the work of a small number of students, not for all the students in the class. When we look at these, your name will have been removed so we won't know whose work it is. Nobody else in the class will know either because the teacher will not show it to them.

Who else will see the video?

Only your teacher and the research team (that's Bob, Carol and Liz) will see the video. No other teachers in your school will see it. We will discuss it only with your teacher when we talk to her/him online. At the end of the project, the video will be destroyed.

Who else will see my classwork?

Only the research team will see the examples of your work from the class. Even then, we will not know whose work we are looking at, as your name will have been removed.

Will other people know what schools were involved?

Nobody outside of the research team will know the names of the schools who have helped us with this project, nor the names of any of teachers who have helped us with the video lessons. Even the International Baccalaureate, who has given us the money to do this project, will not know which the schools who have helped us. When doing research it is very important that the research team keep these names private.

Who will hear about what the project finds out?

Bob, Carol and Liz will write a report for the IB and a summary will be sent to your teachers and your school. The findings will help to improve the way all PYP schools and teachers help students with their learning. Our report will be put on the IB website so that all schools can see what we have said.

Who has given us permission to do this research?

As a research team, Bob, Carol and I cannot just ask schools to take part in a project without first checking that all our procedures follow the rules. Before starting this project, we had to present our plans to a group of experts so that they can approve that what we are asking schools, teachers and students in the school to do does not harm them in any way and that their privacy is protected. We are very happy to say that our study has been approved and that it follows the rules.

How can I let you know where I agree or not?

Your principal and your teacher have already agreed that we can do this work with your class. We would not be allowed to write this letter to you if they had not agreed.

Your parents are also being asked if they will allow it. You cannot take part if they don't allow it.

If you are older than seven, you have to write and tell us if you allow us to video you or not. You will also be asked whether or not we can see an example of your schools work. To do this, you must fill in the form below. You **can say no** and nobody will be annoyed if you refuse. If you are younger than seven, you must tell your teacher whether it is OK to video you or that it's not OK but you do not have to put it in writing.

To tell us you do or don't consent

Please fill in the form below by

- ticking the first box if you agree with each sentence, and
- ticking the second box if you don't agree with one or more of the sentences.

Remember, you are free to refuse, even if your parents have agreed.

If you want to know more about the study or you need help to understand the letter, please ask your teacher first. If the teacher does not know the answer, he or she will email me to find out what you want to know.

Thank you for taking the time to read this letter. Bob, Carol and I will be pleased to work with your class if you agree.

Best wishes

Liz

Student consent form

I have read the student letter above which explains what the research study is about.

I understand that the letter above is asking me to take part in a lesson that will be video recorded.

I understand that the letter above is asking for examples of my classwork to be shown to the research team .

I understand that the video lessons and the examples of my classwork will be seen only by the research team (Bob, Carol and Liz) and by my teacher.

I understand that I do not have to take part if I don't want to and that I can change my mind.

I understand that the lesson videos will be destroyed at the end of the project to protect my privacy

I understand that this research will be published in a report but that no names of people or schools will appear in it.

Please tick the following box to indicate whether or not you agree to taking part.

☐ I AGREE to take part in the above research

☐ I DO NOT AGREE to take part in the above research

Signature: _____ Date:_____

(Print Name)

Appendix C Survey Questionnaires

IB Thinking Skills Project PYP case studies: School Principal questionnaire

School name: _____

School country: _____

Size of school

1. Number and gender of students enrolled in your school: _____male _____female

2. Number and gender of teachers employed in your school: _____male _____female

3. Number of staff other than teachers employed in your school?_____ teaching support and _____other staff

Curriculum arrangements in the school

4. What IB curriculum programmes does the school follow? Please circle as appropriate.

PYP MYP IB Diploma

5. For the PYP, does the school follow a national or local country curriculum for the discipline-based parts of the curriculum?

or

6. Does the school follow the IB recommended scope and sequence for the discipline-based parts of the curriculum?

7. For how many years has the School taught the PYP?_____

8. Does your school teach early years children, aged 3-5 years? _Yes No (circle as appropriate)

9. Does your School follow the PYP early years programme? __ Yes No (circle as appropriate)

10. Any other information about the curriculum arrangements that is important for the school?

General background characteristics of the students who attend your School

11. What are the nationalities or cultural background of the students in the school?

_____

12. What is main social and economic background of the students in the school?

_____

13. What are the main mother tongues of the students in the school?

_____

14. Any other information about the characteristics of your students that you consider to be relevant to this project?

_____

Current Curriculum Priorities

15. Within the context of the PYP, is the school pursuing any specific curriculum and/or assessment priorities right now? If so, please explain

16. To what extent has the school got a specific interest in teaching thinking skills as part of the PYP transdisciplinary framework? Please explain.

17. Does the school follow a particular approach to teaching thinking (e.g., Visible Routines, Thinking-based learning, Philosophy for Children, Multiple Intelligences, or any other approach). If so, please explain

IB Thinking Skills Project PYP case studies: PYP coordinator questionnaire

This short questionnaire is to give us some contextual information about you and your students.

1. Gender_____ Male/ Female (delete as appropriate)
2. What are your teaching qualifications?_____
3. How many years have you been teaching?_____
4. How many years have you been teaching the PYP?_____
5. How many years have you been coordinator for the PYP?_____
6. How many years have you worked in this school?_____
7. What is the extent of your professional development related to the PYP
    a. Within the School (e.g. in-house training, mentoring)?

    b. Outside school? (e.g. local workshops, online learning, conferences)

8. Do you have a specific interest in teaching thinking skills? If yes, please tell us as much as you can about it.

9. Any other information about your professional development that you think is important for your role as PYP coordinator?

10. For the PYP, does the school follow a national or local country curriculum for the discipline-based parts of the curriculum?

11. How does that national curriculum mesh with the transdisciplinary framework? Are there any specific issues that arise in this context?

12. Does the school follow the IB recommended scope and sequence for the discipline-based parts of the curriculum?

13. Does your School follow the PYP early years programme for under sixes? ___Yes No (circle as appropriate
14. How does the PYP early years programme mesh with any national guidelines for this age group?

15. Any other information about the curriculum arrangements that is important for the school?

IB Thinking Skills Project PYP case studies: Classroom teacher questionnaire

This short questionnaire is to give us some contextual information about you and your students. We are looking at a range of experience, so don't worry if you are relatively inexperienced.

About you

1. Gender: _____ Male Female (delete as appropriate)
2. What are your teaching qualifications?_____
3. How many years have you been teaching?_____
4. How many years have you been teaching the PYP?_____
5. How many years have you worked in this school?_____
6. What is the extent of professional development related to the PYP
   a. Within the School (e.g. in-house training, mentoring)?_____
   b. Outside school (e.g. local workshops, online learning, conferences)_____
7. Do you have a specific interest in teaching thinking skills? Please tell us as much as you can about it.
8. Any other information about your professional development that you think is important for your teaching?

About the students in the class you will video

9. Number of children in your class_____
10. Ages_____
11. Gender_____male_____female
12. Main national or cultural background_____
13. Main social and economic background_____
14. Mother tongue_____
15. Are there any children with special needs?_____
16. Is there any other information you think might be relevant?

Appendix D Interview Protocols

Research Question Focus	Domain of the Question	Indicative Questions for PYP Co-ordinators	Indicative Questions for Classroom Teachers
Relationship between thinking and learning Articulating thinking as an objective Hooks and devices for linking positioning thinking in the PYP transdisciplinary framework	General	What is involved in being a PYP co-ordinator? What are your main tasks throughout the year? What are your general views about how thinking develops in the PYP curriculum?	
	Planning	How does the transdisciplinary skills framework get linked into planning the inquiries? More specifically, how do thinking skills get linked in? How is it organised with the classroom teachers? In your view, what are the main issues that emerge when linking thinking skills into the inquiries?	How do you go about planning a specific inquiry What about links to the thinking skills framework? How does that work?

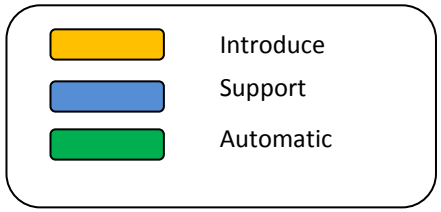
Promoting thinking and deep learning in the classroom	Teaching and classroom practices	In your role as PYP co-ordinator, to what extent, if any, do you have input into the instructional techniques that individual teachers adopt in their classrooms? Does the school follow any specific approaches for teaching thinking….? In your view what are the main challenges involved when developing children's thinking?	Do you adopt any specific approach to the development of thinking? What other teaching methods do you normally use to provoke your children's thinking? What kind of responses are you looking for from the children? What kinds of thinking do your students find challenging? (These questions were customised to the specifics of the teacher's video lesson)
Thinking progression and assessment	Progression	Does your school have expectations about how the students' thinking should develop over time? For example, in lower primary classes vs upper primary classes? Explain…… Or across different inquiries in the same year? Explain……	What kinds of responses do you expect from the children in your classroom that would reassure you that they thinking well – or at least beginning to improve ……..?

		In your view, what are the main issues related to identifying progression in learning and thinking skills?	
	Assessment	Does the school have an approach to the assessment of the PYP transdisciplinary skills? Specifically, how do you approach the assessment of the thinking skills elements? Additional questions about feedback and use of rubrics. In your view, what are the main issues related to the assessment of thinking skills?	When it comes to any written work that they do, would you include any indicators of their thinking in your assessment or in your feedback to them? Any examples of rubrics that you would use?
Thinking and deep learning (and followed up through additional emails)	Concluding the interview (*For the interviewer, ask the interviewee to forward any examples of written guidance or materials that were referred to during the interview, and that might be significant*)	The term 'deep learning' has been used several times across the interviews. What is your interpretation of the meaning of deep learning? From your perspective, how does the use of thinking skills enhance or promote deep learning?	How do you know that what you are doing helps deepen to children's learning?

Additional open questions		What additional guidance or support in relation to PYP thinking skills would you find useful in your role as PYP co-ordinator? Is there anything else you would like to say about the development of children's thinking and the PYP, or any additional comment you would like to make on the topics we have discussed so far? Thank you for your help.	Finally, is there anything else you would like to say about how children's thinking develops within the PYP inquiry framework?

Appendix E Example of an Age-Related Progress Map from Lotus School

VISIBLE THINKING – SCOPE AND SEQUENCE 2016



PRE KINDER		KINDER		1st grade		2nd grade		3rd grade		4th grade		5th grade	
See- Think - Wonder	-Observations -thoughtful interpretations	**See- Think Wonder**	Observations -thoughtful interpretations	**See- Think Wonder**	Observations -thoughtful interpretations	**See- Think Wonder**	Observations -thoughtful interpretations	**See- Think Wonder**	-Observations -thoughtful interpretations	**See- Think Wonder**	Observations -thoughtful interpretations	**See- Think Wonder**	-Observations -thoughtful interpretations
What makes you say that	-Build explanations. -promotes evidential reasoning	**What makes you say that**	-Build explanations. -promotes evidential reasoning	**What makes you say that**	-Build explanations. -promotes evidential reasoning	**What makes you say that**	-Build explanations. -promotes evidential reasoning	**What makes you say that**	-Build explanations. -promotes evidential reasoning	**What makes you say that**	-Build explanations. -promotes evidential reasoning	**What makes you say that**	-Build explanations. -promotes evidential reasoning
Think Pair Share	Understanding through active reasoning and explanation	**Think Pair Share**	Understanding through active reasoning and explanation	**Think-pair-share**	understanding through active reasoning and explanation	**Think-pair-share**	Understanding through active reasoning and explanation	**Think/Hear Pair- Share**	Understanding through active reasoning and explanation	**Think/ Hear Pair- Share**	Understanding through active reasoning and explanation	**Think/ Hear Pair- Share**	Understanding through active reasoning and explanation
PRE KINDER		**KINDER**		**1st grade**		**2nd grade**		**3rd grade**		**4th grade**		**5th grade**	
Headline	Summarizing and consolidating	**Headlines**	Summarizing and consolidating	**Headlines**	Summarizing and consolidating	**Headlines**	Summarizing and con solidating	**Headlines**	Summarizing and consolidating	**Headlines**	Summarizing and consolidating	**Headlines**	Summarizing and consolidating

	ideas, events, and experiences.		ideas, events, and experiences.		ideas, events, and experiences.		ideas, events, and experiences.		ideas, events, and experiences.		ideas, events, and experiences.		ideas, events, and experiences.
Zoom in	-Describe Uncovering and making connections -infer -Interpret	**Zoom in**	-Describe -Uncovering and making connections -infer Interpret	**Zoom in**	-Describe -Uncovering and making connections -infer Interpret	**Zoom in**	-Describe -Uncovering and making connections -infer Interpret	**Zoom in**	-Describe -Uncovering and making connections -infer Interpret	**Zoom in**	-Describe -Uncovering and making connections -infer Interpret	**Zoom in**	-Describe Uncovering and making connections -infer -Interpret
Thinking Keys	Looking at things from different perspectives	**Thinking Keys**	Looking at things from different perspectives	**Thinking Keys**	Looking at things from different perspectives	**Thinking Keys**	Looking at things from different perspectives						
		Step Inside	Explore different perspectives and viewpoints	**Step Inside**	Explore different perspectives and viewpoints	**Step Inside**	Explore different perspectives and viewpoints	**Step Inside**	Explore different perspectives and viewpoints	**Step Inside**	Explore different perspectives and viewpoints	**Step Inside**	Explore different perspectives and viewpoints
Beginning Middle End	Observing and Imagining	**Beginning MiddleEnd**	Observing and Imagining	**Beginning Middle End**	Observing and Imagining	**Beginning Middle End**	Observing and Imagining	**I use to think…but now I think**	-Reflect on their thinking -explore how and why that thinking has changed. -reasoning abilities and recognizing cause and effect relationships.	**I use to think…but now I think**	-Reflect on their thinking -explore how and why that thinking has changed. -reasoning abilities and recognizing cause and effect relationships.	**I use to think…but now I think**	-Reflect on their thinking -explore how and why that thinking has changed. -reasoning abilities and recognizing cause and effect relationships.
PRE KINDER		**KINDER**		**1st grade**		**2nd grade**		**3rd grade**		**4th grade**		**5th grade**	
		Colour, Symbol, Image CSI	-Identify the essence of ideas	**Colour, Symbol, Image CSI**	-Identify the essence of ideas	**Colour, Symbol, Image CSI**	-Identify the essence of ideas	**Colour, Symbol, Image CSI**	-Identify the essence of ideas	**Colour, Symbol, Image CSI**	-Identify the essence of ideas	**Colour, Symbol, Image CSI**	-Identify the essence of ideas

		Generate Sort-Connect-Elaborate: Concept maps	Uncovering and organizing prior knowledge to identify connections	**Generate Sort-Connect-Elaborate: Concept maps**	Uncovering and organizing prior knowledge to identify connections	**GenerateSort Connect Elaborate: Concept maps**	Uncovering and organizing prior knowledge to identify connections	**Generate Sort-Connect-Elaborate: Concept maps**	Uncovering and organizing prior knowledge to identify connections	**Generate Sort-Connect-Elaborate: Concept maps**	Uncovering and organizing prior knowledge to identify connections	**Generate Sort-Connect-Elaborate: Concept maps**	Uncovering and organizing prior knowledge to identify connections
						Connect Extend Challenge	Connections between new ideas and prior knowledge. - ongoing questions, puzzles and difficulties as they reflect on what they are learning	**Connect Extend Challenge**	Connections between new ideas and prior knowledge. - ongoing questions, puzzles and difficulties as they reflect on what they are learning	**Connect Extend Challenge**	Connections between new ideas and prior knowledge. - ongoing questions, puzzles and difficulties as they reflect on what they are learning	**Connect Extend Challenge**	Connections between new ideas and prior knowledge. - ongoing questions, puzzles and difficulties as they reflect on what they are learning
				Chalk Talk	Uncovers prior knowledge and ideas, questioning	**Chalk Talk**	Uncovers prior knowledge and ideas, questioning	**Chalk Talk**	Uncovers prior knowledge and ideas, questioning	**Chalk Talk**	Uncovers prior knowledge and ideas, questioning	**Chalk Talk**	Uncovers prior knowledge and ideas, questioning
										Compass Points	Metacogni-tion evaluate their learning.	**Compass Points**	Metacogni-tion evaluate their learning.
PRE KINDER		**KINDER**		**1st grade**		**2nd grade**		**3rd grade**		**4th grade**		**5th grade**	
						I use to think… but now I think	-Reflect on their thinking -explore how and	**I use to think… but now I think**	-Reflect on their thinking -explore how and why that	**I use to think… but now I think**	-Reflect on their thinking -explore how and why that	**I use to think… but now I think**	-Reflect on their thinking -explore how and why that

							why that thinking has changed. -reasoning abilities and recognizing cause and effect relationships		thinking has changed. -reasoning abilities and recognizing cause and effect relationships.		thinking has changed. -reasoning abilities and recognizing cause and effect relationships.		thinking has changed. -reasoning abilities and recognizing cause and effect relationships.
				Circle of View Points	Consider different and diverse perspectives	**Circle of View Points**	Consider different and diverse perspectives	**Circle of View Points**	Consider different and diverse perspectives	**Circle of View Points**	Consider different and diverse perspectives	**Circle of View Points**	Consider different and diverse perspectives
		Think – Puzzle - Explore	-Connections to prior knowledge - stimulate curiosity - lay the groundwork for independent inquiry.	**Think – Puzzle - Explore**	- Connections to prior knowledge - stimulate curiosity - lay the groundwork for independent inquiry.	**Think – Puzzle -Explore**	Connections to prior knowledge - stimulate curiosity - lay the groundwork for independent inquiry.	**Think – Puzzle - Explore**	-Connections to prior knowledge - stimulate curiosity - lay the groundwork for independent inquiry.	**Think – Puzzle - Explore**	-Connections to prior knowledge - stimulate curiosity - lay the groundwork for independent inquiry.	**Think – Puzzle - Explore**	-Connections to prior knowledge - stimulate curiosity - lay the groundwork for independent inquiry.
		Question Starts.	Activating curiosity and generating questions for exploration.	**Question Starts.**	Activating curiosity and generating questions for exploration.	**Question Starts.**	Activating curiosity and generating questions for exploration.	**Question Starts**.	Activating curiosity and generating questions for exploration.	**Question Starts.**	Activating curiosity and generating questions for exploration.	**Question Starts**.	Activating curiosity and generating questions for exploration.
PRE KINDER		**KINDER**		**1st grade**		**2nd grade**		**3rd grade**		**4th grade**		**5th grade**	
						I use to think..but now I think	-Reflect on their thinking -explore how and why that	**I use to think..but now I think**	-Reflect on their thinking -explore how and why that thinking has changed.	**I use to think..but now I think**	-Reflect on their thinking -explore how and why that thinking has changed.	**I use to think..but now I think**	-Reflect on their thinking -explore how and why that thinking has changed.

							thinking has changed. -reasoning abilities and recognizing cause and effect relationships		-reasoning abilities and recognizing cause and effect relationships.		-reasoning abilities and recognizing cause and effect relationships.		-reasoning abilities and recognizing cause and effect relationships.
				Thinking Hats	Analyze from different perspectives	**Thinking Hats**	Analyze from different perspectives	**Thinking Hats**	Analyze from different perspectives	**Thinking Hats**	Analyze from different perspectives	**Thinking Hats**	Analyze from different perspectives
								3-2-1-bridge	-Uncover their initial thoughts about a topic - connect these to new thinking about the topic after they have received some instruction	**3-2-1-bridge**	-Uncover their initial thoughts about a topic - connect these to new thinking about the topic after they have received some instruction.	**3-2-1-bridge**	-Uncover their initial thoughts about a topic - connect these to new thinking about the topic after they have received some instruction
						Sentence – phrase-word	-Reason with evidence -Build explanations -Discover the complexity	**Sentence phrase-word**	Reason with evidence -Build explanations -Discover the complexity	**Sentence –phrase-word**	Reason with evidence -Build explanations -Discover the complexity	**Sentence –phrase-word**	Reason with evidence -Build explanations -Discover the complexity

Appendix F Example of Age-Related Progression Map from Carnation School

Independence – thinking and acting independently, making their own judgements based on reasoned argument, and being able to defend their judgements.	
Kinder/Prep Children **(working with the teacher)**	• Demonstrates enthusiasm and excitement when engaging independently in the world • Shows growing confidence in becoming independent within the classroom setting • Can inquire, question and experience in order to gain more independence • Shows curiosity to expand their world view • Uses prior knowledge to promote participation and greater willingness in tasks • Refers to teacher and personal goals independently to support their learning • Follows daily routines and with less prompting
Year 1/2 Children **(developing independence)**	• Uses their growing knowledge base to participate confidently in independent tasks and take further risks • Asks questions to balance the connection between sought reassurance and the pursuit of a reward • Actively engages in classroom roles and responsibilities • Uses success criteria to reach learning expectations • Demonstrates they are beginning to create personal goals
Year 3/4 Children **(working with certain levels of independence)**	• Seeks and applies feedback on their own personal performance • Shows they are beginning to provide accurate feedback • Monitors their own actions to improve their progress towards key learning outcomes • Generates their own questions in relation to a topic • Shows an understanding of their roles and responsibilities within the community • Demonstrates they are beginning to undertake self and peer assessment more frequently • Shows they can monitor own behavior and how to manage it

Year 5/6 Children **(depth)**	• Can actively seeking feedback on their own performance • Demonstrates a willingness to provide constructive detailed feedback to peers • Shows the motivation to take action and willing to follow through with desired outcomes • Demonstrates an increased level of self-governance to pursue and persist with interests • Demonstrates the self-motivation to build upon strengths and weaknesses

Appendix G Examples of Developmental Continua for Decision-Making in Persuasive Writing, for Causal Reasoning and for Judging the Reliability of Information (below)

RUBRIC FOR PERSUASIVE DECISION MAKING ESSAYS

Indicators	Expert	Practitioner	Apprentice	Novice
Main Idea	Starts essay with a strong recommendation that is choser from at least three other options and does not repeat the consequences used as support.	Starts essay with a strong recommendation that is choser from at least three other options and does not repeat the consequences used as support.	Starts essay with a recommendation that is chosen from fewer than three other options and does not repeat the consequences used as support.	Does not start essay with a recommendation or starts by repeating consequences used as support. Does not mention options considered.
Evidence	Cites at least three positive and negative consequences each relevant to the recommendation as evidence for and against the recommendation.	Cites some, but less than three, positive and negative consequences each relevant to the recommendation as evidence for and against the recommendation.	Cites some consequences as evidence for the recommendation, some of which are not relevant.	Cites few positive and/or negative consequences in the main body of the essay.
Examples	Supports each consequence with at least one example. Provides details in the examples. Well organized.	Supports some, but not all, consequences with at least one example. Provides some detail in the examples. Organized.	Rarerly uses examples to support the consequences cited.	Uses no examples to support the consequences cited.
Concluding Paragraph	Returns to recommendation and, based on the body o the letter, explains why it is best despite the negative consequences.	Returns to thesis, elaborates it, but does not explain why it is best despite the negative consequences.	Returns to thesis but merely repeats main idea.	No concluding paragraph.
Conventions of Writing	Has few (if any) errors and follows appropriate conventions including spelling, paragraphing, and punctuation.	Has some errors and mainly follows conventions, including spelling, paragraphing, and punctuation.	Has some errors in spelling and punctiuation.	Has many errors in spelling and punctuation.

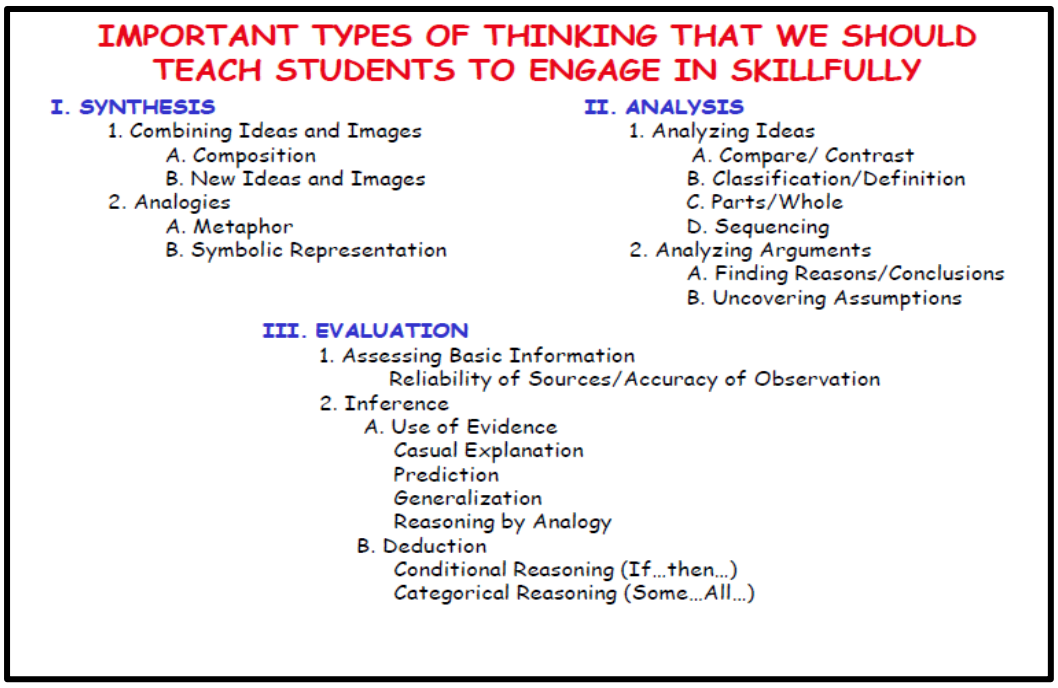
RUBRIC FOR SKILLFUL CAUSAL EXPLANATION ITEMS ON NCTT ASSESSMENT OF CRITICAL THINKING

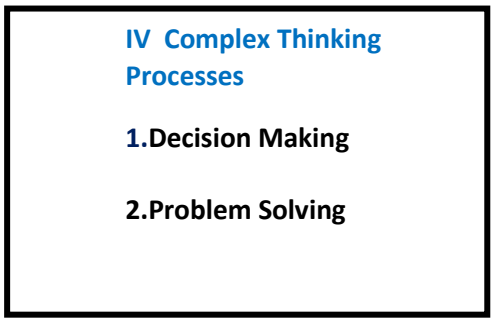
High Skill Level	Moderate Skill	Low but Acceptable	Weak Skill Level	No Skill
SELECTION OF EVIDENCE OR EXPLANATION				
Makes clear and elaborated connection between plausible evidence and possible cause	Describes connection of plausible evidence and possible cause but not much elaboration.	Merely says evidence is evidence for possible cause.	Selects plausible evidence or cause but makes no connection	No selection or selection of unconnected evidence/ possible cause
SELECTION OF DEGREE OF SUPPORT				
Identifies direct observation as strong, but needing to be strengthened by corroboration, explains why, cites indirect evidence as weak.	Identifies direct observation as strong, but needing to be strengthened. and indirect evidence as weak	Identifies direct observation as strong in contrast to indirect evidence as weak. Does not explain why..	observation as in favor, but does not provide an explanation.	Fails to identify direct observation as in favor.
METACOGNITION				
Identifies skill as causal explanation, explains strategy, and elaborates.	Identifies skill as causal explanation and explains strategy	Identifies skill as causal explanation and partially explains strategy	explanation but does not explain strategy	Does not identify skill as causal explanation.
POSSIBLE CAUSES				
Identifies a variety of possible causes	Identifies some but not many possible causes	possible causes	cause	Identifies no possible causes or things that are not possible causes.
RESEARCH				
Identifies text as source of evidence and explains why.	Identifies text as source of evidence	author's writings as source of evidence.	library as source of evidence.	Fails to identify source of evidence.

RUBRIC DETAILS FOR ASSESSING LEVEL OF SKILL USED IN JUDGING THE RELIABILITY OF A SOURCE OF INFORMATION

High Skill Level	Moderate Skill	Low but Acceptable	Weak Skill Level	No Skill
	IDENTIFICATION OF CRITERIA			
Identifies all factors present or needed from the thinking map.	Identifies factors present from the thinking map in each of the major categories.	Identifies some factors present from the thinking map but misses one or more categories.	Identifies very few factors present from the thinking map.	No identification of factors or identifies just factors that are irrelevant.
	JUDGMENT OF RELIABILITY			
Explains clearly plausible connection between specific factors present and reliability, and elaborates	Explains plausible connection between specific factors present and reliability, but no elaboration	Cites plausible reason why judgment made but does not connect relevant factor with reliability.	Cites reason why judgment made but does not explain. Reason may be viable.	Fails to provide a reason or cites a clearly irrelevant reason.

Appendix H Thinking Based Learning Model Important Types of Thinking





Appendix I THINKING SKILLS SCOPE AND SEQUENCE based Swartz TBL, adapted from Lotus School

PRE KINDER	KINDER	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5
Parts-Whole	Parts- Whole	Parts- Whole	Parts-Whole	Parts- Whole	Parts- Whole	Parts- Whole
Compare/Contrast	Compare/Contrast	Compare/Contrast	Compare/Contrast	Compare/Contrast	Compare/Contrast	Compare/Contrast
Decision Making	Decision Making	Decision Making	Decision Making	Decision Making	Decision Making	Decision Making
		Problem Solving	Problem Solving	Problem Solving	Problem Solving	Problem Solving
Developing Creative Ideas	Developing Creative Ideas	Developing creative ideas	Developing creative ideas	Developing creative ideas	Developing creative ideas	Developing creative ideas
		Establishing sequences/ranking	Establishing sequences/ranking	Establishing sequences/ranking	Establishing sequences/ranking	Establishing sequences/ranking
		Classifying (TD)	Classifying (TD&BU)	Classifying (TD&BU)	Classifying (TD&BU)	Classifying (TD&BU)
			Analyzing and Assessing Arguments	Analyzing and Assessing Arguments	Analyzing and Assessing Arguments	Analyzing and Assessing Arguments
		Composing metaphors based on analogies	composing metaphors based on analogies	composing metaphors based on analogies	composing metaphors based on analogies	composing metaphors based on analogies
			Evaluating Predictions	Evaluating Predictions	Evaluating Predictions	Evaluating Predictions
			Best Causal explanation	Best Causal explanation	Best Causal explanation	Best Causal explanation
			Determining reliable Sources	Determining reliable Sources	Determining reliable Sources	Determining reliable Sources

Principles of Curricular Implementation of thinking skills

1. Teachers can introduce these skills at any grade prior to these, but they must be introduced by the grade indicated.
2. Red indicates where these skills are introduced. After they are introduced they need to be followed by many practice lessons on the same skill by the same and different teachers at the same and higher grade levels. During this process students can be asked to do activities on these skills on their own.
3. TBL lessons that are taught on the same thinking skill vary in content and subject area. They should be planned that way.