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Thinking and Metacognition

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Introduction

It seems that only until recently, educators (including teachers, lecturers, educational administrators, professors) have shown interests in the overlooked theme 'thinking' in education. For the past 2 years, the concern of including the thinking component into educational courses has increased as revealed by the launch of the Information Technology (IT) Master Plan in education (April, 1997), the National Education program (May, 1997) and the framework of Thinking Schools and Learning Nation (June, 1997). These educational programs intend to shape new avenues to cultivating thinking persons, creative individuals and independent learners. Consequently, schools and educational institutions here organized workshops, seminars and conferences related to the theme 'thinking'. In November 1997 and 1998, the Singapore Educational Research Association annual conference highlighted thinking, IT and creativity. Educational modules include the discussion of problem solving, critical and creative thinking, and metacognition.

In this paper, we would like to share our insights into the theme 'thinking and metacognition'. Our aim is to provide an overview of this crucial topic. Thereby, readers are aroused to explore the theme further on their own and thus to be self-directed learners. We divide our paper into three main sections. In the first section, we describe what thinking is and how thinking is related to learning. In the second section, we define metacognition and its relation to learning. We also discuss the training of metacognitive skills. In the third section, we infer some implications for educators with regard to this specific theme.

Thinking

DEFINITION OF THINKING

The word 'think' is one of the most frequently used verbs in everyday conversation. 'To think' denotes the meanings of having an opinion, a belief about and an attitude towards something, using the mind to solve or decide something, having an idea or a thought, considering the

possibility of doing something, producing a new idea, remembering a name or a fact, and so on. Connotations of thinking in various languages may provide some understanding of how people in different cultural settings perceive the thinking process. The word 'thinking' in Japanese is *omou* represented by a vertical combination of two characters 'field' (above) and 'heart' (below). According to Ojibayashi edited by Matsumura published in the 1989, five major connotations are associated with *omo*u:

- to evaluate and judge in heart (*kokoro*) or to form an opinion;
- to bring about the event and the thought that appear in the brain (*atama*);
- to give attention to and be conscious;
- to show concern of someone's future undertaking; and
- to miss the beloved or someone in the home country.

Thinking according to the Oxford English dictionary edited by Simpson and Weiner in 1989 refers to three major connotations, namely, to conceive in mind or to exercise the mind, to call to mind or take into consideration, and to be of opinion, deem, judge, and so on. Thinking or *Denken* as cited in the German Brockhaus Encyclopaedia volume III published in 1990 describes complex abilities. Thinking links the visible objects, words or figures. There are various manifestations of thinking. Given its inherent tacit nature, thinking is basically inferential and thus always takes its form in body movements or languages. Productive thinking is the formulation of organized and systematic opinions after treating a problem for a long duration. It seems that the word 'thinking' in Japanese compared to that in English and German emphasizes both cognitive (*atama*) and affective (*kokoro*) domains. We may interpret that the Japanese who live in a collectivist society value interpersonal relations. They may regard highly interdependency, intimate social contact, and group behaviour. The Japanese culture places a great emphasis on affection in light of maintaining harmonious human relationship. Living in the individualistic society, the English and the German may regard independent thinking and behaviour highly. An individual makes his/her opinions freely based on the facts and information that he/she gathers.

Thinking is a natural process performed by all human beings, irrespective of their age, gender, and aptitude. More important, thinking occurs in contexts. Socio-cultural factors influence a person's thinking process. Thinking is a covert process. Most of the time, we may not

realize when thinking takes place and how it performs. Thinking occurs in every moment in life. It is an active process that requires prior knowledge and language to formulate. Language, be it in written or articulated form, is a primary tool for expressing. The ability to visualize image and formulate linguistic expressions allows cognitive agents to develop representations of knowledge and concepts. Thinking is a cyclical process. A thinking person or a thinker examines the information properly. Before deriving a conclusion, he/she analyses the problem, possible solutions and consequences of the best solution carefully and repeatedly. With new information or in a new situation, the thinking process begins again.

THINKING IN PSYCHOLOGY

Thinking is one of the essential topics of psychology. Many discussions about thinking can be found under the overarching topics 'cognition', 'cognitive psychology', 'metacognition', 'problem solving', 'intelligence', 'creativity', and so on. With the advent of computer technology and artificial intelligence research (e.g. game theory and operational research) since the 1950s, the study of thinking has gained its acknowledgement. The information-processing model, for instance, intends to understand human cognition in terms of technological processes.

The study of cognitive activity is fundamental to psychology and education. Conventionally, thinking is perceived as a mental activity that a person performs when information is gathered and used. Thoughts evolve in thinking processes. They are integrated information of a person's knowledge of a certain field (topic) and of his/her experiences. In psychology, thinking is investigated not only from thoughts (products), but also from the processes (how thinking occurs), components (what constitutes thinking) and socio-cultural influences on human behaviours and thinking. Beyond the laboratory and experimental framework, psychologists attempt to understand thinking from the laypersons' perspectives. It is believed that common people's conceptions of thinking can enrich our understanding of thinking in contexts. The study of everyday cognition and practical intelligence, for instance, relates the study of thinking to everyday life usage.

THINKING AND LEARNING

In a conventional framework, education is defined as the process of imparting knowledge and skills to students. Education provides the opportunity to learn and to teach. While the teacher delivers

information, the students listen to and receive information. The communicative mode between the teacher (knowledge deliverer) and the students (knowledge receivers) is transmissive — from the teacher to the students. Under this learning-teaching model, thinking is not highlighted explicitly (it does not mean that thinking processes do not occur) (see Figure 1).

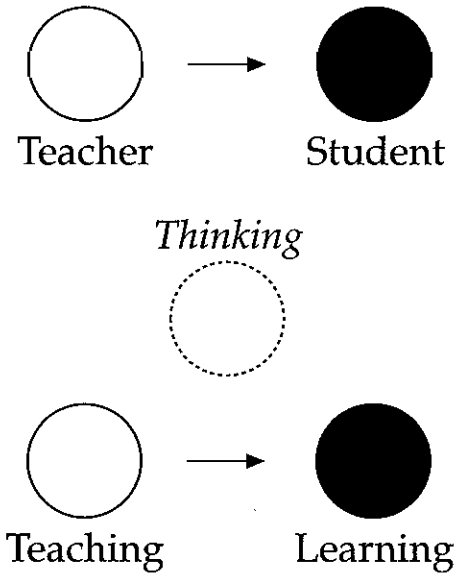

Figure 1: A conventional model of educational processes

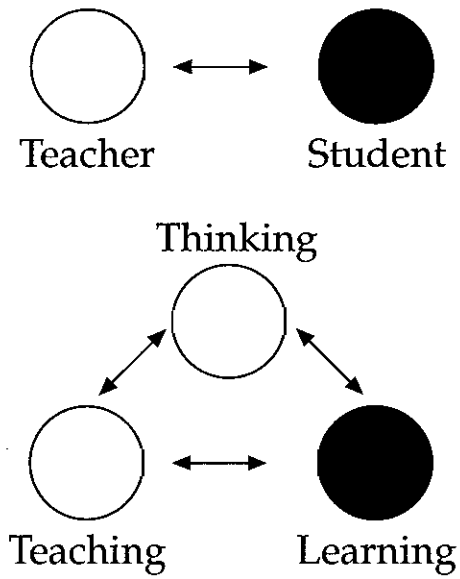

Figure 2: An unconventional model of educational processes

In an unconventional framework, the teacher and the students are interdependent, and are involved actively in learning, teaching and thinking processes (see Figure 2). Teaching and learning are mediated by a culture of sharing, negotiating and producing work. Teachers and students interact and communicate intensively during knowledge and

skills acquisition. Reflection and collaboration are two important principles of learning in the classroom. Through reflection students gain insight into their own strengths and weaknesses, and access to their own repertoires of strategies of thinking and learning. Collaborative learning promotes an interdependent atmosphere that values joint responsibility, mutual respect as well as a sense of personal and group identity.

METACOGNITION

DEFINITION OF METACOGNITION

Metacognition is the capacity to reflect upon one's own thinking, and thereby refers to the aspect of monitoring and managing thinking. Metacognition emphasizes the importance of self-conscious management of one's own learning and thinking processes. It is concerned with knowing how to use a cognitive skill such as evaluating or planning complemented by knowing when and where to use it. Inspired by Vygotsky's (1978) sociocultural theory, the tenet of metacognition can be enriched through social interactions, especially with more capable others (his well-known notion of zone of proximal development, ZDP). Metacognition is a kind of cognitive variable that is amenable to social exchanges because insights about self-appraisal and self-management can be promoted by other people as well as self-discovery. In a sense, metacognition is a mirror of one's knowledge and thinking, and the reflection can come from within the individual or from other people. Hence, metacognition is a kind of shared knowledge.

Since the 1980s, researchers in the field of instructional and developmental psychology have shown an intensified interest in metacognition. Although there is still quite a bit of confusion about what the term means and about its usefulness as a scientific construct, most scholars in the domain of learning and instruction tend to agree that metacognition involves two main aspects, namely, metacognitive knowledge and metacognitive skills (Brown, Bransford, Ferrera & Campione 1983). Specifically, metacognitive knowledge is related to personal resources, task requirements and learning strategy (cognitive, motivational and environmental). It includes knowing about the strengths as well as the weaknesses of one's cognitive capacities. Examples are being aware of the limits of short-term memory, and knowing that our memory is fallible but that one can use aids (such as mnemonics) for retaining information. Also involved are beliefs about

cognition and ability, for instance, believing that one's mathematical ability is strong. Metacognitive skills (or self-regulatory processes) are such as planning, self-monitoring and self-evaluating. In particular, the self-monitoring mechanism can be defined as the executive control structure that organizes and guides our learning and thinking processes. This control structure includes skills such as planning a solution process, monitoring an ongoing solution process, evaluating and, if necessary, debugging an answer or a solution; and reflecting on one's learning and problem-solving activities.

Evidence supporting the crucial role of metacognition for learning and problem-solving has been obtained in comparative studies of skilled and weak problem-solvers of different ages and in a variety of content domains including mathematics. For example, **Schoenfeld (1985)** found that in comparison with an expert problem solver, students lacked essential metacognitive monitoring, assessing and decision-making skills. One could say that skilled thinkers and problem solvers are characterized by a high level of action control, that is, a systematic and persistent orientation toward a preconceived objective. This implies that they constantly monitor their activity and, whenever necessary, make the required corrections. Taking this into account, it is not surprising that more and more voices are heard demanding more explicit attention to metacognitive skills instruction.

METACOGNITION AND LEARNING

What are the merits of acquiring metacognitive knowledge and skills? Metacognitive knowledge and skills help learners become active participants in their own performance rather than be passive recipients of instruction and imposed experience. As metacognition emphasizes personal appraisal and management, it is oriented to the analyses of individual differences in cognitive development and learning. Metacognition can provide students with knowledge and confidence that enables them to manage their own learning and empowers them to be inquisitive and zealous in their pursuits. As metacognition is embedded in cognitive development and represents the kind of knowledge and executive abilities that develop with experience and schooling, it is both a product and a producer of cognitive development. The constructive, personal and strategic thinking that is involved in metacognition is amenable to classroom instruction. Self-appraisal and self-management (the two essential features of metacognition) invite both cognitive and motivational explanations because skill and will are interwoven in reflections and anticipations about learning.

More importantly, students learn to be confident in their thinking and learning processes through the acquisition of metacognitive beliefs. Metacognitive beliefs are expectations that students hold with regard to thinking and learning. Different beliefs about the role of ability, effort, luck, controllability and other factors in academic achievement show marked variations among children who succeed or do not succeed in classrooms (Weiner 1992). In fact, students' beliefs reveal four cognitive dimensions that influence their orientation to school learning — agency, instrumentality, control and purpose (Paris & Winograd 1990). Firstly, agency beliefs are defined as expectations about the extent to which agents (e.g. the self or social others) possess or can obtain potential means. Students must develop beliefs about themselves as self-directed learners and their own cognitive capabilities in different areas. Secondly, instrumentality beliefs are related to the means-ends relations that are perceived between educational strategies and outcomes. In particular, students need to realize the utility of various cognitive strategies such as questioning and note-taking. Thirdly, controls beliefs enable students to develop their own power to control and direct their own thinking. They need to believe that their actions are responsible for successful performances and that failure is neither inevitable or uncontrollable. Fourthly, purpose beliefs allow students to understand the purpose of their own learning. They need to have positive expectations for their performance and value success. Presumably, metacognitive beliefs guide decision making at critical junctures in classroom learning. With metacognitive beliefs, students can evaluate aspects of the learning situation (e.g. whether personal resources match the task requirement). Students are the forerunners of their decision-making and thus their actions.

Of the strategies deployed for training metacognitive skills, modelling (e.g. through an expert's thinking aloud when performing an intellectual activity), reflective questioning (self- or other-initated), collaborative or cooperative learning, scaffolded instruction and cognitive coaching are reported to be significant for enhancing metacognitive skills. Students' metacognitive-awareness can be promoted by informing them about effective problem-solving strategies and discussing cognitive and motivational characteristics of thinking. The effects of metacognitive training include the transferrence of responsibility for monitoring learning from teachers to students themselves (i.e. independent learning), and fostering positive self-perception, affect and motivation among students (i.e. gaining of personal insights). Noteworthy is that teachers should train themselves as 'reflective practitioner' through various means, for instance, journal writing (a diary form of writing reflections on

their own teaching methods, the contexts of educational institution, students' performance, etc.) and communications with 'like-minded others' (i.e. colleagues).

Furthermore, the cognitive strategy of self-explanation has proven to be beneficial for learning when students construct explanations of problem solutions (Chi *et al.* 1989). Specifically, in the domain of mathematics, Schoenfeld (1985) fostered the metacognitive skills of his students by teaching them heuristic strategies (i.e. guidelines for students to explore a problem but do not necessarily lead to a solution), control strategies (i.e. for appropriately deploying one's own resources like mathematical knowledge and skills), epistemic systems (i.e. belief systems about oneself, the learning domain and the world), and postmortem analysis (i.e. comparing one's own solution with that of an expert after a given task is performed). Another frequently quoted example of training metacognitive skills is 'reciprocal teaching' method (Palinscar & Brown 1984) which, based on Vygotsky's theory, is a programme especially designed for enhancing reading. It consists of four steps — questioning, summarizing, clarifying and predicting. Each student of a collaborative learning group takes turn to assume the role of a teacher to implement the four steps during reading activities. In the same vein, the programme "Fostering Community of Learners" (Brown & Campione 1996) has been developed. It is an eclectic approach based on social-constructivist theories. It aims to promote metacognitive skills underlying multiple forms of higher literacy such as reading, writing and argumentation. At its simplest level, there are three parts — engaging in research activity, sharing expertise and performing consequential task. A range of learning activities is devised to motivate, enable and support this central research-share-perform cycle. These learning activities include research seminar, guided writing, consultation with experts, peer and cross-age teaching, to name just a few.

The recent instructional approach that has attracted much research attention is Collins, Brown & Newman's (1989) "Cognitive Apprenticeship" model which is also grounded in Vygotsky's theory. The approach involves immersing a novice in an expert culture. Through a sequence of novice-expert interactions in form of modelling, coaching and scaffolding, the novice may internalize critical cognitive skills demonstrated by the expert. Of particular importance is to explicate cognitive processes which can thus be approximately visible as well as open to feedback and reflection. Subsequently, the novice is encouraged to practise the newly learnt skills by exploring novel situations with the expert's support gradually faded.

Lastly, to furnish readers some concrete guidelines about the teaching of metacognitive skills, we cite the work of Pressley and associates (1990):

- Select a few strategies with which to begin, and teach these strategies across the various content areas as part of the ongoing curriculum. Additional strategies should be introduced only after the initial strategies have been fairy well established.

- Describe the strategies being taught and model their use for the students, comment aloud on how the strategies should be performed.

- Model the strategies again, re-explain those aspects of using the strategies that are not well understood.

- Explain why the strategies should be used, what they accomplish, and the specific situations in which they should be used.

- Provide plenty of guided practice by having students using the strategies for as many appropriate tasks as possible, provide reinforcement and feedback on how the students can improve their execution of the strategies.

- Encourage students to monitor their performance when using the strategies.

- Encourage generalization of the strategies by having students use them with different type of materials in various content areas as well as their continued use.

- Increase students' motivation to use strategies by heightening student awareness that they are acquiring valuable skills that are at the heart of competent functioning.

- Emphasize reflective processing rather than speedy processing. Try to eliminate as much as possible high anxiety on the part of students. Encourage students to shield themselves from distraction so they can attend to academic tasks.

IMPLICATIONS FOR EDUCATORS

Thinking education entails individual and institutional efforts to maximize the development of an individual's potential. It goes beyond

the conventional educational objectives that end at delivering knowledge and skills by the educators. During the process of knowledge and skills acquisition, individual students are active learners and thinkers. They discover their strengths and weaknesses, and search for the best learning strategies that can help them learn effectively and think rationally. In a thinking classroom, individual students are learners, partners, researchers and sometimes teachers. They discover new knowledge independently, in a group or with the teacher's guidance. Throughout the learning processes, the teacher and the students interact frequently, communicate openly as well as share experiences and information.

Thinking education can facilitate various qualities such as high social awareness, good social and cognitive competencies. A thinking person is an individual who is aware of his/her roles in the family and society. He/She makes decision, infers information and relates information to situations. He/She possesses the competence to withstand obstacles and hindrances and to tolerate ambiguity. A thinking person has good interpersonal and communicative skills that can convince others of his/her constructive ideas and solutions. The ideas that a thinking person suggests are useful, practical and relevant to contemporary problems and issues. Acquiring metacognitive skills and knowledge is essential for the development of a thinking person. When a person is self-aware and self-regulated, he/she can shape his/her own path of development. Thinking education is defined in socio-cultural contexts. Hence, educators have to ensure that learners acquire meaningful social experiences and a sense of belonging to their peers and community. The ultimate aim of thinking education is to realise an individual's potentials. Consequently, he/she can lead a pleasant and healthy life and contribute substantially to his/her community. Besides the awareness of their own thinking processes, learners should be alert to the consequences (positive and negative) that may be brought forth by their acts and suggestions. Constructive thinking is governed by human conscience. Hence, educators should ensure that the thinking curricula include the knowledge and skills acquisition in the academic, social and interpersonal domains.

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