Affective Effects of Metalearning Intervention

by Tey Sau Hing
Seng Seok Hoon
Muriel Lim-Quek
Agnes Chang
(National Institute of Education/
Nanyang Technological University
Singapore)

ABSTRACT

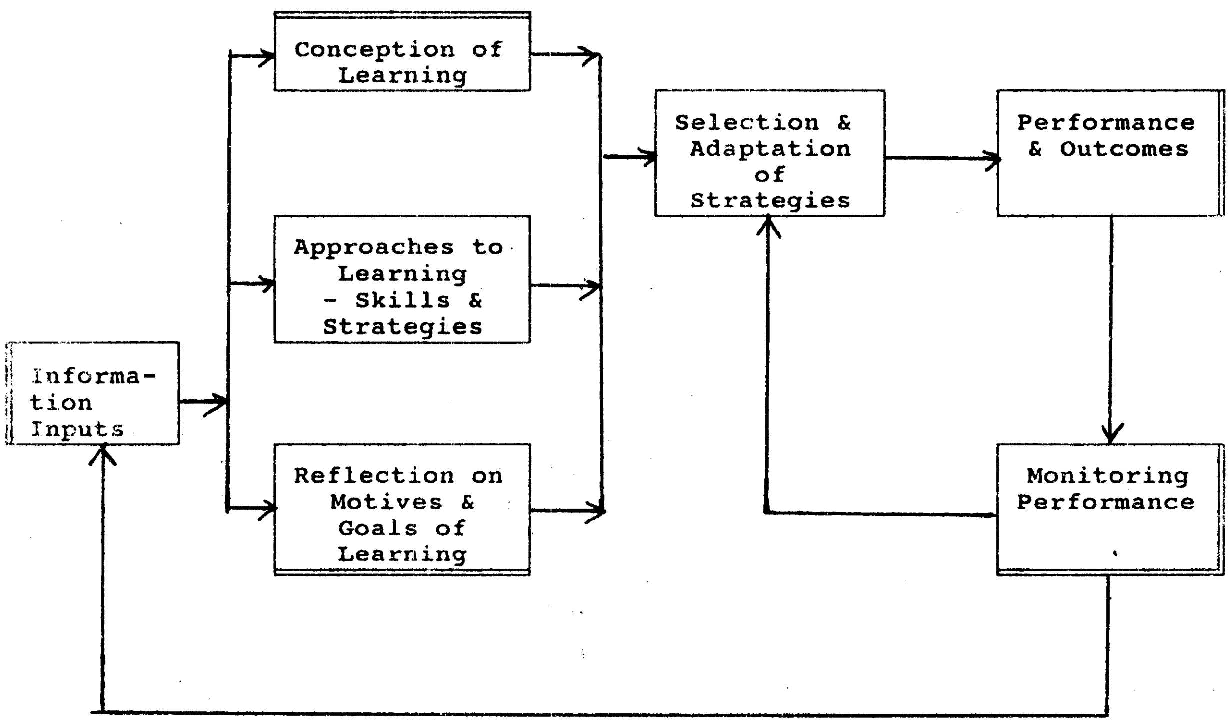
This paper is an attempt to capture the affective effects on the Primary Five students as a result of incorporating metalearning strategies in the teaching of Mathematics, Science and Social Studies. The introspection methodology was used whereby the students were interviewed and asked to make confidence, ease-of-learning and feeling-of-knowing judgements on their learning and performance in the three subjects after intervention. Their judgements were then matched with the gains in mean scores of their final over their mid-year examination results to determine students' metalearning experiences in monitoring their learning of academic subjects. Prior to intervention, observations were made of students' problem-solving behaviours to gain insight into students' metalearning functioning. This information subsequently served to guide the choice of appropriate intervention strategies. Results showed clearly that the academically weaker students were deficient in their monitoring system. They had a tendency to overestimate their abilities at performing academic tasks, yet at the same time, lacked the confidence when confronted with problem-solving tasks. It was observed that these students did encounter difficulty in organization, was not able to apportion their time appropriately to different types of problems and they tended to give up easily in the face of failure to solve the problems. After intervention however, the experimental students which included the weaker ones as well appeared to have improved in their confidence judgements and seemed more accurate in their predictions of their own performance at various academic tasks.

KEYWORDS: Metalearning, intervention, affective, primary students, Mathematics, Science, Social Studies, problem-solving.

We have set ourselves the most challenging task in an attempt to capture the affective effects from our metalearning study. To come up with an operational definition for "metalearning" is in itself difficult for there is a dearth of literature in this aspect of metacognition, let alone to combine it with the affective dimension. This latter element is elusive. What are we looking for? How do we determine its component variables?

Referring to our Model of Students' Metalearning Process (Figure 1) which was derived basically from both Biggs & Telfer's (1987) and Lorna Chan's (1987) works, we came to agree that a study of the affective dimension of metalearning should involve a deeper exploration into the monitoring of metalearning experiences.

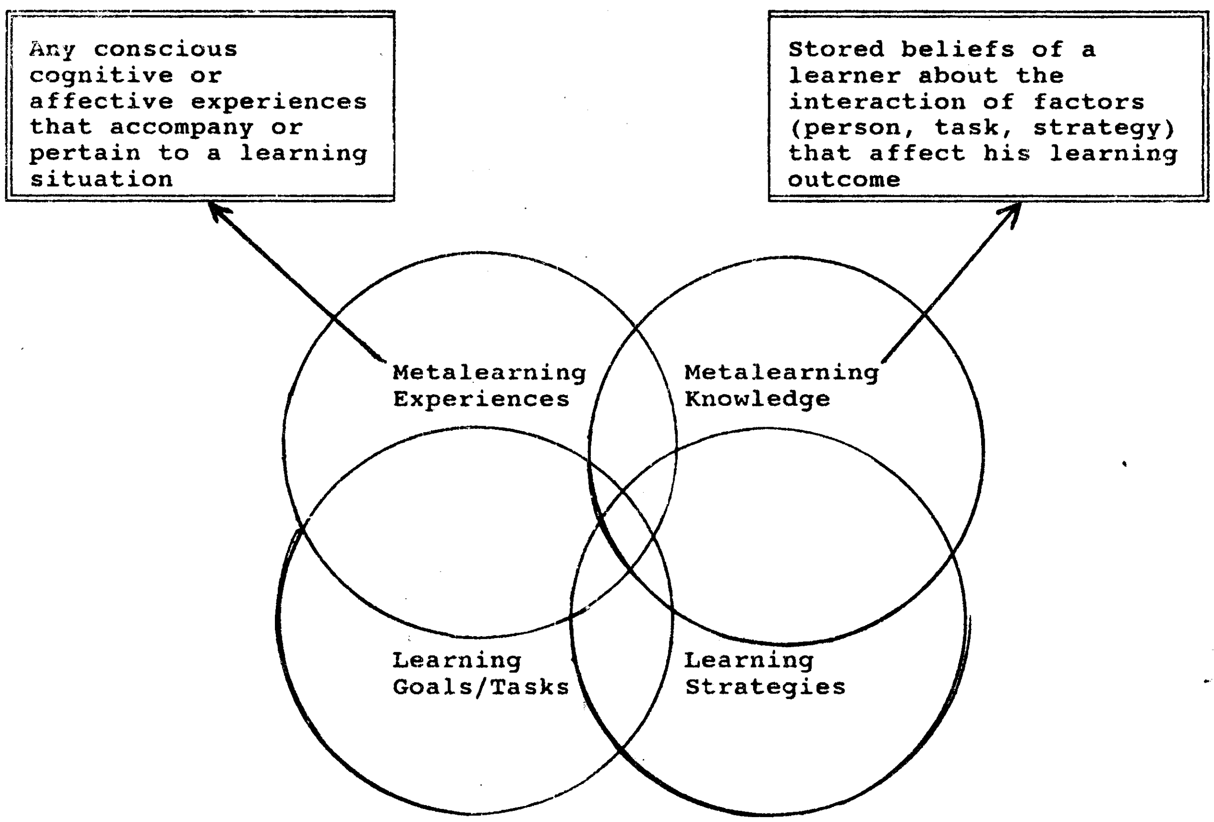
Figure 1: A Model of Students' Metalearning Process



Drawing a parallel from Flavell's definition of metacognitive experiences in his Model of Cognitive Monitoring (1992), "metalearning experiences" is seen as any conscious cognitive or affective experiences that accompany or pertain to a learning situation. Some examples of such experiences may relate to a student's sense of puzzlement over a concept introduced by a teacher, feeling of uncertainty of success in an academic exercise, wondering whether what was read was understood, belief in a variance between performance and goal and an assessment of the quality of the problem-solving processes. Metalearning experiences therefore involve careful highly conscious thoughts on the part of a learner as to where he is and what sort of progress he is making or is likely to make in the process of learning. There is planning beforehand and evaluation afterwards to ensure quality control in learning.

According to Flavell's model (1992), the monitoring of cognitive enterprises proceeds through the actions of and interactions among metacognitive knowledge, metacognitive experiences, goals/tasks and actions/strategies. Following from this, metalearning experiences would therefore effect on learning goals/tasks, learning strategies and "metalearning knowledge". These experiences could cause the learner to evaluate, select, revise or abandon task, goal or strategy. Conversely, such experiences could change the "metalearning knowledge" structure of the learner which includes his beliefs about the interaction of factors viz person, task and strategy that would affect his learning outcomes. Our conception of monitoring in metalearning can be summarized diagrammatically as shown in Figure 2.

Figure 2: Monitoring in Metalearning



One affective dimension to our study was therefore to examine students' judgements of their own responses to various academic tasks in Mathematics, Science and Social Studies. Nelson & Narens (1992) have identified several types of monitoring judgements that a learner needs to make in order to attain his norm of study. These judgements could be made as retrospective monitoring or prospective monitoring of his academic performance. Retrospective judgements express the learners' confidence of his own past responses to academic tasks, whereas prospective judgements involve predictions of subsequent responses. The latter type of judgement might require the learner to infer the ease of learning an academic item, decide on the employ of strategies to make the learning of the item easier or to predict his own future ability for retrieval of the item and hence the effects on his academic task performance. Prospective ease-of-learning judgements therefore include a priori choice-of-processing judgement as well as an initial plan for the allocation of study time to various academic tasks, whilst prospective feeling-of-knowing judgements would lead to changes in plans for learning and performance. Such monitoring mechanisms would go on until the learner's judgement of his learning has reached the norm of study.

In our metalearning study, we used a methodology that is commonly employed by researchers in metacognition to determine the students' prospective as well as their retrospective judgements of their learning in Mathematics, Science and Social Studies. The introspection methodology selected requires eight of the experimental students to make verbal reports of their own monitoring of learning during an interview about their assessment of task difficulty for the solution of problems in the three academic subjects under study, strategies that can be employed to facilitate the learning of the respective subject and also, the students' confidence in their final examination as compared to their mid-year examination results. The students' confidence judgement, ease-of-learning judgement and feeling-of-knowing judgement were then matched with their examination results to conclude on their behaviours at monitoring metalearning experiences.

The eight students interviewed found the learning of the three academic subjects under study enjoyable. Mathematics was seen as challenging. Science provided the opportunities for scientific exploration. Social Studies offered the chance to know more about other countries of the world. They felt that Mathematics was easier to understand with the help of problem generation and pattern identification learning techniques. The concept mapping technique was found to facilitate the learning of Science. Questions were seen by the students as challenging for the mind to think about Mathematics, Science and Social Studies. Six of the students, especially the weaker ones amongst them, felt that group discussions of solutions to Mathematics, Science and Social Studies problems were helpful in the learning of the subjects. Two of the better students however found intra-group conflicts disturbing and distracting to learning and therefore would prefer to work alone.

On comparing the students' ease-of-learning judgement with their metalearning behaviour displayed in the classroom, it was observed that the pattern identification and checking of solutions to problems techniques were frequently used by the students in their Mathematics and Science lessons. In addition, the experimental students often used techniques like clue identification, search for alternative solutions and thinking aloud when planning the steps to solve their mathematical problems. There were a few other learning techniques observed, but they were less frequently employed by the students. These learning techniques included concept mapping, questioning, linking new information to previous knowledge and defining Mathematics and Science problems in their own ways.

On being asked about how confident they were in their own performance in the three subjects for the final examination as compared to the mid-year examination, all the eight students expressed confidence that they had improved in their learning of the subjects and consequently would obtain better grades for the final. The confidence expressed in getting better grades for a more major examination seemed to act as a strong motivator to learning which might partly explain the students' feeling of enjoyment in studying the three subjects.

Prior to drawing some conclusions on the students' metalearning judgements, let us first examine how their monitoring behaviours have affected their academic performance in Mathematics, Science and Social Studies both in their mid-year and final examinations as well as their performance in the pre- and post-test specially designed for the purpose of this study. Their results are as shown in Tables 1 and 2 respectively.

Table 1: Mid-Year and Final Mean Scores for English, Mathematics, Science and Social Studies

SCHOOL & CLASS		N	ENGLISH			MATH			SCIENCE			SOCIAL STUDIES		
			M	F	D	M	F	D	M	F	D	M	F	D
X	1E	24	77.3	79.8	2.5	71.0	86.9	15.9	75.6	76.1	0.5	64.0	73.3	9.3
	2E	20	62.5	67.7	5.2	48.6	64.5	15.9	63.4	58.1	-5.3	62.6	80.8	18.2
C	2C	8	73.8	74.3	0.5	69.5	73.7	4.2	79.0	70.0	-9.0	64.4	83.3	18.9
	1C	12	33.0	34.0	1.0	20.0	13.9	-6.1	37.9	42.9	5.0	54.6	47.4	-7.2

X = Experimental school and classes
C = Control school and classes
N = Number of subjects from class
M = Mid-year examination mean scores
F = Final examination mean scores
D = Differences between mid-year and final mean scores

Table 2: Pre-Test and Post-Test Mean Scores on Problem-Solving Tasks

SCHOOL	NUMBER OF STUDENTS	PRE-TEST MEAN SCORES	POST-TEST MEAN SCORES	DIFFERENCE
X	44	64.75	99.18	34.43
C	21	78.28	73.09	-5.19

X = Experimental school
C = Control school

Taking the results together, it would appear that our experimental students have shown a clear tendency at monitoring their learning activities in the three subjects and they can be accurate in their assessment and predictions of their own learning abilities. Except for the weaker students who had overestimated their capability at performing in Science, the experimental students' confidence judgement in obtaining better grades for all the three subjects in the final as compared to the mid-year examination was not misplaced. They had actually obtained gains in mean scores in all the other subjects and the gain of 15.9 marks in Mathematics for each of the two classes in the experimental group was most impressive. The improvement made in their results to the problem-solving tasks designed specially for this study was even more dramatic. In the post-test, the experimental students had gained a mean score difference of 34.43 marks over their pre-test. This is especially significant when compared with the control group who had regressed by 5.19 marks in their post-test results.

Our results, therefore, thus lend some support to the many works done in this area of research. Flavell's study (1970), for example, which investigated children's ability to predict their own memory span and to monitor the current state of their learning, found that accuracy in prediction increased dramatically as children developed from preschool through fourth grade. It was concluded that with development, children come to know more about their memory system and they show an increasing tendency to monitor their cognitive activities. Our work however is not concerned with developmental differences, but it has shown that Primary Five students have the monitoring facility for the learning of Mathematics, Science and Social Studies and this capability can be raised to the conscious through instruction and as a result they become more realistic and accurate in their predictions of their learning abilities.

There was another dimension to Flavell's study (1970) that was of interest to us. In that study, Flavell and his team-mates observed that younger children have a stronger tendency to terminate study before they are ready to recall. On each of the three trials where the subjects were required to study a set of pictures for as long as they felt was necessary to facilitate recall of the names of the pictures in the correct order, the younger children were not as adept at monitoring their current state of learning as the older ones who spent significantly more time studying the sets before recall was attempted.

There are also a number of research studies found in the literature which looked into the comparative differences in the metacognitive functioning of children with learning problems and those more capable ones prior to giving instructional training. In a series of laboratory studies carried out by Brown (1978) and Campione & Brown (1977), it became clear that retarded children did show a deficit in their metacognitive competence. Retarded children were found to be less insightful about their memories than non-retarded children of comparable age. The study by Brown & Lawton (1977) on the feeling-of-knowing phenomenon showed the mildly retarded children less able to predict their ability at recognising a name than their non-retarded counterparts. Brown, Campione & Murphy (1977) found their retarded subjects as compared to the non-retarded ones less aware of their own working memory limitations and they drastically overestimated their memory span. It was again found by Brown, Campione & Barclay (1979) that retarded children tended not to monitor their state of learning accurately. In an earlier study by Tenney (1975), the retarded subjects could not distinguish clearly the kinds of material that were easy or difficult to remember. The retarded were less able to construct organised lists of key words to facilitate retrieval than the non-retarded children. Subsequently, Brown & Campione (1977) observed that retarded children did not allocate time differentially according to whether the items were easy or difficult to recall.

Across research on confidence judgements after recall, the usual finding is that people are over-confident about their preceding memory performance. This seems to be especially the case for the younger children and children with learning problems. Perhaps, this explains the results as presented in Table 1. The weaker students in both the experimental and control groups tended to overestimate their abilities in Mathematics, Science and Social Studies whereas the better ones had only shown over-confidence in Science.

In our own study, we had used the observation technique to determine students' behaviour at handling problem-solving tasks. In particular, we were interested in comparing the behaviours of the academically better and weaker students in problem-solving situations. First of all, it was observed that the more academically-inclined students spent relatively more time reading a problem before attempting a solution to the problem. Comparatively, the weaker ones spent less time comprehending and organising the steps to solving a problem. The latter had also failed to consider carefully all the key factors given in each problem prior to its solution. A failure on the part of the weaker students to allocate time appropriately according to the demands of each problem-solving task might be an indication of incompetence at monitoring metalearning activities. This observation had provided the data and guided us subsequently in our intervention work.

Another observation made of the problem-solving behaviour of the two groups of students was the strategies used to find a solution to each problem. In this respect, it was observed that the better students were more systematic and organised in their approach to problem solving. The weaker students were observed to lack that organisational capability and depended on a trial-and-error approach to solving the problems. Furthermore, the weaker students seemed to think that there was only one specific method to solving a problem and only one solution to each problem. Whereas the better students displayed more flexible problem-solving behaviour. They attempted to explore alternative ways to solve a problem and also seemed more alert to the possibility of different solutions to each problem. Another point observed was that the weaker students needed much probing and prompting throughout the whole process of solving a problem, whereas the better ones were able to explain and elaborate on their solutions without as much assistance from their interviewers. All the observations we have made thus far seem to point to the conclusion that the ease-of-learning judgements of our weaker students are less developed than their more academically-inclined counterparts. The weaker students do display a deficit in their choice and employ of strategies to deal with problem situations successfully. Even in the case where they have been successful in solving a problem, they might still lack the metalearning facility to monitor and make clear to themselves the processes of solving a problem. As a result, the weaker students might become less adept and flexible at the use of problem-solving strategies in handling problems encountered in the future.

In observing our subjects' confidence at handling problem-solving tasks, we found the better students more relaxed, they displayed more self-confidence and were well-spoken. On the other hand, the weaker students were tense, they lacked the confidence in finding a solution to every problem and asked for help more often than their better counterparts. Given a choice, the academically weaker preferred to work in groups as they could gain confidence through discussions of solutions with others whilst the better students showed more confidence in finding the solutions to problems by themselves. There was another interesting phenomenon which we had observed, but did not go deeper into the issue in our intervention work. The weaker students seemed to have developed a "learned helpless" attitude and they gave up more easily in the face of failure as compared to the better ones who persevered and attempted to complete all the problem-solving tasks given. Even though it is beyond the scope of our study to explore the learned helplessness phenomenon (Seligman, 1975), but it remains our contention that past experiences with failures have affected the weaker students' belief in their ability at monitoring their own learning and consequently reduced their self-efficacy at handling problem-solving tasks.

There appears to be a paradox when we compare our observation of students' confidence at problem solving with their confidence judgement of their performance in Mathematics, Science and Social Studies. The weaker students obviously lacked the confidence in performing academic tasks and yet they tended to overestimate their ability at such tasks. However, we did not see this as a contradiction, but rather the two sets of results together provided further insight into the weaker students' metalearning experiences. It became more clear the insecurity and uncertainty felt by this group at their ability in monitoring their own learning and in controlling their performance at various academic tasks.

Referring to Table 1 again, it is observed that after intervention where the teachers in the experimental school had incorporated metalearning strategies in their teaching of Mathematics, Science and Social Studies, the students seemed to be more accurate in predicting their own performance in these subjects. Compared to the control group who overestimated their abilities at all the three subjects, the experimental group was more correct in their predictions that they had done better in the final examination except in the case of Science. From these results, it appears that it is possible to teach students to "metalearn", that is to become more conscious of their own monitoring experiences of learning, through building metalearning activities into classroom instruction.

In summary, our conclusions on the affective effects of our metalearning intervention included the following:

a. Our Primary Five students have developed the facility for monitoring their own learning,
b. Metalearning experiences can be raised to a more conscious level through instruction,
c. Metalearning instruction given can help the Primary Five students become more realistic and accurate in their predictions of their own abilities,
d. Weaker students have a tendency to overestimate their abilities in Mathematics, Science and Social Studies,
e. Better students may be more accurate in their estimation of their own abilities, but they still tend to overestimate their own ability in Science,

f. Weaker students may lack the facility to allocate time appropriately according to task demand, thus indicating their incompetence at monitoring metalearning experiences,

g. Weaker students do need help in the choice and employ of suitable strategies for solving different types of problems,

h. Weaker students lack the metalearning facility to monitor and make clear to themselves the processes of solving different types of problems,

i. Weaker students lack the confidence in problem solving and yet they display overconfidence in their assessment of their own abilities, thus indicating a sense of insecurity and uncertainty at monitoring their own metalearning activities.

j. Primary Five students can be taught to "metalearn" by incorporating metalearning activities in classroom teaching.

It is appropriate at this juncture to draw some implications from the results of our study for teaching and learning purposes. Teachers at Primary Five level should incorporate metalearning activities in their instruction in order to raise their students' awareness of their own learning capability and to help them make more accurate judgements about their own performance level in various academic subjects. Instruction perhaps should include teaching students to employ different strategies for the learning of Mathematics, Science and Social Studies. For example, pattern identification and the use of time lines and geometric figures might be useful for solving mathematical problems, while concept mapping and inquiry processes might be more appropriate for learning Science and Social Studies. There seems to be an urgent need to teach students organisational skills as well as skills in allocating appropriate study time in order to be to handle different types and levels of problems. When teaching students how to use their metalearning functioning facility, it is perhaps more effective to give informed instruction together with self-control training. Informed instruction would provide students the information about themselves, the tasks and the strategies that could be employed to learn the various academic subjects. Self-control training would give students the explicit instructions about the monitoring, checking and evaluating of the process of their learning in various subjects. This should include activities whereby the students, especially the weaker ones, are allowed to "think aloud" and to verbalize the processes of solving different types of problems in Mathematics, Science and Social Studies. From time to time, students are required to make confidence judgements, ease-of-learning judgements and feeling-of knowing judgements and they are subsequently given feedback on the accuracy of their assessments of their own learning capability. This feedback information should improve students' ability at monitoring their metalearning functioning, which in turn should improve their confidence judgements, thus reducing the chance for the learned helpless phenomenon to set in and as a result they become more persevering in problem-solving situations. The overall effect would be an improvement in students' belief in their capability at controlling their own learning and academic performance results.

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