Identifying and Developing Strategies: Beyond Achievement

Dr. Haneet Gandhi

Central Institute of Education, University of Delhi, Delhi 110007, India.

To put into praxis the theoretical assumptions that self-regulation skills are teachable (Schunk and Zimmerman, 1998), this paper describes a research on the efficacy of an instructional approach, the Strategic Content Learning approach adopted to promote self-regulated learning in average mathematics performers of grade VIII of Indian schools. These students with poor metacognitive skills, who lacked productive approaches in implementing or adapting learning strategies, were helped to manage their cognitive, volitional and motivational skills. Concomitantly, the students were helped in identifying and developing strategies while solving problems in mathematics. They also developed their personalised strategies that they could transfer across problems and time, thus becoming better self regulators.

Keywords: Self-regulation, metacognition, Strategic Content Learning

Naïve self-regulators need support and assistance to engage flexibly in the sequence of cognitive processes that comprise self-regulated learning (Schunk and Zimmerman, 1998). Drawing from a socio-cultural perspective social dialogue between the more learned peer and/or adult conducted within the context of meaningful tasks in students' 'Zone of Proximal Development (ZPD)' (Vygotsky 1978) promotes self-regulation. This general description of scaffold instructions though agreeable leaves the exact nature of adult guidance unspecified. Stone (1993) further articulates the nature of interactive instructions and suggests that support must be provided during scaffold instruction in a form of 'prolepsis' i.e. instructors make comments or statements that students strive to interpret, given their current incomplete understandings (optimally in their ZPD). It is this quest to make sense of the adult communications that promotes the active construction of knowledge and that spurs students' development of self-regulation. Butler (1995, 1998a, b) proposed an instructional approach, 'Strategic Content Learning (SCL)' to implement the theoretical assumptions of Stone (1993).

In Strategic Content Learning Approach, both instructors and students are equally charged with interpreting each other's comments, as a way of establishing a shared communicative context within which interactive discussions will be meaningful to students (Butler 1998a, b; Gandhi 2009).

This paper summarises the instructional dynamics and research findings of a study advocating the efficacy of SCL approach in promoting self-regulated learning in average mathematics performers of grade VIII of Indian origin. The study helped these students to remediate their performance by reflecting on their inaccurate understanding of the mathematical tasks, unproductive metacognitive knowledge, negative motivational beliefs, interfering external causal attributes such as frustration and anxiety, and faulty self-regulated skills.

An Overview of Strategic Content Learning (SCL) Model

In Strategic Content Learning approach, students are supported to engage in the cycle of self-regulated activities associated with successful learning. These activities include analysing task demands, selecting, adapting, or even inventing personalised or task specific strategies, implementing and monitoring strategy effectiveness, self-evaluating performance, and revising goals or strategies adaptively (Figure 1).

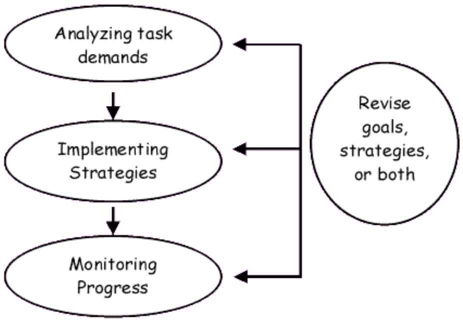

Figure 1: Strategic Content Learning Approach (Butler 1995, 1998a, b)

SCL is based on an analysis of self-regulated or strategic performance. Key instructional goals are defined, including students' construction of metacognitive knowledge, motivational beliefs, and self-regulated approaches to learning. In making students self-regulated a central instructional guideline is for teachers to support students' reflective engagement in cycles of SRL (i.e., task analysis, strategy implementation, self-monitoring). For example, to support the sampled group of students in solving problems in mathematics, the teacher started by helping them analyse the common task selected (problems in mathematics). They were asked to interpret available information (e.g. information given in the problem). They were guided to identify and implement strategies for meeting task requirements (e.g. organising the given information, finding relationship between the given information and what has been asked for in the problem). Finally, the students were supported to self-evaluate outcomes in light of task criteria (e.g. Are they happy with the solution strategy, can there be any other method of doing the same problem) and to refine their task-specific strategies so as to redress problems or challenges encountered (e.g. is their chosen method an elegant one, to compare and judge the most appropriate solution strategy for solving the problem).

A primary emphasis was not on teaching predefined strategies for completing academic tasks but to think about what the students would have done on their own if the teacher weren't there. The teacher guides students in their cognitive processing so that they become successful, intervening only when required. No direct explanations of the concepts are given. From a theoretical perspective, it could be argued that, if instruction focuses primarily on the direct explanation of predefined strategies, students may be inadvertently excluded from the problem-solving process central to self-regulation (Butler, 1993, 1995). If it were the teacher who has analysed a task, anticipated problems, and defined useful strategies, then students would have little opportunity to solve problems themselves and arrive at strategies. To avoid this problem, the teacher co-constructed strategies with students, bridging from task analysis. The teacher and the students worked collaboratively to find "solutions" (i.e., strategies) to the given problem. So, for example, when defining strategies for solving a problem, the students were to consider strategy alternatives in light of task demands (e.g., what strategies will they adopt to solve the problem, will they make a table, draw a diagram or do guess and check, etc.). Then, while working through the task collaboratively, the students were supported to try out strategy alternatives (e.g., to apply different problem solving strategies to solve the same problem), judge strategy effectiveness (e.g., whether they found the ideal and an appropriate strategy, how do they know), and modify strategies adaptively. Over time, through these iterative processes, the students (ideally) learnt how to construct personally effective strategies for meeting varying problems in mathematics.

Implications for instruction based on this integrated view are that teachers should (a) Collaborate with students to complete meaningful work (to generate a context for communication), (b) Diagnose students' strengths and challenges by listening carefully to students' sense making as they grapple with meaningful work, (c) Engage students in collaborative problem solving while working towards achieving task goals, (d) Provide calibrated support in given students' areas of need to cue more effective cognitive processing, (e) Use language in interactive discussions that students might employ to make sense of experience, and (f) Ask students to articulate ideas (e.g., about task criteria, productive strategies) in their own words to promote distillation of new knowledge.

For instance, to support average mathematics performers with their math problem solving, each group and the teacher worked collaboratively on the mathematical problems to set a context for communication (collaborating to complete meaningful work). The teacher began by observing students solve one or two problems, asking them to think aloud and discuss with their peers as they worked (diagnosing students' strengths and challenges). Attention focused on how they interpreted their task (the given problem), interpreted or understood mathematical concepts, represented problems, identified solution strategies and implemented procedures, and monitored their work collaboratively. Then, as described earlier, the teacher assisted the students to work recursively through cycles of task analysis, strategy use, and self-monitoring (collaborative problem solving while working towards finding a suitable strategy). When the group did well, the teacher supported them to recognise their success and reflect on the strategies they just used that worked (articulating ideas). The students documented these strategies in their personal math journals that they could review, test, and refine over time. When they encountered difficulties, the teacher assisted them to solve more effectively (calibrated support). For example, sometimes the teacher directed their attention to a sample problem and supported them to interpret that information. The students were helped to verbalise new insights and to try out new ideas (articulating ideas). Note that depending on the whole group's areas of difficulty discussion focused on problem-specific strategies (e.g., how to solve an algebraic equation), strategies usefulness for solving math problems in general (e.g., always checking your work in-between the steps, seeing patterns), and/or strategies focusing on learning math more independently (e.g., working through simpler examples if stuck, breaking the problem in parts, plan sub problems while working, computing on smaller numbers instead of large numbers).

Methodology

The study was carried out with 5 small-groups (5-8 students in each group) of average mathematics achievers of class VIII from 5 different English medium schools of India. Both boys and girls were selected.

An essential component of the study was students' voluntary participation; therefore in the first stage of multi-purposive sampling only those students were selected who voluntarily felt the need of assistance in learning mathematics. Subsequently, average achievers in mathematics (60-65% in last two years annual exams in mathematics) with average intelligence (45-55 percentiles on Cattle's Culture Fair Intelligence Test: Scale II) were finally selected from 5 different schools.

With each group the sessions were conducted for 15 days (of 1-1½ hour duration) wherein students worked in groups (peers and teacher) within the instructional dynamics of SCL. In a session 3-4 problems were taken and after completing the discussion on a problem the students were given private space and time to write their personal reflections in their respective journals.

In the pre-post research design the indicators of self-regulation were assessed both qualitatively and quantitatively. Qualitative data that assessed students' gradual success in becoming self-regulated by gauging their areas of problems and their approaches to overcome them was obtained through observations, researcher's field notes and comments, transcripts of audio tapes, students' self-reflections taken out from their math journals and the changes in initiation roles of students and instructor as the instructional sessions progressed. The quantitative inputs were attained through questionnaires on metacognition, self-efficacy, and perceptions of causal attributions that students generally state for their good or poor performance in mathematical tasks. The same questionnaires were administered during the pre and post-test situations. In addition to above, two parallel sets (one each for pre and post test) of non-routine mathematical problems were made to assess students' accomplishment in solving mathematical problems. This coalescence of inputs from qualitative and quantitative sources provided an in-depth view of each student's progress and a record of process of the instructional intervention. It also allowed for an explicit tracing of the relationships between instructions and outcomes.

Results and Discussions

One of the most consistent findings across the five groups was a positive shift in student's knowledge and beliefs related to the process of learning. In each group it was observed that students had developed a focused understanding about mathematical problems and problem solving strategies. For instance, a shift in comments of one of the students can be observed through his annotations taken from his math journal from three phases: initial, middle and last. There were instances of positive shifts in student's metacognitive understanding revealing his better understanding about mathematical problems, problem solving strategies and management of learning.

> In the initial phase (on one of the problems): I didn't find this problem interesting. My friends could do it, but somehow I did not understand anything. It was stupid of me to think in those terms… I felt a little awkward when the problem was over, because it was stressing me… I did not understand a bit what I am supposed to do…
>
> By the middle phase his reflections were more insightful: I needed help from my group members… It is good to write and think… I underlined the important words…it was also fun to draw diagrams…
>
> In the latter sessions: It was an easy problem. I could break the problem into sub parts. …solving smaller problems was easy… though lengthy but it leads to the answer. I understood the method to solve it. It was great. I liked this problem.

A noticeable increase was also observed in improved confidence level in students' work and in their learning styles. This can substantiated from the transcripts of the audiotapes extracted from early, middle and last phases of the interactions.

> Students: Ma'am we are really bad in mathematics
>
> Teacher: What makes you think that?
>
> Student1: I study a lot but when I see the paper I go blank
>
> Student2: I don't think I can do well in math…. I can't remember the formula
>
> Student3: I do lot of careless mistakes. I just can't get the answer.
>
> Teacher: What do you think would help you to improve?
>
> Student1: I don't think I can ever like the subject
>
> Student2: We always get low marks.

A conversation of the same group, taken from middle phase:

> Students: Ok, if we would have thought of it a little more we would have definitely done it.
>
> Teacher: How do you feel after doing this question?
>
> Student1: Good, … I think I can now do better in my exams. Ah! (Relaxed)

Latter phase transcript:

> Students: I think we know how to do this. Please don't help us. Give us time we will show you.
>
> (They worked in the group for 5-10 min)
>
> Students: We have done and checked the answer too.
>
> Teacher: Have you verified?
>
> Student: I think we don't need to… well… it's done and …correct!.

As the intervention progressed, students had developed personalised strategies that targeted their solution to the tasks. To trace changes in student's strategic approaches to problems in mathematics, their strategy descriptions were chronicled over time and related to their specific difficulties with tasks. Analyses also depicted that most of the students had independently transferred strategies across contexts, time and problems. Transcripts of one such observation from one of the groups:

> Early Phase: We don't know how to solve it we have never seen such problems. … How can we do this… any hints? (looks at the teacher)
>
> Middle phase: O.k. now let's think. First, let's break the problem and understand what it says…Maybe converting it into algebraic form may help.
>
> Last phase: (Each student was equally participating in the solution. Each one of them gave a suggestion and after much discussion, grappling and convincing each other they came to a common consensus): This could be done by drawing a table as I see this value is increasing as that. (After a pause).. can you see this relation… well let's start… (there is lot of discussion and they stated scribbling in the sheets).

Comparing the verbatim from the phased transcripts provide evidence of students becoming strategic performers as the intervention sessions progressed. They could understand problems more quickly, think of the problem solving strategies that were useful in solving problems and could justify and verify their strategies. Initially students didn't have a faith in their working but gradually they became active participants who could control their thinking. They had a better understanding of their strategies and could judge their own working.

Early phase interactions:

> Students: What should we do?

Teacher: Think…

(Long silence, no progress)

Teacher: It is better if you first rethink on what you have already done. (No response)

Teacher: let's try to rethink on our previous steps. Ok let's see what is given. (No action taken)

Teacher: Ok let's do it altogether again. Let's try to put whatever has been asked for

(The students and the teacher re-look at the given problem and the teacher rereads the problem several times, underlining some key words that might help them)

Teacher: So… should we begin?

Student: Ah… (Pauses and hesitant of replying)…ah… does it mean we take the first value as "x"

Middle phase interactions:

Teacher: Why did you work backward?

Students: because the problem is like that. (Students work on the problem)

Students: See it becomes easier like this…

Last phase interactions:

Students: This was a good problem. We enjoyed it.

Teacher: What did you learn?

Students: That this problem was not as difficult as we thought. We solved each subpart in an order. We just thought if we draw the diagram this might help… Ayush could see it after we drew this. Now he also agrees…

As the sessions progressed it was observed that students had started taking lot of interest in their work. They had all, eventually, learned to think about the task, devise or plan the strategies that would be most appropriate in solving a problem. They often provided convincing logical arguments in support of their selecting or choosing the problem solving strategy. It was observed that in initial sessions students took lot of time to solve a problem. They usually took 10-15 min in only grappling with the problem with no concrete idea of initiating the work. Peer discussions were also limited and not all the students were involved. Students generally relied on the teacher to begin and provide the solution. In gradual sessions it was observed that students took less time to solve the problems and finally in the latter sessions it was observed that students could efficiently organise their strategies and hence could come to the solution in much less time and with fewer instructions from the teacher. This account of time and instructions corroborate students as becoming better mathematics problem solvers. The collective data advocates improvements in students' increased awareness of selection, adaptation or invention of personalised or task specific strategies.

Strategies that students developed included steps focusing on each of the cognitive processes central to self-regulation. For example, students' strategies included steps related to problem analysis (e.g. " find out what the problem is asking for"); strategy selection based on problem requirements (e.g. "I think we need to make a table"); strategy use (e.g. "most of the times it helps to break the problem"); self-evaluation (e.g. "reread and think about how my equation relates with given information of the problem") and strategic adjustments (e.g. "if confused, take a break and rethink about the underlined words").

As suggested earlier, strategic learning may be best evidenced when students responsively adapt strategic approaches based on task demand. Thus, a good measure of shifts in self-regulated approaches would be student's independent development of strategies. In this study, students were observed to add steps to their developing strategies that targeted activities such as task analysis, strategy selection, self-evaluation, and self-monitoring. Evidence for changes in student's self-regulated approaches was also provided by student's descriptions of how they transferred strategic approaches for use across problems. In many cases, students described adapting specific strategy steps from their previously attempted strategies. For instance, while attempting a problem they commented:

> "Oh! This is similar to the one we had done before; the only difference is… This should be simple to solve."
>
> Another example can be drawn from the math journal of one of the students:
>
> "I knew what she (teacher) wants us to do, so, I translated (from English to Hindi) it (problem) for my friends. Heena did not understand it. When Pinky and I were talking about it, Heena got it … the way we do by putting arrows between the variables helped in making connections…. I was happy that we were right. I knew we should work systematically because if we do not plan we can't get it right…"

Consistent shifts in student's attributions indicated that students were more likely to attribute successful performance to internal factors like ability, effort, strategy use, motivation rather than the external factors like luck, help from others or conditions in the environment.

Conclusion

Through these qualitatively detailed and cumulative analysis it was ascertained that the participants not only developed and mastered task-specific strategies, but also learned how to self regulate more effectively. The research had served to introduce the Strategic Content Learning as a successful instructional approach for promoting Self-Regulated Learning in average performers of mathematics of class eight in small group situation. Notable results were consistent gains in task performance and metacognitive awareness about mathematical tasks and strategies. Also important were the findings that all the students were actively involved in developing strategies for themselves, and that the majority of students reported adapting productive approaches for use across the problems.

In short, the SCL approach seems to be a workable instructional approach wherein students and teachers work collaboratively in a shared communicative context and in the process of striving to understand each others comments become better performers and reflectors.

Notes

The names are fictional.

References

Butler, D. L.1995. Promoting strategic learning by post-secondary students with learning disabilities. *Journal of Learning Disabilities*, 28:170-190.

________ 1998-a. The Strategic Content Learning approach to promoting self-regulated learning: A summary of three studies. *Journal of Educational Psychology,* 90(4):682-697.

________1998-b. A Strategic Content Learning Approach to promoting Self-regulated learning by students with learning disabilities. In *Self Regulated*

Learning. From Teaching to Self-Reflective Practice, ed. D. H. Schunk and B. J. Zimmerman, 160-183. New York: Guildford Publications.

Butler, D.L. and Winne. P.H. 1995. Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, 65:245-281.

Gandhi, H. 2009-a. Problem solving in mathematics through Strategic Content Learning approach: Promoting self-regulated learning. *Unpublished doctoral dissertation.* Department of Education, University of Lucknow, Lucknow, India.

Gandhi, H., and M. Varma. 2009-b. Strategic Content Learning approach in promoting self- regulated learning. Paper presented in epiSTEME-03, An International Conference to Review Research on Science, Technology and Mathematics Education: India. 119-124

MacLeod, W.B. Butler, D.L. and Syer. K.D., 1996. Beyond achievement data: Assessing changes in metacognition and strategic learning. Paper presented at the annual meeting of American Educational Research Association: New York.

Schunk, D. H. and Zimmerman, B. J. 1998 *Self Regulated Learning. From Teaching to Self-Reflective Practice*. New York: Guildford Publications.

Stone, C.A. 1993. What's missing in the metaphor of scaffolding? In *Contexts for Learning: Soci-cultural Dynamics in Children's Development,* ed. E. Forman, N. Minick and C.A. Stone. 169-183. New York: Oxford University Press.

Vygotsky. L. 1978. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Zimmerman, B.J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, 81, 329-339.