

# Promoting and Monitoring Self-regulated Learning Techniques in Engineering Schools

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***Abstract:** Self-regulated learning (SRL) comprises a set of processes that students can use with the objective of improving academic performance. SRL has been the subject of research for over two decades and there is a general acceptance that the methodology has some real value in helping students to increase academic achievement.*

*There remains some uncertainty about how best to introduce SRL to students, to encourage use of SRL, and to measure the benefit (or otherwise) of its practise. Tools for SRL have been developed and are available to students and educators. This paper discusses how SRL may be taught and how student usage of the techniques may be encouraged and monitored.*

## Introduction

Research into SRL continues and the field is widely recognized as being important in the context of enabling students to improve academic achievement. Challenges remain in getting students to use SRL methodology, determining the value of SRL and in obtaining definitive measures of its effect.

Self-regulated learners are those who actively participate in managing their time, construct their own goals and strategies, and monitor and control their own cognition, motivation and behaviour (Pintrich, 2004). SRL comprises four phases: forethought, planning and activation, and: monitoring, and: control, and: reaction and reflection.

Regulation extends to:

**Beliefs** with respect to goal orientation, or understanding reasons for performing the task, and its importance, utility and relevance. Beliefs about one's self-efficacy (judgments about ability to carry out the task), and perceptions of the difficulty of the task may be subject to regulation.

**Self** in the context of, for example, positive self-talk. Extrinsic motivation may be increased by the promise of a reward for successfully completing the task. Intrinsic motivation may be boosted by turning the task into a game, or by engaging with peers to share understanding of concepts of the subject at hand. The value of the task to the individual may be increased by relating the task to real life experience or potential relevance to a chosen career.

**Behaviour** in terms of effort management. One monitors effort applied to the task and adjusts as required. This aspect is particularly important when the task is perceived to be boring. Recognition of when, how and where to seek help is a component of behaviour regulation.

It is vital that students learn to regulate procrastination, which in the student setting includes failing to complete tasks on time, and leaving work until the last minute. Procrastination is not automatically overcome by adopting SRL methods (Wolters, 2003), though through practising SRL learners may make some progress in reducing this undesirable behaviour.

Two views of procrastination are popular. The first suggests that it results from stable personality traits such as perfectionism, identity style and self-consciousness. The second implies that the roots of procrastination lie in less stable, situationally determined influences, such as fear of failure, evaluation anxiety, or feelings of incompetence. Engineering educators in general are probably not equipped to

overcome procrastination based on stable personality traits, but all educators should be capable of reviewing their practise in order to reduce the impact of the situational factors. Adjustments to assessment methods and provision of detailed feedback may have considerable value in reducing assessment anxiety. Procrastination is linked to beliefs regarding ability to complete tasks, and a desire to avoid hard work and extended effort. Students who practise SRL are not necessarily less likely to procrastinate than non-practitioners.

Of course motivation is an important aspect of learning. Two types of motivational beliefs are often used to describe self regulated learners, namely self-efficacy and goal orientation. Self-efficacy can be summarized as a belief in one's ability to perform a given task. Goal oriented learners may have differing goals. One learner may have the goal of subject mastery, whilst the goal of another learner may be oriented toward performance. Generally students who exhibit a mastery orientation tend to be more adaptive and have better cognitive outcomes than those who are not oriented toward mastery. Performance oriented students are more concerned with obtaining better grades than others, obtaining some reward or proving their self-worth to parents, teachers and peers. These latter students generally are less adaptive than the former, and are less willing to undertake difficult tasks and more willing to give up when confronted with a significant challenge.

It is suggested that performance goals may be divided into performance-approach and performance-avoidance orientations. Students with the performance-approach tendency are concerned with looking good to others, whereas those who display performance-avoidance focus on avoiding demonstration of a lack of ability or skill.

A second wave of SRL research is associated with developing measures to determine measures of the effectiveness, and student feelings toward SRL (B. J. Zimmerman, 2008). One method used for obtaining data is the use of online diaries. Although many students have engaged in SRL practise in the classroom situation, it appears very few proactively undertake SRL at home. The online diary concept is intended to stimulate adoption of SRL, whilst simultaneously providing data about its use, effectiveness and student feelings toward SRL. Zimmerman describes a project in which a software package, "gStudy", was used to record traces of student learning behaviour.

The package communicates with online learning resources, and records observations of individual student activity. For example, activities such as frequency and patterns of highlighting text, accessing learning support material, and obtaining feedback. Such data are logged unobtrusively. The package incorporates a diary feature in which students note metacognitive judgments, such as deciding to return later to work not initially understood, and comments about understanding of, and feelings about the material.

In an experiment designed to measure the value of SRL in students of computer programming, forty students were randomly divided into two groups (Kumar et al., 2005). One group (the treatment group) received training in SRL whilst the control group received none. Both groups completed a programming task after the training period and their work was graded by an independent evaluator in accordance with conventional practise for evaluating programming work. Grades awarded ranged from A+ to D. Of the A grades awarded, 70% were gained by the treatment group. The control group received 73% of C and D grades. B grades were shared almost equally between both groups. The authors concluded that, by incorporating SRL theory into the programming teaching, they enabled their students to obtain better programming performances than would have been achieved if SRL training were not given.

Problems in under preparation of students and high attrition at the University at Buffalo, New York, have been addressed over two decades (Tinnesz, Ahuna, & Kiener, 2006). In addition to being poorly prepared for study at university, students showed a lack of motivation in that only 34% of them reported undertaking six or more hours of independent study per week. The approach taken is the introduction of an elective paper named Methods of Inquiry (MoI). The MoI paper exposes students to theories, strategies and techniques for learning and thinking. Over the two decades during which the paper has been running graduation rates have risen from 32% to 41%, and the retention rate is 6% higher among students who have completed the MoI paper than in those who have not.

At Maastricht University, in Holland, a study was conducted among first-year psychology students to consider the relation between SRL strategies and academic achievement (Van Den Hurk, 2006). The study revealed that students who spend more time than other students in planning require less individual study time to complete their work. Not only do students who carefully plan their time allocation appear to work more efficiently than those who do not plan well, they achieve higher marks in cognitive tests.

Bernhard Schmitz and Bettina Wiese investigated the process of SRL among 40 Civil Engineering students at a German university (Schmitz & Wiese, 2006). Participants kept a diary in standardized format for each of seven weeks. The forty students were divided into two groups, experimental and control. All participants received training in the use of diaries. Members of the experimental group received four, two-hour sessions in SRL training, and the control group received none. During the first session students were introduced to SRL concepts and received instruction on the use of the diary. Important aspects of goal setting were developed during the session.

At the second session experience with the diaries were discussed and time management strategies were discussed as tools to assist with goal achievement. Methods of procrastination avoidance were discussed also. Day-planning and week-planning instructions were given with the help of pre-structured forms.

Time management and use of time during the previous week were discussed at the third session. Strategies were then developed to avoid wasting time. Self-motivation was introduced, and students learned about extrinsic and intrinsic motivation factors. Small groups of students were formed to evolve methods of self-motivation and arranging positive study environments.

The final session comprised learning about self-instruction in the context of eliminating negative thoughts and engaging in positive self-talk. Finally instruction was given in how to manage concentration as well as use of progressive relaxation techniques.

Analysis of data retrieved from the diaries compared outcomes from the experimental group with those from the control group. Students in the experimental group showed significant gains in intrinsic motivation, self-efficacy, effort, attention, self-motivation, handling distractions and reducing procrastination. Members in the control group showed some improvement in motivation.

Whilst no clear data linking SRL with academic achievement is presented, the study does claim that use of a structured diary in conjunction with SRL was valuable in assisting students with goal setting and time management.

The relation between homework frequency and academic achievement was the subject of an investigation across 1976 students in 125 seventh grade mathematics classes in German schools (Trautwein, Köller, Schmitz, & Baumert, 2002). It was found that many, short homeworks had a positive effect on student achievement. Lengthy homeworks had a slightly negative effect. Further, it was shown that students had a strong tendency to avoid lengthy and or difficult assignments.

## Discussion

The foregoing suggests that, in general, significant numbers of students are not self-motivated to the extent that would be expected in university students destined for success. Procrastination is a factor encountered by several researchers. A tendency to avoid large and or difficult assignments has been observed in many cases. The use of structured diaries, whether in hard copy or online, serves at least two purposes. Firstly, students may use diaries for planning and time management, as well as for recording reflections on aspects of their learning, motivation, procrastination and other factors. Secondly, diaries may provide data for researchers attempting to evaluate SRL or trends in motivation, feelings and whatever else may be recorded in a particular diary.

A set of tools for students to use in practising SRL was proposed by Barry Zimmerman (B. Zimmerman, 1989) and has been modified for use in a particular learning environment by the present author and a colleague (Jowitt & Jovanovic, 2007). Instruction in SRL was given, and instructional

material (including the modified tools) was made available to students of Mechanical Engineering at AUT University during semester two, 2007 and semester one, 2008. Students were advised of the potential benefits of SRL and were strongly encouraged (without compulsion) to practise techniques of planning, time management, self-reflection and self-motivation through positive self-talk, using the tools (abridged) presented below.

### **1. Self evaluation:**

The student checks any work done to ascertain its correctness to the greatest extent possible.

### **2. Organizing and transforming:**

The student plans the work before starting. Transforming, especially in the context of essay-type assignments and reports, may include copying, then paraphrasing course material or material gleaned from other sources.

### **3. Goal-setting and planning:**

Goals are generally short term, mostly fitting within with time frames from a minimum of few days to a maximum of two semesters. Plans may be established for carrying out an assignment, preparing for a test or exam, or for an approach to an entire module.

### **4. Seeking information**

Familiarity with information retrieval from library and or internet is vital.

### **5. Self-monitoring**

The student should observe feelings about self-efficacy, comprehension, motivation and procrastination.

### **6. Environmental structuring**

The study environment should be conducive to preferred learning circumstances. Distractions such as television, computer games and telephones should be eliminated. Cell should be phones turned off and left in another room. Lighting should be arranged so the work is well illuminated, without shadow, and bright lights are not directly visible. A good supply of fresh air should be maintained.

### **7. Self-consequences**

Reward for good performance. When a major assessment is handed in on time, and or when a target mark is achieved. The target does not have to be 100%, a mere pass will suffice for a new student or one who has been failing. The target may be set a little higher as the course of study progresses. Striving for continuous improvement (even in small increments) will eventually build self-efficacy.

### **8. Rehearsing and memorizing**

May include recording and replaying lectures, reading aloud, and practicing computations. Procedures for solving mathematics-intensive problems may be learned by repetition.

### **9. Seeking social assistance**

Appropriate sources of help within the faculty or university should be identified. Help from friends, peers, and should be sought as appropriate. Participation in study groups is beneficial.

### **10. Reviewing records**

Students should regularly review marks obtained for assignments. Persistent low marks in a module should indicate that additional effort is required in that module.

Neither group of students showed any better outcomes in terms of academic achievement than previous groups in the same papers. Likewise, the perennial problems of procrastination and lack of motivation appeared to persist unchanged. Since only 20% of students accessed the material no valid conclusions can be drawn from the experience. What can be concluded is that efforts must be made to increase the uptake of SRL among students.

It is apparent that a structured approach to SRL must be undertaken by students and teachers alike. To this end a pro forma for student self-reflection is proposed. It requires the student to pause every half hour to review performance during the previous thirty minutes and to note perceptions of what actions were taken, results achieved, level of concentration and distractions that may have been present. It is suggested that this pro forma be incorporated into a diary so that the student regularly makes observations and records details of perceived performance.

Based on the premise that students who plan their work well are better able to manage their time and spend less time in successfully completing assignments (Van Den Hurk, 2006) it is suggested that planning is one of the most important facets of SRL. From the student perspective regular self-monitoring and self-reflection must rank very highly, and from the educator perspective understandings of motivation and procrastination are as important as providing SRL knowledge and resources.

Procrastination needs special consideration as it may not necessarily be overcome by SRL (Wolters, 2003). It appears that even well motivated students may be subject to procrastination, especially that which is due to situational factors. As such procrastination, whilst important, is beyond the scope of this paper.

It has been demonstrated that students are more willing to take on many, small tasks rather than a few large, difficult tasks (Trautwein et al., 2002). Any project, regardless of how complex and overwhelming it may appear, is simplified when broken down into a number of small, manageable tasks. Perhaps the project of engaging marginal students in their learning would become more achievable if small assignments were given regularly, especially during the first year of the university course, rather than fewer, larger assignments.

If SRL really does have role to play in increasing graduation and retention rates, as claimed for the MoI paper (Tinnesz et al., 2006), then of course it is all of our interests to pursue it actively. Aside from ideological considerations, the harsh reality is that our future employment will probably depend more on course completion rates than currently.

## Conclusion

Strong links between self-efficacy, motivation and academic performance are established. Deficiencies in these areas are often attributable to poor organization and inadequate study techniques on the part of learners. It is proposed that under-performing students will benefit from knowledge of SRL techniques, in particular planning and self-reflection. In order to verify that SRL is working, regular monitoring is required. This may be largely facilitated through the use of diaries. Emerging software packages make the extraction of data from online diaries a relatively simple process

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