*Journal of Engineering Education Transformations ,*
*Volume 35 , No. 2 , October 2021 , ISSN 2349-2473, eISSN 2394-1707*

# Self- Regulated Learning (SRL) Strategies on Engineering Faculty Members, Executives, And Students

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**Abstract :** The Indian engineering faculty members need to be exposed to self-regulated learning strategies and adult learning methods to plan effective competency development programs for the engineering graduates. The engineering students need to be informed on the industry needs and the performance desired in the workplaces. Without a focus on improving skills analysis, planning, design concepts, and high-order cognitive skills, problem-solving abilities and critical thinking skills, many engineering students performed poorly in the basic and core engineering courses. Some of the students displayed a negative response for a few applied science courses. These are due to their self-regulated learning system. In this research, six batches of engineering faculties have been trained to focus on the students' self-regulated thinking, acting, behaving, and engaging in purposeful activities. The impact is that the engineering students actively manage their metacognition, motivation, and behavior after passing through the self-regulatory process. The trained faculties prepared their instructional design on the needs of the contextual knowledge and their utility on professional development. The increase in pass percentage after redesign improved to 16.17% in the basic courses, 17.37% in the core courses, and 5.99% in the advanced courses. When the faculty members are trained in the appropriate instructional design to meet the demands of the fast-growing and knowledge-based economy, this resulted in unprecedented students' success not only in their examinations but also in their performances in the workplace. Further, the executive and employee development programs are to be carefully planned and implemented to get maximum return on the investment (ROI) in the fast-changing manufacturing technology.

**Keywords:** Self-Regulated Learners (SRL), Performance Management, Faculty Development Programs (FDP), Planning Executive Development Programs (EDP), Metacognition, & Intrinsic Motivation.

## 1. Introduction

Most of the engineering students displayed maximum academic achievement at the time of entry into the engineering programs, but their performance decreased after joining the engineering college. Even some of the high achievers failed in many basic and core courses. The problem is due to self-regulation which relates to the use of cognitive processes such as critical thinking, taking-action, metacognition, behaving and engaging in purposeful professional activities. The engineering students are self-directed,

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autonomous, and independent. They carefully plan their education so that they can transfer to the workplace.

The executives of various companies were deputed to engineering colleges for training and development programs so that they can reduce the cost of production, accidents, energy consumption, improve quality and productivity.

The faculty members of the engineering colleges need to be trained in planning various courses for self-directed learners from novice students to executives of industries. The fast-developing country, India, needs high-quality professional trainers and educators.

## 2. Literature Survey

According to Zimmerman (1994), self-regulated learning (SRL) is learners' "self-generated thoughts, feelings, and actions which are systematically oriented toward attainment of their goals". Hence, it's a self-direction process through which the participants can transform their mental skills into professional skills. According to Zimmerman (2002), self-regulated learning is a cyclical process, wherein the participants plan for a learning task, monitoring their performance, and then reflecting on the outcome. The cycle then repeats as the learner uses the reflection to adjust and prepare for the next task. The process should be tailored for individual learners and for specific learning tasks.

Butler and Carter's (2004) "Socio-Constructive Model of Self-Regulation" enables the investigation of the interplay between metacognitive knowledge and metacognitive control within the context learning activity

Markus Dresel et al. (2015) have proposed a structural model that differentiates SRL competencies in terms of descriptive, procedural, and conditional knowledge regarding different types of self-proposed model.

The Cycle of Self-Regulated Learning [Zimmerman, (2002); Zumbrunn et al. (2011)] for training and development programs of in-service participants like industry executives

Many organizations approach engineering colleges to train their executives and employees to modernize their manufacturing processes. The executives have their self-regulated learning concepts. They need to be counselled and trained. The following are the instructional design processes in conducting executive development.

1.Plan, Set Goals, and Layout Strategies,

2. Use strategies and monitor their performance,

3. Self-Reflect on Their Performance

According to Zimmerman (2002) the three stages of self-regulated learning are:

1. Planning Stage- The participants establish their goals and performance standards.

2.Performing Stage- The participants demonstrate their commitment to their learning experience; they compare their progress with the standards established at the planning stage.

3.Reflection Stage- They evaluate their learning experience, reflecting over feedback, storing the concepts, rules, and cognitive strategies for use in future learning.

Three Layered Conceptual Model of SRL Boekaets (1999) proposed the three-layered conceptual model of self-regulated learning is presented in Table-1.

**Table 1 : Three Layered Model of SRL**

| Layer | Representation |
|---|---|
| Regulation of the processing modes | Choice of cognitive strategies or learning styles or deep approach |
| Regulation of learning process | Use of \\\\\ metacognitive knowledge and skills to direct learning (monitoring, and evaluating and correcting skills) represents the future utility of leaning style like metacognitive knowledge |
| Regulation of self | Choice of goals and resources (regulation of self and motivation) |

How do organizations adapt to changing contexts?

Due to continuous improvements in contextual knowledge and emerging technology, the organizations improve their skills and competencies

of their employees in planning, designing, and manufacturing by using high performing machines, training their shop floor- employees and supervisors using software, and ensures high quality and competitive products. Due to this, the employees must be trained by appealing to their self-regulated learning process. They select the most suitable trainers, with an appropriate environment, motivate them to improve their skills and abilities. This is presented in Table 2.

**Table 2 : SRL of the Employees**

| Changing Workplace | Employees | Focus-Self Regulated Learning |
|---|---|---|
| Advanced Production Methods | Senior Executives | Goal Setting, Strategic Planning, Self-reflection. |
| High Productivity | Middle-Level Managers | Performance, Attention focusing, & task strategies |
| Use of Software | Operators | Planning to acquire new skills |
| Improved Quality | Shop Floor Employees | Acquiring new Abilities |

This leads to planning employee development programs, improved performance, and assessment of the improvements and quality contribution. The employees are guided to undertake self-regulated learning. They assess their self-efficacy and set goals to master new skills. They evaluate the learning strategies and choose the best. They improve their performance under the encouragement of qualified trainers. They continue to self-regulate their learning. The employees can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their learning process. It is in line with a social cognitive perspective (Bandura, 1986), self-regulated learning occurs.

Singer and Bashir (1999) have described self-regulated learning as a meta construct defined as a set of behaviors that are used flexibly to guide, monitor, and direct the success of one's performance' and 'to manage direct interactions within the learning environment to ensure success'.

Vermetten, Vermunt, and Lodewijks (1995) presented evidence of associations between a deep approach to learning and a preference for opportunities for the internal regulation of learning, and between a surface approach to learning and a preference for external regulation. Coffield et al. (2004) and Rayner (2007) represented the future pedagogical utility of learning style approaches, i.e. to develop metacognitive knowledge and awareness.

Ning Fang et al. (2016) conducted a summer program focused on engineering education research on self-regulated learning. They offered a variety of activities catered, and designed for students, including orientation, seminar series, and a final symposium. The students tend to be ready to learn what they believe they need to know (Albert Kamp, 2016, David Beanland & Roger Hadgraft, 2013). Their learning orientation is problem-centered, task-oriented, and life-focused (Graham J Davies et al. 2007). They are internally motivated, and the students must manage their cognition, motivation, and behavior after passing through certain self-regulatory processes. The students must set realistic goals, strategizing to achieve these goals. Metacognition is the knowledge of individuals about their cognitive processes and the strategies they use to control these processes (Michael Bassis, 2015).

Criteria Suggested by Zimmerman to apply across most self-regulated learning perspectives

1. Purposive use of specific processes, strategies, or responses by participants to improve their professional achievement.

2. Use of a self-oriented feedback loop involving participants monitoring the effectiveness of their learning strategies and responding to feedback with changes in self-perceptions or learning strategies.

3. A motivational dimension-involving self-efficacy belief-which determines the choice of self-regulatory processes, strategies, or responses.

These criteria are to be considered whenever new methods are to be introduced in the colleges or industries to improve performance.

Needs of the Engineering Faculties

The engineering faculties are to be exposed to the cognitive system, cognitive knowledge, self-system, intrinsic motivation, students' perceived value of learning tasks, students' metacognitive system, self-

guidance system, learned helplessness, and at-risk learners. This research is centered around these concepts and develops guidelines for the faculty for a systematic instructional design.

According to Linda Nilson (2019), self-regulated learning is about one's relationship with one's ability to exert the effort, self-control, and critical self-assessment necessary to achieve the best possible results.

## 3. Andragogy

Malcolm S. Knowles' Theory of Andragogy is a learning theory that is developed on the specific needs of adults. Knowles emphasizes that executives are self-directed and expect to take responsibility for decisions. Executive development programs must accommodate this basic aspect. The following table summarizes the processes of self-directed learning and andragogy (Table-3).

**Table 3 : Andragogy**

| ***Factor*** | ***Self-Directed Learning (Butler & Cartier's Model)*** | ***Andragogy (Malcolm S. Knowles' Theory)*** |
|---|---|---|
| Self-concept | Ready to meet the challenges | Increasing self-directedness |
| Experience | Trying to gain experiences. | Learning is a rich resource for learning |
| Readiness | Ready due to self-perceptions | Development Tasks of social roles |
| Time Perspective | Self-regulating | Problem centered |
| Learning Climate | Students engage in learning | Mutually respectful, Collaborative & Informal |
| Planning | Based on contexts, strengths, and interests. | Mutual self-diagnosis |
| Objectives | Personal objectives | Mutual negotiation |
| Design | Self-regulating activities | Sequenced in terms of readiness problem units |
| Activities | Cognitive strategies | Experiential techniques (Inquiry) |
| Evaluation | Compare outcomes with internal or external standards | Mutual re-diagnosis |

## 4. Objectives of Research

1. To identify the possible reasons for large failures of the engineering students in the basic and core courses even though they have achieved very well in their higher secondary examinations.

2. To assess the students' learning process, self-system, learning and belief, the perceived value of the learning tasks, and metacognitive system.

3. To suggest guidelines to the faculties on students' self-system, counseling the students on the utilities of core and basic courses in engineering, and use the principles of andragogy in the instructional design.

4. To review the self-regulated learning strategies of the faculty members

5. To review the self-regulated learning strategies of employees of industries

Part-1 Research Methodology

To develop the skills of engineering faculty in planning needed instructional design and delivery based on SRL the following instructional activities have been undertaken:

A set of six engineering colleges in the southern region have been selected and the around 30 faculty members in each college have been trained on the principles of self-directed learning (SRL), andragogy, a cognitive system, metacognitive system, a cognitive knowledge, self-system, students' learning process, learned helplessness system, andragogy, and at-risk learners, and perceived value of tasks. The faculties have been requested to identify the learning difficulties of their students, the performance of the students on the basic and the core courses in the semester examinations. They have been guided to redesign the courses and the instructional methods. The needs for various courses, their utility in engineering projects, planning, design, prototype, testing and improving, program educational objectives, and the planned outcome are discussed.

They revised and improved the courses and included many field-specific cases. Further, the impact of new technologies on engineering is also discussed. The career planning of the students has been evaluated. This created a purposeful learning environment. They communicated the value of learning the basic and core courses and why the engineers need to learn. This helped the students to focus on their cognitive system, learning process, intrinsic motivation, and improved performance. The outcomes of this methodology have been assessed through the results of the semester examinations. The students were given case studies to investigate and offer solutions. This is like offering jobs in fast-growing companies. This has motivated them to concentrate on the needed skills and competencies. They desired to undertake field-specific problems.

Many desired to choose a design-oriented project, and some desired manufacturing jobs. Their motivation was highest. This methodology is almost like project-based learning or problem-based learning. The major differences are the learners' motivation and achievement goals are tapped. They also incorporated their projects in to their portfolio. They actively participated in the industrial exposures. A few got internships in leading companies.

## 5. Analysis of The Performance

The performance of students of six institutes are presented as outcomes in basic courses, core courses, and advanced courses in Table-4 below:

**Table 4 : Increase in Performance in the Examinations**

| College | Average Pass % (Basic Courses) Before | Average Pass % (Basic Courses) After Redesign | Average Pass % (Core Courses) Before | Average Pass % (Core Courses) After Redesign | Average Pass % (Advanced Courses) Before | Average Pass % (Advanced Courses) After Redesign |
|---|---|---|---|---|---|---|
| C1 | 62.4 | 74.7 | 58.2 | 69.7 | 86.1 | 91.1 |
| C2 | 67.3 | 77.1 | 59.3 | 69.8 | 86.3 | 90.8 |
| C3 | 68.5 | 78.5 | 60.7 | 70.1 | 89.1 | 92.4 |
| C4 | 59.6 | 69.4 | 58.6 | 67.2 | 88.4 | 92.3 |
| C5 | 58.5 | 75.1 | 56.6 | 67.3 | 80.7 | 89.1 |
| C6 | 57.4 | 69.3 | 54.4 | 63.7 | 81.6 | 87.2 |
| Average | 62.28 | 72.35 | 57.97 | 67.97 | 85.37 | 90.48 |
| **% of increase** | **72.35-62.28 =** | **16.17** | **67.97-57.97 =** | **17.37** | **90.48-85.37 =** | **5.99** |

Inferences and Discussions

Average pass per cent increases in the Basic Courses (Chemistry, Physics, Mathematics) after improvements in the instructional design = 16.17%

It is inferred that the changes in the instructional design and delivery substantially improved the performance of the first-year students. It is further inferred that the needs of the basic courses have been well received by the students and they have understood the needs of these courses and studied well.

Average pass per cent increase in the Core Courses (Drawing, Engineering Courses) = 17.3%.

The updated instructional design has improved 17.37% pass percent increase on the average.

Average per cent increase in the Advanced Courses = 5.99.

It is inferred that the students have understood the needs of the advanced courses even before the improved instructional design. Hence, the average pass per cent increase is only 5.99.

Role of Faculty in SRL

The following steps must be taken by the faculty members to achieve the goals of SRL:

· Counselling, Coaching, and Mentoring of the participants in the planning stage.

- Assisting on the growth of the job market
- Skills and competencies needed
- Choosing the courses to meet the career goals
- Reviewing the performance
- Aiding to improve the performance
- Suggestions for undertaking research projects
- Planning publications
- Suggestions to undergo industrial training
- Suggestions for preparing portfolios and campus interviews, and
- Guidance for postgraduate programs.

Part-2: Focus on Self-Directed Faculty Development Programs

Many graduates join the teaching profession as soon as they graduate. Later after serving for about five years, they avail the leave to pursue postgraduate programs. Again, after another five years, some would plan to undergo Ph.D. programs. This process of updating their skills and competence can be modeled under self-regulated learning as follows:

i). Planning Stage (Metacognitive learning strategies)

- Changing contexts in higher education (their growth demands higher degrees like master's and Doctoral degrees),
- They self-evaluate their mental capability,
- They choose to self-regulate their further learning,
- They plan, and set goals to acquire a postgraduate degree in the desired field of specialization,
- Choose appropriate institute/ university which offers desired advanced courses or change to another institute or choosing another guide,

ii). Performance Stage (Cognitive learning strategies: Deep learning and transformation)

- They allow the time for classes, assignments, field visits, etc.) (Time Management)
- Choose desired courses, an internship in industry, taking prescribed tests and submitting the assignments, topic for dissertation or thesis, (Motivational Orientations)
- Undertake projects and publishing papers to get desired grades (Situational Motivation state)

iii). Reflection Stage

- Monitor their progress like grades, and publication of original papers in desired outstanding journals,
- They evaluate their performance against the standards prescribed for graduation or employment
- Acquire needed competence for guiding the students or undertaking sponsored research projects or to bid projects under Multinational National Companies (MNCs) International Development Agencies (IDAs).

This process can be modeled as similar to Boekaets' (1997 &1999) model since the action of the participant encompasses motivation, cognitive and metacognitive aspects.

Barriers to Self-Regulated Learning

- Approval to pursue the planned courses was denied by many educational administrators.
- Improper course schedules
- High course fees
- Conflicts with the guides/supervisors
- Lack of laboratory resources
- Lack of desired electives

The educational leaders must ensure that the goals are achieved due to systematic efforts of the training and development process.

Part-3: Opposition to Implement Certain Advances in the Curriculum and Instruction to Implement by the Faculty Members

Many faculty members have Self-Regulated Learning (SRL) based on the available resources, management support and the feasibility of implementing the advances need in the curriculum, instructional methods, evaluation, and industrial exposure. Some of the resistances brought forwarded are as follows (Table-5):

**Table 5: Changes and Faculty Reactions**

| Changes Contemplated | The Reaction of the Faculty Members |
|---|---|
| Introduction of Industry-Specific Curriculum in Engineering Programs | The faculty felt that there is no response from the industry; the management will not modernize the facilities in the labs and workshops; there is no active partnership between the institute and industry; and no need to support the industry when they pay less salary to the graduates. |
| Improvements to the instructional methods like to use case study, blended methods, industry-sponsored dissertation, etc. | There is no need to change the current instructional methods; there are no proper case studies to supplement the classroom teaching; industries are not interested in sharing the data and information to undertake the dissertation works; there is no benefit to the faculty; there is a large shortage of faculty; the institute is located in a rural area, etc. |
| Part-time programs | Additional work; can't find spare time; there is no reward; promotion is based on non-academic criteria, etc. |
| Development self-instructional of modules and MMLPs | Shortage of supporting staff, shortage of Software like Director, Toolbook, and Authorware, etc. for developing multimedia learning packages. |

Suggested Solutions

Improve the resources and infrastructure, salary, and recruit and promote faculty based on their academic credentials, initiate active collaboration between the Institute and industry, and implement strategic planning. The mere introduction of changes will not improve performance in such poor academic environments. There is a need for capacity development, quality improvement, and efficiency improvement. Self-regulated learning of the faculty reflects the poor resources, motivation, recognition, and rewards. Until the academic ecosystem is improved, implementation is not possible. There is a need for constant interactions between the trainers and the sponsors in planning, reviewing, and improving the development programs.

Part 4: Development Programs for Executives of Companies

These development programs could be planned by the organization to inculcate the needed skills and abilities. 12 short-term programs have been conducted for 208 executives of private companies and government engineering departments and presented in Table-6.

**Table-6 Executive Training**

| Context | Type of the Training Program |
|---|---|
| Improving skills and competencies that are related to current occupation. | Short-term courses on contextual knowledge and skills. Sponsored customized in-house programs. |
| Acquiring advanced skills and professional competencies for promotion or new jobs in another company | Part-time graduate and postgraduate programs; Flexible sequential summer and winter schools; massive online open courses. |
| Advanced production processes based on upgrading the manufacturing to world-class standards | Training in similar companies, Corporate universities, Training in the collaborator's plants. |
| Advanced knowledge in creating a moder n manufacturing plant. | Focused postgraduate programs and internship s in the modern production units which is similar to the proposed manufacturing units. |
| Consultant to industry | Full-time or Part -time Doctoral Program |

There is a need for constant interactions between the trainers and the sponsors in planning, reviewing, and improving the development programs.

Characteristics of Executive Learners

Based on the discussions, the following information has been obtained. Most of the executives have their self-regulated learning strategies and have an identifiable mission. Further, the following characteristics need to be considered in planning development programs:

- Bringing the past experiences to the classroom/ training organization.

- Pursuing self-direction based on the personal and organizational mission.

- Coming to the classroom to resolve the doubts and to get solutions

- Ready to learn the advances in his/her areas which are needed to fulfill his/her goals

- Learner's educational interest should meet his/ her career goals

- Values the program when it meets his/her areas of concern.

The Motivation of Executive/ In-Service Learners

Almost all the executives have the motivation to perform very well in a challenging environment. Some of the issues are as follows:

- Social relationships, associates with similar professional experiences,

- Ready to meet the classroom challenges,

- Ready to undertake social work,

- Plans to upgrade his professional advancement,

- Looks for advances in the theories related to his current works,

- Looks for new knowledge and higher-order cognitive development.

Barriers to Pursuing the Needed Training Programs

From the feedback of executives, the following barriers are received:

- Too short courses

- The course objectives are too shallow

- Lack of practice sessions

- Lack of guidance to select the training institutes

- Lack of qualified trainers

- Lack of coaching and mentoring

- Lack of quality manuals and job-aids

These barriers have to be eliminated in future courses.

Part-4: Planning and Implementing Executive Development Programs who are deputed by organizations for improving the performance of the organization based on the Self-Regulated Learning

208 Executives of various companies and government departments have been trained in SRL. The focused areas are:

1. Reducing the Manufacturing Cost of Auto-Ancillary Components,

2. Reducing the Power Consumption for Cement companies,

3. Improving the Environment Quality around Cement Plants,

4. Improving the Safe Work Practices in a set of 25 Cement Companies,

5. Improving the Skills of Agricultural Students in Fruit Processing in a developing country,

6. Improving the Skills in Trekking for the instructors in a mountaineering institute,

7. Improving the Performance of Hotel Managers established by a state,

8. Improving Managerial Skills in Small Business Units of local entrepreneurs.

9. Certifying the skills acquired by the experienced workers through skill testing based on the NVEQF Model.

10. Developing skills in video production.

Instructional Development Process

- Conduct needs assessment survey based on the improvements to be introduced in the workplace.

- Evaluate the existing practices, leadership, tools, ergonomics, resources available, prevailing environment of the organization, interpersonal relationships in the workplace.

- Evaluate the reasons for poor performance.
- Evaluate the existing skill levels of the employees/ workers/ students.
- Analyze the learning tasks.
- Set the goals, objectives to meet the planned developments.
- Assess the needed equipment, tools, resources, operating manuals, job aids, work-place environment, instructional manuals, case studies, action research problems, & participant activities.
- Plan the instructional package to improve the skills.
- Counsel the participants on the program.
- Get the feedback and input so that the needed changes can be introduced.
- Improve the motivation by describing the outcome and benefits to the organization as well as to the participants.
- Conduct participative skill development/ or knowledge development programs with a planned instructional method with appropriate learning aids, on-the-job practice, and safe work practices, to reach preplanned outcomes.
- Clarify their doubts.
- Focus on skill transfer.
- Ensure the needed resources in the organization after completion of the training.
- Get a evaluation of the participants' performance by the sponsoring agency.
- Discuss and make changes desired.
- Observe the performance of the participants and interact.
- Train them to overcome the obstacles in the workplace in consultation with the managers of the organization.
- Monitor the improved performance and progress.
- Get the feedback on the resources, tools, job aids, manuals, leadership, interpersonal relationships, environment, appreciative inquiry on their performance.
- Coach the participants wherever required.
- Guide them on time management.
- Adopt proper planning, needed strategies, and suggest self- monitoring.

This training helped the senior faculty members to plan and implement many training and development programs for the MSMEs and local government executives.

## 6. Conclusion

The faculty of the engineering colleges need exposure and training on the socio-cognitive learning theory, self-regulation, self-system, metacognition, self-regulatory process, motivation, and behavior, setting realistic goals, self- evaluation, designing instructions to appeal to the self-system of the students, achievement motivation. They must be councilors, coaches, and mentors to the learners. The instructional design should be based on the self-regulated learning of the engineering students.

This approach has improved the pass percentages as follows: Basic Courses: 16.17%; Core Courses: 17.37% and Advanced Courses: 5.99%.

It is concluded that instructional design based on self-regulation and self-efficiency would enhance the performance and competence of the engineering students and they will become industry-ready.

The faculty need to be trained in planning executive development programs which are sponsored by various companies in the state. The outcome assessed after 5 years shows a substantial improvement in the performance of the organization.

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