The Science behind Self-regulatory Behaviours of Student Teachers
A Neurocognitive Outlook

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Abstract

Teachers play a pivotal role in teaching-learning, societal and nation building. In this perspective, the teacher quality determines students' learning, societal and national development. The preparation of quality teachers is possible through self-regulation practices in the Teacher Education programme. Self-regulated teachers understand their accountability and the importance of their role. They perform well in preparing lesson plans, curricular designs, teaching aids, word choice, group building and in giving individual attention in teaching and learning. It also facilitates the teachers to sense their students' mood, body language and classroom environment in their teaching. Neurocognitive concepts explain how the self-regulation process occurs in one's brain in a scientific way. It also explains how the quality behaviours will emerge. The integration of neurocognitive ideas in the field of education promotes effective performance of teachers as well as the learners. This paper delineates the scientific factors involved in the construction of self-regulated behaviour of student teachers.

INTRODUCTION

The growth and development of a country is measured by its economic status. This economic status is achieved through quality of education; it depends upon the quality enhancement in the Teacher Education programme. The concept of quality in education has gained attention among policymakers,

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Teacher Educators, teachers, parents and students. A teacher is the most important catalytic agent of the society who influences the quality of education. Quality enhancement in Teacher Education improves the quality of education. The quality of teachers also directly influences the self-regulation process in a behavioural perspective.

Neuroscience is the scientific study dealing with the structure and function of the nervous system. The neuroscientific concepts explain how the process of self-regulation occurs in our brain. Proper application of neurocognitive concepts in the Teacher Education programme influences self-regulation among the student teachers. It helps develop the attitude, knowledge, skill and professional competencies of a teacher among the student teachers.

Self-regulation

Self-regulation refers to self-generated thoughts, the control of one's emotions that channelise the behaviour towards the attainment of personal goals. Self-regulated students consciously think and sensitise the internal and external circumstances and perform in a meaningful way. It enhances problem solving behaviour, motivation and decision making as well as the intention of systemic mindfulness of the students. The components of self-regulation include personal, behavioural and environmental factors. The behavioural self-regulation involves self-observing and strategically adjusting performance processes, such as one's method of learning. Environmental self-regulation involves observing and adjusting the environmental conditions or outcomes, and the covert or personal self-regulation involves monitoring and adjusting cognitive and affective states, such as imagery for remembering or relaxing. These three components interact and interlink with each other, whenever and wherever better adjustment and performance are required. Thus, self-regulation involves triadic processes that are proactively as well as reactively adapted for the attainment of personal goals.

Self-regulation allows people to make plans, choose from alternatives, control impulses, inhibit unwanted thoughts, and regulate appetitive behaviour (Heatherton 2011). Whereas poor self-control puts people at risk of various health and interpersonal problems, those who are best able to self-regulate their behaviours demonstrate better mental health (Duckworth & Seligman 2005, Tangney et al. 2004). Self-regulation proposes that a critical balance exists between the strength of an impulse and an individual's ability to inhibit either the desire itself or performance upon the desire.

Self-regulation and Self-regulatory Strength

Self-control or self-regulation is defined as the capacity to override natural and automatic tendencies, desires, or behaviours; to pursue

long-term goals, even at the expense of short-term attractions; and to follow socially prescribed norms and rules. In other words, self-regulation is the capacity to alter the self's responses, to achieve a desired state or outcome that would otherwise not arise naturally. Thus, the goal of self-control is to interrupt the self's tendency to operate on automatic pilot and to steer the behaviour consciously in a desired direction.

The construct of self-regulatory strength is relevant at the stage when a person has detected a discrepancy and is ready to initiate actions to reduce it. At this point, the person must have the inner psychological resources (that is, self-regulatory strength) necessary to alter behaviour in a way that will bring oneself closer to the internal standards or goals. This form of self-regulation is one important function of the executive system, which also subsumes other forms of volitional and active capabilities of the self, including planning and problem solving, goal-directed behaviour, decision making, as well as logical and intelligent thought.

Cognition in Self-regulation Formation

The four general phases of cognition involved in self-regulation are helpful in the formation of the individual. The first phase of forethought, planning and activation, stimulates the planning and goal setting as well as activation of perceptions and knowledge of the task and circumstance. It also enhances the self in relation to the task. The second phase is monitoring, which concerns various processes that represent the metacognitive awareness on different features of the self or the task and context. The third phase is the control which involves efforts to control and regulate different aspects of the self or the task and context. Finally, the fourth phase represents various kind of reactions and reflections on the self or the task and context.

The process of developing self-regulation engages different cognitive strategies. The cognitive strategy of cognitive planning and activation contains three general types of planning or activation: (i) target goal setting, (ii) activation of relevant prior content knowledge and (iii) activation of metacognitive knowledge. Target goal setting involves the setting of task-specific goals. Forethought and planning involves the activation of relevant prior knowledge. Activation of prior knowledge can and does happen automatically and without conscious thought. Students, who are self-regulating themselves more, can actively search their memory for relevant prior knowledge before they actually begin performing the task.

Cognitive control and regulation includes the cognitive and metacognitive activities of the students who engage in activities to adapt and change their cognition. The students attempt to control, regulate and change their cognition

according to the achievement of the goal and current progress towards the goal. One of the central aspects of the control and regulation of cognition is the actual selection and use of various cognitive strategies for memory, learning, reasoning, problem solving and thinking. The selection of appropriate cognitive strategies enables the students to have a positive influence on learning and performance.

The cognitive processes of reaction and reflection involve students' judgements and evaluations of their performance on the task as well as their aspirations for performance. The good self-regulated students do evaluate their performance; at the same occasion, students who avoid self-evaluation are not aware of the importance of self-evaluation in terms of the goals set for the task. Good self-regulators evaluate each and every action of theirs for better performance.

Self-regulation in the Brain

An understanding of the brain mechanisms underlying self-regulation can provide valuable insights into how students are able to regulate and control their thoughts, behaviours, and emotional states, and what happens on those occasions when they fail to do so. Though neuroscience has formed a relatively clear picture of the brain systems that give rise to reward motivation, the field has struggled to coalesce around a unified view of the control mechanisms that support self-regulation.

One commonly held view of self-regulation is that humans have evolved specific control systems, particularly within the prefrontal cortex (PFC), that permit superior planning and behavioural flexibility, perhaps owing to the disproportionate amount of cortical expansion in the human PFC (Rilling 2006). The PFC supports high-level cognitive abilities necessary for self-regulation, such as working memory, response inhibition, attentional filtering, decision making, and planning (Miller & Cohen 2001, Tranel et al. 1994). Anatomically, the PFC is the portion of the frontal lobe that lies anterior to the primary and secondary motor cortices. Researchers generally agree that the PFC can be divided into several distinct areas, although the precise anatomical boundaries separating sub-regions of the PFC are debatable. Three PFC sub-regions have been identified as important for self-regulation: the ventromedial PFC (vmPFC), the lateral PFC (including the dorsal and ventral convexities), and the anterior cingulate cortex (ACC).

Ventromedial Prefrontal Cortex

The exact anatomical boundaries between the vmPFC and OFC (Orbito Frontal Cortex) are coarsely defined, perhaps owing to the fact that the orbital PFC and vmPFC are cytoarchitectonically similar (Ongur & Price 2000). As a result, these terms are often used interchangeably when

referring to regions along the ventral medial wall of the PFC. The superior border of the vmPFC is considered to originate around the genu of the corpus callosum [including the medial aspect of Brodmann Areas (BAs) 11, 12, and 25 and the ventral portions of BAs 10 and 32], and the inferior border often overlaps the gyrus rectus and the middle orbital gryus. The vmPFC shares reciprocal connections with subcortical limbic structures such as the amygdala (Amaral & Price 1984) as well as regions typically associated with reward processing, such as the ventral striatum (Haber et al. 1995). Because of its interconnectedness with both the amygdala and ventral striatum, the vmPFC has been implicated in both emotion regulation (Quirk & Beer 2006) and self-regulation of social and appetitive behavior (Fehr & Camerer 2007, Hare et al. 2009, Lin et al. 2012).

Lateral Prefrontal Cortex

The lateral PFC is composed of both the dorsal and ventral convexities—specifically, BAs (Brodmann Areas) 8, 9, and 46 and 44, 45, and 47—and it receives highly processed sensory input from the dorsal and ventral visual streams (that is, the so-called what and where pathways) (Barbas 1988). It projects to secondary motor regions (Petrides & Pandya 1999), the basal ganglia (Nambu 2008), and the ACC and vmPFC (McDonald et al. 1996). The lateral PFC has been traditionally associated with language

functions in the left hemisphere (BAs 44, 45, and 47) and more generally, with core executive processes such as working memory (Curtis & D'Esposito 2003, Smith & Jonides 1999), response selection (Thompson-Schill et al. 2005), and response inhibition (Garavan et al. 1999). As such, the lateral PFC may play a crucial role in supporting many of the complex cognitive operations needed for successful self-regulation (Cohen & Lieberman 2010).

Anterior Cingulate Cortex

The anterior cingulate is the agranular portion of the cingulate, incorporating both the mid cingulate and the anterior perigenual cingulate (BAs 24, 25, and 32). Although not strictly a part of the PFC, the anterior cingulate cortex (ACC) is widely associated with cognitive control and conflict monitoring. A functional dissociation along the dorsal and ventral aspects of the ACC has emerged from meta-analyses of neuroimaging studies reporting ACC activity (Bush et al. 2000). Specifically, activity in the dorsal ACC (dACC) often signals the occurrence of cognitive conflicts during a variety of tasks that encourage response competition (for example, the Stroop task), including those that involve the commission of errors (Botvinick et al. 2004, Carter et al. 1998, Kerns et al. 2004). By contrast, activity in the ventral ACC is more typically associated with social and emotional

processes (for example, Somerville et al. 2006, Whalen et al. 1998).

Successful self-regulation involves many executive functions, each of which may have a neural signature that differs, depending on specific task demands, (for example, controlling thoughts, reappraising emotion, or inhibiting prepotent responses during a Stroop task), and any one test of executive function may tap only one piece of a larger control system. Thus, a network-level approach may help delineate which systems are important for successful self-regulation.

FEATURES OF SELF-REGULATION SYSTEM

- Self-regulation system must be conscious, unlike automatic and implicit influences of sub cortical reward activity; effective self-regulation relies on conscious, ongoing attempts to regulate behavior (Baumeister & Masicampo 2010, Hofmann et al. 2009, Posner & Rothbart 1998). As a consequence, self-regulation is effortful and slow by comparison. Event-related neuroimaging studies hoping to glimpse momentary instances of self-regulation may fail to do so because a self-regulation system designed in this way would perpetually lose to the faster, automatic sub cortical systems. To compensate, a conscious, effortful self-regulation system must be tonically engaged to be ready in advance for incoming reward cues.

- Self-regulation system must understand time. An effective self-regulation system must be capable of understanding what the ventral striatum cannot—that short-term, immediate rewards can have negative long-term consequences. As such, a self-regulation system must be capable of long-term goal planning and goal maintenance to effectively regulate against impulses with long-term negative consequences and to promote behaviours with no short-term immediate reward (for example, exercising) that are intended to improve long-term well-being (Baumeister & Heatherton 1996).

- Self-regulation system must be configurable. Long-term goals change, and different situations necessitate regulation of different impulses. As cortical real estate is limited, the individuals are not likely to have an independent self-regulation system for each of their vices. An effective self-regulation system must therefore be domain general and capable of swapping and updating goal parameters as situations dictate.

- Self-regulation system must be anatomically positioned to interact with both processing and output systems. If self-regulation systems are domain general and configurable, then they must be interconnected with multiple

processing systems to exert control over impulses or motor plans that conflict with long-term goals.

Six Main Domains of Self-regulation Formation

Self-regulation of an individual involves developing one's own interpersonal and intrapersonal self-regulation, within one's conscious mind. The development of interpersonal and intrapersonal self-regulation processes takes place in six main domains: (i) self-awareness, (ii) managing one's own emotions, (iii) motivating oneself, (iv) recognising emotions in others, (v) handling relationships, and (vi) self-evaluation. While intrapersonal self-regulation includes self-awareness, managing one's own emotions and self-evaluation, the interpersonal self-regulation includes recogniing emotions in others and handling relationships. These six self-regulatory domains function in a meticulous way to interact with each other for the development and conscious maintenance of self-regulation.

1. *Self-awareness* is an 'awareness of both our mood and our thoughts about that mood', in the words of John Mayer (1993). It creates awareness of one's moods as one experiences them. When one gets into a bad mood, one does not ponder and obsess about it, and is able to get out of it sooner. In short, one's mindfulness helps manage one's emotions. Self-

awareness represents an essential focus, one that attunes us to the subtle murmurs within, that can help guide our way through life. This inner radar holds the key to managing what we do, and just as important, what we do not do. This internal control mechanism makes quality teachers.

There are two major streams of self-awareness — 'me', which builds the narrative about our past and future; and 'I', which brings us into the immediate present. The 'me', as we have seen, links together what we experience across time. The 'I', in stark contrast, exists only in the raw experience of our immediate moment (Daniel Goleman 2013).

The mind deploys self-awareness to keep everything to do on track. Meta-cognition — thinking about thinking — lets us know how our mental operations are going, and adjust them as needed; meta-emotion does the same with regulating the flow of feeling and impulse. In the mind's design, self-awareness is built to regulate our own emotions, as well as sensing what others feel.

2. *Managing one's own emotions* is a sense of self-mastery to know their own emotions and control them in a manner to be able to express it in a meaningful way. The positive and negative emotions determine the sense of well-being. Positive emotions enhance good, self-

regulatory mechanism among the students. Managing one's own emotions reduces the emotional instability and activates the conscious act of thinking.

The process of self-regulation is closely connected with process of emotional regulation. Students apply different strategies in managing their emotions. The Process Model of Emotion Regulation (Gross and Thompson 2007) explains the five families of emotion regulation strategies. The first family is that of situation selection, where a person can control the appraisal process before it even begins by actively choosing to place oneself in particular contexts and not others. The second family of emotion regulation strategy—situation modification involves direct efforts

promote desired emotions, while ignoring cues that promote undesired emotions. Attentional deployment gates particular cues into the appraisal process, allowing some aspects of the situation to become the focus of attention, while excluding others from it. A fourth family of strategies, referred to as cognitive change, allows a person to modify the meaning of particular cues, once those cues have gained access to the appraisal process. The fifth family of emotion regulation strategy, response modulation, affects only the outputs of reappraisal process. Using this strategy, control processes can suppress or augment behavioural manifestations of one's emotional state, such as smiles, frowns, or tendencies to approach or withdraw.
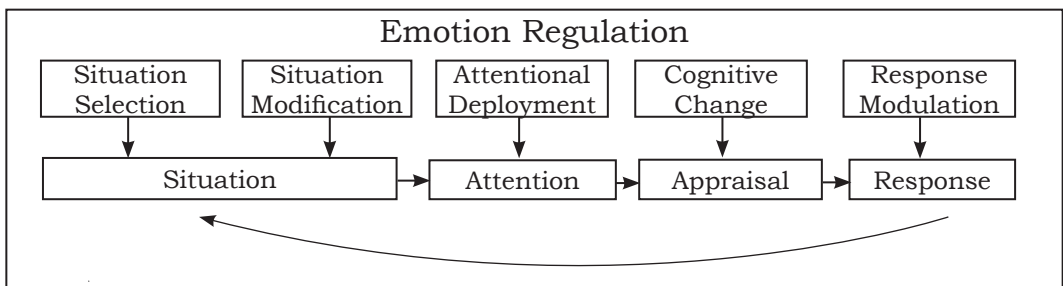

Figure 1. A process model of emotion regulation that highlights five families of emotion regulation strategies
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to change the situation to modify its emotional impact. Once the particular context has been set, a third strategy may direct attention to the environmental cues that

Managing one's own emotions helps to regulate the self-management behaviour. Activating the well-balanced thinking and emotions of the individual

regulates ones self-management. Its function is to initiate plans and actions to achieve the desired goals. Self-management consists of the ability to effectively integrate the three components of self-regulation.

- Appropriately identify the problem, formulate an accurate mental representation of the event, and plan behaviour according to relevant information;

- Implement cognitive activity in a manner that will promote personal success and satisfaction; and

- Monitor and evaluate internal and external feedback to execute behaviour to meet obligations and duties (Sternberg 1988).

Self-management of the teacher enhances the desirable goal and controls the undesirable behaviour. Managing one's emotions facilitate the management of their own moods and develop self-management behaviour among teachers.

3. *Motivating oneself is* the marshalling of feelings of enthusiasm, zeal and confidence in achievement of the goal. It is one of the domains in the process of self-regulation. It energises the mind and body towards achieving a goal. Emotion and motivation are closely intertwined; emotions are often evoked when motives are achieved or thwarted, and thus, they can be indicators of an underlying motivational state. Conversely, emotions influence motives by activating approach or withdraw behaviours. For instance, a student who wants to graduate with high honors is highly motivated to study. After receiving a bad grade, however, the student's emotional response may lead to a behaviour that reduces the likelihood of attaining the goal (Dale Purves et al. 2008).

Students who are motivating oneself direct their behaviour towards the task, have judgements of competence to perform a task, task value beliefs and personal interest in the task. It enhances the effort, persistence, involvement, performance and learning aptitude among the students. Motivating oneself increases the self-regulation of personal interest to the attainment of the task. It also varies according to the situation and contextual features of the student. The students can control and regulate their own motivation according to their interest, need and satisfaction in job performance.

There are many different strategies that students apply to motivate themselves. They control their negative emotions and increase their positive emotions to the task. The strategies of self-efficacy, self-affirmation and self-worth and positive self-talk regulate the motivation to oneself. Intrinsic positive emotions of joy, interest, happiness and enthusiasm

regulate the motivation among the students.

Motivating oneself speaks to the more general sense, in which channelling emotions towards a productive end is a master aptitude. Whether it be in controlling impulse and putting off gratification, regulating our moods so they facilitate rather than impede thinking, motivating ourselves to persist and try, try again in the face of setbacks, or finding ways to enter flow and so, perform more effectively (Daniel Goleman 1996).

4. *Recognising emotions in others* is the ability of understanding others emotions through facial reading, tone of voice and the behavioural actions. It creates emotional self-awareness in the students to understand others feelings to maintain a good relationship with them. This makes them better at callings such as the caring professions, teaching and management. Recognizing emotions in others generates empathy towards them. It is a kind of self-regulation process to realise and recognise others feelings and moods. This understanding helps form strong interpersonal relationships with others. 'You need to understand your own feelings to understand the feelings of others' (Tania Singer 2010).

Supersensitive reading of emotional signals represents a zenith of cognitive empathy, one of the three main varieties of the ability to focus on what other people experience. This variety of empathy lets us take other people's perspective, comprehend their mental state, and at the same time, mange our own emotions while we take stock of others. This is a top-down mental operation to regulate our self-regulation to understand others.

In contrast, with emotional empathy we join the other person in their feelings along with them; our bodies resonate in whatever key of joy or sorrow that person may be going through. Such attunement tends to occur through automatic, spontaneous and bottom-up brain circuits. Emotional empathy recognises what another person thinks and resonates with their feelings.

It does not necessarily lead to sympathy, concern goes further—leading us to care about them, mobilising us to help, if need be. This compassionate attitude builds on bottom-up primal systems for caring and attachment deep down in the brain, through this mix with more reflective, top-down circuits that evaluate how much we value their well-being. Cognitive empathy gives the ability to understand another person's ways of seeing and thinking (Daniel Goleman 2013). The self-regulatory process of recognising emotions of others allows us to think about our own

thoughts and feelings. We need to apply the same reasoning to other people's mind. It enhances in reading a person's feelings, gets stronger and thus, paves the way for smoother social interactions.

5. *Handling relationships* is the skill of managing one's own emotions, and understanding others emotions. This type of self-regulation creates awareness about others feelings and thinking. It facilitates the individuals to understand their own behaviour and others behaviour for managing relationships better. Handling relationships triggers one's social sensitivity and social skill for better adjustment in the society.

    To manifest such interpersonal power, students must first reach a benchmark of self-control, the beginnings of the capacity to damp down their own anger and distress, their impulses and excitement, even if that ability usually falters. Attunement to others demands a modicum of calm in oneself. Tentative signs of this ability to manage their own emotions emerge, when students control and regulate their cognition and emotions. Thus, handling emotions in someone else—the fine art of relationships requires the ripeness of two other emotional skills, self-management and empathy.

    With this base, the 'students' skills' are to be developed. These are the social competencies that make for effectiveness in dealing with others; deficits here lead to ineptness in the social world or repeated interpersonal disasters. Indeed, it is precisely the lack of these skills that can cause even the intellectually brightest to be found in their relationships, coming off as arrogant, obnoxious or insensitive. These social abilities allow one to shape an encounter, to mobilize and inspire others, to thrive in intimate relationships, to persuade and influence, to put others at ease (Daniel Goleman 1996). Students who have this type of social competence perform well in classroom management as well as in institutional management.

6. *Self-evaluation* refers to comparing self-monitored information with a standard or goal, such as a sprinter judging the practice runs according to his or her best previous effort. There are four distinctive types of criteria that students use to evaluate themselves: mastery, previous performance, emotional adjustment and social sensitivity. Mastery level self-evaluation triggers the self-analysis of their mastery in subject as well as further improvement of the subject. Self-analysis of previous performance facilitates the students to know their own strength and weakness in each and every action. It also enhances the better adjustment and attitude of the students. Self-evaluation of emotional adjustment generates good management skill in managing and expressing

emotions. Social sensitivity stimulates the understanding and recognising ability of the need of others, need of the society and better social adjustment. This evaluation enhances the personal improvement on social consciousness. Self-evaluation makes the students indulge in a self-reflective practice. It allows the student teacher to evaluate their progress towards learning goals.

Activation of past memories of the individual regulates one's own self-evaluation. During this process, the individual controls his emotions and triggers his reflective memories. It refers to comparing self-monitored information with a standard or goal, such as a sprinter judging practice runs according to his or her best previous effort. There are four distinctive types of criteria the teacher needs to evaluate themselves: mastery, previous performance, social sensitivity, thoughts and actions.

1. The student teacher has to evaluate one's own mastery level of the present curriculum. One should know one's strength and weakness in mastery level. This self-evaluation enriches the content knowledge in the teacher trainee.

2. The student teacher has to evaluate one's own previous performance as well as the student performance based on the transactional competencies. It involves comparisons of current performance with earlier levels of one's behaviour, such as baseline or the previous performance.

3. The student teacher has to evaluate one's own social sensitivity to develop societal skills. One should analyse the existing social needs in the globalised world. Accordingly, the curriculum, method of teaching and method of learning gets changed. This social sensitivity triggers transactional competencies among teacher trainees.

4. The student teacher has to evaluate one's own thoughts and actions in classroom teaching and learning. They should evaluate where, when and how the thoughts and actions are used during the subject content transaction.

A self-regulated student teacher evaluates instructional effectiveness based on comparison with his previous performance. As a result of this evaluation process, one develops their behavioural, cognitive and affective responses.

CONCLUSION

Self-regulation is a process controlling one's own thoughts and feelings to achieve long-term goals. The self-regulated teachers improve their competencies through their thoughts and self-evaluation. This process meaningfully integrates the cognition and emotion of the trainees to think consciously and to take action in achieving their goals. Neurocognitive perception explains how neural

networks of the brain function during the self-regulation. It also creates awareness about the brain areas involved in the self-regulation process. The proper understanding of neurocognitive concepts in self-regulation formation among Teacher Educators enhances their awareness about neurocognition. It helps the Teacher Educator and teacher education programme to prepare quality teachers.

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