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Examining Mindfulness in Education

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***Abstract*—**Despite the availability of numerous learning opportunities ranging from face-to-face to computer-based learning, there is need for better understanding of how to support the development of cognitive skills in students. Research has shown that cultivation of mindfulness skills help to develop cognitive skills such as retention, thinking, problem solving, and emotional balance. However, there is only limited research on the effect of mindfulness training in educational settings. We examined cognitive abilities of university students as identified in Bloom's taxonomy and mindfulness skills during a single traditional face-to-face class room session. We hypothesized that mindfulness is a specific cognitive ability that supports the development of other cognitive skills. This pilot study included 148 students from undergraduate and postgraduate programs at two universities in Sri Lanka. The study assessed cognitive abilities, including retention, thinking, out-of-the-box thinking, note-taking and mindfulness at the end of a one-hour lecture. The results showed that students' self-reported mindfulness following a lecture was significantly lower than other cognitive abilities. These results suggest conducting a more formal controlled experiment to investigate the effect of mindfulness training in education.

***Index Terms*—**Education, Cognitive skills, Mindfulness, Learning, Computing, Bloom's Taxonomy, Attention

I. Introduction

Over the last three decades, there has been an explosion of interest in mindfulness meditation and its impact in medicine, psychology and promotion of well-being. Since the late 1970s, there has been an exponential growth of research publications related to mindfulness meditation [1]. In the early 1980s, Jon Kabat-Zinn introduced a mindfulness meditation program in the West as a tool to reduce stress [2]. From the early 1980s until the late 1990s mindfulness-based interventions (MBIs) were limited to behavioral medicine. However, mindfulness meditation is now a major area of study in clinical and health psychology, cognitive therapy, neuroscience, education, business, and leadership. Research has demonstrated the effectiveness of mindfulness to improve clinical symptoms and well-being. Research on mindfulness in educational settings, however, has been limited, despite evidence that mindfulness meditation may enhance cognitive capabilities [3], [4].

It is evident that students at all levels are increasingly facing greater challenges in regulating their attention and are experiencing increasing rates of anxiety [5]. For instance, about 12% of the population in North America suffers from social anxiety, and more importantly 80% of these individuals developed social anxiety before reaching the age of 18 years old. Undoubtedly, the increase in anxiety disorders in young adults is partially influenced by deficits in educational opportunities and systems that prepare students to face the increasing complexity of the modern world. We suggest that one possible remedy is mindfulness meditation because it has been shown to reliably reduce symptoms of stress, anxiety and depression, as well as increase attention, emotional balance and cognitive abilities [6], [7]. To empirically test this hypothesis, we conducted a cross-sectional study to determine whether trait mindfulness is related to cognitive abilities in 148 students from undergraduate and postgraduate programs. Using Bloom's taxonomy for teaching, learning and evaluation [8], we examined the cognitive capabilities of note-taking, retention, thinking, and out-of-the-box thinking following a one-hour lecture. More importantly, we examined mindfulness by assessing whether the students were aware of when their attention was diverted from the lecture, and whether they were capable of re-orienting their attention to the lecture. The objective of the research was to generate empirical evidence of the relationship between Bloom's taxonomy and mindfulness in a real-world learning context, namely a university lecture. Our intention was to conduct this pilot study as a basis for a subsequent controlled experiment to examine the effect of

mindfulness training on cognitive skills development in educational settings. We observed that without such a preliminary study, students are not ready to participate in formal mindfulness training within the Sri Lankan culture. This is due, in part, to the existence of differing views and acceptance of mindfulness practice in Sri Lanka. For this pilot study, we hypothesized that university students would endorsement mindfulness skills at a significantly lower than any of the other cognitive skills identified in Bloom's taxonomy.

Rest of the paper is organized as follows. Section II discusses the related work in mindfulness training to various sectors with a special reference to educational settings. Section III presents the theoretical background for our research. Section IV presents the Methods, while Section V is on Results. Section VI concludes the research with a discussion.

II. Related Works in Mindfulness Traning

Advances in computer technology have opened numerous computer-based methods for supporting education. Such initiatives range from delivery of course material, assisting in the learning process, evaluation and giving feed-back to the learner. For example, Davar has described the use of modern ICT/computing for enabling, reading, hearing, seeing and doing in the learning process [9]. This project has gone from traditional classroom learning to what is called smart classroom. One specific result of this project is the achievement of higher levels of employment in students who trained in the smart classrooms. Despite the power of computer-based learning, research by Chou and colleagues has shown the importance of face-to-face teaching, and the importance of evaluating combinations of learning methods [10]. There are also numerous studies on the commuter-based learning for computing areas such as open source [11], computer programming [12], web learning [13] and so forth. Much research has been conducted on different forms of web-based learning such as e-learning [14], and effectiveness of MOODLE [15]. However, there is little research in computer-based learning that has investigated the development of the cognitive skills during learning sessions. Lavy and Yadin used SOLO taxonomy for assessing cognitive skills developments in system analysis and design modules in computing [16]. They concluded that SOLO taxonomy is inadequate for assessing cognitive skills in students. We suggest that the study of cognitive skills in students would benefit from measurement of retention power, thinking power, note taking and maintenance of attention. These cognitive skills are considered very essential to support focused reading and processing of material online and to reduce overlearned maladaptive habits of mindless browsing which is counterproductive to learning. Next we discuss research on cognitive skills developments, with a particular emphasis on cultivation of mindfulness in the traditional classroom setting.

Mindfulness training programs in educational settings have taken root in several countries, including England (Mindfulness in Schools project, DotB), USA (Mindful Schools and MinUp), Canada (Mindfulness Education), Israel (The Mindfulness Language), and India (The Alice Project) over the last ten years[17]. The majority of education focused MBIs [18]–[20] are based on modifications of the Mindfulness-Based Stress Reduction (MBSR) program developed by Kabat-Zinn.

At the Preschool level, simple exercises have been developed to introduce and train mindfulness [3]. These include developing awareness of pictures, sound, and coordination of hearing and physical actions. Lillard has studied the parallels between practices at the Preschool level and mindfulness training strategies [3]. We suggest that early childhood learning is largely based on simple awareness rather than through a complex thinking process or referring to a body of prior knowledge. Activities related to mindfulness practices can be seen in Montessori education. Knowing the parallels between mindfulness training and Montessori activities might reveal that cultivation of mindfulness is more of a natural process than a purposely created series of exercises in preschool children. Stated another way, mindfulness can be developed while engaging in day-to-day life activities. Research by Geeta and colleagues has shown that use of an abacus enhances attention abilities and may support the development of other cognitive features such as momentary storage of transitional data, number identification, and quick manipulation [21]. Thus, the relationship between mindfulness and cognitive skills may be more of a natural process that can be developed during simple daily life activities.

Several MBIs have been implemented in school settings at the primary and secondary levels as well. Mindfulness training has been shown to improve attention in students in first, second and third grades of elementary school [22]. In K-12 educational settings, MBIs have demonstrated increases in students' working memory, academic skills, social skills, emotional regulation, self-esteem, and decreases in anxiety and stress [23]. The same study also revealed that mindfulness training improves teachers' sense of well-being, teaching self-efficacy, class room management and supportive relationships with students. Another program called Mindfulness-Based Wellness Education (MBWE) [19] produced increases in teaching self-efficacy and physical health. The Cultivating Awareness and Resilience in Education (CARE) program has shown that mindfulness training enhances present-moment awareness, compassionate and listening ability of teachers, as well as improved well-being and more autonomous motivation in students [24]. Stress Management and Relaxation Techniques (SMART) [25] produced decreased occupational stress, increases in mindfulness skills and work motivation and improved the interaction between students and co-workers. Thus there is growing evidence for the positive impact of MBIs in primary and secondary educational settings.

Some studies have begun to examine the effects of mindfulness training in the college and university settings. These studies are primarily concerned with students' well

being or/and development of cognitive skills in college settings. Ritvo and colleagues have pointed out that mindfulness interventions started to gain popularity in view of the high cost and inefficiencies in traditional counseling of university students [20]. Eisenberg and colleagues have pointed out that almost one third of university students suffer from symptoms of depression and anxiety [26]. Mrazek and colleagues demonstrated that a mindfulness intervention can increase performance in the Graduate Record Exam perhaps via reducing mind wandering and increasing working memory[27]. Furthermore, mindfulness meditation reduced the frequency of negative automatic thoughts of undergraduate students [20]. With regard to wellbeing in students, several studies have shown that mindfulness meditation influences emotional regulation [28], focused attention, sensory-motor awareness [22] and attention stability [29]. Thus, there is growing evidence that mindfulness meditation in school settings may be useful in improving mental health and psychological functioning.

III. Theoretical Background

This section presents a theoretical foundation for our research based on Bloom's taxonomy [8] and Buddhist theory of mindfulness [30]. As such, we explain how Bloom's taxonomy can be used to identify cognitive skills relevant to the following of a lecture and also point out the association between mindfulness and other cognitive skills. Bloom's taxonomy has been used extensively to evaluate students' performance. However, there are no studies that have examined the relationship between Bloom's taxonomy and mindfulness skills in a classroom setting.

A. Bloom's Taxonomy

Bloom's taxonomy has been the most popular educational theory of assessment of students [8]. Bloom defines learning as a process that develops cognitive, affective, and psychomotor skills in an individual. The cognitive domain refers to knowledge acquisition and the development of intellectual skills [31]. The affective domain [32] focuses on the capacity to deal with emotions, values, appreciation, enthusiasm, motivations, and attitudes. The domain of psychomotor skills [33] refers to the development of physical movement, coordination, and motors skills. Our research is primarily focused on the cognitive domain of Bloom's taxonomy, which is further elaborated into subcomponents: *remembering*, *understanding*, *applying*, *analyzing*, *evaluating* and *creating* [34]. Using Bloom's taxonomy, we point out that the basic level of cognitive capacity is remembering or *retention* ability. The next level comprises understanding, applying, analyzing and evaluating, which are necessarily associated with the capacity to *think*. The highest level of cognition involves creativity or the capacity for *out-of-the-box thinking*. Thus, on the basis of Bloom's taxonomy, we postulate *retention*, *thinking*, and *out-of-the-box thinking* as three essential cognitive skills required to follow a lecture. We also consider *note-taking* as an integral part of following a lecture. Note-taking can also be considered under psychomotor skills domain in Bloom's taxonomy.

B. Mindfulness

We go beyond Bloom's taxonomy and postulate that mindfulness is also as a cognitive skill that may support following a lecture successfully. As stated earlier, mindfulness can be seen as a cognitive feature that contributes to developments of cognitive skills that map onto Bloom's taxonomy. Next we present an overview of mindfulness.

The origin of mindfulness training is rooted in Buddhism [30], [35], [36]. In its simplest form, mindfulness can be understood as paying *attention* in a particular way, on purpose in the present moment in a non-judgmental manner [2], [36]. Within Buddhism, there are diverse views of mindfulness [1] that refer to its myriad functions in different contexts. Here, we focus on the connection between mindfulness and Bloom's taxonomy. We focus our discussion of mindfulness on its relationship to educational cognitive skills including sustained attention, reorientation, executive control, thinking, retention and understanding.

Attention: Sustained attention is essential for a person listening to a lecture. One of the major obstacles to sustained attention during a lecture is mind-wondering. Many Buddhist texts [30], [37] identify attention to the present-moment as an essential characteristic of a state of mindfulness. All other roles of mindfulness, which are discussed below are also dependent on the ability to maintain attention. When attention is sustained, a student may be able to retain knowledge. Thus attention is required but not adequate for a learning process.

Reorientation: Ability to notice when the attention is misdirected and to redirect it back to the relevant task is yet another characteristics of mindfulness. This is also an essential ability for successful learning. The gate-keeping role of mindfulness in Buddhism [35], [38] is analogous to the reorientation feature of mindfulness. A gatekeeper should be aware of the main entrance, while being alert to what happens in the proximity of the entrance. We do not expect a gatekeeper to maintain focused attention on the main entrance all the time, but to be aware of events in the surrounding area. This characteristic highlights the fact that mindfulness is not only concentration or sustained attention. Therefore, if a student is unable to reorient the mind while listening to a lecture, he/she will not be able draw from past experience to nurture the current learning process.

Executive control: Mindfulness also entails executive control, which is a set of goal oriented cognitive control processes that support the ability to shift attention volitionally to a desired object. Buddhist texts refer to executive control feature of mindfulness as *indriya* in Pali [38], [39] or the power to override other mental factors as needed. This characteristic of mindfulness enables the student to control the allocation of attention during a lecture.

Retention: Mindfulness also enables the retention of information or experience. *Smrti*, the Sanskrit word translated into English as "mindfulness," refers to remembrance, memory, reminiscence, or recollection [40]. In this context, *smrti* refers to 'momentary memory', or memory of the present-moment, and not the recollection of the past. Students know very well that the mind drifts away during a lecture, and involves forgetting to bring the mind back into the current activity of following the lecture. When the student remembers that he/she is following a lecture, then the student can bring the mind back immediately to the lecture. Note that although mindfulness refers to momentary memory, this also aids long-term retention or memory power. There is debate on the role of mindfulness in memory [39], [41], but it is beyond the scope of this paper. However, in the context of education, the value of retention power is undisputed.

Thinking: Mindfulness includes the capacity to think clearly in a meaningful manner. This requires sending the mind to the past and future to understand the present moment. Learning has a strong connection with prior knowledge. By its very nature, thinking sends the mind from one object to another, and in the absence of mindful adherence to the object of attention, thinking may be unrestrained or uncontrolled. Thinking without mindful adherence activates mind wandering. For example, if a student is not mindfully attending during a lecture, he/she may not notice that the mind has wandered to another object. Obviously, if the student is aware at the moment when the mind drifts away, he/she can take action to redirect the mind back. As a person develops mindfulness, it might result in a stronger focused thinking ability. Enhancing thinking ability is essential for successful learning.

Understanding: Scaffolding the ability to learn and understand is a primary goal of education. Mindfulness might enhance the cognitive skill of understanding. Buddhist theory suggests that mindfulness enables understanding and insight that lead to freedom from mental distress and suffering [42]–[44]. In conjunction with cognitive skills such as retention and thinking, understanding is an essential outcome of education. In Bloom's taxonomy, understanding is a prerequisite to higher level cognitive skills such as applying, analyzing, evaluating and creating.

Fig.1 depicts the relationship between some characteristics of mindfulness and cognitive skills related to education. The innermost two circles show some characteristics of mindfulness, while the outer circle depicts cognitive skills identified in Bloom's taxonomy.

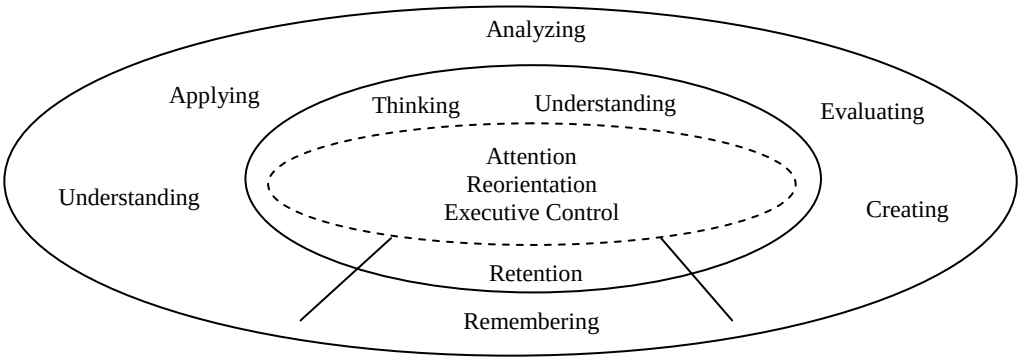

Fig.1. Summary of Characteristics of Mindfulness and Bloom's taxonomy

IV. Methods

We conducted a study to examine mindfulness and cognitive capabilities (i.e., retention, thinking, out-of-the-box thinking, note-taking and mindfulness) in university students during a one-hour lecture. Each of the five constructs (retention, thinking, note-taking, out-of-box-thinking and mindfulness) was measured from 0 (poor) to 20 (excellent) performances.

A. Participants and Data Collection

Participants included 148 students (66% male) comprised of 136 undergraduate (92%) and 12 postgraduate (8%) students in six different course modules from two different universities in Sri Lanka. The study sample reflects the current observed proportion of males and females in higher education in Sri Lanka. Four different lecturers delivered the lectures in this study. The lecturers were briefed about the nature of study. This was essential given that neither the lecturers nor the students had prior experience in mindfulness meditation. Lecturers were instructed to explain the study to the students and obtain informed consent prior to *the* beginning the lecture. To reduce error, an interviewer administered each questionnaire and recorded student responses. We examined note-taking ability by analyzing the contents of notes produced by each student during the one-hour lecture. Students' notes were examined to determine how much students wrote notes that went beyond what the lecturer wrote on the board and spoke. In the assessment, marks were given for the notes with the consent of each student. To assess retention, each student was asked to list major topics covered in the lecture during the last hour. Those who spontaneously recalled the major topics in the same order discussed were given higher marks. To assess thinking, students were asked a short question that required analyzing and synthesizing 3 major topics

covered in the lecture. Out-of-the-box thinking was assessed by asking a question related to major topics in the lecture that was not discussed. For example, a question could be: Which of the topics covered might be developed within next five years? Please justify your answer. To measure mindfulness, the lecturers were instructed to ask questions that assessed essential parameters of mindfulness and three components of attention (vigilance/alerting, reorienting, and executive control), Each student was asked (a) whether the student was aware when their mind wandered away from the lecture, (b) whether it was possible to bring the mind back to the lecture, (c) how frequently the mind drifted away from the lecture, and (d) when your mind wandered, did it have an impact on your retention, thinking, note taking and out-of-the-box thinking. We used an interview-based data collection method to assure that the questions were clearly understood by students.

B. Data Analysis

First, a descriptive analysis was performed for the data obtained from the questionnaire survey to obtain a general summary. Then one-way ANOVA was used to compare the mean values across the five cognitive skills: retention, thinking, out-of-the-box thinking, note-taking and mindfulness. We tested the null hypothesis of no difference between the means of any of the five cognitive skills. When the null hypothesis was rejected, pair-wise comparisons were conducted using Bonferroni corrected post hoc tests to examine differences between five cognitive skills. As in all applied analytical methods, $p < 0.05$ was considered as the a priori level of significance. Data analysis was performed using SPSS 16.

V. Results

Based on normative data, the students' ability in note taking, retention, thinking and out-of-the-box thinking were in the positively moderate level. However, mindfulness values were significantly lower. The corresponding descriptive statistics are given in Table 1.

More specifically, the level of performance in note taking showed a range from 10 to 20. This indicates that all students in the study sample had moderate to high levels of performance in note taking. Among them half of the students show considerably high level of performance as the corresponding median value is equal to 15. Compared to their ability in note taking, their retention power is low. Among them, one fourth show poor level of retention power. However, in contrast, another one fourth of the study sample shows high level of retention ability. The corresponding 75^{th} percentile was equal to 15. The students' ability in thinking and out-of-the-box thinking are rather low. In both aspects, one fourth of the study sample has shown poor level of performance. The corresponding 25^{th} percentile which is equal to 10 provides the evidence. Compared to the above four skills, ability to stay in class with mindfulness was considerably lower, with a range from 1 to 10. This suggests that all the students found it difficult to generate mindfulness in class.

Table 1. Descriptive Statistics Of Level Of Performance In Cognitive Skills

		Note Taking	Retention	Thinking	Out-of–the-Box Thinking	Mindfulness
Sample size		148	148	148	148	148
Mean		13.97	13.00	12.91	12.61	6.76
Median		15.00	12.00	12.00	12.00	5.00
Mode		15	15	10	10	10
Std. Deviation		2.634	2.745	2.967	2.873	2.679
Variance		6.938	7.537	8.802	8.252	7.175
Range		10	15	15	15	9
Minimum		10	5	5	5	1
Maximum		20	20	20	20	10
Percentiles	25	12.00	10.00	10.00	10.00	5.00
	50	15.00	12.00	12.00	12.00	5.00
	75	15.00	15.00	15.00	15.00	10.00

The results of a one-way ANOVA revealed that the mean level of performance in different cognitive skills differed significantly (p-value < 0.001*)*. Post hoc t-tests using a Bonferroni correction further revealed that the students' ability in note taking was significantly higher than that of other four skills: retention (p-value= 0.027), thinking (p-value = 0.011), out-of-the-box thinking (p-value = 0.0003) and mindfulness (p-value = 0.000). It further revealed that there was no significant difference between their ability in thinking, out-of-the-box thinking and retention. The corresponding median value of 12 (out of 20) reveals that their ability in those aspects is in a positively moderate level, but they need further assistance and guidance in developing those skills. However, compared to the above four aspects, their ability to generate mindfulness in class was significantly low (p-value=0.0000). This highlights the need for training to help students improve mindfulness and their cognitive performance.

The students who obtained 15 or above rating for all the four aspects; note taking, retention, thinking and out-of-the-box thinking were selected from the study sample and further analyzed. Just over one fourth (~27%) of the study sample reported high ratings for all the four aspects; note taking (mean= 16.08, SD = 1.526), retention (mean = 15.95, SD = 1.535), thinking (mean = 16.35, SD = 1.511) and out-of-the-box thinking (mean = 16.02, SD = 1.609). Even this subsample who scored high in these four skills reported considerably low mindfulness values (mean = 4.75, SD = 1.891).

Similarly the students who obtained 10 or below rating for all the three aspects; retention, thinking and out-of-the-box thinking were selected from the study sample and further analyzed. Since all the students in the study sample have shown favorable performance in note taking, the factor note taking was not considered when filtering. Nearly one fifth of the study sample was found with poor level of performance in all three aspects; retention (mean = 9.75, SD =1.005), thinking (mean = 9.82, SD = 0.945) and out-of-the-box thinking (mean = 9.68, SD = 1.056). However their note taking ability was found to be considerably high. The corresponding median value (15) provides the evidence to confirm that. Further it must also be noted that, compared to the high-performing students, poor-performing students in the study sample have a little higher ability to stay in class with mindfulness with a mean value of 7.79 (SD = 2.833). That may be due to the reason that high-performed students usually try to argue facts and concepts while others pay less effort on arguing things on their own during the lecture.

VI. Discussion and Conclusion

The goal of our pilot study was to examine the relationship between cognitive skills defined in Bloom's taxonomy and mindfulness skills during a single lecture in university level students. Our research demonstrated that students have a considerable ability in note-taking, but poor abilities in retention, thinking and out-of-the-box thinking. In fact, students with lower performance, getting below 10 for all cognitive aspects, scored well in note-taking. One explanation is that students who have poor cognitive skills tend to take more notes.

Students' level of mindfulness was far lower than the level of other cognitive features. Given the lack of training in mindfulness or other meditation techniques, it is not surprising that students scored so low in mindfulness skills. We also confirmed that in the subsample of students with higher scores in thinking, still had low scores for mindfulness. This suggests that mindfulness and thinking may be de-coupled or unrelated. However, this interpretation needs to be confirmed in future studies.

In conclusion, our research provides empirical evidence that mindfulness training may be warranted for university students. In the future, we intend to investigate the effects of longer-term mindfulness meditation training in university students and to examine the effect of mindfulness on other cognitive skills and educational performance. Furthermore, we intend to conduct such experiments for conventional face-to-face learning and also for computer-based learning.

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Asoka S Karunananda obtained his Doctoral Degree in Computer Science (Artificial Intelligence) from the University of Keele, UK. His research interests include ontological modeling, multi agent systems, machine learning, artificial cognitive systems, natural language processing, theoretical computing and mindfulness interventions in educational settings.

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He has a particular interest in exploiting eastern philosophical perspectives for modeling of human mind. Recently, as a part of a collaborative project, he has launched, the first ever mind simulator, BMind, which is based on an eastern model of mind. He has secured more than 150 publications in International Journals and Conferences. So far he has produced 8 MPhil/PhD students and has currently been supervising 5 doctoral candidates.

He is a Senior Professor at University of Moratuwa. Prof. Karunananda is a member of IEEE, life member of Sri Lanka Association for Advancement of Sciences, and Founder member of Sri Lanka Association for Artificial Intelligence. He is a commonwealth scholar and won many awards for promoting computing education and research in Sri Lanka.

Philippe Goldin earned a PhD in Psychology at Rutgers University, directed the Clinically Applied Affective Neuroscience laboratory at Stanford University for a decade and is now an assistant professor and founding faculty in the Betty Irene Moore School of Nursing at the University of California Davis Health System.

His NIH-funded clinical research focuses on functional neuroimaging of emotion regulation mechanisms of mindfulness meditation, compassion meditation, cognitive-behavioural therapy and aerobic exercise in adults with anxiety, mood, and chronic pain disorders. Dr. Goldin helped develop the Search Inside Yourself program at Google and also the Search Inside Yourself Leadership Institute (SIYLI.org) which delivers mindfulness-based emotional intelligence and leadership skills training programs world-wide.

Priyanga D. Talagala is currently a first year PhD student at Monash University, Australia. Her research interests include Data Mining, Statistical Computing, Outlier Detection and Education. She obtained her BSc (Special) degree in Statistics with a First Class Honors from the University of Sri Jayewardenepura, Sri Lanka. She was awarded the Professor R.A. Dayananda Gold Medal for the best academic excellence in Statistics (2012) by the University of Sri Jayewardenepura, Sri Lanka.

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