10. MANAGING EMOTIONS

Outcomes of a Breathing Intervention in Year 10 Science

ABSTRACT

Learning science can be an emotional experience. Recent research reveals that middle-years students experience negative emotions such as frustration and anxiety while learning science. Strategies to help students manage their emotions in science classes are emerging, but require further investigations to ascertain their effectiveness. In this study, an intervention, which adopted short deep breathing exercises to help students manage their emotions was trialled in a Year 10 science class. The aim of the study was to determine students’ emotional responses as well as the practicalities for implementing such an intervention. We conducted research using an ethnographic case study method where the teacher implemented short episodes of deep breathing exercises with students during each science lesson for seven weeks. Salient themes emerged from the analysis of video and audio files, field notes, students’ emotion diaries, 19 individual student interviews, and two teacher interviews. We present one main finding in this chapter; that is, students who experienced the negative emotions of frustration/anxiety reported that the breathing exercises changed their emotions. On the basis of this finding we suggest that teachers could use deep breathing exercises to help students experiencing negative emotions in class to ameliorate their emotions.

Keywords: middle-school science, emotions, emotion regulation, deep breathing

With less static, less noise, traditional cognitive restructuring enters [...] people listen better. It’s a more fertile environment, so you can do what you are so well trained to do – the cognitive work, the positive ideation. (Benson, 2008)

Donna King, Stephen Ritchie, Senka Henderson, Maryam Sandhu and Ben Boland (2017) conducted a study in a middle-years science classroom that showed managing students’ emotions is necessary because negative emotions such as frustration and anxiety can impact negatively on students’ learning, concentration, and confidence to persist with challenges. They found that alarmingly, negative emotions experienced over a number of lessons lead to more intense emotions of embarrassment, sadness, and despair. Such unresolved negative emotions may manifest as a dislike for science.
and lead students to disengage in the middle years and opt out of science in the senior years. In this study, we investigated a deep breathing strategy that afforded students a technique for managing negative emotions. We were hopeful that the practice of deep breathing would provide students with opportunities for “less static, less noise” as Herbert Benson’s quote above suggests, and enable them to create a more “fertile environment,” for negative emotions to be ameliorated.

Prior to conducting the study, we searched for effective interventions that attempted to reduce negative emotions and help students to improve their focus, engagement, and learning. We found mindfulness practices had evolved from recent developments in contemplative neuroscience (or the ability of the brain to change its structure and function), and were used in educational contexts. Like many mindfulness intervention studies found in the literature, our intervention was adapted from the MBSR (Mindfulness Based Stress Reduction Program) that was designed for clinical purposes by Jon Kabat-Zinn (2003). Mindfulness is a particular way of paying attention, described by Kabat-Zinn as “the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience” (p. 145).

Our choice of intervention needed to be both easily implemented and easily communicated to teachers and students as well as spanning a short timeframe to minimize the interruption to the science lesson. We chose breathing meditation since it not only is an important part of mindfulness training, but suited the constraints within which we were working. Breathing meditation is where students are taught to focus on their breath to bring their attention to the present moment while allowing other thoughts to dissipate. Such an intervention has been shown to reduce stress and mood disturbance and improve mood regulation (Mental Health Foundation Mindfulness Report, 2010). We called our intervention “deep breathing exercises” where the name reflects the actions required by students and teachers.

In the classroom, the teacher, or one of the researchers, guided the students through the deep breathing exercises that took three minutes (a full description is in the Methods section). The teacher in the study, Mr. Boyd (a pseudonym) was reluctant at first to adopt the deep breathing exercises with his year 10-science class since they were a diverse multicultural group with a couple of students who were difficult to engage. However, after discussions with Donna King (first author) and Head of Science he agreed to “give it a go.” All science teachers in the school received two professional development sessions consisting of deep breathing training by a yoga teacher trained in mindfulness practices. Advantageously, Mr. Boyd was an experienced martial arts teacher and familiar with diaphragmatic deep breathing.

THEORETICAL PERSPECTIVES

Jonathan Turner (2009) suggests that most researchers agree on four primary emotions that all humans experience: anger, fear, sadness, and happiness. He explains that emotions are produced in social situations, and hence the social setting
contributes to the arousal of discrete emotions. He posits that the sociocultural conditions contribute to the generation of intense emotions and are central to theorizing about emotions. For example, in a classroom a teacher may experience anger when a student is rude or “answers back”; which may impact on other students in the class. “Answering back” or “defending their position” may be part of a student’s home culture and a normal way s/he engages with adults. For a teacher who regards “answering back” as rude, such an exchange may become heated between the teacher and student generating negative emotions that affect the face-to-face encounter. Furthermore, if students in the classroom witness the exchange, then the interaction can affect the larger social structure of the classroom as students stop their work to observe the encounter generating a collective negative mood. Turner suggests that by understanding the sociocultural origin of the discrete emotion, insights into how these emotions affect the micro- (e.g., face-to-face interactions), meso- (e.g., classroom procedures) and macro- (e.g., school policy) levels of social reality can be revealed. Furthermore, emotions are valenced; that is, they can be categorized as positive and negative as described by Jan Stets (2010) and can be felt at varying levels of intensity from low- through medium- to high- intensity states. For example, Turner (2002) categorises enjoyment as being positively valenced and anxiety as negatively valenced.

EMOTIONS

Our previous research has shown that students experience both positive and negative emotions when learning science (e.g., King, Ritchie, Sandhu, & Henderson, 2015). We found that positive emotions such as happiness, joy, surprise and wonder were expressed during specific activities such as demonstrations and laboratory activities whereas negative emotions such as frustration and anxiety were expressed when learning cognitively challenging chemistry concepts (King et al., 2017). Furthermore, Alberto Bellocchi and Stephen Ritchie (2015) found that pride and triumph were emotions experienced by middle school students when they understood science concepts, were involved in social interactions, and achieved success on challenging tasks. Catherine Milne and Tracey Otieno (2007) found that students’ emotions were important for both learning and engagement in science.

THEORIES OF EMOTION REGULATION

James Gross (1998) explains that “emotion regulation” refers to “how we try to influence which emotions we have, when we have them, and how we experience and express these emotions” (p. 275). Sander Koole (2009) describes it as “the set of processes whereby people seek to redirect the spontaneous flow of their emotions” (p. 6). Gross (2008) argues that “regulation of emotions” refers to “the heterogeneous set of processes by which emotions are themselves regulated” (p. 500) rather than “regulation by emotion” which refers to emotions coordinating various biological
systems. Relevant to this study, regulation of emotions may include specific skills such as deep breathing exercises to moderate negative emotions such as anxiety.

Gross (2008), a psychologist, explains the difference between intrinsic and extrinsic emotion regulation; that is, intrinsic refers to a person regulating his or her own emotions and extrinsic refers to a person regulating the emotions of someone else. Such a distinction applies to this study where the breathing intervention was an extrinsic emotion regulator implemented by the teacher to teach students strategies for regulating their emotions. However, students may choose to use these skills when necessary to regulate their own (intrinsic) emotions.

Scott Jacobs and James Gross (2014) have conducted psychological research culminating in the five families of emotion regulation strategies organized through the “temporal point that they target” or the point in time that the emotion regulation strategy is initiated (Jacobs & Gross, 2014, p. 185). The five families are: situation selection, situation modification, attentional deployment, cognitive change and response modulation (Gross, 1998). Of relevance to this study is the response modulation approach. Deep breathing is an example of a response-focused emotion regulation tool if used by students in response to emotional arousal. However, psychologists such as Norman Farb, Adam Anderson, Julie Irving, and Zindel Segal (2014) argue that if deep breathing is used in conjunction with the mindfulness suite of contemplative practices (i.e., nonjudgmental attention to present-moment sensation) it may be used in the attention deployment stage where students’ attention can be returned to the current situation rather than progressing to appraisal processes and responses. However, such techniques are relatively new to education and their classification as response-focused based on Gross’s framework is suitable if students use the strategies in response to physiological feelings rather than as a meditative/mindfulness tool practiced on a daily basis.

Gross’s framework is useful for distinguishing the “temporal unfolding of emotion” and categorization into antecedent (i.e., strategies used to prevent the emotional experience) versus response forms of emotion regulation (i.e., strategies used during or after the emotional experience) (Jacobs & Gross, 2014, p. 89). Many psychological researchers, including educational researchers such as Leanne Fried (2011), adopt Gross’s terminology and the separation between antecedent and response-focused emotional management. Interestingly, a study by James Gross and Oliver John (2003) found that cognitive strategies, such as cognitive reappraisal were more effective than strategies aimed at regulating bodily affects. Targeting the earlier stages of the emotion cycle is more effective at decreasing emotional response than later processes that target the emotional response itself (Jacobs & Gross, 2014, p. 187).

EMOTION REGULATION IN EDUCATIONAL SETTINGS

There has been some research on emotion regulation in educational settings. Using Gross’s classification system, Fried (2010) found that antecedent emotion regulation strategies were positively correlated with student personal competence.
On the other hand, Fried found that response-focused emotion regulation strategies such as breathing or counting to ten were negatively correlated with student social competence. In particular, Fried suggests using meditation and mindfulness strategies with a focus on enhancing student emotion regulation development. Andrew Winzelberg and Frederic Luskin (1999) suggest that such strategies may also help students and teachers relieve stress.

Nancy Eisenberg, Tracy Spinrad, and Natalie Eggum (2010) suggest that emotion regulation is increasingly viewed as a foundation for well-being, academic performance, and positive adjustment throughout life. Also, Paulo Graziano, Rachael Reavis, Susan Keane, and Susan Calkins (2007) found that appropriate emotion regulation contributes to successful academic outcomes over time and Monique Boekaerts and Lyn Corno (2005) found that students who regulate their emotions are more successful at learning tasks. One recent study by Louisa Tomas, Donna Rigano, and Stephen Ritchie (2016) showed that middle-years students were able to regulate their negative emotions when working together to complete a video project. Also, Sharon Melnick and Stephen Hinshaw (2000) found that emotion regulation affords the individual the skills to have some control over his or her behaviour and remain connected with the environment. An earlier study by Marsha Linehan (1993) found that emotion regulation skills such as identifying and labeling emotions, allowing and tolerating emotions, increasing positive emotions, self-soothing, breathing, and distraction have been found to help with high distress. Conversely, Nancy Eisenberg, Tracy Spinrad, and Cynthia Smith (2004) found that students with poor emotion regulation will have more difficulty adjusting to school settings and deficits in emotion regulation represent a core feature of many emotional and behavioural problems in adolescence such as anxiety, depression, self-injury, and substance abuse. Gail Gumora and William Arsenio (2002) found that early adolescent emotional dispositions and academic affect (i.e., their emotions and feelings about their academic ability) made a significant contribution to academic achievement. They found that students who perceived themselves as experiencing more negative affect during academic tasks such as anxiety, frustration, and anger, had a poorer sense of their academic competence, lower achievement scores, and lower grade point averages.

While we acknowledge that some negative emotions experienced by students such as frustration are necessary for the process of completing a task (King et al., 2017), we were concerned with the negative emotions that were barriers to student learning as revealed in our previous study (King et al., 2017). The literature on regulating emotions through mindfulness practices provided a rich source of ideas which informed the development of our deep breathing intervention.

REGULATING EMOTIONS THROUGH MINDFULNESS PRACTICES

Ellen Langer (2000) describes mindfulness as the process of drawing distinctions between things enabling a person to be situated in the present. Although many
techniques can be used to achieve mindfulness, Mark Greenberg and Alexis Harris (2012) suggest that most share a common focus of sharpening concentration or attention, through building regulation skills to manage stress effectively.

Stress, which may be due to emotions such as anxiety, cause a biological reaction in the body known as the “flight or fight” response. In this case, the central nervous system signals the adrenal glands to release hormones which cause the heart to beat faster, respiration rate to increase, blood vessels in the arms and legs to dilate, digestive process to change and glucose levels (sugar energy) in the bloodstream to increase to respond to the emergency. Mindfulness practices such as deep breathing or yogic breathing have been tried to calm such stress response systems. Paul Lehrer and Richard Gevirtz’s (2014) research has shown that by voluntarily controlling breathing patterns, it is possible to influence autonomic nervous system functions, including heart rate variability and cardiac vagal tone.

General research on mindfulness practices reveals that mindful people recover from bad moods more quickly and have less frequent negative thoughts, are able to let negative thoughts go when they arise and have higher and more stable self-esteem that is less dependent on external factors (Mental Health Foundation Mindfulness Report, 2010). Also, Felicia Huppert and Daniel Johnson (2010) found that the benefits of mindfulness for cognitive function include improvements in focused and selective attention, the awareness and acceptance of our thoughts, and feelings including painful thoughts where such practices may contribute to resilience.

Christine Burke (2010) suggests that research on regulating emotions through mindfulness practices is emerging in educational contexts with a small body of literature appearing with studies of children and adolescents. The emerging research on adolescents has focused predominantly on disadvantaged youth or students with special needs. A study by Tamar Mendelson, Mark Greenberg, Jacinda Dariotis, Laura Gould, Brittany Rhoades, and Philip Leaf (2010) showed that mindfulness and yoga intervention for urban youth had a positive impact on problematic responses to stress including rumination, intrusive thoughts, and emotional arousal. A second study by John Meiklejohn et al. (2012) showed that mindfulness meditation for 5 to 10 minutes at the beginning of each class resulted in decreased state and trait anxiety for adolescents with learning disabilities. A third study by Lydia Zylofska, Deborah Ackerman, May Yang, Julie Futrell, and Nancy Horton (2008) on ADHD (attention-deficit-hyperactivity-disorder) students showed improvements in self-reported ADHD symptoms, anxiety, depressive systems, and working memory. One study by Robert Wall (2005) of mainstream middle-school students showed that a combined Tai Chi and mindfulness-based stress reduction program enabled improved well-being, calmness, relaxation, sleep, and resulted in less reactivity, increased self-care, self-awareness, and sense of interconnection or interdependences with nature. However, there is a call for more evidence-based research that includes rigorous scientific investigation to deepen the empirical evidence of the efficacy of these interventions (Meiklejohn et al., 2012).
Deep breathing is one mindfulness tool that can be used in conjunction with raising awareness of the body and nonjudgmental attention to present-moment sensation. There has been one study that used a program called “Learning to BREATHE” which trialled a mindfulness curriculum with adolescents. The program helped students understand their thoughts and feelings and learn mindfulness tools for managing negative emotions and provided opportunities to practice the skills in a group setting. Patricia Broderick and Stacie Metz (2009) found that participants in the program reported reductions in negative affect, increased feelings of calmness, relaxation and self-acceptance, improved clarity around the emotions they experienced and increased skills for emotion regulation after program completion. The authors suggest that such programs are an effective way to teach students to use mindfulness to manage negative emotions and to understand thoughts and feelings (Broderick & Metz, 2009). Based on such previous research, we adopted deep breathing in conjunction with attention to present-moment sensation as the mindfulness tool for year 10 science students.

CONTEXT – SCHOOL, SCIENCE UNIT, STUDENTS

The school where the study was situated was an inner-city school in Brisbane, Australia, which attracted students from broad socioeconomic backgrounds. The total enrolment was 1150 students from Grades 8 to 12 including 15% of students from non-English speaking backgrounds. The Grade 10 science class consisted of 6 boys and 13 girls aged from 14–15 years. The class was chosen for the study because the teacher, who had been part of a previous study with the authors, was interested in building on the research (see King et al., 2017). Parents and guardians for all students in the study signed ethical permission forms that allowed video and audio recordings, interviews and the collection of data relevant to the study. The University through which the study was conducted granted ethics approval.

The students were completing an innovative unit on sustainability designed in conjunction with Donna and the teachers, that used authentic scientific data. Essentially, students were required to analyse data such as water usage, temperature and thermal control, electricity consumption and solar generation supplied by the Queensland University of Technology’s Science Cube. At the start of the unit, students visited the Cube and were given a tour of the world-class interactive learning and display space (see http://www.thecube.qut.edu.au/about/) before exploring the interactive digital, multi-touch screens and attending information sessions explaining the many sustainable features of the Cube. In such a way, they were equipped with information about sustainable building features that provided background information for the assessment task. The unit consisted of 19 lessons that were approximately 50 minutes long, including a variety of activities such as computer-based lessons, teacher-led lessons, and group work. On completion of the unit, students were required to present the data analysis for one sustainable feature of the Cube incorporating the use of technology.
METHODS

In conjunction with Robert Stake’s (2006) approach to case study, we adopted an ethnographic case study design focusing on qualitative inquiry into a single case. We were immersed in the year 10 science class and attended 19 lessons over an 8-week period. During these lessons, the teacher conducted a breathing intervention where the students did deep breathing exercises for approximately 3 minutes (explained in detail below). There were 20 students in the class; however, one student was absent most of the time and was not included in the study. Out of the 19 students, one student did not participate in the breathing exercises due to medical reasons, however, she offered insightful comments both in emotion diaries and in the final interview, so was still included as a participant. All 19 students were interviewed at the beginning of the term to discuss the implementation of this intervention as well as being interviewed at the end of the term (see Appendix 1 for interview questions).

Ethnographic data were collected including videos, interviews, field notes and students’ emotion diaries completed at the end of each lesson. First, we discuss how students identified and recorded their emotions in the emotion diary. Second, we explain the analytic techniques in more detail through the meso-level analysis (i.e., observation, interview, emotion diary and video).

Emotion Diary

Based on the work of Turner (2007), we included 9 discrete emotions in an emotion diary adapted from the work of Michalinos Zembylas (2002) for students. These emotions were agreed by a panel of researchers, as the most salient for middle-years students. They included excitement, happiness, enjoyment, pride, anxiety, frustration, disgust, annoyance, disappointment and “other emotions” where students could record emotions not listed such as enthusiasm, embarrassment, anger, fear, irritation, guilt, and shame. Next to each emotion was an emoticon (face showing the emotion). Students identified the classroom circumstances that evoked the arousal of this emotion through instructions that read, “please say, in your own words, what you were doing, what happened when you experienced the emotion, and at what or whom the emotion was directed”.

In a lesson prior to the study, Donna was invited into the class to meet the students and explain the emotion diary and how students identified their emotions. She explained that a physiological reaction might occur where students experience a particular feeling or a bodily change such as a change in their heart rate or breathing. Students were given a practice emotion diary to complete for the current science lesson and Donna addressed any questions. A whole-class discussion followed where students shared their recorded emotions and Donna responded with elaborations for other possible classroom situations that may elicit emotions. We were confident that students could discern accurately their emotions and the emotion label they were
assigning to the recorded emotion. Furthermore, we were confident that students would record accurately when emotional arousal occurred and what may have triggered the emotion. The emotion diaries were the first data analysed.

*Meso-Level Analyses (Observation, Interview, Emotion Diary, Video)*

We began our analysis with the emotion diaries by entering the emotions as recorded by students in a spreadsheet. A graph of the discrete emotions experienced each lesson provided information about the range of emotions and frequency of positive and negative emotions. Next, we coded responses to the question at the bottom of the emotion diary related to the breathing intervention specifically. In this question students were asked: “After you did the breathing exercises, did you experience any change in your emotions? If so, which emotion/s did it change?” We matched these responses with students’ identified discrete emotions in the diary and the corresponding explanation for the emotion. This enabled us to search for any instances of changes in emotions as a result of the intervention. Simultaneously and iteratively we referred to video data from three cameras to observe students closely while doing the breathing exercises to understand what was happening for individual students. Next, we analysed their responses to the final individual interview questions for emerging themes using a color-coded spreadsheet (i.e., green for positive response, red for negative response, blue for neutral response, and darker shades of green for very positive responses and darker red for very negative responses). Finally, we triangulated the data by checking for consistency with emerging themes from the emotion diary, video data, and field notes. As tentative themes emerged we undertook further searching for confirmatory and disconfirmatory evidence. The final themes were decided after thorough analysis of all data sources. We present one major theme in this chapter.

*Breathing Intervention*

From the literature search and our previous research on students’ negative emotions experienced in science classes (King et al., 2017), we decided to adopt an intervention that may provide a tool for developing emotion regulation skills and possibly contribute to the amelioration or transformation of students’ negative emotions. We chose one of the mindfulness practices, deep breathing, which affords students the opportunity to focus on present-moment sensations while increasing the blood flow to the brain. Such an intervention fulfilled the constraints of time for teaching students and teachers the technique as well as taking up minimum time in the science class.

Initially, we asked the teacher to do deep breathing exercises at the beginning and middle of the science class using his discretion to choose a suitable time. The teacher relied on students’ non-verbal cues (e.g., they were restless and not focussing or had a sad/frustrated face) or natural breaks between activities to do the exercises. Based
on our in-class observations, discussions with students, and comments in the emotion diaries; we became aware, by week three, of students’ preference for the breathing exercises to occur in the middle of the lesson. We then refined the exercises to occur once in the middle of the lesson for three minutes.

The deep breathing exercises began with the teacher asking students to sit upright with their feet on the floor and shoulders relaxed. The teacher asked students to place the palm of their hands on the front of their belly and feel the belly expand like a balloon as they breathe in. They were asked to breathe out and feel the belly deflate. The intention was to afford students the opportunity to bring their attention to the body and the bodily sensations they were experiencing during the in and out breaths. In this way, we were integrating mindfulness practices, which embrace breathing as a way of focusing on present-moment sensations. Guided by the teacher, the students were reminded of the procedure and were stepped through the breathing exercises each lesson. During the first four weeks, the deep breathing exercises were done once or twice with 10 breaths each time. Later, the deep breathing exercises intervention was adjusted to occupy three minutes, consisting of the following sequence:

1. One minute semi-guided deep breathing, which was about 6–8 breaths,
2. One minute unguided while students concentrated on their breathing silently or used this minute to ignore any negative thoughts maintaining a relaxed posture,
3. One more minute semi-guided deep breathing.

These exercises occurred in every science lesson for 7 weeks or 19 lessons. One of the major findings from the intervention is explained below.

*Students who experienced negative emotions, such as frustration/anxiety/annoyance reported that the breathing exercises changed their emotions*

The analysis of the emotion diaries and interview data revealed that 18 out of 19 students reported a change in their emotions as a result of the deep breathing exercises at some stage during the course of the intervention. At the bottom of the emotion diary, students were afforded the opportunity to comment about any changes in emotions they may have experienced after the breathing exercises. Table 10.1 summarizes the comments that occurred most frequently.

Table 10.1 shows there were 62 comments throughout the 19 lessons where students reported that breathing exercises relaxed or calmed them or reduced stress. Interestingly, there were 17 comments reporting that the exercises energized them. After analyzing these data, the authors returned to the emotion diaries to search for the reported emotions students were feeling prior to and after the intervention. In such a way, we were triangulating data for evidence of changes in emotions as a result of the breathing intervention.

The analysis revealed that of the 100 comments about the positive effect of the breathing exercises, students referred to them as contributing to: relaxing or calming them, reducing stress, energizing them, enabling them to be more focused, refreshed
or clearer in the head. On 86 occasions students had ticked in the emotion diary that they had been experiencing specific negative emotions such as frustration/anxiety/annoyed/disappointed or anger prior to the breathing exercises providing further evidence that students reported the breathing contributed to a change in their emotions. Students often wrote comments next to the discrete emotion explaining why they were experiencing the negative emotions with the most common reasons referring to assessment and workload related issues. Of the remaining 14 occasions, students did not identify a specific emotion in the emotion diary but completed the section at the bottom explaining their change in emotion and what caused the change.

The analysis of the interview data and ethnographic data supported the claim that students reported the breathing exercises changed from feeling negative emotions such as anxiety, frustration, and annoyance to a calmer emotional state. From our observations, this “calmer state” continued beyond the breathing exercises when the collective noise in the room became quieter after the intervention. Furthermore, the teacher explained the same observation in a follow-up interview:

After the couple of minutes, three minutes they just, all of them, not all, all of the ones who did breathing you can see they are quiet and calm just went, up … OK and got to it straight ahead, like there wasn’t really much more discussion there was just get to the work, might have been just the time to think and plan and get themselves organized and doing it, so that’s what I mean by it works to see the difference in their work ethic almost before and after it. (Follow-up interview)

Table 10.1. Student comments about changes to emotions after breathing

<table>
<thead>
<tr>
<th>Comments on emotion diary to question: “After you did the breathing exercises, did you experience any change in your emotions? If so, which emotion/s did it change?”</th>
<th>Number of times this comment occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>It made me feel relaxed and calm</td>
<td>51</td>
</tr>
<tr>
<td>The stress was gone/ less stressed</td>
<td>11 = 62</td>
</tr>
<tr>
<td>Felt more awake/more energized/hyper</td>
<td>17</td>
</tr>
<tr>
<td>More focused</td>
<td>8</td>
</tr>
<tr>
<td>Happy</td>
<td>5</td>
</tr>
<tr>
<td>Felt good/better-refreshed/clearer head</td>
<td>8 = 100</td>
</tr>
<tr>
<td>Tired/sleepy</td>
<td>20</td>
</tr>
<tr>
<td>No change in emotions/neutral</td>
<td>61</td>
</tr>
<tr>
<td>Negative comments about the breathing/ interrupting their work etc…</td>
<td>13</td>
</tr>
<tr>
<td>Change to negative emotion or negative emotion did not change (i.e., student still feels negative emotion after breathing)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>195</strong></td>
</tr>
</tbody>
</table>
To investigate this observation more empirically, we conducted an objective comparison of sound power by using the prosodic parameter intensity scale available through the PRAAT software (http://www.praat.org a free scientific computer

Table 10.2. Reported changes in negative emotions by students

<table>
<thead>
<tr>
<th>Name</th>
<th>Discrete Emotion</th>
<th>Comment next to Discrete Emotion</th>
<th>Comment to question at bottom: “After you did the breathing exercises, did you experience any change in your emotions? If so, which emotion/s did it change?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas</td>
<td>Anxiety</td>
<td>Assignment due today</td>
<td>felt relaxed and the stress was gone after the breathing I felt more relaxed than before. Before, I felt more stressed on assignments</td>
</tr>
<tr>
<td>Sarah</td>
<td>Anxiety</td>
<td>I don’t really understand what to do for Part A</td>
<td></td>
</tr>
<tr>
<td>Scott</td>
<td>Frustration</td>
<td>needed help with excel</td>
<td>felt more relaxed</td>
</tr>
<tr>
<td>Evan</td>
<td>Annoyed</td>
<td>no tablets to do any work on so hard to do assignments</td>
<td>the breathing exercises were helpful, it helped me plan my assignment and release stress</td>
</tr>
<tr>
<td>Brigid</td>
<td>Anxiety</td>
<td>because I have so many assignments</td>
<td>Before the breathing I felt really stressed and worried but after we did the three minutes of breathing I felt tired and calm</td>
</tr>
<tr>
<td></td>
<td>Frustration</td>
<td>because my computer is taking forever to restart</td>
<td></td>
</tr>
<tr>
<td>Stresses and Worried</td>
<td></td>
<td>Before the breathing I felt really [S]tressed and worried</td>
<td></td>
</tr>
<tr>
<td>Cassie</td>
<td>Disappointment</td>
<td>I felt really disappointed that my group was not able to start Part B and that the lesson was not productive.</td>
<td>I felt really pressured and panicky before the breathing. However, afterwards I felt happier and calm and didn’t feel as though the assignment was impossible.</td>
</tr>
<tr>
<td></td>
<td>Stressed</td>
<td>I was really stressed in the middle of the class realizing how little time is left to complete the whole assignment in time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressured and Panicky</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
software for speech analysis). Since the deep breathing exercises took about three minutes, we prepared three video clips that included about a minute before and a minute after the whole breathing exercise. Our criteria for choosing these three clips was to ensure that the teacher’s voice, which could have an effect on the prosodic values, was not a part of the sound files. This was important for an accurate analysis of the students’ voices.

The data for the lessons in Table 10.3 were typical of the changes in prosody we observed before, during, and after the breathing intervention in the study. We found that the average intensity of the collective classroom noise decreased during and after the intervention for most lessons.

Table 10.3. Comparisons of prosody (intensity) before, during and after the deep breathing intervention

<table>
<thead>
<tr>
<th>Samples</th>
<th>Before DB (in dB)</th>
<th>During DB (in dB)</th>
<th>After DB (in dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>81.14</td>
<td>58.98</td>
<td>68.03</td>
</tr>
<tr>
<td>Week 4</td>
<td>84.66</td>
<td>66.15</td>
<td>75.37</td>
</tr>
<tr>
<td>Week 5</td>
<td>75.29</td>
<td>57.08</td>
<td>68.84</td>
</tr>
<tr>
<td>Week 6</td>
<td>83.33</td>
<td>69.37</td>
<td>74.22</td>
</tr>
<tr>
<td>Week 7</td>
<td>84.34</td>
<td>70.80</td>
<td>78.96</td>
</tr>
</tbody>
</table>

1 db=decibels

Interestingly, eight students commented on their ability to focus better after the breathing exercises. The following examples in Table 10.4 are four representative comments.

Table 10.4. Reported changes by four representative students in their ability to focus better

<table>
<thead>
<tr>
<th>Name</th>
<th>Students’ comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alison</td>
<td>It calms and let’s refocus and get your head around the work when stressed</td>
</tr>
<tr>
<td>Bridie</td>
<td>focusing-thinking-calming down and then you have nothing to worry and then you just do your work</td>
</tr>
<tr>
<td>Karen</td>
<td>like it makes you to look on things better, and realize that you don’t need to be frustrated, there are other ways around it, rather than just ?!!? and getting frustrated</td>
</tr>
<tr>
<td>Cassie</td>
<td>[ ] you know the deep breathing will help just rethink at the situation, feel more, relax and you can see it’s not that bad like I said, you can just carry on</td>
</tr>
</tbody>
</table>

Students appreciated the deep breathing exercises for affording them an opportunity to re-focus and persist with the task rather than giving up on it. Such persistence suggests students displayed the resilience necessary to overcome obstacles to
learning and pursue challenging tasks. In summary, the breathing exercises helped to manage students’ negative emotions and reduce their stress. Also, there was evidence that it helped them to “have new perspective on the problem at hand” (Courtney, interview).

Case Study: Cassie’s Changes in Emotions

Cassie was a high achieving student who stood out as conscientious, well-behaved and willing to help other students. We chose Cassie as our case to illustrate the way students’ emotions appeared to be affected by the intervention because she articulated her thoughts and feelings clearly in interviews. In the final interview, Cassie expressed her reflections on the value of the breathing exercises:

Donna  Overall what do you think about breathing exercises in science classrooms?
Cassie  I think they are really effective at times especially when you are getting to the point that you are being pressured, you can take a while to relax because normally when you got so many assignments especially in other subject[s] you don’t usually get that time to relax, just stop and think, rethink through the processes, it has been really effective, I found especially the last few weeks just actually going through and thinking, it’s not [as] bad as it looks, it’s not [as] pressurizing as it seems you know that impossibility.
Donna  Anything else you would like to add?
Cassie  Going back to when I said about being stressed I think, helps there because when you are in stress mode, you feel as if you just can’t do anything, so having that time to just relax and breathe it sort of calms you down, slows down time, and when you come back from that resting period, you feel you can, you feel recharged so you can get straight into it and you can see I need to do this whereas stressed you can’t really do that, you feel time locked and you can’t break up that … because in today’s society because it’s so busy you hardly have that time to relax and just take a moment to reflect upon everything and how you can better it. (Follow-up Interview)

These comments highlighted Cassie’s ability to reflect deeply on the stresses she experienced as well as the effect of the breathing exercises. She explained how “having that time to just relax and breathe” brings a sensation of calm that enabled a clearer mindset for dealing with the pressures experienced in life. Also, Cassie often commented in the emotion diaries about the value of the breathing exercises for reducing her negative emotions. We decided to search the videos for further evidence of Cassie’s change in emotions. Lesson 3 in Week 5 stood out because Cassie wrote in the emotion diary “I felt more happier after the breathing exercises which extended throughout the lesson” and also, she had written next to the emotion
of frustration: “I felt really frustrated at the beginning wondering how I’m going to get everything finished this week-end.” Furthermore, she wrote next to the emotion of happiness: “I felt very happy throughout the lesson helping everyone and generating productive work.” Also, Donna’s field notes reported this lesson as salient for emotional analysis since there were changes in students’ expressions before and after breathing. Consequently, we decided to analyse this lesson more closely to examine Cassie’s facial expressions, body gestures, and utterances for her expressed emotions.

**Episode One: Before Deep Breathing**

At the beginning of the lesson, Cassie, Britney, and Sophie were sitting together and engaged in short interactions while Cassie looked at her monitor (and occasionally Britney’s and Sophie’s) intensely. We micro-analysed a seven-minute and 40-second episode prior to the deep breathing exercises to examine Cassie’s emotional expression before and after the breathing intervention. During this episode, Cassie does not smile. Figure 10.1 shows Cassie concentrating on her laptop during this time.

At 2:08 minutes into the audio recording, Brigid (on the left of Cassie in Figure 10.1) tries to attract Cassie’s attention by turning towards her. The following excerpt is the conversation between Brigid and Cassie at this point in time:

**Excerpt One: Cassie’s Concentration**

During this whole episode, Cassie continues to concentrate on the work she is doing and does not smile. She does not respond to Brigid’s interruption and occasionally looks frustrated. On one occasion, she raises her hands in the air as if she is exasperated or frustrated with the work she is doing (see Figure 10.3). We concluded
that Cassie’s frustration was directed at her assignment where she was analysing data for a report. The deep breathing occurred 7:40 minutes from the beginning of Episode One and just after Cassie’s display of frustration.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Speaker</th>
<th>Utterance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cassie</td>
<td>ok ((puts her hand up – while she is still looking at her monitor))</td>
</tr>
<tr>
<td>2</td>
<td>Brigid</td>
<td>I was thinking ...</td>
</tr>
<tr>
<td>3</td>
<td>Brigid</td>
<td>((Brigid sighs right after she realizes that she doesn’t have Cassie’s attention – see Figure 2))</td>
</tr>
<tr>
<td>4</td>
<td>Cassie</td>
<td>((ignores Brigid))</td>
</tr>
</tbody>
</table>

*Figure 10.2. Brigid sighs because Cassie is ignoring her*

that Cassie’s frustration was directed at her assignment where she was analysing data for a report. The deep breathing occurred 7:40 minutes from the beginning of Episode One and just after Cassie’s display of frustration.

*Figure 10.3. Cassie before the deep breathing*

*Episode Two: After the Deep Breathing*

Interestingly, we observed a change in Cassie’s facial expressions and gestures after the deep breathing exercises. She now was smiling as she engaged with her peers to
help them with the task. She no longer ignored their questions but willingly assisted as needed (see Figure 10.4). At 12:40 after the exercises, Cassie was smiling and happy as shown in Figure 10.5.

![Figure 10.4. After the deep breathing exercises](image)

![Figure 10.5. Cassie is happy](image)

The video clip shows Cassie repeatedly smiling with friends and she moves from her seat to go and help another student. Furthermore, in Figure 10.5, Cassie appears happy. Using Paul Ekman and Wallace Friesen’s (2003) Facial Action Coding System (FACS), and Jimmi Harrigan’s (2008) suggestions for analysis of body movements and gestures we analysed the emotional expression. In Figure 10.5, Cassie’s lips are parted with the teeth and jaws together in a grin. There are wrinkle lines running from the nose out and down to the area beyond the corners of the mouth. These “naso-labial folds” occur partly as a result of the pulling back and up of the corners of the lips and are a characteristic sign of the happy facial expression (Ekman & Friesen, 2003). We found further evidence to support the emotion diary data and interview data of Cassie’s change in emotions from frustration to happiness after the deep breathing exercises. The intervention of deep breathing changed the way air entered and exited the body, allowing for different equilibria to establish through Cassie’s changing physiology, which affords further changes of emotions. We conclude that as a result of participating in the deep breathing exercises Cassie appears to have changed her emotions along with myriad physiological conditions.

Contradiction: On occasion, students perceived the deep breathing exercises negatively. There were 13 occasions when students reported negative comments.
about the breathing, such as interrupting their work or after the breathing intervention they experienced more negative emotions. The following examples in Table 10.5 are representative examples of these comments written by students:

<table>
<thead>
<tr>
<th>Name</th>
<th>Discrete Emotion</th>
<th>Comment next to Discrete Emotion</th>
<th>Comment to question at bottom:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scott</td>
<td>Frustration</td>
<td>With excel</td>
<td>No felt angrier</td>
</tr>
<tr>
<td>Courtney</td>
<td>Frustration</td>
<td>Word is so annoying!!</td>
<td>it stopped me half way through my work which was really frustrating</td>
</tr>
<tr>
<td></td>
<td>Disgust</td>
<td>I HATE WORD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annoyed</td>
<td>OUR ASSIGNMENT IS HARD!!</td>
<td></td>
</tr>
<tr>
<td>Sarah</td>
<td>Frustration</td>
<td>I have 5 assignments all due next week. I have almost finished all of them</td>
<td>After doing the breathing exercise, my emotions did not change at all from before. Right now, I feel stressed about all of the assignments that are due next week.</td>
</tr>
<tr>
<td>Edward</td>
<td></td>
<td></td>
<td>It helped when I was really stressed about the assessment other times….when I wasn’t feeling anything, it didn’t help that much</td>
</tr>
</tbody>
</table>

The 13 occasions where students reported negatively about the breathing intervention predominantly related to computer issues, stress about assessment tasks and that the breathing exercises interrupted their flow of work highlighting that they were unable to resolve issues preventing the negative emotions. While there were exceptions, the breathing exercises appeared to help most students regulate their negative emotions and re-focus on the task at hand. In fact, almost all students associated the effectiveness of breathing exercises to the times that negative emotions were present. Yet some students specifically mentioned that the breathing exercises were not as effective in the absence of negative emotions. One representative comment from the follow-up interview is below:

Anna  You know when it’s helpful? When you are actually stressed, if you aren’t sad or like that don’t (sic) really help. Like when you are
stressed about your assignment, the breathing calm you down and relaxes you so you can get a clearer mindset but if you are feeling normal the breathing exercise doesn’t really [help]…

THE VALUE OF DEEP BREATHING IN SCIENCE CLASSES

The deep breathing exercises were conducted using mindfulness meditative strategies and enabled students to focus on their breathing and bring their attention to the present moment allowing other thoughts to dissipate. In response to their physiological sensations, this research shows that the breathing afforded opportunities for students to alleviate negative emotions. Science classes can elicit emotions of anxiety and frustration for students when they find the work cognitively challenging (King et al., 2015). This was confirmed in this study when many students reported experiencing negative emotions during science classes and found the deep breathing exercises helped them to manage their emotions. In most instances, students were experiencing feelings of stress, frustration, and anxiety prior to the deep breathing exercises but these feelings were ameliorated subsequently.

James Gross and Ross Thompson (2007) categorise the deep breathing exercises as a response-focused extrinsic intervention, which proved successful for managing negative emotions for the majority of students in this class. This supports previous work where emotion regulation has been shown to be a foundation for well-being, academic performance, and positive adjustment throughout life (Eisenberg, Spinrad, & Eggum, 2010). This study makes a new contribution by showing that an intervention, such as deep breathing exercises in science classes, can ameliorate negative emotions, and in some cases, change negative emotions to positive ones. However, the deep breathing exercises intervention was not as successful for students who were not experiencing negative emotions or who found the exercises interrupted their work. Further research is needed to explore a variety of mindfulness interventions to understand further the impact on students in science classes who experience the types of emotions theorised in James Davis’ (2016) work known as undramatic or mundane emotions.

Using Turner’s (2007) theoretical perspective enabled the analysis of discrete emotions through multiple methods using a variety of data sources. Furthermore, the meso and micro-analyses were important for triangulating the findings and determining the emotional expressions accurately. With clear instructions, students recorded their emotions on emotion diaries, which provided a rich source of data for identifying discrete emotions and changes to emotions as a result of the deep breathing exercises. We suggest for further studies on emotion regulation that multiple data sources such as observation, interview, emotion dairy and video are collected to discern students’ expressed emotions accurately and any changes to emotional expression that are associated with the intervention. As such, these changes may represent cultural transformations or breaches to everyday classroom practices that Stephen Ritchie and Jen Newlands (2016) define as events. Their analysis is
important for understanding better salient emotional outcomes that inform science teaching and learning.

The students in this study had limited knowledge about deep breathing exercises or any intervention that could be used to manage their emotions. Based on the positive outcomes from this study, we suggest that students need to be taught about emotions, emotion regulation, and how to manage their emotions. Such strategies may enable improved focus and concentration as found in this study. Malgorzata Powietrżynska and Al-Karim Gangji (2016) argue that it is our responsibility as science educators to include neuroscience and mindfulness practices as part of the biology curriculum so that students learn how to have a healthy mind as well as a healthy body. We support this suggestion and encourage teachers to use deep breathing exercises as one possible practice.

ACKNOWLEDGEMENTS

This work was supported by the Australian Research Council, administered by the Queensland University of Technology under Grant LP110200368.

REFERENCES


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**APPENDIX 1**

**Interview Questions for Students:**

1. When learning science/or working on your assignments etc. – you might face problems/challenges what would you do? What would be your emotions/reactions?
2. Overall what do you think about breathing exercises in science classrooms? How do you compare it with other subjects?
3. For some students, breathing exercise seems to work well sometimes and not so well on other days. Can you think of any reason? (Time of the science period-what about science lesson time)
4. Why it did/not work for you?
5. For some students, it’s been most of the time un/successful. Any insight/idea on that?
6. Which part of deep breathing works the best for you?
7. How can we make this work better?
8. Would you do the breathing exercise on your own when facing challenges in other subjects? Why or why not?

Interview Questions for Mr Boyd:

1. Can you categorise the students into certain groups, if so, what are they and why?
2. Overall what do you think about breathing exercises in science classrooms? Please elaborate.
3. Based on students’ comments from the emo diaries, the breathing seems to work well sometimes and not so well on other days. Can you give any explanation/s for this?
4. Have you noticed any changes in yourself when you do the breathing?
5. Have you noticed any changes in students since you have begun the breathing with them? If so, what are they?
6. Can you see any value for breathing during science compared to other classes?
7. What do you think about doing this exercise in the last term?
8. What do you think is the main issue with this intervention being successful?
9. What do you think about students facing problems while learning science? What’s their reaction, feeling? How do they react? What is their emotion? What would you do?
10. Would you do the breathing again with another science class? Why or why not?

ABOUT THE AUTHORS

**Donna King** is an Associate Professor in science education. Her research in science education spans three interconnecting fields: the emotional engagement of students in science in the middle years, using engineering contexts for teaching science and context-based science education. An outcome of this work is the development and implementation of innovative context-based units where teachers have adopted new pedagogical approaches for teaching science. Recently, she completed a project with a team of researchers from the Queensland University of Technology and the Department of Education and Training to establish a STEM (Science, Technology, Engineering and Mathematics) Hub for schools where teachers worked with industry partners to connect STEM in the classroom with real-world STEM. She was recently invited to be the co-chief editor of the international journal *Research in Science Education*. 
**Maryam Sandhu** is a research assistant at the Queensland University of Technology. Her main focus is analysing classroom data in terms of students’ and teachers’ emotions during teaching and learning by applying different research methodologies, utilizing various software and Ekman facial expression recognition. She has worked on several research projects related to emotions, emotional climate in classrooms and mindfulness with the other co-authors.

**Senka Henderson** is a researcher and lecturer at the Queensland University of Technology (QUT), Brisbane, Australia. Senka’s first career developed a background in pharmacology, biochemistry and drug discovery, and she has worked in research laboratories investigating new discoveries in carbohydrate chemistry. In her second career as an educator she has worked on three science education research projects exploring the emotions of pre-service science teachers in university settings and students in high school science classrooms. Currently she is involved in science education research at both QUT and Murdoch University, in Western Australia. Senka is also teaching science education at the Faculty of Education, QUT.

**Stephen M. Ritchie** has been fortunate to collaborate with such trail-blazing international scholars as Kenneth Tobin and Wolff-Michael Roth on several projects throughout his career. It has been just as satisfying for him to apply what he learned in these projects to support younger researchers (notably, Associate Professors Alberto Bellocchi, Donna King and Louisa Tomas) as their careers have emerged, and as they assume leadership roles to continue the cycle of mentoring early career researchers themselves. Stephen’s research has focused mostly on learning and teaching in science classrooms as learners are engaged emotionally in meaningful activities in the pursuit of scientific literacy. Early research with his collaborator at James Cook University, Donna Rigano, set the scene for major theoretical advances that followed while he was Professor of Science Education at Queensland University of Technology. His research efforts slowed down somewhat while he was the Dean of the School of Education and Acting Provost at Murdoch University over the last five years. As his formal leadership duties and his academic career draw to a close, he hopes to renew his efforts in supporting colleagues in science education research, and even pursue new interests outside of science education.