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[King, Donna, Henderson, Senka, & Sandhu, Maryam](#)
(2019)

Deep breathing as a mindfulness practice in year 10 science.
In Tobin, K (Ed.) *Mindfulness in education*.
Routledge, United Kingdom, pp. 91-101.

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Deep breathing as a mindfulness practice in year 10 science

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Donna King is an associate professor in science education. Her research in science education spans three interconnecting fields: the emotional engagement of students in the middle years including using deep breathing interventions to ameliorate strong emotions, developing 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*.

Dr Senka Henderson is a researcher and a lecturer at the Queensland University of Technology (QUT), Brisbane, Australia. Senka's first career emerged from a background in pharmacology, biochemistry, and drug discovery. Senka has worked in research laboratories investigating new discoveries in carbohydrate chemistry. Her second career as an educator has included three science education research projects that researched 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 also teaches science education in the Faculty of Education, QUT.

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 the Paul Ekman framework for facial expression recognition. She has collaborated with the co-authors on several research projects related to emotions, emotional climate in classrooms, and mindfulness.

Deep breathing as a mindfulness practice in year 10 science

Abstract: Abdominal deep breathing (DB) has been used in conjunction with paying attention on purpose to the present moment as a mindfulness tool to help students develop skills for managing emotions. While studies are emerging that investigate outcomes of mindfulness practices with adolescents, how to implement such practices, and students' reactions to them, requires further research. This study examines a DB intervention in a year 10 science class where the teacher implemented DB exercises in each science lesson. One main outcome reported in this study is that the time to adapt to the DB exercises and experience its effectiveness varied for individual students. Gleaned from our presence in the classroom and speaking with the teacher and students, we suggest nine recommendations for implementing DB exercises in Australian middle years classrooms.

Keywords: deep breathing; mindfulness; middle years; science

Deep breathing as a mindfulness practice

Mindfulness practices have their roots in the emerging multidisciplinary field of contemplative neuroscience which is founded on the brain's ability to change its structure and function (Davidson with Begley, 2012). In education, there is a growing field of research as scholars seek evidence-based ways to improve students' wellness so that they can lead fulfilling and productive lives (Tobin, 2017). Mindfulness is a particular way of paying attention on purpose to the present moment in a way that is non-judgmental to the unfolding of experience (Kabat-Zinn, 2003). Deep abdominal breathing is one mindfulness tool that can be used in conjunction with nonjudgmental attention to present-moment sensation to ameliorate heightened emotions and help students to manage feelings of stress and anxiety (King, Sandhu, Henderson, & Ritchie, 2017).

Previous research from 14 programs that directly train primary and secondary students in mindfulness have shown positive outcomes; such as, students experienced

improvements in working memory, attention, academic skills, social skills, emotion regulation and self esteem as well as decreases in anxiety, stress and fatigue (Meiklejohn et al., 2012). A further analysis of 24 psychological studies showed that mindfulness-based interventions in children and youths showed promising outcomes in relation to improved cognitive performance and resilience to stress (Zenner, Herrnleben-Kurz, & Walach, 2014). An additional study focussed on using breathing as a mindfulness tool with adolescents called “Learning to BREATHE” and showed that there was an increase in students’ feelings of calmness, relaxation, and self-acceptance, improved clarity around the emotions they experienced, and increased skills for emotion regulation after program completion (Broderick & Metz, 2009). Such positive results highlight the many benefits of mindfulness practices for adolescents, especially with a deep breathing focus. From our previous work with middle years students, we saw a need for trialling a deep breathing (DB) intervention in conjunction with paying attention to the present moment, to help teachers and students find ways to address students’ self-report of negative emotions.

Background to this study

This study occurred in the third year of a three year Australian Research Council linkage grant where students’ emotions in the middle years of schooling (i.e., years 8 -10) were investigated. In the second year of the study we analysed and later published research on students’ negative emotions (e.g., embarrassment, sadness, and distress) when learning introductory chemistry concepts (i.e., King, Ritchie, Sandhu, Henderson, & Boland, 2017). These findings highlighted to the research team that there was a need for strategies to help students manage negative emotions for improved perseverance on challenging tasks. The teacher in the second year of the study agreed to continue this work in a follow-up study where we implemented the mindfulness practice of DB exercises as an

intervention to assist students to ameliorate negative emotions. For the majority of the 19 lesson unit (8 weeks), students were working on an assessment task around the theme of sustainability. Each lesson was approximately 60 minutes long, including a variety of activities such as computer-based lessons, teacher-led lessons, and group work.

Professional Development for the science teachers

In the third year of the grant and prior to the teaching of the sustainability unit, the majority of the science teachers in the school received two two-hour professional development sessions consisting of 2 x 40 minutes of DB training by a yoga teacher trained in mindfulness practices. The yoga instructor modelled four different DB techniques; belly breathing, finger breathing, the four-sided stretch, and the seated twist. All techniques required students to learn how to do belly breathing. As the yoga teacher instructed the teachers, they participated in the exercises.

The belly breathing technique was most salient for this study where initially, the yoga teacher modelled the seated upright posture required for deep breathing. She explained how the correct posture allows space for the diaphragm to move and lungs to expand (see Figure 1), affording a greater amount of fresh oxygen into the lungs while inhaling. The instructor modelled each of the six steps outlined below for the belly breathing technique:

- (1) Place palm of hands on the front belly
- (2) *Breath in* and notice the belly expand like a balloon
- (3) *Breath out* and notice the belly deflate
- (4) Take your time as you breathe in and out, let your body move slowly
- (5) On each breath, allow the body to relax-shoulders soften
- (6) Imagine any tension dissipating out through the feet, as the balloon deflates

<< Insert Figure 1 Here >>

Figure 1. Yoga instructor modelling Step 1: Place palm of hands on the front belly.

Fortuitously, the teacher (Mr. Boyd – a pseudonym) was an experienced martial arts teacher and familiar with deep breathing. However, he was reluctant to adopt the DB exercises with his year 10-science class at first since they were a diverse multicultural group with a couple of students who were difficult to engage. However, after discussions with the first author and Head of Science, he agreed to “give it a go.”

Methods

This interpretive research adopted an ethnographic case study design aligning with Stake’s (2006) approach to case study for qualitative inquiry. We were immersed in the year 10 science class for 8 weeks collecting ethnographic data including videos, interviews, field notes, and students’ emotion diaries completed during each lesson. In these diaries, students recorded their emotions they experienced during the lesson with a brief comment explaining what they were doing when the emotion occurred (for more information on diaries see King, Ritchie, Sandhu & Henderson, 2015). At the end of the diary they answered a question which asked: “After you did the breathing exercises, did you experience any change in your emotions? If so, which emotions/s did it change?” Out of 19 students in the class, only one student did not participate in the breathing exercises due to medical reasons. Each student was interviewed at the end of the study for approximately 10 minutes where salient aspects of their emotion diary responses and deep breathing comments were discussed.

Analysing students' emotions and responses to Deep Breathing exercises

Initially, the analysis involved graphing the discrete emotions experienced by the students to analyse the frequency of positive and negative emotions. Following this, we coded the responses at the end of the diaries which related to the breathing interventions specifically. Simultaneously and iteratively we referred to video data from the 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 colour-coded spreadsheet. The outcomes for this paper focus on the DB methods used by the teacher and how this impacted two case study students – Scott and Bridie (pseudonyms).

How the DB was introduced to the year 10s

Mr Boyd was cautious when introducing the DB exercises because he was aware that the students in his class may be self-conscious when doing them. In the introduction to students, he explained what they will be doing:

So, we will be doing the breathing in the first couple of minutes of the lessons. What I want is everyone to give it a go. I want everyone to try to do it. I know it will be difficult and really embarrassing, BUT I will close the door and no one will be able to see you guys apart from yourselves. There won't be any reason to feel bad or be picked on as you are the only ones who will see it. There are a few different types of breathing that we can do, and I'll show them to you. The first one, is probably the easier to do, hands on your belly and breathing in for three seconds, then out for three seconds, really trying to push your belly out when you breathe in. Really try to draw the air down into your belly. (Mr Boyd, Video transcript, 6/12/15)

He went on to explain the other three techniques and finished the introduction by giving students a choice about which one they will do: *“So I will leave it up to you to choose one that you want to do. Feel free to try any of the breathing techniques, but right*

now we will just do the first one together as a practice.” He explained also to students how the DB exercises helped calm his mind when it was “firing lots of thoughts” and he was having trouble focusing. When he saw the students trying hard to do the exercises properly, he praised them and said how happy he was with their mature and responsible approach.

Initially, the teacher did the DB exercises at the start and in the middle of the lesson using his discretion to choose a suitable time. He relied on students’ non-verbal cues to determine a suitable time (e.g., when they were becoming restless and needed a break). By week three, after examining the data we found that students had a preference for the exercises to occur only in the middle of the lesson. Mr. Boyd changed the structure to doing the exercises once in the middle when there was a natural break in the lesson and he refined the DB method to three steps:

- (1) One minute semi-guided deep breathing which was about 6-8 breaths
- (2) One minute unguided while students concentrated on their own silent breathing paying attention to the present moment
- (3) One minute semi-guided deep breathing

In this paper, we report one key assertion from the analysis that informs the DB methods we propose.

Students’ experiences of the Deep Breathing exercises

The analysis revealed that the time to adapt to the deep breathing exercises and experience its effectiveness varied for individual students. We found that there was a variation in the time students took to report positive outcomes such as “calms me down.” In particular, we noticed changes to students’ reported emotions and comments in the emotion diaries at two salient time intervals: weeks 3 and 5. We use two representative cases – Scott and

Bridie to describe these findings.

Case One: Scott's change in focus for the DB exercises took three weeks

Scott's comments and reported emotions changed from positive to negative after week 3 of the breathing exercises. We revisited the videos of Scott engaging in the DB exercises and found that in the first two weeks, Scott did the DB exercises very quickly and then returned to his work. We also found that despite showing all the physical signs of participating through placing his hands on his belly and completing the belly breathing, he was distracted by glancing at his computer screen during the exercises (see Figure 2 (a)) and playing with his pen (see Figure 2 (b)). On both of these occasions he answered the question at the bottom of the emotion diary about whether the breathing exercises changed his emotions and he wrote "no." However, we found that in week 3 there was a change in his responses similar to the analysis of 11 other students' reported emotions and diary responses. The video data showed that he began to focus on his breathing exercises without other distractions, pushing his computer to the side rather than in front of him (see Figure 2 (c)). For the whole three minutes he did the breathing as instructed by the teacher. His emotion diary responses changed too and for the first time he acknowledged that the DB exercises changed his emotions to be "more relaxed and less anxious." These feelings of being relaxed and less stressed were reported on six different occasions from week three onwards (see Table 1).

<<Insert Figure 2 Here >>

Figure 2. Scott's change in concentration with the DB exercises

Table 1. Scott's comments about the changes to emotions after breathing exercises

<<Insert Table 1 Here >>

Since we found his change in attitude to the DB exercises interesting, we probed him about it in the follow-up interview at the end of the unit:

- Donna When learning science or working on your assignments, you might face problems or challenges. What would you do? What would be your emotions or reactions?
- Scott Generally, I'm pretty frustrated, I just don't like to be stuck on something.
- Donna Is there anything that works for you, enables you to get over this frustration?
- Scott I usually ask for help, I hadn't really done the breathing thing before so that works well for me, I like that.
- Donna How and why did it work for you?
- Scott It calms me down a little bit and so I will have a fresh head, and I can just look at the problem from a different angle, and yeah get it down

These comments in the interview highlight how the breathing exercises were new for Scott and that they calmed him down, gave him a “fresh head” so that he could “look at the problem from a different angle.” When we asked him why the DB exercises did not work for him in the first two weeks, he responded:

I think I was a bit close minded in the beginning. I think I didn't want to do it in the beginning because I thought... oh... I just cut into the work I have.... it's five minutes out of my period, I need to get some work done, this is gonna be a bit of [a] hinderer. But in the middle, towards the end, I kind of thought it's research, it's gonna affect other people. I need to take it seriously, keep an open mind about things, help other people (Interview 7th November, 2014).

Scott reflects on how he changed his perspective about the importance of the research for completing the deep breathing exercises. In this interview, he reflects on the importance for taking the DB exercises seriously when he explains how his participation could have an impact on other people and how he decided to “take it seriously” from then onwards. Our analysis showed this change began in week three. This is an important finding when considering implementation of deep breathing mindfulness practices with adolescents; that is, students need to know the purpose for the DB exercises. We have

incorporated these findings into suggested recommendations for doing DB with middle years students in the discussion section of the paper.

Case Two: Bridie's change in focus for the DB exercises took five weeks

We found a similar pattern for Bridie where she changed from reporting negative comments about the DB exercises to positive comments in week five. Prior to week five she wrote on five occasions that the DB exercises made her feel “more tired.” However, in week five she reported that the DB exercises were “good – made me work better.” These comments can be seen in Table 2, which summarizes her responses to the emotion diary question about the DB exercises:

Table 2. Bridie's comments about the changes to emotions after the DB exercises.

<<Insert Table 2 Here >>

We examined the videos and field notes more closely to watch Bridie's behavior in class to seek a deeper understanding of how she participated in the DB exercises prior to week five. We noticed that previously, Bridie was distracted by her friend Kelly when doing the DB exercises. For example, in the photos below taken in week three (Figure 3 (a) and (b)), Bridie was sitting very close to one of our cameras and we could hear the audio recording clearly. She began the breathing exercises by closing her eyes and breathing until her close friend Kelly moved closer to her while staring at her. Bridie suddenly opened her eyes appearing surprised by Kelly's actions and they both laughed during the exercises. Bridie was distracted and talking to Kelly for the remainder of the DB exercises while the rest of the class were doing the breathing exercises. This happened on 9 out of 10 lessons in the first four weeks of the DB intervention. Furthermore, from the analysis of all the emotion diary entries, we found another two students who showed

a change in their responses from week 5 with comments before week 5 such as: “the breathing exercises made me sleepy” to during week 5: “I was calm” and “the stress was gone.”

<<Insert Figure 3 (a and b) Here >>

Figure 3 (a and b). Week 3- Bridie (RHS) distracted by Kelly (LHS) during DB exercises.

By week five Bridie was participating more fully in the exercises as seen by her closed eyes, hands on her knees and belly breathing (see Figure 4).

<<Insert Figure 4 Here >>

Figure 4. Bridie is doing the DB exercises in Week 5.

We asked Bridie about the DB exercises in the follow-up interview and her response showed that she eventually could see the value of doing the DB exercises for reducing her worry so that she could “just do the work.” She also explained how sitting with certain girls made it difficult for her to do the DB exercises, especially when some of the girls stared at her. Furthermore, she acknowledged that she did not want to do the DB exercises in the beginning because she “had no idea what it was for.” This highlights the importance for reiterating to students the purpose of the DB exercises and moving students who may distract each other. Also, these cases show that persevering for a number of weeks is necessary for 15 of the 19 students to appreciate the value of the DB exercises. We probed Bridie’s perspective on the DB exercises in the follow-up interview:

Bridie Breathing really does work, like the best. But, maybe if that one person is frustrated, maybe focus on them for like a bit more, if that makes sense. Maybe, like, talk them through, like “It will be ok”, then maybe they can just sit there and do the breathing

themselves because they are focused more, as everyone else is doing it. You know maybe ... because when everyone else does it, it's different, everyone is like, yeah.

Donna You said breathing works, tell us why?

Bridie Because you are like focusing and then you are like, you have to think which means you like calm down and then it's like ... oh yeah ... and then afterwards it's like ... ok I have nothing to worry about, just do the the work, I don't know, it's just good.

Donna And doing it with the whole class, does that seem to work?

Bridie Depends who you sit with. Like when I sit with girls I don't know I feel like they are looking at me and I just like (long pause) ((shakes hand and head as if it's a done deal)) ... ok stop! Because they don't ... some don't do it all the time and I'm like ok, makes me not wanna do it and then sitting with Scott ... and ... I don't know his name

Donna Evan

Bridie Like I was into it more, like I didn't feel like someone was in my face. Some of the girls stare at me and I'm like ... ok, stop!

RA In the beginning you were negative?

Bridie At the start of the term everyday was bad, I had problems ... I don't know [I] didn't want to do it, I had problems and I didn't want to do the breathing, I had no idea what was it for, and I was like, why am I doing this? At the start of the day I was always in a bad mood. But now, I'm like, ok I [can] tell [you] what I actually feel.

Bridie confirmed in the interview that she found it difficult to focus on the DB exercises early in the unit and when the other girls “stared at her.” By the end of the unit she changed her perspective and reflected that “breathing really does work” for focussing her attention on her work.

Lessons learnt and recommendations

This study highlighted some important considerations for teachers when implementing DB mindfulness practices in a middle years classroom. Our analysis has shown that the response to the DB exercises is individual and variable depending on how the student chooses to participate (or not) (e.g., Bridie) and if the student can see the purpose of the exercises (e.g., Scott). Through persistence, both students experienced positive outcomes from the exercises although it took a significant amount of time for there to be positive participation (i.e., 3 weeks for Scott and 11 students; 5 weeks for Bridie and 2 students). While the outcome from the study leads us to some recommendations for implementing DB in middle years classrooms, each class may have individual requirements. We found in this study that the teacher developed his own methods that suited students' needs and

responded to emotion diary comments and feedback from students. Also, this study shows that it is necessary to persist beyond the initial few weeks so that students who may not have been engaged initially have a chance to participate when they are ready.

We observed the implementation of the DB exercises over eight weeks recording field notes as well as talking to the teacher and students. Gleaned from our immersion in the field, and watching the teacher experiment with various strategies, we decided on nine recommendations (listed below), that may help teachers who are trying the DB exercises in middle years classrooms in Australia.

- (1) Professional Development for teachers may enable skills to be learnt from a qualified practitioner.
- (2) Teacher directed DB exercises may assist students to learn the correct posture and breathing techniques.
- (3) Clear explanations reiterated frequently may help students to understand the purpose of the DB exercises.
- (4) Experimenting with the structure may enable the teacher to find a time and procedure that suits the needs of the class.
- (5) Considering the classroom placement of students may enable less distraction between students.
- (6) Continuing the DB exercises over a longer time frame may enable distracted students to join in when ready.
- (7) Providing an optional exercise/activity may afford students an alternative if they do not want to participate.
- (8) Including some tools such as emotion diaries, interviews and journals may allow for feedback from students.

- (9) Praising students when they are doing the DB exercises well, may encourage ongoing good practices.

The follow-up interviews revealed that all 19 students who participated in the DB exercises appreciated the opportunity to do them in science and were positive about the impact they had on managing their focus to do tasks. Many of the students also expressed how they used the breathing exercises in other situations in their lives especially when “feeling stressed” about assessments. We recommend that teachers trial these DB exercises in middle years science classes as an intervention to educate students about their health and wellbeing and to provide strategies that may assist them to ameliorate anxiety.

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Tables and Figures



Figure 1. Yoga instructor modelling Step 1: Place palm of hands on the front belly.



Week 2.1
(a) Glancing at his
computer screen

Week 2.2
(b) Playing with his
pen

Week 3.1
(c) Doing DB

Figure 2. Scott's change in concentration with the DB exercises.

Table 1. Scott's comments about the changes to emotions after breathing exercises.

Week (Lesson)	Comment to question at bottom of Emo Diary: " After you did the breathing exercises, did you experience any change in your emotions? If so, which emotions/s did it change? "
1.1	maybe a little more relaxed-not much change
1.2	a bit less focused
1.3	My emotions did not change dramatically.
2.1	No
2.2	No
3.1*	I felt a bit more relaxed and slightly less anxious about assignment
3.2	I felt more relaxed
3.3	No felt angrier ????
4.1	No emotions changed
4.2	I felt relaxed but not lethargic. Before the breathing exercises I did not feel very stresses but there was definitely and improvement in relaxation
4.3	I felt significantly more relaxed and had a slightly better understanding of the work that needed to be done.
5.1	Prior to the breathing exercises I felt tired but not too stressed as I had finished most of my assignment work. However, after the exercises I felt more energised
5.2	I did not notice any extreme change this time. I felt slightly less full, like less thoughts in my head but that's about it.
5.3	I felt more relaxed after the breaths. Mainly feeling a lot less stressed about assessment
6.1	Before the breathing exercises I was feeling very stressed about school work. However, after the breathing exercises I felt a lot more relaxed and prepared.
6.2	before the breathing exercises I felt very stressed however after I felt less stressed. There was not a noticeable difference this time.

*Change in his responses

Table 2. Bridie' s comments about the changes to emotions after the DB exercises.

Week (Lesson)	Comment to question at bottom of Emo Diary: “ After you did the breathing exercises, did you experience any change in your emotions? If so, which emotions/s did it change? ”
1.1	no comment
1.2	more tired
1.3	Made me feel tired, dopy :(
2.1	Not sure how I'm feeling today, in a BRIE mood :)
2.2	Made me feel tired and not willing to do anything.
2.3	
3.1	Made me feel good & more awake, which is a change I normally feel tired
3.2	Made me feel tired
3.3	Made me feel tired and although made me not want to work as much
4.1	No exact same today
4.2	
4.3	
5.1*	Was good . Made me work better
5.2	
5.3	
6.1	After my breathing exercises I felt more relaxed and
6.2	Before-tired, stabbing in the stomach, stressed from school work. After-relaxed , although still stressed.

*Change in her responses



(a)



(b)

Figure 3 (a and b). Week 3- Bridie (RHS) distracted by Kelly (LHS) during DB exercises.



Figure 4. Bridie is doing the DB exercises in Week 5.