

ATTENTION SPAN IN CALCULUS CLASSES AND YOGA BREAKS

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Abstract

Although the attention span among students has reduced in the age of technology and communication, some mathematics classes have a similar duration as decades ago. We have been making use of several strategies to try to mitigate this out-of-date approach, such as active learning methodologies like flipped learning. However, expository periods cannot be avoided, and as the difficulty level of concepts increases, the more difficult it is for a student to stay focused during an entire class.

Our aim is to find the most appropriate pauses during classes, that maximize attention and effective learning. We found out that redirecting student's attention to some non-related subject, which is simpler, relaxing and appealing, the overall classes' effectiveness improved substantially.

In this direction, we combine simple yoga stretches, breathing and mindfulness exercises with reflection about yoga related words and ideas, in order to deal simultaneously with several difficulties caused by long expository classes.

Within all the yoga related words and ideas, it is very important that the choices we make do not conflict with people's beliefs and religions. Moreover, we can choose ideas that are not only relaxing and neutral, but whose reflection on them allows students to acquire strategies to better deal with their stressful lives. For example, the word "detachment", often and wrongly confused with "indifference", can trigger a reflection useful to cope with the common stress related to assessment. The awareness that, after doing our best in an exam, there is no way to further control the final result, can be liberating. We present in this article a list of the words and ideas we have used in classes. Together with an explanation of the most common misinterpretations about them, we propose ways of application to students' lives.

Finally, we describe in detail the yoga stretches, breathing and mindfulness exercises we have also applied during classes. It is our intention to provide teachers with sufficient information and confidence so that this strategy can be easily replicated.

We have been implementing and trying to improve these pauses during the years in several mathematics courses in Higher Education. From these experiments, we have collected feedback from students and teachers that allowed us to accomplish the reflections we share in this article, with the potential to be reused in other contexts.

Keywords: Yoga breaks, attention span, calculus, higher education.

1 INTRODUCTION

Attention span, the amount of time we can be focused, as reduced over the years. We can see for ourselves that it is difficult to keep attention in one task. The electronic devices are constantly showing new notifications, and there is a high pressure to do everything as fast as possible. We are not interested in discussing attention span but instead, to deal with the reduction of attention span in the classes. Information about attention span and references can be found, for example, in [1], where the author affirms: "The academic literature is replete with articles and books supporting and propagating the conclusion that lectures should adhere to the 10- to 15-min attention span that is characteristic of modern students".

Calculus is a subject that requires a high concentration effort that may be difficult to maintain during long periods of time. In order to maximize the overall effectiveness of classes, a natural strategy is to introduce breaks. We are interested in finding the most effective breaks possible and have tried several possibilities.

Our context is the University of Aveiro, Portugal, where we have been implemented yoga breaks with first-year and second-year students of calculus courses.

A common practice among teachers is to let students go outside for some minutes, in the middle of a two-hour class. This kind of break is beneficial for several reasons. After one hour of class, concentration

diminishes considerably. Leaving the classroom for some minutes allows students to move their bodies after being seated for a long time, to get some fresh air and to direct attention to something else other than mathematics. Nevertheless, there are two main problems with these breaks: students do not meet the stipulated break time, and most of the times several students return speaking and agitated. Hence, after the break the conditions to continue the class are not ideal.

This motivates our question: how to introduce breaks, short in time but with high effect on students' concentration for the remaining part of the class?

Our first approach was to ask students to stand up and do some stretches. This is still beneficial for students' bodies, and they do not return to the class restless. We explain to students why we are doing this in calculus classes but still there is some discomfort, for some students. Also, just doing stretches feels like the time used in breaks is not being use the most effective way.

Therefore, we have ended up with what we call yoga breaks, a combination of yoga stretches, breathing techniques, words for reflection, and a mindfulness practice.

The word "mindfulness" was first introduced by T.W.R. Davids in 1881, in relation with the word "Pali", a mental factor important in the Buddhist Noble Eightfold Path [2]. An important reference that popularized Buddhism in the west and is highly cited is the Vietnamese monk Thich Nhat Hanh [3]. The term became popular due to the stress programs MBSR and MBCT created by John Kabat-Zinn [4], since several clinical trials were made, showing that mindfulness-based programs can be helpful for treating anxiety and depression.

Modern yoga has usually a high component of yoga postures practice, contrary to what happened in ancient yoga, where the focus was seated meditation. This is very natural. As people tend to have lives much more sedentary than before, we can argue that it is more important a practice with some stretching and mobility exercises. Although some philosophies associated with modern yoga have many centuries and have origin in the region of India, this kind of postural practice is more recent, and it comes from the West more than from in India [5].

Several philosophies are associated with modern yoga, including the old Samkya, the Yoga Sutras of Patanjali, Advaita Vedanta, Buddhist philosophy [6], etc. Since, associated with yoga, there are theist and non-theist philosophies, monotheistic and polytheistic, dualist and non-dualist, there seems to be no such thing as "the yoga philosophy". Nevertheless, the importance of mindfulness, of being in the present moment, seems to be considered by all yoga practitioners. Hence, a yoga practice with emphasis on mindfulness, may be useful for everybody without conflicting with philosophical preferences.

There are many studies suggesting that mindfulness can have a positive effect on teaching and learning [7]. Although we have a mindfulness exercise using the breath and sensations as an anchor, we give mindfulness instructions also in the exercises. Hence, we can say that the yoga breaks we suggest are based on mindfulness.

Regarding the words for reflection, starting with "mindfulness", we present a set of ten words we have used in the yoga breaks, together with the explanation of how they can trigger useful reflections. These words can be reused in different contexts.

In addition to those we suggest, other ideas, from yoga related philosophies, are also acceptable as a starting point for a reflection that can be applied to the sometimes-stressful academic live and can be considered in perspectives that do not conflict with peoples believes.

We have been implementing yoga breaks in calculus 3, a second-year course, for several years, and have also used this tool in calculus 1, a first-year course. These courses are part of the curricula of several sciences and engineering courses and so have hundreds of students registered.

2 METHODOLOGY

The effect of introducing yoga breaks in calculus classes is analysed both by direct observation of students' behaviour in the classes and from students answers to an informal survey. This experiment is essentially an empirical qualitative case study, also including some numeric data, with positive results. Our main goal is not to generalize, but instead to provide information for this experiment to be easily adapted and reused in different contexts, aiming for beneficial consequences.

We start by describing in detail what was done in the yoga breaks and then present the observed consequences of their introduction in the classes. Direct observation in the classes and answers of students to an open question in the survey constitute our most important data, since they provide us ideas and material for reflection.

Before the first yoga break, the teacher explains that he is also a yoga teacher and is going to introduce yoga breaks to help with classes' effectiveness. We notice that being a yoga teacher for several years obviously helps in the implementation of yoga breaks in the calculus classes. But we believe that this is not essential, and, in fact, our intention is that this article helps any teacher to feel confident to implement yoga breaks in his/her classes.

A typical yoga break starts with the teacher stating that a yoga break is going to be made, in an appropriate occasion, like after some mathematical problem is solved, erasing the blackboard, and switching of the projector, with the purpose of not letting any mathematics visible. Then he writes one yoga related word in the blackboard and makes a small reflection. After that, some stretches are made and the yoga break ends with a mindfulness or breathing exercise.

We have used several yoga related words in our yoga breaks. We present ten of them here with the hope that may be useful to be reused in other contexts. Since mindfulness is the main mental factor emphasised by the yoga practice we have been using, the most natural first word to be written in the blackboard is precisely "mindfulness". The simple action of erasing the blackboard, turning of the projector and writing this word, not related to mathematics, in large letters in the middle of the blackboard has the effect of arousing students' attention and curiosity. Then a brief explanation of the meaning, importance and utility of the word follows. Probably the most known definition of mindfulness is the one by Kabat Zinn, as the "awareness that arises through paying attention, on purpose, in the present moment, non-judgementally". Programs based on mindfulness was shown to be effective for relieving stress and depression and are useful do deal with chronic pain in terminal diseases [8]. For some students, the practice of mindfulness may help to deal with stress and anxiety caused by academic live, especially assessment.

The word "detachment", often and wrongly confused with "indifference", can trigger a reflection useful to cope with the common stress related to assessment. The awareness that, after doing our best in an exam, there is no way to further control the final result, can be liberating. There is no indifference but instead the awareness that we did our best in that moment and that creating stress in the body or in our mind by editing the past, is not going to change anything. Hence, we can simply let go instead of wasting energy.

Another important word is "acceptance", often confused wrongly with "resignation". Resignation can mean that we simply give up. There is an active approach in acceptance. We recognize what exists in the present moment as it is, instead of pretending it is different. This puts us on the best possible starting point to deal with the situation. For example, imagine you do not have enough time to do a deep study of some subject. You can deceive yourself and plan a deep study you do not have time to do or instead you can accept your situation and plan a more superficial study, by selecting some essential concepts, that is possible to follow.

What can help with academic live is reflecting about "appreciation" and trying to generate that mental state. A problem we have in our university is students' attitude. Many students act like if they are forced to be there, not showing interest in studying. The ability of appreciating what we already have does not imply that we do not fight for something better. But the lack of this ability may take us to a miserable state of in dissatisfaction. We can, for instance, appreciate the fact that we are in a peaceful country studying in a good university.

The following two words "ahimsa" and "satya" are from the Pantanjali's Yoga Sutras. We use words in Sanskrit because is difficult to find a word in our language with the same meaning, the same way we use the word "mindfulness" in English instead of Portuguese. The word "ahimsa" is often translated to "non-violence". The idea is not pretending we are very kind people. Instead, ahimsa refers to a practice of non-violence, either towards ourselves or towards others, that goes far beyond mere physical aggression, and that is beneficial to practice, due to the positive feeling it provokes in us. For example, we can force us to work beyond a limit, being violent to our own bodies and minds. This awareness and attitude of ahimsa can make us more efficient and prevent problems.

The usual translation of "satya" to a single word is "true". This practice does not mean simply to not lie but also to be realistic about ourselves. For example, are we overestimating of our work capacity? Here we take the opportunity to say that these "yoga related words" can be combined with each other, for interesting and liberating reflections. For example, we can practice ahimsa together with satya when we

recognize that we are, or there is a potential in us, for violence. Sometimes yoga practice takes practitioners to an illusory world of kindness and non-violence. We prefer to see yoga as a tool that may help us to be complete. There are several facets or, as Jung says, subpersonalities in every human being [9]. We can use the yoga ideas and tools to more aware and rooted in reality, including all its aspects, instead of rejecting or pretending that parts of us do not exist.

Our last four words appear in the early Buddhist texts, common to all traditions, and in the Yoga Sutras of Patanjali [10]. They are often referred as the four divine states, meaning that if we are able to maintain one in your minds we feel in Heaven. The words are: metta, karuna, mudita and upekkha.

The word “metta” can be translated to loving kindness or a general state of good will. This can be applied to others but also to us. And, in particular, to our attitude towards the work we have to do. It is much more favourable to approach studying with a general state of good will then as an annoying obstacle.

The word karuna is often explained as what happens when metta meets suffering. It is translated to “compassion” and means a combination of empathy with a genuine aspiration to help to alleviate the suffering of someone we see as equal. It is wrongly confused with pity, which puts us in some position of superiority. What sometimes is needed in competitive and stressful academic environments is self-compassion, or karuna directed to oneself. Without it we can either work too hard or party too much in a less healthy way.

The word “mudita” means feeling happy when something good happens to someone else. It is the opposite of envy. We can focus on our grade being lower than our colleague grade and feel bad, or instead, be happy for him/her. In any case the grades will keep the same, the only difference is the way we feel. Again, it is a practice that we may do, not because of some moral imposition, but because it is beneficial to ourselves and also to others.

Finally, the word “upekkha”, usually translated to equanimity, refers to the ability to be with everything, either happiness or sadness, for example. A common simile is the ability to be in the ocean and allow all waves to pass, just letting them go, large waves and small waves, waves of any kind. Life in the university has all kind of situations, positive and negative, and we can simply let it be.

With all words and reflections, it is important to repeat that we are not trying to indoctrinate anyone, but simply suggesting several reflections, with the intention of moving attention away from mathematics and giving a diversity of possibilities that may be useful for more people.

It is not common, but sometimes a student makes some question related with the suggested yoga word. The best way to proceed is trying to focus on student’s feelings, as suggested by Rosenberg and his non-violent communication [11] and give a further short explanation with the goal of helping the student, instead of trying to defend our ideas.

After writing the word on the blackboard and its explanation, exercise’s part follows. This physical part of the yoga breaks intends to be as effective as possible to alleviate stress from the body after being seated for a long time. Hence, we start by asking students to stand up for extending the legs. After that, several yoga poses can be made but we try to structure the sequence to do the main movements of the spine and back. So, a forward bend and a gentle back bend are usually included. Then side bends and twists to both sides are made.

A sequence of poses we have used in yoga breaks is illustrated in Fig. 1. Following the pictures from left to right we start with a forward bend, in the first picture, where the most important is trying to round the whole spine. The posture in the picture is possible to do if we have a table in front of us. It is better than bringing our hands close to the floor, a common forward bend that does not round the whole spine and it is not so easy to do in a classroom with limited space. A back bend follows, in the second picture, and again the whole spine should arch. The shoulders are rotated backwards and go down and we push the chest up bringing our shoulder blades close together. When doing a back bend, it is common to bend more the lower back. Simply saying to open the chest or to “undo the hump” is enough to improve the posture.

In a side stretch, illustrated by the third picture, some students also twist a little what makes the posture less effective. Giving a simple indication do face the chest forward, or to move the shoulder backwards so the shoulders are in a plane parallel to the front wall, is enough for students to align correctly.

We must adjust the postural practice to the space we have in the classroom. In an amphitheatre we cannot ask student to spread their legs. Hence, for doing a simple twist, illustrated by the fourth picture, we can simply say they should move the right leg a bit forward and the left leg a bit backwards. Then, the most important thing is that, in a twist, the arm that moves forward is the opposite of the leg that moves forward. In this case, like shown in the picture, the left arm should go forward.



Figure 1. A simple yoga set: forward bend, back bend, side bend and twist.

Finally, when tension from the spine and back is released, a mindfulness exercise follows, either standing, or already seating back in the chair. Seating in the chair, the usual indications, like indications to observe the breath are given. Just be aware of breathing in and breathing out, paying attention without interfering, just observing. If the mind wanders it is normal, the whole idea is to notice it, without judging, and bring the attention gently back to the sensations associated with breathing.

As an alternative to the mindfulness exercise, simple pranayama, or breath control exercises were suggested. Some of these exercises, for some people, induce relaxation faster than mindfulness alone. A simple one is to inhale while counting from 1 to 4 and exhaling while counting from 1 to 8. The breathing should be slow but not uncomfortable, and exhaling should last double the time of inhaling. A slow exhaling is the most important for the relaxing effect due to its activation of the parasympathetic system, saying that everything is all right. Instead of trying to impress people with complicated exercises, we believe it is better to teach simple and easy to remember exercises together with simple explanations of way they work.

3 RESULTS

From direct observation of students' behaviour improvement in the classes comes our best result. We can clearly see students' difficulty to maintain attention before a yoga break. After the yoga break, they are silent and look relaxed. Then they pay attention to mathematics without effort, actively participating in the activities.

We have used an informal questionnaire about the course of second year calculus, including two questions about yoga breaks. The most important one is the open question (a), allowing students to say what they think about doing yoga breaks in calculus classes. The other question (b) asks, "Is it beneficial do have yoga breaks in calculus classes?" and students select they level of agreement from 1 to 10 (where 1 means "total disagree" and 10 means "totally agree"). The questionnaire was answered by 68 students and the answers to this last question are summarized in the charts on Fig. 2, showing clearly that yoga breaks are valued by students in general.

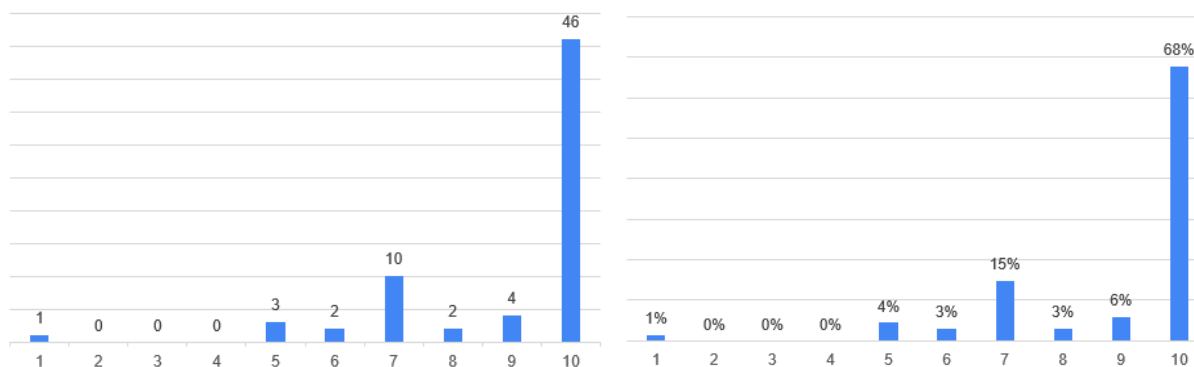


Figure 2. Are yoga breaks beneficial in calculus classes? (68 students; scale: 1-10)

We can see that 68% of students answer 10 to question (b). This corresponds to the enthusiasm students show for yoga breaks, remembering the teacher to introduce yoga breaks in several moments in the classes.

More useful to our reflections and work are students' answers to the open question. The most "negative" answer to question (a), given by a student with answer "1" to question (b) was the following: "Unnecessary and embarrassing/annoying". We can see that, persuading students to participate in the yoga breaks can have a positive effect of helping some students to release from shyness. Nevertheless, this does not work with all students, and some may continue to feel uncomfortable with some public exposure involved in the yoga breaks. Hence, it is important to achieve this balance, trying to persuade students with some lightness but always letting room for them to not participate, and somethings even giving them the possibility to leave the room for some minutes.

Another less positive answer was: "important for the relaxation of the students, could be better if the other students took them seriously and did not take advantage of them to talk or cause confusion". In some breaks, students did not become silent immediately, what is natural since there are about thirty-five students in the class. Sometimes the teacher must explain that it is important to be silent even in the case of non-participation in the yoga break. In almost every class all present students have actively participated in yoga breaks, and all got silent for some time.

A third answer that was not positive was simply "indifferent". Then there were three neutral answers like students saying that they did not participate in any yoga break. The other 38 answer were statements supporting the yoga breaks.

Several supportive statements simply say they liked the yoga breaks. In 22 of these statements, it is explicitly referred that yoga breaks have a positive effect for improving concentration. The relaxing effect of yoga breaks is referred in 17 statements.

Now we present some interesting answers to open questions with additional observations. This answer mentions the positive effect on the body, in addition to concentration and stress relieving, "the yoga break allows you to improve attention in class and often the stress we have, from the middle of the class it sometimes becomes quite difficult to continue paying attention and the yoga break is a breath of fresh air, enough to come back to pay attention and break the body posture of sitting for so long".

The following comment refers explicitly the incapacity of the human brain to focus for a long time: "It is more than proven that the human brain is unable to concentrate for more than 1 hour without stopping, in extreme cases it manages to maintain absolute focus for an hour and a half. So, 2-hour classes are too long to be productive".

Another observation in the following comment is that yoga breaks can help to prevent back pain when students have several classes in the day: "They help a lot in increasing concentration, since, with tiredness, it is difficult to pay attention to the full 2 hours of class. In addition, they help to prevent back pain on days with a lot of classes."

Moreover, 5 answers suggest that yoga breaks should be implemented in other classes.

In general, we can see from the answers to the questionnaire that students have received well the introduction of the yoga breaks in the classes. As we already said, direct observation of students allows us to say that there was a substantially improvement in attitude in the second part of the class, after the

yoga break, when compared with classes without breaks or with breaks letting the students go out for some minutes.

4 CONCLUSIONS

Yoga breaks have been considered useful by many students, and teachers can also observe more appropriate student behaviour in classes where yoga breaks are used. Although the kind of breaks we used seem to be very effective with our students, they may need to be adapted to different contexts, for example depending on the level of competition and anxiety of students. Moreover, although the breaks have been improved during the years we do not know if they can be further improved. Also, we have been experimenting with the way we do the breaks, but we still have to work on the number of breaks in classes and the most effective moments to introduce them.

An important consequence of this kind of yoga breaks is that students have contact with several technics to deal with stress and depression, problems that have increased in the recent years in part due the pandemic and international conditions. Since the yoga breaks introduced in the classes include a large variety of techniques and reflexions, there is a higher probability of some of the tools to be useful to many students. This is difficult to measure and compare to other situations, where no yoga breaks are done.

Students' concentration clearly declines after some time in calculus classes and students look distracted, talk to each other, use their mobiles and so on. A yoga break catches back students' attention and curiosity and, most importantly, after the yoga break there is remarkable improvement of concentration and general students' altitudes.

ACKNOWLEDGEMENTS

This work is supported by The Center for Research and Development in Mathematics and Applications (CIDMA) through the Portuguese Foundation for Science and Technology (FCT - Fundação para a Ciência e a Tecnologia), references UIDB/04106/2020 and UIDP/04106/2020.

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