Journal of University Teaching & Learning Practice

Volume 18
Issue 6 *Standard issue 3*

Article 13

2021

Using deliberate mistakes to heighten student attention

Abey P. Philip
Curtin University, Malaysia, abeypp@curtin.edu.my

Dawn Bennett
Bond University, Australia, dabennet@bond.edu.au

Recommended Citation

Philip, A. P., & Bennett, D. (2021). Using deliberate mistakes to heighten student attention. *Journal of University Teaching & Learning Practice, 18*(6), 193-212. https://doi.org/10.53761/1.18.6.13

Using deliberate mistakes to heighten student attention

Abstract

Attracting and retaining students' attention is a concern for educators at every level of education, including those in higher education. Despite compelling evidence that student-centred pedagogies enhance attention, motivation and learning gain, exposition-centred delivery in forms such as lectures persists across higher education. Contemporary research on student attention suggests that student concentration in class begins to wane within 10 minutes; that neither tutorials or lectures tend to engage students effectively; and that the optimum length of a lecture is as little as 30 minutes. Where previous studies of student attention have focussed on the impacts of active listening, flipped classrooms and authentic assessment, the exploratory study reported here sought to determine the impact of a "deliberate mistake strategy" (DMS). The study engaged 103 undergraduate business students who self-assessed their attention span before and after a DMS was employed within their semester-long unit. Analysis of the students' self-report involved paired sample t-tests and revealed that students' attention span had increased significantly as the result of their engagement in DMS; there were no significant gendered differences. Cohen's *d* revealed a large effect size with students reporting that DMS had helped them to increase their perceived attention span when in class. Amid continued debate about how to engage students and growing realisation that multiple approaches are needed, the findings suggests that the use of a simple strategy such as DMS merits further attention.

Practitioner Notes

1. Lessening mind wondering or lack of attention among students demands action by both instructors and students.
2. A deliberate mistake strategy heightens student attention and consciousness with little preparation work for instructors and no additional technology demands.
3. Students need both attention (as analyser) and consciousness (as synthesiser) to spot deliberate mistakes, and they enjoy the challenge.
4. A deliberate mistake strategy has particular relevance in content-heavy and/or long classes such as traditional lectures.

Keywords

Student engagement, attention, consciousness, higher education, learning

Background and Context

Educators, scholars and curricular designers are paying increased attention to the cognitive and neural basis of learner attention and the strategies with which to attract and retain students' attention in class (Kahu & Nelson, 2018; Maguire et al., 2017; Tai et al., 2019). In large part this interest has been motivated by scholars' growing understanding of the educational impact of mind wandering. Hollis and Was (2018), for example, sought to understand the distractions of social media among undergraduate students and found that higher levels of mind wandering predict lower academic performance. Wammes and Smilek (2017) came to the same conclusion, but of interest they found that students' mind wandering is less prevalent when watching classes on video that when they attend live classes.

Although mind wandering is not a new challenge for educators, scholars including Szpunar et al. (2013) find that cognitive mind wandering among students when in class has progressively increased over time, with an associated decrease in the length of students' attention span. As such, learner attention presents as a critical challenge. Bunce et al. (2010) emphasise that non-engagement is often unintentional and that students try to re-engage when they realise their attention has lapsed. Ward and Wegner (2013, n. p) agree, commenting that "attention becomes disconnected from perception, and people's minds wander to times and places removed from the current environment".

One of the earliest studies on mind wandering among students in class was conducted by Johnstone and Percival (1976), who observed that students start to experience mind wandering between 10 and 18 minutes of class commencement. The prevalence of mind wandering was found to increase over the course of a class such that students might experience mind wandering every three to four minutes towards the end of a class. Around the same time, Stuart and Rutherford (1978) found that lecturers believe the maximum concentration of students to be between 10 and 15 minutes.

In line with Johnstone and Percival's observations and emphasising many of the challenges of traditional lectures, the lecturers in Stuart and Rutherford's study reported that students' attention span fell steadily as the class progressed. Although Johnstone and Percival's study has been critiqued over the intervening years, and despite Stuart and Rutherford's suggestion that the optimum length of the lecture may be as little as 30 minutes, lectures of two or more hours remain a feature of most degree programs over 40 years later.

There is also general concern that many of the claims about student attention are purely theoretical, made without sufficient evidence, or methodologically unsound (see Bradbury, 2016; Nold, 2017; Szpunar et al., 2013). Bradbury (2016) is one of several scholars to question the validity of studies which claim that students have a 10 to 15-minute attention span; rather, he suggests, the solution lies in good teaching. The characteristics of "good teaching" in higher education are understandably a dominant topic in educational research. The negative performance impact of asking students to concentrate on a single task over extended periods of time, for example, has been reported by Tomporowski and Simpson (1990), Helton and Warm (2008) and Laurie-Rose et al. (2015). Szpunar et al. (2013) are among many scholars to have endorsed the need for teachers to introduce frequent changes of topic or brief exposures to a single topic. Devine et al. (2013) add that educators' beliefs and expectations can be influenced by students' social class, gender and ethnicity. However, Otting et al.'s (2010) research on the link between mind wandering and the learning process concludes that good teaching is insufficient in and of itself to control students' interest and attention.

In addition to research on teaching strategies to enhance attention, scholars have focussed on the role of students. Dunlosky et al. (2013), for example, assert that students can improve their learning skills if they learn and apply techniques such as elaborative interrogation, self-explanation, summarisation, highlighting concepts, keyword mnemonics, re-reading and practice testing. Helber et al. (2012) suggest that students can develop their cognitive skills and focus their thoughts using meditation, and Reilly (2020) responded to disruptions in learning caused by the global pandemic by introducing daily mindfulness to enhance cognitive functioning.

Another dominant theme relates to the influx of new technologies and the impact of digital andragogy on adult learning (Blackley & Sheffield, 2015). Many digital tools for learner engagement have been studied in relation to learner attention. Bunce et al. (2010, p. 1442), for example, researched the impact of clicker questions (to which students respond using a response system or clicker device) on student attention during both lectures and tutorial sessions. The authors concluded that student attention in the digital age still "alternates between being engaged and nonengaged in ever-shortening cycles throughout a lecture segment". Risko and colleagues (2013) similarly questioned the assumption that new technologies are the solution, finding that students' dual concentration on technology and classroom can in fact lower student attention. Weurlander et al. (2017) add that the potential benefits of pedagogical and curricular innovations can be thwarted when there is conflict with educators' underlying beliefs about teaching and learning.

In sum, student engagement is an accepted factor in academic success; however, engaging large and diverse student cohorts in multiple educational settings remains a challenge for curricular designers and educators alike. Keeping this in mind, and mindful also of the time constraints of both teachers and students, the study reported here trialled the use of a deliberate mistake strategy (DMS) to reduce mind wandering during lectures and tutorials. In contrast to claims that adequate attention and consciousness is the responsibility of students, the study was mindful of the role of educators (Risko et al., 2013; Wilson & Korn, 2007) and proposed a cognitive strategy led by instructors.

Specifically, we hypothesised that students' in-class attention span would increase through the inclusion of regular cognitive tasks in the form of a DMS. Whilst there was no prior evidence to suggest that any impact might be gendered, we recorded students' gender alongside their response to enable explorative analysis. The study posed two research questions: 1) Does students' in-class attention span increase through the inclusion of regular cognitive tasks in the form of a DMS? 2) Are there gendered differences in mind wandering before and/or after implementing DMS?

Theoretical Framework

This article reports on an exploratory study in which the authors developed and tested a DMS designed to heighten students' in-class concentration. The study was prompted by multiple attempts within a traditionally structured business degree to hold students' attention for the entirety of a class. Although these attempts had met with varying degrees of success, they had confirmed the need to focus our attention to the *substance* of students' thinking (Levin et al., 2009; Warren, 1993).

The result of these endeavours, DMS, is grounded in cognitive development and takes as its theoretical framework Krathwohl's (2002) revision of Bloom's 1956 taxonomy of educational objectives. Shown at Figure 1, Krathwohl re-ordered categories within the cognitive process dimension to bring these in to line with current educational objectives. Krathwohl also separated the noun and verb, with the noun relating to knowledge and the verb relating to cognitive process. A new category within the knowledge dimension of the taxonomy recognised metacognitive knowledge: knowledge in which functional and dimensions of learning come together.

In seeking to reduce mind wandering, Robison and Unsworth (2018) found that individuals with greater cognitive abilities can reduce mind wandering by completing related and demanding tasks.

This observation is in line with Smallwood and Schooler's (2006) contention that mind wandering decreases when individuals are engaged in a primary task that involves controlled processing, thus limiting the extent to which attention is divided between internal thoughts and feelings and the external environment (originally described as decoupling: see Antrobus et al., 1966).

Figure 1.

Krathwohl's revision of Bloom's taxonomy (2002, adapted by Bennett & Ferns, 2017).

The cognitive process dimension							
The functional dimension	**The knowledge dimension**	*Remember*	*Understand*	*Apply*	*Analyse*	*Evaluate*	*Create*
	Factual knowledge						
	Conceptual knowledge						
	Procedural knowledge						
	Metacognitive knowledge						

Factual Knowledge
Basic elements students must know to be acquainted with a discipline or solve problems.
Conceptual Knowledge
Interrelationships among the basic elements within a larger structure (*for example, industry or workplace*) that enable them to function together.
Procedural Knowledge: How to do something: methods of inquiry, criteria for using skills, algorithms, techniques, and methods.
Metacognitive Knowledge
Knowledge of cognition as well as awareness and knowledge of one's own cognition.
Remember
Retrieving relevant knowledge from long-term memory.
Understand
Determining the meaning of instructional messages (oral, written and graphic).
Apply
Carrying out or using a procedure in a given situation.
Analyse
Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.
Evaluate
Making (*learning or workplace*) judgments based on criteria and standards.
Create
Putting elements together to form a novel, coherent whole or make an original product.

Against this background, we hypothesised that students' in-class attention span would increase through the inclusion of regular, demanding cognitive tasks in the form of a DMS. The DMS technique draws on "mindless theory" as proposed by Robertson et al. (1997), who conclude that insufficient attention to tasks can result in slips of action because automatic, unintended action sequences are inappropriately triggered. Robertson and colleagues add that a lack of exogenous support for attention during the gaps between critical stimuli fails to keep observers attentive to the task; this eventually leads to observers being unaware of even the critical stimuli.

The explanation for this seems to lie in Smallwood and Schooler's (2006, p. 131) observation that mind wondering involves executive control and yet seems to lack explicit and deliberate intent. This is attributed to a lack of meta-awareness—"awareness of the current contents of our personal experiences"—such that we don't notice when other concerns displace the tasks or goals on which we had been focussed. Through DMS, then, we increased exogenous support for attention by creating deliberate mistakes aligned with key learning concepts associated with the unit of study.

This focussed students on the critique of key concepts, for which they needed to combine the functional dimensions of learning to create metacognitive judgements.

Gendered differences in learning are widely discussed in the educational literature: for example, whilst males are typically associated with logical and rational decisions, females are associated with intuition and analytical skills (Deng et al., 2016; Richardson & King, 1991; Wehrwein et al., 2007). Similarly, there is evident that males tend to be multimodal and females tend to be unimodal (Wehrwein et al., 2007). We note that the extant research tends to treat gender as binary and there is therefore a lack of research which considers identities outside the gender binary.

The literature generally concludes that teaching style has more influence than does students' gender. According to (Charles, 2017), there is also little evidence that the gender gap differs considerably among countries, reflecting cross-national variations in women's socioeconomic roles or gender stereotypes in science. Despite the wealth of literature on the impact of different pedagogical approaches on student learning, there is little research on how these pedagogies affect students' cognitive abilities and whether this affect differs by gender. As a secondary aim, we sought to explore differences in attention based on gender.

The Deliberate Mistake Strategy

The literature confirms that consciousness and selective attention are complementary but independent processes in learning (Baars & Gage, 2010; Dehaene & Changeux, 2011; Nani et al., 2019; van Boxtel et al., 2010). Table 1 illustrates a range of common visual, auditory and kinaesthetic (VAK) strategies. Reciprocal eye contact is one such (visual) strategy (Böckler et al., 2014; Haataja et al., 2021).

Table 1.

Visual, auditory and kinaesthetic (VAK) strategies

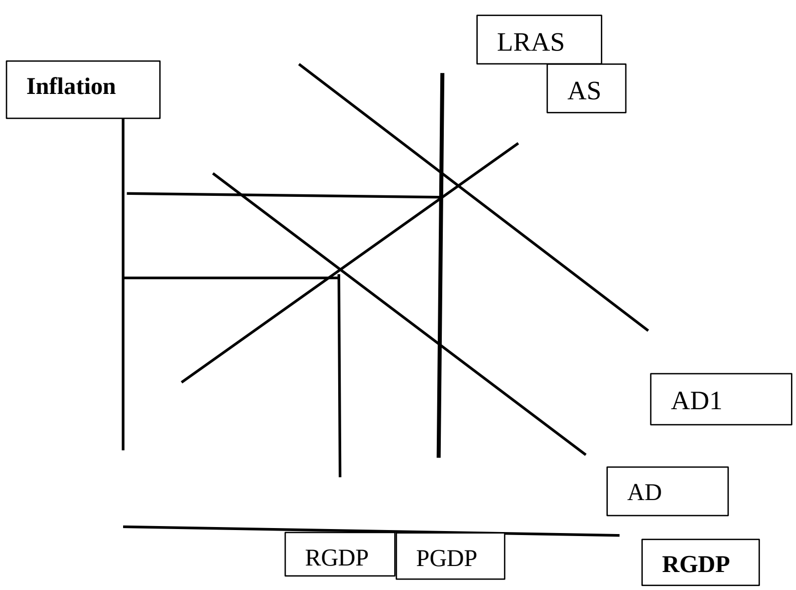
Learning Style	Teaching strategies
Visual	In-person demonstrations
	Slide show presentations
	Word and colour usage
	Spatial awareness
	Video presentations
	Role plays
	Games
	Reciprocal eye contact
Auditory	Learning by listening (i.e., lectures)
	Discussions
	Audio
	Asking questions
	Presentations
	Mnemonics
	Music
Kinaesthetic	Role plays
	Listening to music
	Listening to lecturers while walking
	Learning by writing
	Learning by drawing

Our DMS example comes from the field of macroeconomics and involves a class on recession and inflation. In simple terms, when an economy undergoes a recession, a central bank might use expansionary monetary policy to expand the economy. The central bank might buy securities or bonds from the financial market, leading to an increase in the supply of money within that market. This leads to a surplus of money in the market and subsequent pressure to reduce the cash rate; this leads in turn to a decrease in interest rates. When interest rates reduce, consumers consume more and investors invest more, thus the net export will be positive. This generates an increase in aggregate demand, which shifts to the right. In theory, a recession can be resolved by employing expansionary monetary policy.

In the DMS example, students are first taught about recession and aggregate supply and demand with the help of the diagram shown at Figure 2. Using the DMS strategy, bolded words might later be swapped and the instructor might tell students that the economy experiences inflation rather than recession. Asking students to confirm whether the statement is right is intended to bring their attention and consciousness back to the concept. Author one had found in previous classes that students often mis-label the axes when recreating the concept as a figure. Using a DNS strategy to reinforce the concept, the instructor might mis-label the axes when reviewing the concept and ask students whether the figure is correct. Another example is a DMS strategy in the form of a statement: for example, "due to contractionary monetary policy the AD will shift left" (rather than right). The instructor would watch the class to see whether anyone spots the mistake and, if not, give students the opportunity to do so.

Figure 2:

Example of Deliberate Mistake Strategy in Macroeconomics



Legend

AD: Aggregate Demand

AD1: Aggregate Demand-1

AS: Aggregate Supply
LRAS: Longrun Aggregate Supply

PL: Price Level

RGDP: Real GDP is a country's total economic output adjusted for price change.

PGDP: Potential GDP is sustained over the long term.

Procedures

Sample and recruitment

The study involved 103 undergraduate business students enrolled in an economics unit which was delivered at the Malaysian offshore campus of an Australian university. The semester-long unit, Principles of Economics, was a compulsory class for all undergraduate business students. The unit was delivered as a weekly two-hour lecture and one-hour tutorial, both of which were taught by author 1. Among the participants, 66 (64.1%) were females and 37 (35.9%) were males; there were no non-binary responses. Students attended both lectures and the tutorial classes.

Ethical approvals from the university's Human Research Ethics Committee were in place before the study commenced. Student participation was voluntary and students could withdraw from the study at any time without prejudice or negative consequences. Students received a written consent form and information sheet and they were assured of their anonymity. Demographic information was limited to gender.

Instruments

Students self-assessed their attention span before and after they encountered the DMS and they were asked to report the impact of DMS on their attention. We also drew on students' anonymous post-unit evaluation comments, drawing out any unsolicited comments relating to the use of DMS. The nature of the "deliberate mistakes" was informed by *Mindless theory* (Robertson et al., 1997) and Krathwohl's (2002) revision of Bloom's taxonomy, described earlier. Given our focus on learner attention, particular attention was paid to higher orders of cognitive development outlined by Bouchard (2011) and the metacognitive dimension of self-knowledge discussed by Pintrich (2002). An example of DMS is included in the following section.

Approach

Students were introduced to DMS during their first class, explaining how the technique might work in a class setting and letting students know that it would be a feature of their classes across the semester. DMS was employed as a continuous learning strategy and students were advised that they could encounter "mistakes" from the second week of semester. Students self-assessed their perceived attention span in minutes and seconds in week one and again in the final week of semester.

Author one identified the major concepts to be covered in the unit and decided which of these would be the target of deliberate mistakes each week. Deliberate mistakes were made only after a major concept had been covered and students had had ample opportunity for discussion and questions. Students were reminded at regular points during semester that deliberate mistakes would be made when the lecturer reviewed major concepts; they were challenged to spot these mistakes and correct the lecturer. An example of a deliberate mistake strategy was given at Figure 1.

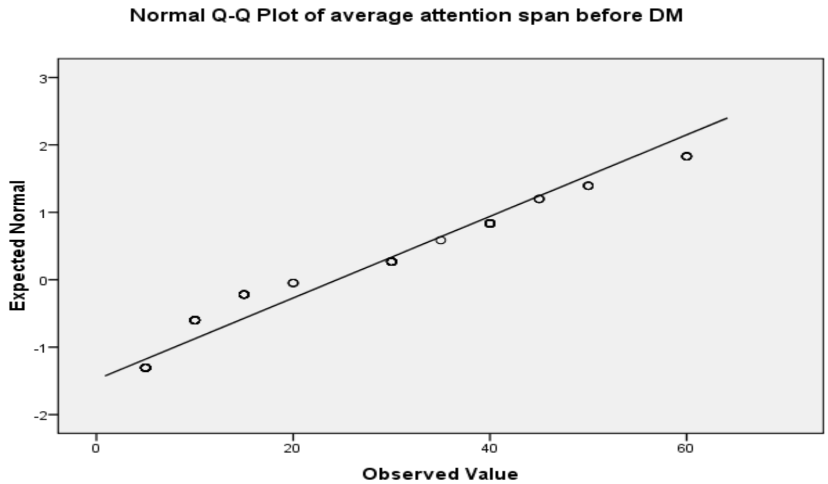
Findings

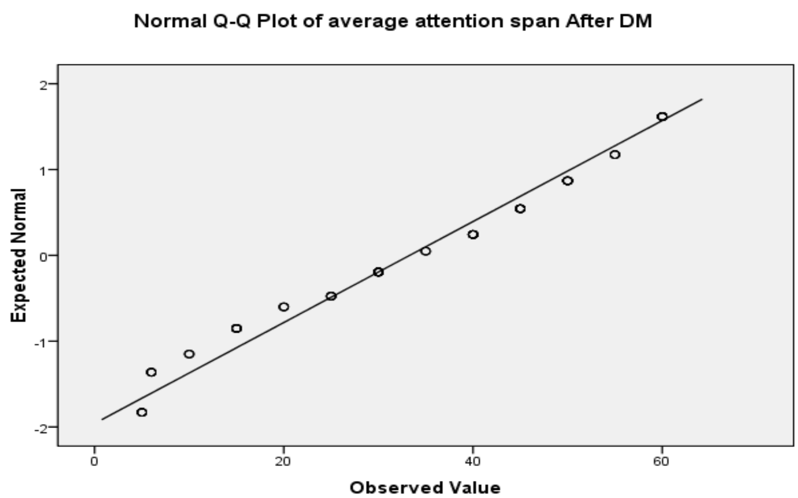
Quantitative data

Quantile-quantile (Q-Q) plots, skewness and kurtosis statistics indicated that the data was normally distributed. First, quantile-quantile (Q-Q) plots were used to check the normality of the variables. Illustrated at Figure 3, the variables were normally distributed both before and after using DMS. Skewness and kurtosis levels were estimated at .48 and -.82 respectively before implementing DMS and at -.12 and -1.09 respectively after implementing DMS. These results were more than sufficient to conduct t-tests (Posten, 1984; Schmider et al., 2010).

Figure 3.

Normal Q-Q plot of students' perceived attention span before and after DMS





Paired sample t-tests were conducted to ascertain the mean average attention span before and after implementing the DMS. Shown at Table 2, the average student's attention span prior to DMS was 24.47 (SD=16.54); after DMS it was 33.30 (SD=17.00). The data shows an average increase in attention span of around 8.83 minutes after implementing DMS.

Table 2.

Student attention span before and after implementing DMS

Variables	N	Mean (minutes)	Skewness	Kurtosis
Students' attention span before implementing DMS	103	24.47	.484	-.822
Students' attention span after implementing DMS	103	33.30	-.122	-1.090

The correlation between the two conditions was estimated at r=.89, p<.000, suggesting that a dependent samples t-test was appropriate to calculate the effectiveness of DMS reported by the sample. The null and alternative hypotheses were stated as follows:

H0: $\mu 1 = \mu 2$ ("the paired population means are equal") -------- (1)

H1: $\mu 1 \neq \mu 2$ ("the paired population means are not equal") -------- (2)

Shown at Table 3, the null hypothesis of students' attention span being equal was rejected (t (102) = -11.28, p<.001): students' attention span after implementing DMS was statistically significantly higher than their attention span beforehand.

Table 3.

t- test and descriptive statistics before and after implementing DMS

Average attention span	M	SD	n	95% CI for Mean difference	r	t	df
Before DM, average attention span After DMS	-8.834	7.946	103	-10.39, -7.28	.000	-11.284	102

Cohen's *d* (Cohen, 1992) is an appropriate effect size measure for two groups with similar standard deviations and of similar size. Cohen's *d* was estimated at 0.527, which is a large effect. The analysis confirms that students believed the implementation of DMS had helped them to increase their attention span when in class.

Next, we sought to ascertain whether there was a gendered difference. Before implementing DMS, male students had reported an attention span of M=26.22 (SD=17.30) compared with female students' slightly lower reported attention span of M=23.49 (SD=16.48). To test the hypothesis that the attention span of male and female students was associated with statistically significantly different means before implementing DMS, we performed an independent sample t-test. The assumption of homogeneity of variance was tested and satisfied via Levene's F test (F (101) =.68, p=.675). The t-test was associated with a statistically insignificant effect (t (101) =.80, p=.424), confirming that there was no significant gendered difference in students' attention span before implementing the strategy.

The second t-test explored whether DMS had a gendered impact on attention span. After implementing DMS, male students reported an attention span of M=31.08 (SD=18.74). This time, female students reported a longer attention span than their male peers (M=34.54; SD=15.95), suggesting that although the mean attention span of both male and female students increased after implementing DMS, the increase was greater among female students.

We conducted a final independent sample t-test to test the hypothesis that the male and female students were associated with significantly different means after implementing DMS in the table-4. The assumption of homogeneity of variance were tested and satisfied via Levene's F test (F (101) =.22 p=1.51). The independent samples t-test was associated with a statistically insignificant effect (t (101) =-.99, p=.323), confirming that gendered differences in increased attention span following DMS are not significant.

Table 4.

t- test and descriptive statistics before and after implementing DMS, by sex

Average attention span before DMS	**Sex Male**			**Female**			**95% CI for Mean difference**			
	M	**SD**	**n**	**M**	**SD**	**n**		**r**	**t**	**df**
	26.22	17.30	37	23.48	16.15	66	-4.02, 9.48	.424	.803	101
Average attention span after DMS	Sex Male			Female			95% CI for Mean Difference			
	M	SD	n	M	SD	n		r	t	df
	31.08	18.74	37	34.55	15.95	66	-10.39, 3.46	.323	-.993	101

The student voice

As author one was the unit lecturer and thus in a position of power, we did not include questions about the perceived efficacy or attraction of DMS within the attention span self-assessment instrument. Anonymous post-unit evaluation surveys were voluntary at the university and they were also the place where students freely voiced both positive and negative comments; hence, we turned to the survey comments for open appraisals of DMS.

Thirteen students mentioned DMS in their feedback and 12 of the comments were positive. Indeed, asked how the unit might be improved, two students asked for an increase in the number of deliberate mistakes! Indicative student comments are included to follow.

> *His deliberate mistakes allow me not to lose focus. In the foundation year, I had to study economics but I hated this because it was boring. But, after being taught by [author one], I like this unit very much! Especially the 'deliberate mistake' - it is very useful to help me to pay attention to what he says.*

> *I love how he uses 'deliberate mistakes' in teaching. It sure helps me a lot by listening attentively and understanding the unit more. … Now, economics is one of my favourite subjects.*
>
> *My lecturer/ tutor used deliberate mistakes which I personally think was a smart move as this aids me in focusing more in class and makes the class more interesting. Apart from that, with this technique, I feel like I could understand more in class. It also helps me to remember what is being said in class.*
>
> *He not only emphasized the points we should comprehend but also deliberately made mistakes to help us pay attention and correct the mistakes. In my view, this is a way that can strengthen our knowledge of economics. Hence, I'm now more interested in learning economics, not just memorizing economics for the purpose of the examination.*
>
> *… when he does deliberate mistakes, sometimes the students get confused. It's better if he does deliberate mistakes after the students really understand the concept of whatever he's teaching.*

Students' comments are in line with author one's observation that during a DMS moment, students with less attention would simply nod their head in agreement whilst attentive students would correct it. This technique helped him to gauge the attentiveness of individual students and to engage those students who were less attentive. Students appeared to enjoy reporting a deliberate mistake and their interventions opened discussion on *what* was wrong and *how* it might be corrected. In this sense, the study aligns with Tait et al.'s research on the use of humour in university teaching. Although this is anecdotal evidence, we feel that it is an important inclusion. We note, however, the final student comment, which was the only negative comment from students. This serves as a reminder that not all students grasp a concept at the same rate. As such, DMS needs to be appropriately scaffolded.

Discussion

Our DMS strategy sought to engage students by alerting them to deliberate mistakes made by the instructor in a physical (face-to-face) class. We observed an increase in student attention from five to 10 minutes across the 90-minute class and the strategy was favourably evaluated by students. In seeking to explain the impact of DMS, we note that the students needed both attention (as analyser) and consciousness (as synthesiser) to spot the deliberate mistakes (van Boxtel et al., 2010). The strategy also negated the need for negative interventions: for example, asking students whether they were listening or to please pay attention!

Robinson and Unsworth (2018) contend that deliberate mind wandering is most often prompted by a lack of motivation. It is without doubt the responsibility of teachers to engage and motivate students. However, the research evidence suggests that good teaching is insufficient in and of itself to control students' interest and attention. In reality, large classes and tiered lecture theatres make it difficult for lecturers to know whether students' minds are on task. Moreover, the negative performance impacts of limited concentration are rarely replicated within the practical tasks which are more typical within smaller classes, labs, fieldwork settings and workplace learning contexts. The fact remains that although students in class may think that their mind and body are in the same place, they might nod their heads in agreement and appear to be engaged even as their attention is elsewhere (Killingsworth & Gilbert, 2010).

Mind wandering leads to superficial representations of the external environment. During mind-wandering, cognitive resources become engaged by internal activity unrelated to the learning environment. This ubiquitous phenomenon is common in relatively passive environments such as the higher education lecture theatre and it limits students' ability to concentrate for a long period of time. A partial solution within the traditional lecture setting is to focus student attention and motivation during the most complex or time-consuming aspects of a unit of study. This is because key concepts can be complex and can demand students' concentration over extended periods of time. With a focus on key concepts, DMS was designed to lessen students' mind wandering during traditionally structured classes and to help lecturers become more aware of when mind wandering occurs. The strategy responded to both educational and neurological research including Barbara and Paul's (1997) work on epistemological theories, Helton and Warm's (2008) research on mindlessness and vigilance, Manly et al.'s (1999) study of sustained attention and Robertson et al.'s (1997) ground-breaking work on attention loss as being variously spontaneous or deliberate.

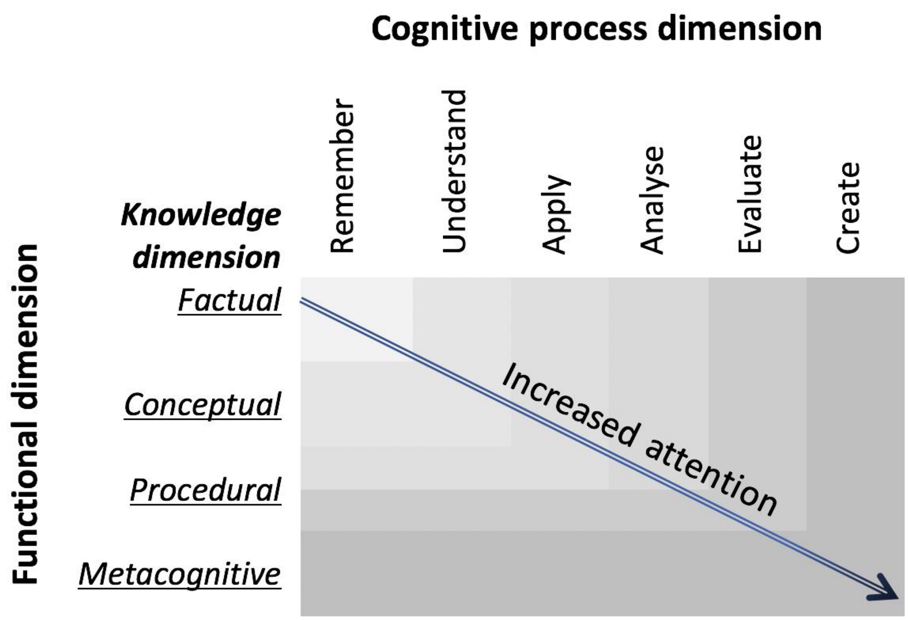
Moving past the idea that the causes of and solutions to mind wondering lie purely with teachers, attention might transition to the question of how a massified higher education system with diverse student bodies, large classes and multiple modes of delivery can engage students more fully in the learning process. Examples of this in action are seen, for example, in the students as partners work spearheaded by Matthews (2017), in research-driven learning initiatives (Healey & Jenkins, 2009), in problem-based learning (Hmelo-Silver, 2004), in meta-cognitive approaches to career design (Bennett & Ananthram, 2021) and in both work-integrated and community-based learning (Ferns & Lilly, 2015; Johnston et al., 2015).

One of the main implications of this study is the potential for a simple DMS to help lecturers gauge students' attention, bring them back on task and increase their ability to self-monitor and manage their attention. The simplicity of DMS means that it can engage students without the need for curricular change or additional resources. We emphasise that DMS relies on students understanding the strategy and engaging with its use. DMS occurs within a reflective cycle such that the mistake is resolved before moving on; its use in blended learning environments has yet to be tested. We were careful in case of students likely to skip over recorded lecture material, for example, not to embed a deliberate mistake on a PowerPoint slide without correcting it in the same presentation.

Students' perceived attention span after implementing DMS was significantly higher than their attention span beforehand. This was due in part to its playful nature and the fact that it did not place students under any undue pressure. We note that students emphasised their deeper knowledge and enjoyment of the subject because of their engagement in DMS. We attribute students' positive reception of DMS to their metacognitive engagement: their ability to make meaning of complex key concepts. To determine whether something was a mistake, students had to engage in the functional, cognitive and knowledge dimensions of learning. Figure 3 illustrates a transition towards deeper learning using Krathwohl's new metacognitive knowledge category within the knowledge dimension of Bloom's taxonomy. In the case of DMS, metacognitive knowledge was achieved through greater attention and critical inquiry; this is where the strategic, structural and self-cognition dimensions of learning came together.

Figure 3.

Impact of increased attention on learning, after Krathwohl's revision of Bloom



The students who engaged in DMS applied their factual, conceptual and procedural knowledge; they analysed (made meaning of) their understanding by breaking material into its constituent parts and analysing how the parts related: to one another and to an overall structure or purpose. They used the resulting metacognitive knowledge to identify, voice suspicion about, and defend their opinion of a deliberate mistake. Students enjoyed the challenge and they took the risk that by voicing their suspicions they were making a mistake of their own.

Concluding comments

This was an exploratory study with a single cohort of students; hence, we do not seek to generalise the findings. The results suggest that DMS might be an effective way to limit students' mind wandering during class and to make both students and lecturers more aware of students' mindfulness. We note also that exploratory analysis by gender revealed no significant gendered difference in students' attention span before or after implementing the strategy. Variables including gender, cultural background and different types of disadvantage merit further exploration.

We did not conduct a study in which 3rd party observers, eye-tracking equipment or neurological equipment was used. Rather, students assessed their own attention spans (perceived attention) before and after DMS, making a note of their initial attention span and adding this to their second attention span measure once the post-DMS self-assessment had been completed. Although third-party observers or monitoring equipment would probably yield a more accurate assessment of attention span, students' self-assessments formed part of their engagement with DMS and had the advantage of them not feeling that they were being "observed". It is possible that simply by calculating their attention span – through the self-assessment task – students were more mindful of their attention in class; hence, some of the increase in attention span could be attributed to students' increased mindfulness. We contend that this affect would have been felt with self-assessment, monitoring equipment and observation.

We did not ask students to evaluate the strategy because author one was in a position of power, as their lecturer, and author two was not geographically distant. The students' tendency to adopt a representative voice has prompted us to rethink this and we will include an anonymous online, qualitative feedback mechanism in future iterations.

Future research might engage multiple cohorts including students who attend their lectures and/or tutorials online. Research might also determine whether students limit their longer attention spans to contexts in which DMS is applied, or whether they apply mindfulness strategies in other contexts. Whereas our study was located within a traditional lecture and tutorial model, future research might apply DMS to other contexts. Finally, we would love to see a study in which students are encouraged to include a single deliberate mistake in an in-class presentation or an assignment with a peer marking component.

References

Antrobus, J. S., Singer, J. L., & Greenberg, S. (1966). Studies in the stream of consciousness: Experimental suppression of spontaneous cognitive processes. Perceptual and Motor Skills, 23, 399-417.https://doi.org/10.2466/pms.1966.23.2.399

Barbara, K. H., & Paul, R. P. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. Review of Educational Research, 67(1), 88-140. https://doi.org/10.3102/00346543067001088.

Bennett, D., & Ananthram, S. (2021). Development, validation and deployment of the EmployABILITY scale. Studies in Higher Education. Published online first. https://doi.org/10.1080/03075079.2021.1888079.

Bennett, D., & Ferns, S. (2017). Functional and cognitive aspects of employability: Implications for international students. In Barton, G., & Hartwig, K. (Eds.), Professional learning in the work place for international students (pp. 203-223). Springer. https://doi.org/10.1007/978-3-319-60058-1_12. https://doi.org/10.1007/978-3-319-60058-1_12

Blackley, S., & Sheffield, R. (2015). Digital andragogy: A 21st century approach to tertiary education. Proceedings of the Ascilite 2015 Australasian Society for Computers in Learning and Tertiary Education (pp. 552-556). Curtin University, Australia.

Bloom, B. S., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of education objectives the classification of educational goals: Handbook I cognitive domain. David McKay Company, Inc.

Böckler, A., van der Wel, R. P. R. D., & Welsh, T. N. (2014). Catching eyes: Effects of social and nonsocial cues on attention capture. Psychological Science, 25(3), 720-727. https://doi.org/10.1177/0956797613516147

Bouchard, G. J. (2011). In full bloom: Helping students grow using the taxonomy of educational objectives. J Physician Assist Educ, 22(4), 44-46. https://doi.org/10.1097/01367895-201122040-00007

Bradbury, N. A. (2016). Attention span during lectures: 8 seconds, 10 minutes, or more? Advances in Physiology Education, 40(4), 509-513. https://doi.org/10.1152/advan.00109.2016

Bunce, D. M., Flens, E. A., & Neiles, K. Y. (2010). How long can students pay attention in class? A study of student attention decline using clickers. Journal of Chemical Education, 87(12), 1438-1443. https://doi.org/10.1021/ed100409p

Charles, M. (2017). Venus, Mars, and math: Gender, societal affluence, and eighth graders' aspirations for STEM. Socius, 3, 2378023117697179. https://doi.org/10.1177/2378023117697179

Dehaene, S., & Changeux, J.-P. (2011). Experimental and theoretical approaches to conscious processing. Neuron, 70(2), 200-227. doi:https://doi.org/10.1016/j.neuron.2011.03.018

Deng, Y., Chang, L., Yang, M., Huo, M., & Zhou, R. (2016). Gender differences in emotional response: Inconsistency between experience and expressivity. PLoS One, 11(6), e0158666. https://doi.org/10.1371/journal.pone.0158666

Cohen, J. (1992). Statistical power analysis. Current Directions in Psychological Science, 1(3), 98-101. https://doi.org/10.1111/1467-8721.ep10768783

Devine, D., Fahie, D., & McGillicuddy, D. (2013). What is 'good' teaching? Teacher beliefs and practices about their teaching. Irish Educational Studies, 32(1), 83-108. https://doi.org/10.1080/03323315.2013.773228

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. Psychological Science in the Public Interest, 14(1), 4-58. https://doi.org/10.1177/1529100612453266

Ferns, S., & Lilly, L. (2015). Driving institutional engagement in WIL: Enhancing graduate employability. Journal of Teaching and Learning for Graduate Employability, 6(1), 116-133. https://doi.org/10.21153/jtlge2015vol6no1art577

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415. https://doi.org/10.1073/pnas.1319030111

Haataja, E., Salonen, V., Laine, A., Toivanen, M., & Hannula, M. S. (2021). The relation between teacher-student eye contact and teachers' interpersonal behavior during group work: A multiple-person gaze-tracking case study in secondary mathematics education. Educational Psychology Review, 33(1), 51-67. https://doi.org/10.1007/s10648-020-09538-w

Helber, C., Zook, N. A., & Immergut, M. (2012). Meditation in higher education: Does it enhance cognition? Innovative Higher Education, 37(5), 349-358. https://doi.org/10.1007/s10755-012-9217-0

Helton, W. S., & Warm, J. S. (2008). Signal salience and the mindlessness theory of vigilance. Acta Psychologica, 129(1), 18-25. https://doi.org/10.1016/j.actpsy.2008.04.002

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hollis, R. B., & Was, C. A. (2016). Mind wandering, control failures, and social media distractions in online learning. Learning and Instruction, 42, 104-112. https://doi.org/10.1016/j.learninstruc.2016.01.007

Johnston, M., Bennett, D., Mason, B., & Thomson, C. (2015). Finding common ground: Combining participatory action research and critical service-learning to guide and manage projects with Aboriginal communities. In Bartleet, B-L., Bennett, D., Power, A., & Sunderland, N. (2015), Engaging first peoples in arts-based service learning: Towards respectful and mutually beneficial educational practices (pp. 51-70). Springer. https://doi.org/10.1007/978-3-319-22153-3_4

Johnstone, A. H., & Percival, F. (1976). Attention breaks in lectures. Education in Chemistry, 13(2), 49-50.

Kahu, E. R., & Nelson, K. (2018). Student engagement in the educational interface: Understanding the mechanisms of student success. Higher Education Research & Development, 37(1), 58-71. https://doi.org/10.1080/07294360.2017.1344197

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. Science, 330(6006), 932-932. https://doi.org/10.1126/science.1192439

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. Theory into Practice, 41(4), 212-218. https://doi.org/10.1207/s15430421tip4104_2

Laurie-Rose, C., Frey, M. C., Sibata, E., & Zamary, A. (2015). Effects of memory load and test position on short-duration sustained attention tasks. American Journal of Psychology, 128(4), 445-458. https://doi.org/10.5406/amerjpsyc.128.4.0445

Levin, D. M., Hammer, D., & Coffey, J. E. (2009). Novice teachers' attention to student thinking. Journal of Teacher Education, 60(2), 142-154. https://doi.org/10.1177/0022487108330245

Maguire, R., Egan, A., Hyland, P., & Maguire, P. (2017). Engaging students emotionally: The role of emotional intelligence in predicting cognitive and affective engagement in higher education. Higher Education Research & Development, 36(2), 343-57. https://doi.org/10.1080/07294360.2016.1185396

Manly, T., Robertson, I. H., Galloway, M., & Hawkins, K. (1999). The absent mind: Further investigations of sustained attention to response. Neuropsychologia, 37(6), 661-670. https://doi.org/10.1016/S0028-3932(98)00127-4

Matthews, K. E. (2017). Five propositions for genuine students as partners practice. International Journal for Students as Partners, 1(2). https://doi.org/ 10.15173/ijsap.v1i2.3315

Nani, A., Manuello, J., Mancuso, L., Liloia, D., Costa, T., & Cauda, F. (2019). The Neural Correlates of Consciousness and Attention: Two Sister Processes of the Brain. Frontiers in Neuroscience, 13(1169). https://doi.org/10.3389/fnins.2019.01169

Nold, H. (2017). Using Critical thinking teaching methods to increase student success: An action research project. International Journal of Teaching and Learning in Higher Education, 29(1), 17-32. https://files.eric.ed.gov/fulltext/EJ1136016.pdf.

Otting, H., Zwaal, W., Tempelaar, D., & Gijselaers, W. (2010). The structural relationship between students' epistemological beliefs and conceptions of teaching and learning. Studies in Higher Education, 35(7), 741-760. https://doi.org/10.1080/03075070903383203

Pintrich, P. R. (2002). The role of metacognitive knowledge in learning, teaching, and assessing. Theory Into Practice, 41(4), 219-225. https://www.jstor.org/stable/1477406?seq=1#metadata_info_tab_contents. https://doi.org/10.1207/s15430421tip4104_3

Posten, H. O. (1984). Robustness of the two-sample t-test. In D. Rasch, & M. L. Tiku (Eds.), Robustness of statistical methods and nonparametric statistics (pp. 92-99). Springer. https://doi.org/10.1007/978-94-009-6528-7_23

Reilly, P. (2020). Developing our students' level of mindfulness during these unprecedented times, Journal of University Teaching & Learning Practice, 17(5). https://ro.uow.edu.au/jutlp/vol17/iss5/20. https://doi.org/10.53761/1.17.5.20

Richardson, J. T., & King, E. (1991). Gender differences in the experience of higher education: Quantitative and qualitative approaches. Educational Psychology, 11, 363-382. https://doi.org/10.1080/0144341910110311

Risko, E. F., Buchanan, D., Medimorec, S., & Kingstone, A. (2013). Everyday attention: Mind wandering and computer use during lectures. Computers & Education, 68(0), 275-283. https://doi.org/10.1016/j.compedu.2013.05.001

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). 'Oops!': Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. Neuropsychologia, 35(6), 747-758. https://doi.org/10.1016/S0028-3932(97)00015-8

Robison, M. K., & Unsworth, N. (2018). Cognitive and contextual correlates of spontaneous and deliberate mind-wandering. Journal of Experimental Psychology: Learning, Memory, and Cognition, 44(1), 85-98. https://doi.org/10.1037/xlm0000444

Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M. (2010). Is it really robust? Methodology, 6(4), 147-151. https://doi.org/10.1027/1614-2241/a000016

Schooler, J. W., Mrazek, M. D., Franklin, M. S., Baird, B., Mooneyham, B. W., Zedelius, C., & Broadway, J. M. (2014). The middle way: Finding the balance between mindfulness and mind-wandering. In H. R. Brian (Ed.), Psychology of learning and motivation (pp. 1-33). Academic Press. https://doi.org/10.1016/B978-0-12-800090-8.00001-9

Smallwood, J., & Schooler, J. W. (2006). The restless mind. Psychological Bulletin, 132(6), 946-958. https://doi.org/10.1037/0033-2909.132.6.946

Stuart, J., & Rutherford, R. J. (1978). Medical student concentration during lectures. Lancet, 2(8088), 514-516. https://doi.org/10.1016/s0140-6736(78)92233-x

Szpunar, K. K., Khan, N. Y., & Schacter, D. L. (2013). Interpolated memory tests reduce mind wandering and improve learning of online lectures. Proceedings of the National Academy of Sciences of the United States of America, 110(16), 6313-6317. https://doi.org/10.1073/pnas.1221764110

Szpunar, K. K., Moulton, S. T., & Schacter, D. L. (2013). Mind wandering and education: From the classroom to online learning. Front Psychol, 4, 495. https://doi.org/10.3389/fpsyg.2013.00495

Tai, J. H. M., Bellingham, R., Lang, J., & Dawson, P. (2019). Student perspectives of engagement in learning in contemporary and digital contexts. Higher Education Research & Development, 38(5), 1075-89. https://doi.org/10.1080/07294360.2019.1598338

Tait, G., Lampert, J., Bahr, N., & Bennett, P. (2015). Laughing with the lecturer: The use of humour in shaping university teaching. Journal of University Teaching & Learning Practice, 12(3). https://ro.uow.edu.au/jutlp/vol12/iss3/7/. https://doi.org/10.53761/1.12.3.7

Tomporowski, P. D., & Simpson, R. G. (1990). Sustained attention and intelligence. Intelligence, 14(1), 31-42. https://doi.org/10.1016/0160-2896(90)90012-I

Van Boxtel, J., Tsuchiya, N., & Koch, C. (2010). Consciousness and attention: On sufficiency and necessity. Frontiers in Psychology, 1(217). https://doi.org/10.3389/fpsyg.2010.00217

Wammes, J. D., & Smilek, D. (2017). Examining the influence of lecture format on degree of mind wandering. Journal of Applied Research in Memory and Cognition, 6(2), 174-184. https://doi.org/10.1016/j.jarmac.2017.01.015.Ward, A., & Wegner, D. (2013). Mind-blanking: When the mind goes away. Frontiers in Psychology, 4(650). https://doi.org/10.3389/fpsyg.2013.00650

Warren, B. (1993). Equity in the future tense [microform]: Redefining relationships among teachers, students, and science in linguistic minority classrooms. Working Paper 1-93 / Beth Warren and Ann S. Rosebery. Distributed by ERIC Clearinghouse.

Wehrwein, E. A., Lujan, H. L., & DiCarlo, S. E. (2007). Gender differences in learning style preferences among undergraduate physiology students. Advances in Physiology Education, 31(2), 153-157. https://doi.org/10.1152/advan.00060.2006

Weurlander, M., Cronhjort, M,. & Filipsson, L. (2017). Engineering students' experiences of interactive teaching in calculus. Higher Education Research & Development, 36(4), 852-65. https://doi.org/10.1080/07294360.2016.1238880

Wilson K., & Korn, J. H. (2007). Attention during lectures: Beyond ten minutes. Teaching of Psychology, 34(2), 85-89. https://doi.org/10.1177/009862830703400202

Funding statement

This research received no specific grant from any funding agency in the public, commercial, or not-for profit sectors.