

December learnometer webinar: these text chats will be live on:

14:00 - 16:00 GMT Friday afternoon December 4th

and again (to help S Hemisphere colleagues) between

08:00 - 10:00 GMT Tuesday afternoon December 8th

WHAT DO LEARNOMETERS MEASURE... ...AND WHY?

Questions in English or Spanish please, put a Q in front of your question

Thanks everyone - this Q&A is closed now; the page is locked, but still available and these questions will circulate as a pdf too.

See you after Christmas for the next light touch webinar on aerosol emissions

<http://hepell.net/aerosols>

Type your questions about the importance of **CO2** in the learning spaces, in this box. Please respect others' contributions here. Thanks..

Q I've read different numbers for the ideal CO2 in learning spaces. Why is this?

A When we started the Learnometer work, the broad view seemed to be that 2,200ppm (parts per million) was the target - keep below that and things would be OK. But over the years more and more quality research gets published with the "safe" level now widely seen as 1,000ppm and for many it is even lower than that. At this point our advice is keep under 1,000ppm and that is a sensible target figure.

Q If I can't see my Learnometer how will I know the CO2 is rising in my classroom?

A The Learnometers all have a cloud based dashboard so you can view via any browser - even on your phone. But actually, once you are aware of CO2 flooding, you can really notice it

anyway. You'll have been in rooms where as you step outside the air feels "less heavy", and also in higher CO2 you have a slight feeling of claminess on your skin. Watching the CO2 numbers on your LoM and learning to understand how your body feels in these "wrong" environments is a very useful skill to develop!

Q Are there any examples of this data being used in policy making?

A I wish we could get ministers of education to engage a bit more (!) but at the local authority level (in England) we have seen real interest. I think that a lot of current change in education is coming from the bottom up and the data we are seeing helps students, teachers and parents ASK for change. We are confident that things will change because we can see that happening now in schools.

Type your questions about the importance of **TVOCs** in learning spaces, in this box. Please respect others' contributions here. Thanks.

Q What does TVOC stand for please?

A Total Volatile Organic Compounds, or **TVOCs**, is a term used to describe the smells you get from fresh paint, or glueing carpets (for example). They're essentially a complex mixture of emissions and do impact on cognitive performance and indeed on wellbeing too. The chemicals used for Deep Cleaning during the CoVID pandemic can make TVOCs in the learning space quite alarmingly high.

Q How do we know which TVOCs to look out for and which products are the worst offending culprits?

A The Learnometers poll 50 different VOCs and some of the worst products are quite surprising. In one secondary school the boys had a habit of all spraying their armpits with Lynx before the lunch break and the VOCs really spiked at that moment! The only way to really check is to try different products and see which score highest (ie worst) on the learnometer.

Q What is the recommended TVOCs level for learning environments?

A TVOCs? as low as you can go! Zero is good! Actually it does seriously flag one thing we saw right away with the research and that is how bad many classrooms are - with people blaming kids for poor attention, and general naughtiness. Too often, the kids are alright but the room literally drives them to distraction.

Type your questions about the importance of **HUMIDITY** in learning spaces, in this box. Please respect others' contributions here. Thanks.

Q How do we change the humidity in our room (it is currently too dry and outside your

guidance on being ideally between 40% and 60%?

A If you have air conditioning, some units make a point of maintaining good levels of humidity, but for most learning spaces plants are helpful because of the moisture in the soil or the hydroponic pellets. And plants of course are a great way (one per pupil) to get CO₂ down and oxygen back up again too.

Q With regards to the above, what are the best types of plants for addressing humidity?

A Luckily NASA has a team of folks thinking about flying to Mars and of course they will need to turn a lot of CO₂ back into oxygen on the way so we have borrowed their list of the best plants, and taken away the ones that might be inappropriate to have around children. What is left, is this list:

- 1: Dwarf palm - preferably Areca,
- 2: Boston fern
- 3: Devil's Ivy
- 4: Chinese Evergreen
- 5: Peace Lily
- 6: Aloe Vera

All safe for classrooms and children, widely available in the UK

Well, it depends on the plant size, of course, but if these are household sized plants, and if they are the right plants (see list above) then one per person is the ratio.

A caveat though, is that plants AT NIGHT don't do photosynthesis, they do transpiration taking oxygen in and then outputting CO₂ (that's a simplification!) So in short, don't put the plants in your bedroom!

Type your questions about the importance of **TEMPERATURE** in learning spaces, in this box. Please respect others' contributions here. Thanks.

Q Should we expect that things like PISA rankings could in fact be impacted by variables like temperature, humidity etc?

A Doubly interesting because with PISA now favouring collaborative problem solving etc the impact on social behaviours matter too. The ethical debate is about fairness - not just at the macro level of a country being under-scored but even in a single examination room where students by the window with good ventilation WILL perform better than someone that the seating plan places in the stuffy dark corner!

Q Are there any studies referring to students (and teachers) performance under low temperature conditions? We are currently on a 10-13°C average due to COVID measures... Thanks

A the data for too warm is very straightforward. After 21 degree performance drops in a straight line, so each degree adds damage. By 23° the impact is statistically significant - your maths test for example would drop about 0.8 - 1.5% However, as we get colder it is less physiologically damaging - you can imagine your body pumping blood faster, so oxygen getting to your brain - but it starts to be actually distracting. 10-13°C would be fine - we tend to say "no such thing as bad weather only bad clothing" so a couple more layers might help. Coats always restrict arm movements so a thermal vest is way better than a puffer jacket!. As I type this my room is at 7°C

Q are those temperatures applicable to all the countries of the world and all the climate zones?

A They are. It turns out that we haven't been on the planet long enough for major evolution to make some better in hot countries than others, although some folk have evolved different levels of the melanocytes that make melanin.

But in terms of temperature and your brain it doesn't really matter if you are an Alice Springs kid or an Alaskan Inuit kid - those numbers are pretty much applicable to everyone.

But bear in mind that beyond the physiology, your brain being VERY cold can be quite distracting... (see above)

Type your questions about the importance of **LIGHT** in learning spaces, in this box. Please respect others' contributions here. Thanks.

Q What level of light should I be aiming for in my classroom?

A It's a mix of LUX levels and Kelvin values. Lux needs to be >500 everywhere (no dark corners) and we are mainly aiming to reach 1,000lux in our projects. LED bulbs - accept no other! And then you need a Kelvin value - a kind of measure of light warmth but also of whiteness and you need that to be 5,500 or higher. The difference in behaviour, attention etc is amazing!

Q How might this contradict different advice around reducing exposure to blue light to mediate sleep disruptions and high cortisol levels?

A one of the reasons we say go for the highest Kelvin values is to get pure white light and to avoid the blue, or warm white variations. Pure white wins every time, blue is mostly a problem.

What is the ideal white light?

Not quite as straightforward as you might hope. In simple terms, you are seeking the "coolest" white light (but caution, see below. The cool or warm description refers to how they look - blue ice is cool, a yellow sunshine is warm. Nothing to do with actual temperature of the bulbs.

Fluorescent tubes are usually under 3,000 Kelvin are much too "warm" / yellow **WORST CHOICE**

"Warm white" LED is 2,700 - 3,000K and is not much better than tubes **STILL POOR CHOICE**

"Cool white" LED is around 3,500 - 4,100 K and is **STARTING TO BE ADEQUATE**

"Natural or daylight" LED is 5,000 - 6,500 K **THE THEORETICAL BEST BY FAR**

Q Is it easy to replace bulbs with these better-for-learning ones! Where do I find them?

A A few years ago changing to LED bulbs needed you to replace the light fitting - which was expensive. Now though LED can retrofit into older light fittings - bayonet sockets, old fluorescent tube fittings etc. The only caveat would be that some of those older fittings have plastic "covers" and these get yellow with age or with dust / dirt so it often helps to throw away the plastic covers as you change the bulbs (unless there is a safety reason for them being there...). We did some calculations a couple of years back and replacing all the school lights with LED paid for itself over 5 years because they use less energy.

When you buy bulbs, even online, you will see somewhere the Kelvin value. Sometimes it just says 6,000K rather than 6,000Kelvin.

Search results for "daylight LED bulbs"



Roll over image to zoom in



GU10 LED Daylight White, Ascher 10 Pack GU10 4W LED Light Bulbs [Daylight White 6000K, Equivalent to 50W Halogen Bulbs, 400LM, AC 220-240V, 120° Beam Angle] GU10 Recessed Lighting, Track Lighting [Energy Class A+]

by Ascher

★★★★☆ 454 customer reviews | 23 answered questions

Price: **£14.99** ✓prime

Note: This item is eligible for **click and collect**. Details

1 new from £14.99

Size: **Pack of 10**

Colour: **Daylight White**



- Pack of 10 GU10 Non dimmable LED;
- 400LM, Replace 50W halogen bulb by 4W LED;
- Can be easily fitted to replace ordinary GU10 halogen bulbs;
- 120° light angle, 6000 Kelvin white light;
- Extremely long life 30000 hours, lowers maintenance costs by reducing re-lamp frequency

There's a page on light here: heppell.net/lighting

Type your questions about the importance of **NOISE** in learning spaces, in this box. Please respect others' contributions here. Thanks.

Q How does the research on low BPM and classical music tie into noise levels in classrooms - is there a comorbidity or otherwise? (one assumes that some noise is better than none at all...)

A We were surprised at how important BPM (beats per minute) turned out to be - a lot of that research came out of things like tyre noise and the impact on driver concentration. I think just plain too loud is fairly obvious, but again the level of "too loud" varied from person to person. So in a classroom setting just subjectively questioning students about "is this too loud" can help calibrate an effective max. You ask about comorbidity and in truth we don't really know at this stage much about the links between variables. If your CO2 is too high, noise too loud, humidity too dry etc I'm not sure we can advise you on which to tackle first - we'd say "sort it all out!" We have a HUGE amount of data though, so these cross links might begin to emerge from that data.

Q Thanks - the interplay of the variables will be a really fascinating thing to see. I wouldn't be surprised if low CO2 levels caused intolerance in other areas

A that's very much our thinking - tolerances can be damaged by sub optimal conditions so there will be, we think, a multiplier effect from having several things wrong at once...

Q Is the rhythm of the air conditioning unit an issue for my students?

A The short answer is probably yes. But to unpack that a bit: Rapid rhythms ARE distracting - some disagreement about how many BPM but certainly as

you get up to the 90s it matters. Air con units often start out quietly, but then bearings wear, dirt and dust unbalances the fan during the months when it's not on, and so on. So they get more & more distracting. Worst case units are usually in sports halls because no one cares about noise in there, but of course they are also used for high stakes testing / exams...

Also, just in passing, as we designed the Learnometers we had to think about the sample duration. For temperature it is just the "now" value, but for sound we had to sample across a short time interlude, otherwise a teacher (for example) clapping hands to get class attention could register as some kind of atomic explosion!

Q Have you tried to use the equalizer methods?

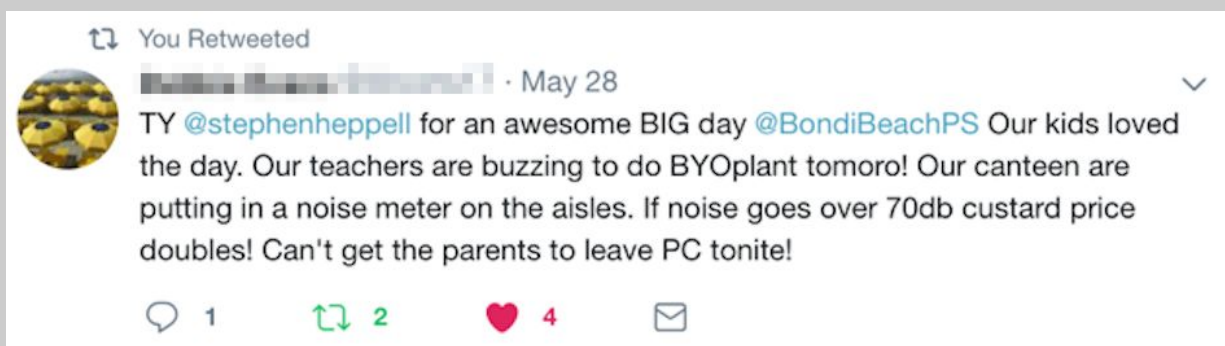
A We have done work looking at the impact of different sound frequencies on learning - particularly low reverberation and children struggling with attention. We have a report on a schoolroom (Fingringhoe Primary School) about to be published about this and I'll make sure a copy is available to everyone.

Meanwhile, the Learnometer looks for decibels rather than any analysis of the noise spectrum. Simply HOW loud rather than what kind of loud.

One interesting feature is that although our tolerance of temperature, or need for light is pretty constant regardless of culture or location, the "how loud is too loud" judgement varies between individuals. People's hearing sensitivity really varies. You may need to survey this with your students and cap it at the level where the first few students start to be distracted.

Q So, if the learning space is too noisy, and the data confirms that.... Then what!?

A We did, at the prototype stage - consider allowing the learnometers to be programmable switches - so that if for example the space became too noisy the wifi would shut off (!) but in practice schools have been ingenious at thinking of their own solutions as incentives, or disincentives. This example from Bondi Beach Primary School in NSW:



Type your questions about the importance of **MICROPARTICULATES (pm2.5)** in learning spaces, in this box. Please respect others' contributions here. Thanks.

Q What are the ethical implications of having schools based in more polluted areas - such as central London - when we know this can have a significant impact on academic results? And

what can we do about it?

A Alarming is the short answer! A huge Chinese research study over (as I recall,) 9 years showed kids in schools in polluted areas (which was mainly a busy road rather than hard core industrial settings - on average dropped a full year of schooling before age 15. That is HUGE!

What to do about it is interesting - in the next webinar (just after Christmas) one of the short videos and the Q&A explore geo-fencing of schools so that, for example, as a polluting vehicle approaches a school it either switches automatically to all-electric drive, or it stops and can go no near. This is work in progress but Fords and others are doing this development right now.

While you wait for that there are air filters and we have been exploring the ones they use in hospitals to filter even tiny germs from the air. We are just looking at a device that fits in a window aperture and makes sure the fresh air that comes in IS fresh. Again, a session on that is in the next webinar (<https://heppell.net/aerosols>)

Q What does the 2.5 number relate to?

A the number relates to the size of the little dust particles it measures. You will have heard about the impact (bad impact) of the soot from diesel cars - those sooty particles are 2.5 or bigger but of course things like the CoVID virus are much smaller. In practice they piggy-back on the soot particles to get around so getting those pm2.5 particles down is good for brains AND for health!

Q. I understand COVID particles are smaller than 2.5 - are there air purifiers that can clean those from my classroom air?

A Yes we are investigating that -, a session exploring what we know is in the next webinar (<https://heppell.net/aerosols>) and there is an interesting case study from a school in Finland. Certainly air purifiers work well in health settings (like operating theatres) - but remember, as it says above, that the nasty little CoVID particles attach to the large dust particles so that they can get across your learning space and into your nose / throat.

Type your **TECH SUPPORT** questions, in this box.
Please respect others' contributions here. Thanks.

Q I cannot select my dashboard when I set up my Learnometer?

A Make sure you accept your dashboard invite emailed to you before you try and connect your device - also be sure to use the email address your invite was sent to.

Q I have just received my Learnometer - where should I put it in my classroom?

A OK - so don't put in on the radiator, under the air con, or in front of the sunniest window - you won't get accurate monitoring. Select a location and perhaps leave it there for a week and then move it on to another position in your classroom. Get your students involved as well - the

device will deliver a rolling message if there is a reading outside of its parameters. You can view the whole, day or week on the desktop dashboard too.

Q How much is a Learnometer?

A They are £330 plus VAT - available from gratnellslearnometer.com - remember it measures 7 environments and a single CO2 monitor can range from £50 to a lot more. This includes one year subscription to the iCloud back up of your data

Q. Is there a way to export the data from my device to show my colleagues?

A. Yes you can download the data via an CSV data format and use a software package such as Excel, Google Sheets to filter, sorted the data and create graphs and reports

Q Is it better to have different questions batteries?

A. The Learnometer has a built in battery. When you first receive your device you should plug into power for at least 24 hours so it is fully charged. The device will last about 6 hours not plugged in. You should plan to recharge your device every night if you use it around your learning or working space

Q Have you tried to do formal testing with control groups?

A All the research papers that we have based much of our metrics on have come from controlled tests. Ethically it is harder to do with children - so we tend to be comparing today (after environment is improved) with yesterday (before it was improved). Both as aggregate data or a whole class and also by individual students.

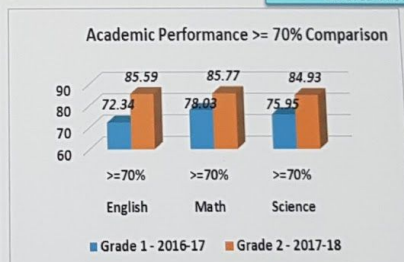
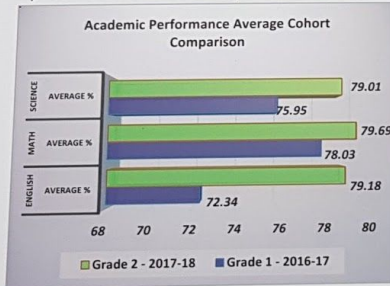
This (below) for example is from the work of Asha Alexander in her schools in Dubai (162 classrooms in total) - it is the kind of thing your own mini-research projects might reveal too.

Impact of modified / adaptive learning environment (LEARNOMETER / INDOOR PLANTS) on students' personal, social and emotional development (behavior / discipline) and academic performance for learners aged 7- 8 years.

Green Initiative- Continue to lead sustainability goals and practices in our commitment to sustainability.

- Improvement of air quality in the classroom that increases student concentration and attention span.
- Carbon dioxide level is maintained low and oxygen is high and hence students are able to breathe good quality air and thereby feeling fresh and active even to the end of the day.
- Modified learning environment resulted in the marked improvement of the academic performance tracked over a period of two academic years.

Student 1 - DO	April 2017	March 2018
Restless/Fidgety/Aggressive	5	2
Sleepy/Tired/Listless	2	1
Attention Span	5	3
Social Communication	2	4
Confidence	3	5
Anxious / Withdrawn	1	3
Avoids Work	5	3



"Student's aggression has reduced considerably, his attention span has improved and so has his social communication .He is able to remain seated for longer duration of time and is able to work as per class expectations with minimal support."

Shuchi Arora
Head of Inclusion



Ms. Aswathy Vinod and Ms. Anyana Chakraborty



Q Can we apply the compensation and complete the map of the space conditions?

A Different parts of rooms are alarmingly varied, in some cases. There is an equity issue here - someone sitting in a dark hot, badly ventilated corner will do less well - in behaviour or academic progress, than someone seated by the window in fresh air.

In the mini-research document we recommend moving Learnometers around the space over time to make comparisons. Remember that the dashboard retains dates and times of data, but you need to keep a record or when & where you moved it...

Q What else are you thinking about measuring?

A We dropped measuring air pressure - there was something of a relationship with what are sometimes called "pressure headaches" and also a student led research project indicated that some children felt "a bit ill" when pressure changed. The problem was that it is not easy to see how we can change air pressure if it is wrong...

We have been looking at movement however (maybe we should run one of these webinars on that topic?) and that is next on our list of variables to add.

