How can a focus on classroom environment contribute to our students’ academic success?

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Learning outcomes

- Explain how design thinking provides an effective approach to improve our students’ experiences in the classroom, and gives classroom users agency to make such improvements.

- Recognise how design thinking can help identify and address problems which derive from environmental variables like air quality, partly by building a research phase into the process to help build understanding of the problem.

- Understand how classroom environmental variables, like air quality and temperature, can affect learning and attainment.
Design thinking

https://www.youtube.com/watch?v=_r0VX-aU_T8
What would you change about your classroom and why?

- We all have things we’d like to change about our classrooms.
- In pairs, interview each other to find out what they would like to change in their classroom, and why (what would be the positive impact of changing it)
- You have 2 minutes for each interview
Collating ideas

- Share and collate your ideas with the rest of your group into a table like the one on the right.
- Some of the ideas from each pair may overlap. Only include each idea once.

<table>
<thead>
<tr>
<th>What do you want to change?</th>
<th>Why do you want to change it?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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Understand how your students experience the classroom and the challenges they may encounter

Building empathy with your students as users of your classroom
Students will also have ideas about what to change in your classroom.

This is important - it’s their success that we want to maximise.

Complete the grid from the perspective of the student. You would usually run this exercise with students.

Try to imagine both what your best students would say, but also those who are ‘not your best’.

Draw the grid on a large piece of paper, and complete it together.

<table>
<thead>
<tr>
<th>Do</th>
<th>Think</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do your students need to do in your classroom?</td>
<td>What do your students think about your classroom?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Say</th>
<th>Feel</th>
</tr>
</thead>
<tbody>
<tr>
<td>What would your students say about your classroom to their friends and parents?</td>
<td>What do your students feel when they are in your classroom?</td>
</tr>
</tbody>
</table>
**Empathy map**

<table>
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<th>Do</th>
<th>Think</th>
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</tr>
</tbody>
</table>
Now that we’ve considered your and your students’ views and experiences of your classroom, both from your perspectives and from those of your students, we need to focus in on a single problem.

Define a problem
Think about the things you wanted to change, and think about the student empathy map.

You should have some good ideas of problems you could address in your classroom(s).

It’s now time to define a problem statement, which defines where you want to get to, and the challenges in getting there.

I want you to choose one problem statement, preferably about the classroom itself.
Defining the problem statement

Define a point of view
Problem statement

“I am a school student, who wants to learn and enjoy their learning in the classroom.”

“I am a school teacher, who wants their students to learn and enjoy their learning in my classroom.”

“I’m struggling because…”
Defining the problem statement

Turn the point of view into a ‘How might we?’ question
Problem statement

“How might we __________________ so that our students can learn and enjoy their learning in the classroom?”
Ideation
Ideation

- Now you’ve written your problem statements, you need to think about possible ways in which you can address the problem.

- There are lots of ways to stimulate creative ideation.
Approaches to ideation

- Brainstorming – draws on the group
- Brainwriting – enables individuals’ participation
- Bad ideas – reduces reticence
- Mind-mapping – problem statement in the centre, idea and consequences leading from the statement
- Sketchstorm – like brainstorming but visualisation may be beneficial
- Fishbowling – two rings, one brainstorming, one listening
- Anti-solution generation
- Jigsawing / envoying / snowballing – use of any group talk techniques to stimulate ideas
- Analogies
- Provocations – building deliberate challenges during the ideation process
- Storyboarding – storyboarding the problem to help ‘see’ ideas for addressing the problem
- Use of AI
Collate your ideas into a ‘If we, then we’ table, which lists the action (under ‘if we’) and the consequence of that action under ‘then we’.

<table>
<thead>
<tr>
<th>If we...</th>
<th>Then we...</th>
<th>Because</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open the windows</td>
<td>Will concentrate better</td>
<td>The air will be fresher</td>
</tr>
</tbody>
</table>
Creating a positive environment for academic success

https://www.maqe.com/insight/the-design-thinking-process-how-does-it-work/
Building understanding to support ideation and prototyping

Understanding the problem to help refine your problem statement, ideation and prototyping
“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because I can’t concentrate in this classroom.”

“How might we change the classroom so I can concentrate better?”
Problem statement

“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because I always get a headache in this classroom.”

“How might we change the classroom so I don’t get a headache so much?”
“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because I can’t read the interactive whiteboard.”

“How might we change the classroom to make it easier to read the interactive whiteboard?”
Problem statement

“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because the classroom is too noisy.”

“How might we change the classroom so the classroom is less noisy?”
Problem statement

“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because the classroom is really dark

“How might we change the classroom to make it lighter?”
Problem statement

“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because I keep feeling sleepy in this classroom.”

“How might we change the classroom so I don’t feel as sleepy during lessons?”
Problem statement

“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because my lesson is at the end of the day and the classroom is so stuffy.

“How might we change the classroom so the classroom is less stuffy?”
Air quality
“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because I keep feeling sleepy in this classroom.”
“I am a school student, who wants to learn and enjoy their learning in the classroom. I’m struggling because my lesson is at the end of the day and the classroom is so stuffy."
Air quality
<table>
<thead>
<tr>
<th>Monitor CO₂ Reading</th>
<th>LED colour</th>
<th>Number of LEDs</th>
<th>Description</th>
<th>What this means for you</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-799 ppm</td>
<td>Green</td>
<td>1 - 2 lights</td>
<td>Indicative of good ventilation</td>
<td>Ventilation is acting to help maintain a good classroom environment, including reducing the risk that airborne diseases are spread.</td>
<td>If CO₂ levels are not rising then you can consider having your windows open slightly less wide or temporarily closing them. Do so gradually and in stages.</td>
</tr>
</tbody>
</table>
Consider the potential to improve ventilation in your classroom for better health and learning outcomes - this might include having more windows & doors open, opening them more widely, or getting any mechanical ventilation serviced.

Consider opening windows and/or doors - higher-level openings first and then, if necessary, also lower-level openings. Continue to monitor the CO₂ levels.
1500-3000 ppm  Red  7 - 8 lights  Indicative of inadequate ventilation

There are quite high levels of shared/rebreathed air in your classroom which, if maintained, might lead to poorer learning and health outcomes. Consider the potential to improve ventilation (for example, by having more air flow by opening any windows and doors, or getting any mechanical ventilation serviced).

Keep checking that ventilation provision (e.g. windows and doors) is fully operational/open and continue to monitor the CO₂ levels. If consistent, notify school leadership.
<table>
<thead>
<tr>
<th>CO₂ level</th>
<th>Colour</th>
<th>Lighting</th>
<th>空气质量</th>
<th>通风建议</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000+ ppm</td>
<td>Red/Purple</td>
<td>9 lights</td>
<td>Indicative of inadequate ventilation</td>
<td>There are quite high levels of shared/rebreathed air in your classroom which, if maintained, might lead to poorer learning and health outcomes. Consider the potential to improve ventilation (for example, by having more airflow by opening any windows and doors, or getting any mechanical ventilation serviced).</td>
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Improving Indoor Air Quality

What can I do to improve my air quality?

**Particulate Matter**
- Use a fan fitted with a HEPA filter.
- Vacuum and dust regularly.
- Cook with the extractor fan on.
- Use candles instead of burning incense.
- Don’t open windows next to very busy roads.

**Volatile Organic Compounds (VOCs)**
- Use solid or liquid cleaning products which are allergy friendly or chemical free rather than sprays.
- Only burn candles in large well-ventilated spaces.
- Consider buying low VOC paints and furnishings.

**Gases (CO, CO₂, NO₂)**
- Cook with the extractor fan on.
- Keep rooms well aired by opening windows 5-10 minutes a few times a day when you’re using them.
- Don’t smoke indoors.
- Get more houseplants (these also help reduce VOC’s and particulate matter).

Cambridge Schools Conference, Orlando, 23-24 June 2023

Creating a positive environment for academic success
#camschoolsconf
Problem statement

- I am a school student who wants to learn in a healthy environment where I can concentrate, but I know from research that after 30 minutes, CO$_2$ levels build up to levels which can affect my concentration and make me feel sleepy.”

- “How might we regulate the CO$_2$ levels in the classroom so I don’t feel sleepy?”
Ideation

- Deploy CO₂ monitors in every classroom
- The teacher should open the windows to ventilate the classroom and keep CO₂ levels below 800ppm
Prototyping and testing

- Opening windows reduced CO$_2$ levels below 800ppm and towards 400ppm

- Some windows were obstructed and couldn’t be opened, or teachers said they were too busy to open them

- Opening windows facing a busy road, led to high NOx and particulate matter entering the classroom
Implementing

Teachers should monitor CO2 levels using a meter.

School leaders should ensure that windows can be opened, or that they open automatically.

They should open windows to stop CO2 building up beyond 800ppm.

For classrooms on busy roads, only open the windows when the traffic is low to prevent entry of particulate matter and NOx. Opening windows overnight, and then in the middle of the day, may be a good solution.
Other impacts of school design on students’ academic success?

Barrett et al. (2015a, b; 2018)
Impact of classroom design

The impact of classroom design on pupils’ learning: Final results of a holistic, multi-level analysis

Peter Barrett, Ray Davies, Yufan Zhang, Lucinda Barrett

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journal homepage: www.elsevier.com/locat/buildenv

The Impact of School Infrastructure on Learning
A Synthesis of the Evidence

Peter Barrett, Alberto Treves, Tigran Shmish, Diego Amboss, and Maria Ustinova

Summary report of the HEAD Project
(Holistic Evidence and Design)

Professor Peter Barrett
Dr Yufan Zhang
Dr Ray Davies
Dr Lucinda Barrett

Cambridge Schools Conference, Orlando, 23-24 June 2023
Creating a positive environment
#camschoolsconf
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<th>Naturalness</th>
<th>Individualisation</th>
<th>Stimulation</th>
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<tr>
<td>Air quality</td>
<td>Flexibility</td>
<td>Complexity</td>
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<tr>
<td>Light</td>
<td>Ownership</td>
<td>Colour</td>
</tr>
<tr>
<td>Temperature</td>
<td>Connection</td>
<td></td>
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<tr>
<td>Sound</td>
<td></td>
<td></td>
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<tr>
<td>Link to nature</td>
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Lighting
Natural light

The importance of daylighting in classrooms and its effect on primary students’ academic performance

16 March 2022

Environmental Design and Engineering MSc student (2020-21) Jean-Baptiste Cloquet reviews the importance of daylighting in schools.

A classroom for primary school children should not only be designed for high academic performance, but also for the well-being of children. And what if some parameters, such as daylighting could both have a positive impact on student’s academic performance as well as their well-being? Indeed, primary school students spend 160 days per year at school and around 5-6 hours a day in classrooms; in the UK [1], and their environment can have a decisive impact on their academic performance [2].

Better student progress (Barret et al. 2015)

Higher attainment in reading and science (Herschong et al. 2002)

Better concentration (Sleegers et al. 2013)

Better physical and mental health and comfort (Sleegers et al. 2013)

Increased reading vocabulary and science test scores (Tanner 2009)
Glare and low frequency fluorescent lights

Glare can cause discomfort and impair task performance (Winterbottom & Wilkins 2008)

Low frequency fluorescent lamps can cause headaches (Wilkins 2003)

Classroom illuminance should be between 300-500 lux at students’ desk (CIBSE)
Actions for you

- Maximise natural light, but avoid glare, keeping lighting even across the classroom (avoiding glare spots or dark spots)
- Use artificial light when natural light inadequate
- Avoid blocking windows with displays and furniture
- Use blinds to avoid glare, but keep blinds open otherwise
- Use a high-power projector on a matt surface to reduce need to use blinds to avoid glare on the screen
- Only project onto a matt surface, rather than a glossy whiteboard, to avoid a glare spot
- Give teachers control over switching individual luminaires on and off.
Temperature
As temperature increases, discomfort increases (Zeiler and Boxem 2009)

As temperature increases, task-performance and achievement decrease (Mendell and Heath 2005)

As temperature decreases (in range 20-25C), maths, science and reading scores increase (Shaughnessy and Shaughnessy 2015)
Actions for you

- If you have a thermostat in your classroom or school, keep the temperature cool comfortable

- If incident sunlight leads to warming, close blinds and open windows

- If the classroom regularly overheats, school leaders should fit external shading to stop radiation entering the room
Sound
Creating a positive environment for academic success

Auditory environment sub-optimal (Picard and Bradley 2001)

Effects of noise on children at school (Shield and Dockerell 2003)

Impact of acoustics on attainment for students with SEN (Barrett et al. 2015)

Impact of acoustics on classroom learning (Canning and James 2012)
Actions for you

- Planting to shield school buildings from noise
- Fit sound absorbent surfaces in classrooms
- Fit rubber feet to movable furniture
- Use carpet to attenuate noise
Ownership
Ownership of the classroom promotes feelings of responsibility (DeVries and Jan 1994)

Display of students’ work fosters greater learning engagement (Ulrich 2004)

Personalised spaces help to promote learning (McMillan 1997)
Actions for you

- Display student work to provide a sense of ownership.
- Make each classroom recognisable from others by distinctive class-made displays / artwork
- Let students personalise aspects of the classroom, e.g. named lockers.
- Classroom infrastructure should be maintained and kept modern, to value students as learners.
Complexity
Complexity

Less visual distraction leads to higher attainment (Godwin and Fisher 2014)

Attainment is higher in sparsely decorated classrooms (Fisher et al. 2014)

High or low levels of visual complexity lead to poor learning outcomes, whereas intermediate level of visual complexity is optimal (Barrett et al. 2015)
Actions for you

- The displays on the walls should be designed to provide a lively sense to the classroom, but without becoming chaotic in feel.

- 20-50% of the available wall space should be kept clear.

"Classroom" by Editor B is licensed under CC BY 2.0.
Colour
Colour can affect learning (Jalil et al. 2012)

Large, brightly coloured areas or white walls with few colour elements do not have a positive impact on learning.

Light walls plus a feature wall in a brighter colour was more effective for learning.

Additional colour elements in the classroom played a complementary, stimulating role. For example, relatively bright colours on the floor, blinds, desk, chairs add extra highlights and flashes of colour.

(Barrett et al. 2015)
Actions for you

- Adopt light walls with a feature wall highlighted in a brighter colour to achieve an appropriate background level of stimulation.
- Avoid simple white environments which lead to restlessness, excessive response, and difficulty in concentration.
- Design displays in a way that is sensitive to the colour in the rest of the room. Increase stimulation if the background is muted. If the background is very bright, adopt muted shades.
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