Do school buildings really matter? It's complicated...

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If you close your eyes and try to remember the very first time you saw a really special building – like the Sydney Opera House – you might just be able to rekindle that initial sensation of jaw dropping wonder. Well, can you feel it?

Glorious edifices seem to inspire millions of people to travel vast distances to pay homage, take selfies and feel good. And this begs a rather important question: *If great buildings can motivate and move us, can suitably designed schools have a similar impact on student learning outcomes?*

In this article, I will review the evidence on whether school buildings really matter, and consider the question above through the lenses of three different hypotheses:

- **Great Teacher Hypothesis** – that differences in student learning outcomes can be largely explained by the oversized impact of outstanding educators, which can be unlocked in both rickety wooden shacks and award-winning megastructures.
- **Great Learning Environments Hypothesis** – that innovative school buildings make the difference by engaging, inspiring and motivating their inhabitants to collaborate in unanticipated ways.
- **Interplay Hypothesis** – that educators make the biggest difference, but their efforts can be greatly magnified in the "right" physical environment or hindered by the "wrong" one.

However, this is not an easy area to unpick. The relationship between the built environment of the school and student learning outcomes is one of the less-researched areas in education (Education Endowment Foundation, 2019; Higgins, Hall, Wall, Woolner, & McCaughey, 2005). The literature is largely dominated by architects' testimonials, small-scale case studies, and very few meta-analyses/systematic reviews, with (sometimes) contradictory findings.

One of the reasons for the lack of quality research is that it is extraordinarily difficult to systematically isolate and assess the impact of buildings: differences in inhabitants' behaviours are often just as diverse within a specific environment as between very different types of buildings. This makes it devilishly difficult to untangle the specific contribution of the built environment on learning.

Therefore, I will summarise the research across four areas where there is (arguably) enough of it to form tentative conclusions about which of our three hypotheses is most plausible:

- The basic environment.
- Open spaces vs traditional classrooms.
- School size.
- Technology in the built environment.

I also (speculatively) consider the oversized role of the built environment in for-profit education, as a proxy signal for quality.

The basic environment

Common sense suggests that if you or I attempted to learn something new while sitting in a sauna or steam room with rock music blaring, our respective levels of learning retention would be significantly curtailed. It just so happens that there are a reasonable number of studies reviewing differing levels of heating, lighting, acoustics and noise, and the impact of these on student achievement (e.g. Clark, 2002; Fisher, 2001; Schneider, 2002; Weinstein, 1979; Woolner, Hall, Higgins, McCaughey, & Wall, 2007). And, somewhat unsurprisingly, the research findings consistently confirm that noisy, hot environments with poor lighting and ventilation/high carbon dioxide levels have an extremely detrimental effect on student learning outcomes. But beyond this, the consensus largely evaporates.

While there are strong opinions on colour schemes and a range of other architectural features, there is limited evidence of (positive or negative) impact on teaching and learning. The findings are largely consistent with a lite version of the "Interplay Hypothesis". In other words, it is teachers that count, but their impact is severely curtailed in hot/cold, noisy, poorly ventilated and dark spaces.

The value of this research on improving learning outcomes in contexts like Australia, where building regulations help to ensure appropriate basic environmental standards are met across all schools, is therefore limited. However, in some of the international contexts where my organisation, Cognition Education Group, has supported Ministries of education (where even electricity and running water can be

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luxuries), there is still room for improvement.

Open spaces vs traditional classrooms

The merits of open spaces vs traditional classrooms have been debated since at least the time of Socrates (Giaconia & Hedges, 1982). The contemporary argument is often couched in terms of a juxtaposition of the following:

- "Factory-like" schools that were designed in the 19th Century, resplendent with: a mechanical bell; walled classrooms; rows of desks facing forward; and a structured timetable to prepare children for routine and mundane industrial work (Robinson, 2015).
- The contemporary need for learners to acquire the 6Cs (collaboration; communication; creativity; critical thinking; citizenship; and character) to prepare them for a fast-changing and highly ambiguous world (Jefferson & Anderson, 2017) – which might be more likely to emerge in open-plan, buzzing and unstructured learning environments.

To unpack this further, an often-made argument is that the skills (or dispositions) of the 6Cs are more likely to emerge from project-, problem- and inquiry-based learning. A second leap is then sometimes made to suggest that the presence of walls between classrooms perpetuates teacher-led rather than learner-centred approaches, and that this inhibits the creativity of learners. Therefore, as the current "factory-like" school buildings come to the end of their life cycle, the argument (a third leap) is made that architects should design more open learning environments to replace them and that governments should fund their creation.

The assumption is that flexible learning spaces with movable walls, furniture and portable technology will change the behaviours of teachers and students and improve both traditional and dispositional learning outcomes (Martin, 2004; McGregor, 2004; Woolner et al., 2007). However, a recent survey of Australian schools suggests that around 75% still utilise traditional classrooms (Imms, Mahat, Byers, & Murphy, 2017). Therefore, if open spaces make a difference to learning, it seems that Australia still has some way to go.

The challenge, however, is with that "if". The 315 studies and four meta-analyses evaluating traditional classrooms vs open spaces show no strong improvement in learner outcomes on standardised student assessments either way (Visible Learning MetaX, 2019). If you have an open space, it works. If you have a traditional closed classroom, it also works. So, in terms of student achievement, whether you have walls or not matters far less than what teachers and students are doing, in whatever space they have, to make learning happen.

The available evidence does, however, suggest that open spaces might be (slightly) more beneficial for enhancing non-academic outcomes such as self-efficacy, creativity, and a positive attitude towards school. While we should err on the side of caution in our interpretation of these findings (as sample populations are relatively small and learner dispositions are difficult to assess), it is another mild nudge in the direction of the "Interplay Hypothesis".

School size

In the aftermath of World War Two, as mass education proliferated across the globe, one of the main considerations of policymakers was generating economies of scale to reduce the burden on taxpayers. The assumption was that the larger the school the lower the economic burden (Barratt, Treves, Shmis, Ambasz, & Ustinova 2019). However, as research began to emerge demonstrating that smaller schools could be just as cost-effective as their larger cousins, interest was reignited as to whether they could also achieve greater student outcomes (Bingler et al., 2002).

Leithwood's and Jantzi's (2009) synthesis of 57 major studies on the relationship between school size and student achievement in the U.S. suggested that:

- smaller schools contributed positively to student outcomes (both academic and non-academic)
- the impact of smaller schools was most powerful for disadvantaged learners
- for primary/elementary schools – when serving disadvantaged learners, numbers should be limited to 500 students but, ideally, no more than 300
- for secondary/high schools – when catering to disadvantaged learners, student numbers should be limited to 1000 and, ideally, no more than 600
- a further benefit of smaller schools is that they can be geographically distributed, reducing both the travel time and cost for learners and parents.

Frustratingly, other research has been much more mixed, finding limited and sometimes no correlation between school size and students' academic performance (see Andrews, Duncombe, & Yinger, 2002; Cotton, 1996). However, more recent work suggests that Leithwood's and Jantzi's conclusions about the strong benefits of smaller schools for socio-economically disadvantaged learners and those with learning difficulties still holds water (Gershenson & Langbein, 2015; Humlum & Smith, 2015).

While none of this research comes from Australia, it does seem to support aspects of the "Great Learning Environments Hypothesis" – particularly in enhancing outcomes for underserved or marginalised communities. However, it is important to note that small schools are not effective simply as a result of being small. They are effective when the educators housed within the buildings work collaboratively to foster a family-like environment for learners and the wider community. And, as Russell Bishop's research attests, with the right professional support and coaching it is possible to build that family like culture across a wide range of school settings (Bishop & Glynn, 2011). So – "Interplay Hypothesis" again.

Technology in the built environment (and supplanting it)

Research on the use and impact of technology within the educational built environment is more bountiful and robust than that of the other categories I have explored in this article. To date, there have been more than 15,398 individual quantitative studies into the impact of technology on student learning outcomes, involving more than 2.12 million participants (Hattie & Hamilton, forthcoming). Of the 27 types of technology interventions that John Hattie and I have catalogued, only two directly reversed learning: over-consumption of television outside school hours; and use of social media both within and outside school.

However, very few of the remaining 25 technology interventions generated what might be called generous or oversized returns on investment. The most promising areas were the use of:

- **intelligent tutoring systems** – both within and outside school to remediate and improve learning outcomes, particularly in mathematics.

- **video analytics systems** – used by teachers to record and review their lessons both individually and collaboratively (e.g. the IRIS Connect platform, which enables teachers to record videos, securely share, anonymise, tag and use data analytics and a range of evaluative rubrics to analyse and enhance their classroom performance).

As the hardware required to drive these effective interventions is becoming increasingly miniaturised, it is compatible with a wide range of building designs. However, with advances in virtual/augmented reality, 5G, haptic wearables and facial motion capture – in terms of quality, price, and miniaturisation – it is possible that the next decade will witness the emergence of digital virtual schools that feel almost like the real thing. In other words, learners could don headsets and wearables and be immediately transported to a digital classroom that is almost indistinguishable from the real environment.

This could help to improve outcomes for Australian learners in remote/rural environments as well as increase access to education in developing countries where the provision of a mass-produced virtual reality headset might prove more cost-effective than building new schools.

The school estate as a parental signalling device

According to World Bank (2019) data, 21% of children in high income countries attend private schools. In the case of Australia, the same data set reports that 41% of secondary students receive their education within the non-government sector – one of the highest rates in the world.
However, there is no clear and unambiguous evidence that private education results in a significantly value-added experience for Australian learners once socio-economic status is filtered (Thomson, De Bortoli, Underwood, & Schmid, 2019). The same research suggests that in some context's government schools might actually be better.

For non-government schools to maintain their enrolments, despite the lack of empirical evidence about genuine value-add, they need to find other means to market or signal their benefits to potential consumers. Some of the signalling mechanisms they have at their disposal include: standardised tests and end-destinations for their students; quality of teaching; and quality of facilities.

For discerning parents, the challenge with the first is that it lacks a counterfactual dimension. The students who achieved strong grades and were successfully admitted to prestigious universities might have achieved the same (or possibly better) had they attended a government school. The challenge with quality of teaching is that it is fiendishly difficult for educational "experts" to reliably assess the quality of the individual teacher's trade craft (Wiliam, 2018). With repeated measures from different trained observers who are all using the same rubrics, we can inch closer to consistency in teacher observation. But, we still cannot infer with reliability which teachers are consistently most effective (Hattie & Hamilton, 2020). If "experts" cannot decide, then what hope for parents?

This leaves only the quality of facilities, where it is objectively possible to assess which swimming pool is the biggest, which recording studio the best equipped, and which yoga suite the most well-appointed. In this context, the school estate becomes a signalling device to parents – with which to (incorrectly) infer better learning outcomes and to justify a long-term investment in school fees.

So, do school buildings really matter?

In this article, I have explored and attempted to summarise the (limited) research on the impact of school building design on student learning outcomes. In broad terms, the data supports an extremely lite version of the "Interplay Hypothesis", that is, educators make the biggest difference, but their efforts can be modestly magnified in the "right" physical environment as well as heinously hindered by the "wrong" one.

The area where the research suggests that the built environment of the school has the most impact is in terms of heating, lighting, acoustics, noise control and ventilation. Effective learning and teaching cannot take place in saunas or walk-in freezers. However, most schools in developed countries – including Australia – have established building standards that cover off those minimum required features. And the more advanced infrastructure available in private schools arguably serves as little more than a parental honey trap.

The research on open spaces vs traditional classrooms finds little difference in impact from either modality – although it should be noted that most of the data was collected outside Australia and that there are significant differences in the open space treatment/implementation conditions reported across the various studies. In relation to school size, the jury is still deliberating; although it is making slightly more positive noises about the impact of smaller schools on marginalised learners.

Finally, the burgeoning data on the impact of technology – both within and outside the built environment of the school – suggests that the returns have been relatively modest regardless of the investment cost. Although virtual reality combined with wearable haptic devices and facial motion capture offer the tantalising (or dystopian?) future prospect of the complete dematerialisation of the school campus.

So, do school buildings matter? It's a complicated interplay. Still, what seems to matter most is what the people are doing inside the buildings.

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