10 THINGS SCHOOLS GET WRONG

AND HOW WE CAN GET THEM RIGHT

"Thoughtful & provocative..."

-Howard Gardner

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CHAPTER 7

COMPUTERS – THE PROBLEM WITH PRIMARY FUNCTION

"HUMANITY IS ACQUIRING ALL THE RIGHT TECHNOLOGY FOR ALL THE WRONG REASONS."

– R. BUCKMINSTER FULLER

Burden of proof.

In a perfect world, this logical obligation ensures any individual making a claim is shouldered with the responsibility of proving that claim. This elevates established knowledge over proposed knowledge in order to protect people from being swept away by the slew of novel ideas propagated each day.

In law, this means accusers must demonstrate grievance: defendants need never prove they *did not* commit a crime. In medicine, this means pharmaceuticals must demonstrate efficacy: clinicians need never prove drugs *do not* alleviate symptoms. In education, this means tools must demonstrate positive impact: teachers need never prove tools *do not* improve learning.

Of course, we do not live in a perfect world.

Too often in law, public opinion shifts the burden of proof back to the defendant, leading to wrongful convictions. Too often in medicine, economic incentives shift the burden of proof back to the clinician, leading to unnecessary patient suffering. Too often in education, external hype shifts the burden of proof back to the teacher, leading to impaired learning.

Nowhere in education has this shift been more blatant than with the adoption of computers and internet technologies.

In a recent international survey, 92% of students reported having access to a computer at school. In New Zealand, 99.7% of schools are equipped with high-speed internet, while in Australia the computer-to-student ratio has dipped below 1:1 (meaning there are more computers than students in school). In the US, yearly expenditure on K–12 learning software exceeds $8 billion annually,

while in the UK each school spends an average of £400,000 on computers every year.

With these numbers, you'd think the burden of proof had been met and that evidence demonstrating the beneficial impact of computers on learning had been clearly established.

Think again.

A 2015 OECD international review of the impact of computers in education states:

> *The results show no appreciable improvements in student achievement in reading, mathematics, or science in countries that had invested heavily in [computers] for education… Students who use computers very frequently at school do a lot worse in most learning outcomes… And perhaps the most disappointing finding of the report is that technology is of little help in bridging the skills divide between advantaged and disadvantaged students.*

After reviewing 126 research studies exploring technology-based education interventions, the global research centre J-PAL concluded:

> *Initiatives that expand access to computers… do not improve K–12 grades and test scores. [Furthermore], online courses lower student academic achievement compared to in-person courses.*

Recently, Larry Cuban, Emeritus Professor of Education at Stanford University and educational technology researcher for over 30 years, summed up the state of affairs:

> *The introduction of computers into schools was supposed to improve academic achievement and alter how teachers taught. Neither has occurred.*

In the references for this book, I have listed 50 'negative' research studies that demonstrate that computers and internet technologies significantly impair learning compared to traditional teaching methods.

Lest you think I'm cherry-picking, I have also listed 50 highly cited 'positive' research studies. Importantly, if you look closely, you'll notice 22 of these studies merely demonstrate that computers *do not harm* learning (they have

the same impact as traditional teaching methods), while 13 of the remaining studies only compare computers to baseline data. This suggests that a full 70% of studies frequently cited to argue for the inclusion of computers in education do not show that computers enhance learning.

Imagine if, after deliberating a court case, a set of jurors voted six for innocent, four for abstain, and only two for guilty. There isn't a judge alive who would sentence a defendant under these circumstances.

Imagine if, after a series of clinical trials, a new pharmaceutical was found to worsen symptoms 50% of the time, have no impact 35% of the time, and only improve symptoms 15% of the time. This drug would never see the light of day.

Imagine if, after 100 research studies, an educational tool was shown to impair learning half the time, be no better than traditional teaching methods over half the remaining time, and improve learning in fewer than two out of every 10 attempts…

The fact that robust evidence has done little to quell the excitement over educational technology suggests that this is not an issue of efficacy. Rather, this is an issue of identity.

Just like gun control, climate change, and vaccinations, this topic likely won't be decided by research and must be tackled at a more fundamental level.

THE BIG ISSUE

It might come as no surprise, but the primary function of a tool is largely dictated by how individuals most often utilize that tool. For instance, if I were to hand you a hammer, you would almost certainly look for a nail to hit. This is not because a hammer can't be used for other purposes; it's because the primary function of a hammer has long been established through previous use and experience.

So, what is the primary function of a computer? A recent survey exploring how over 1500 students around the US aged 8–18 most often utilize this tool provides the answer (values below are per week):

- 10 hours 44 minutes playing video games
- 10 hours 2 minutes watching television or film clips

- 8 hours 14 minutes scrolling social media
- 7 hours 32 minutes listening to music
- 3 hours 25 minutes doing homework
- 2 hours 5 minutes doing schoolwork
- 1 hour 14 minutes reading for pleasure
- 52.5 minutes creating digital content
- 14 minutes writing for pleasure

(Tasks listed above are not always done in isolation: ~30% of computer time is spent multitasking.)

Do you see the issue?

Students spend over 32.5 hours each week using computers to jump between various forms of media and entertainment. This is nearly 6 times more than the 5.5 hours they spend using computers for learning. Include the fact that schools are in session only 180 days per year, and this means that of the nearly 2224 hours (93 days) students spend on a computer each year, less than 9% of that time is used for learning purposes.

This is why, when using a computer for homework, students typically last less than 6 minutes before accessing social media, messaging friends, and engaging with other digital distractions. This is why, when using a laptop during class, students typically spend 38 minutes of every hour off task. This is why, even while getting *paid* as part of a research study to focus on a 20-minute computerized lesson, nearly 40% of students were unable to stop themselves from multitasking.

It's not that modern students have abnormally short attention spans or weak constitutions. It's that when students sit in front of a computer they have thousands of hours of previous use and experience dictating that the primary function is to passively consume rapidly shifting media content.

Don't get me wrong; I am not arguing that computers *can't* be used for learning. I am arguing that they so often *aren't* used for learning, and that trying to shoehorn in this function puts a very large (and very unnecessary) obstacle between the student and the desired outcome. In order to effectively learn while using a computer, students must expend an incredible amount of cognitive effort battling impulses they've spent years developing – a battle they frequently

lose. Furthermore, the energy spent trying to inhibit primary behaviours is necessarily energy not spent focusing on learning.

This is akin to sitting a group of alcoholics around a jug of beer and asking them to use it for learning about buoyancy. It's not that beer can't be used for this purpose (and individuals who have never before come across this drink will have no problem using it in this manner), it's that alcoholics have a deeply embedded story concerning the primary function of beer. As such, in order to undertake the learning, these individuals will have to expend continuous and conscious effort fighting temptation and quelling their instincts. In the end, even if they manage to avoid taking the drink, chances are they will have learned a thing or two about impulse control, but very little about buoyancy.

It's worth mentioning that, even without computers, students naturally struggle with lack of attention, shallow thinking, overconfidence, and other inimical learning behaviours. However, with computers, the likelihood of these behaviours is far greater. Seeing as many schools already struggle with engagement, why would we voluntarily throw a tool into the mix that exacerbates this problem while simultaneously harming (or, at best, not helping) the ultimate goal of learning?

THE THREE APOLOGIES

Despite the fact that neither the data nor the primary function of computers favours their use as a learning tool, enthusiasts still maintain that computers are the answer education has been seeking. Apologist arguments typically revolve around three primary themes.

Apology #1: *Computers have so much potential.*

It's easy to get swept up in the promise of computers in education. Returning to the J-PAL review quoted earlier, after concluding that computers largely harm learning, this group goes on to state:

> *Computer assisted learning shows considerable promise… against this backdrop, promising uses of education technology have the potential to support massive inroads in learning.*

This is the apology that, intentionally or not, shifts the burden of proof.

Potential is what something could be, what it should be, what it ought to be – not what it actually is. This means arguments for potential are not arguments from fact and they do not accurately reflect reality. Instead, they reflect faith, belief, and desire.

When potential is promoted above reality, individuals are unfairly tasked with disproving a fantasy. If you've ever had to convince a sports fanatic that their basement-dwelling team is no good, then you'll recognize that disproving a fantasy is impossible. No matter how much negative evidence accrues, potential will always remain unblemished because it exists in the mind, not on the ground.

I am not arguing against having faith in computers; there is every possibility that someone will eventually invent a digital program that outperforms even the best of teachers. I am simply pointing out that this has not yet happened, and that promissory arguments are not a solid enough foundation upon which to settle issues of education.

Luckily, this apology is easily circumvented by shifting the burden of proof back to its proper location. Schools and teachers should only be asked to consider adopting computers and internet technologies when it has been unequivocally demonstrated that they can significantly improve learning – not when a group of people *believes* they should.

Apology #2: *Computers are ubiquitous.*

Driving. Health insurance. Alcohol. Taxes. Video games. Dating, marriage, and divorce. Mortgages. Laundry. Student loans. Pregnancy. Litigation. Television. Starting a business. Stock investments. Raising children. Criminal records. Rent. Hygiene. Sex. Table manners. Smoking. Retail sales. Moving home. Lego. Job applications and interviews. Self-defence. Negotiations. First aid. Pet care. Hiring employees. Superannuation.

I mention these things to highlight that just because something is ubiquitous does not mean it need be explicitly taught in school. Teachers have long recognized that they are not alone in the journey of education, and that many essential ideas are meant to be passed along by parents, peers, society, and life experience.

With that said, an argument could easily be made that schools should be teaching these ubiquitous subjects – that it's the responsibility of education to

ensure all students are well versed in those things they are certain to encounter in their adult lives.

Honestly, this is a compelling argument with some merit.

However, to argue that a topic *should be taught* is far different from arguing that all things should be taught *through that topic*. The first is an argument about curriculum, the second is an argument about pedagogy. For instance, you might believe we should teach table manners to students (curriculum), but that's different from arguing we should teach all classes in a dining room over dinner (pedagogy).

Here is where the ubiquity apology goes awry. Through some linguistic alchemy, the argument 'we should teach computer skills' has morphed into 'we should teach all skills through a computer'. This has led to an abundance of backward reasoning, such as this excerpt from a 2010 paper exploring the impact of 1:1 computer programs in education:

> *[There has been] a generation of criticism levelled at 1:1 laptop computer initiatives… We raise questions about what classrooms and schools need to look like in order to realize the advantages of 1:1 computing. In doing so, we present a theoretical vision for self-organizing schools in which laptop computers or other devices are essential tools.*

Notice that these authors are not arguing that 1:1 computing has proven effective in schools; they are arguing that schools need to be reconfigured *in order for* 1:1 computing to be effective. As to why it's so important that laptops become essential tools within education, the only conceivable answer is… because they exist!

Although teaching computer skills is a worthwhile goal, it does not follow that we must adapt all of education to achieve this goal. When it comes to effective teaching and learning, we should select the tool best suited to the job, not the tool that is most prevalent.

Apology #3: *Teachers and students are using computers incorrectly.*

It seems nobody is immune to this argument. As referenced earlier, following a three-year analysis of hundreds of thousands of data points and concluding that computers do not benefit learning, the OECD goes on to state:

> *One interpretation of all this is that building deep, conceptual understanding and higher-order thinking requires intensive teacher–student interaction… Another interpretation is that we have not yet become good enough at the kind of pedagogies that make the most of technology.*

To argue that people are not using a tool correctly is merely to argue that they are not using it as the inventor intended. To understand why this apology is so flimsy, we need only return to Chapter 3, where Thamus (Socrates) warned:

> *[T]he inventor of an art is not always the best judge of the utility of that invention to the users of it.*

Philo T. Farnsworth, inventor of the electronic television, *intended* his tool to disseminate knowledge of international culture in order to drive global understanding and peace. Of course, television quickly became a means to disseminate entertainment and market products (leading Farnsworth to ultimately ban television from his household).

Robert Propst, inventor of the action office, *intended* his easily reconfigurable office dividers to promote employee productivity, privacy, and health. Of course, the action office was quickly renamed the 'cubicle' and became a way to maximize office space while lowering employee satisfaction and output (leading Propst to ultimately denounce his invention as monolithic insanity).

Alfred Nobel, inventor of dynamite, *intended* his invention to be used only for industrial purposes and thought its incredible power would preclude it from being used in war. Of course, dynamite quickly became a source of military might and caused untold numbers of deaths (leading Nobel to establish his eponymous prize in promotion of peace).

There is no doubt the engineers and programmers working on educational hardware and software have very specific *intentions* for how their tools should be utilized. Ultimately, however, these intentions are inconsequential. Once a tool makes it into the hands of the populace, it is they who decide how it will (and will not) be utilized. The user is the ultimate determinant of function.

When over 90% of students spend over 90% of their computer time jumping between passively consumed media, we can rest assured that this is the correct

way to use the tool. To blame students because they're not using the tool as the designer intended is no different from arguing from potential: fantasy must play second fiddle to reality.

In the interest of digging deeper, let's give this apology the benefit of the doubt. If computers are in fact being used incorrectly in schools, then what is the correct way to use them? As the OECD states:

> *[Internet and computer technology] is linked to better student performance… when computer software and internet connections help to increase study time and practice.*

In case you missed it, let me rephrase that: learning improves when students *spend more time learning.*

This revelation is not unique to computers. Flashcards, workbooks, whiteboards, an empty milk jug, a box of wet ferrets, my great aunt Justine: when used to increase study time and practice, literally any tool will improve student performance. The relevant question is whether or not computers actually *do* lead to increased learning time. Unfortunately, as we've already established, the answer to this is an unequivocal 'no'.

TEN MINOR APOLOGIES

Once the arguments for potential, ubiquity, and intention have been addressed, a plethora of minor apologies used by computer enthusiasts lose much of their lustre.

1. *We need more time and research to determine how best to utilize computers.*

This might be true. However, like all forms of nascent research, this work should begin with small, controlled groups. To demand that education at large participate in an uncertain experiment is to ask unwitting students and teachers to pay the price for an exploration based on desire. Only after it's clear that computers demonstrate a predictable and reliable learning benefit within smaller studies should we consider how to best scale this work throughout education.

2. *Computers make learning fast.*

The wealth of aforementioned research makes it clear that, when utilized for similar durations, computers by and large impair learning compared to traditional teaching methods. This means students must spend *more* time on computers, not less, to achieve comparable results. In addition, it's not clear that 'speed' has ever been a defining characteristic of learning. Effective learning often requires deliberate effort, thought, and practice; processes that each require time.

3. *Computers make learning fun.*

Although pleasure has been linked to motivation, the correlation between enjoyment and learning is surprisingly weak. Chances are you've sat through an incredibly enjoyable film that you remember little of today. Conversely, chances are you've sat through a confronting film that, thanks to subsequent discussions, you remember deeply today.

The issue of importance is not enjoyment, per se, but how this emotion is leveraged to drive engagement with effective learning practices. That computers may be fun is trivial. Does this fun lead students to undertake meaningful activities known to enhance learning? Unfortunately, the research suggests that this follow-on effect is not occurring.

4. *Computers can help students develop 21st century skills.*

As we explored in the previous chapter, to stay relevant in an increasingly automated world, 21st century citizens must hone those skills that are uniquely human. To this end, critical thinking, creativity, collaboration, and communication have been singled out as important because they are precisely those skills which computers cannot do well. Surely trying to use a computer to teach students how *not to think* like a computer is the same as trying to use water to drown a fish: in no way does the tool suit the purpose.

5. *Computers are adaptive and can guide learning.*

In order for educational computer programs to be adaptive, they must have a predetermined outcome – a correct answer that allows users to be incorrect, thereby triggering the adaptive process. Though this may be effective for surface knowledge, what happens when we wish to take learning deeper? It's

one thing to correctly define the term 'atom', but it's quite another to debate whether or not this definition is clear and meaningful across all contexts, what beliefs led to the atom's discovery, or what the atom's equivalent might be across varied systems of thought.

Once learning progresses beyond binary outcomes, the a priori destinations demanded by computers become a hindrance. Rather than rigid adaptation driving a singular outcome, students require a deeply flexible form of adaptation that allows for ambiguity, ambivalence, and open-ended solutions. Luckily, teachers have been demonstrating this type of adaptability for centuries.

6. *Computers increase enrolment/decrease costs/improve profit margins.*

Though possibly true, this apology does not concern learning and is irrelevant to matters of the classroom. The same is true for arguments concerning ease of scheduling, contact, or assignment submission. Though these are all wonderful benefits supported by computers, they aren't learning considerations and should not be construed as such.

7. *Computers make it easy to collect and analyse data.*

Data is only meaningful when it can be utilized to serve a clear purpose. Unfortunately, the digital data many teachers are tasked with collecting (button clicks, time-on-page, video access statistics) is decontextualized, overwhelming, and incredibly difficult to parse. When data becomes so vast and nuanced as to require the use of a computer for its collection, analysis, visualization, and conceptualization, then it's time to question the function of this exercise.

On the other hand, when the purpose of educational data is made explicit (to guide pedagogy and learning), it becomes far easier to reorient towards that data which is meaningful and worth collecting.

8. *Computers allow access to a wealth of information.*

Approximately 90% of schools can boast possession of a library, meaning 'access to information' is not a problem that modern education has ever truly suffered from.

This apology picks up steam when it incorporates equity. More specifically, it's possible that computers can allow under-privileged students access to

the same materials available to more privileged students. Though I strongly support the ideals of equity, remember the OECD statement quoted earlier: '…technology is of little help in bridging the skills divide between advantaged and disadvantaged students.'

If history has taught us anything, it's that the benefits of a technology are never equally distributed. Even among ubiquitous technologies like the automobile, air conditioning, and (indeed) the computer, there remains a tremendous gulf in quality and peripherals available to the rich versus the poor. Accordingly, if educational equity is the destination, then computers do not appear to be the route.

9. *Computers allow students to choose topics and create personal learning pathways.*

Love it or hate it, one of the primary functions of education has always been the coherent organization of information. Through what they include (and, of equal importance, what they exclude), curricula serve not only to inoculate students from information overload, but also to support learning by structuring content into a rational trajectory.

Without coherent organization, information loses context and becomes a source of confusion rather than a source of clarity. A natural response to this confusion is to focus only on those facts already well understood. This is why, when allowed to choose their own learning pathways, most students gravitate towards topics they are already deeply familiar with (sports, music, video games, etc.). It's not that they lack curiosity; it's that without proper guidance, students become overwhelmed by information chaos and meaning is lost.

When computers are used to reduce the capacity of schools to structure information, they do so at the expense of learner agency and growth.

10. *Computers allow students to access classes whenever and wherever.*

When schools mandate that teachers place lectures online for students to access at their convenience, they send the message that learning is of lesser importance than every other life event. Doctor's appointment? No problem. Hanging out with friends? Go ahead. Hung over? Stay in bed.

To understand the impact of this message, one need only look at the statistics for open online learning courses. Despite millions of worldwide registrations over

the last decade, fewer than 5% of enrolled students have ever completed these digital programs. Even among students who pay for course credit, completion rates are below 50%. Why such abysmal outcomes? Because when education is adapted to the lifestyle of the student, rigour is stripped from the process and personal accountability plummets.

Schools need to treat learning as an event: something that students commit to and build their lives around (not vice versa). When education fails to prioritize, elevate, or revere learning, why should students?

Now, I fully recognize that some individuals have a legitimate reason for being unable to attend live classes. Importantly, this can be (and historically has been) successfully addressed on a case-by-case basis. There's no reason to dismantle educational composition to accommodate for the rare case; it's far more practical to deal with the exception when it arises, while keeping the larger composition intact.

SO NOW THEN…

For over a decade, I have been asking educators to provide unambiguous examples of when they successfully used computers to benefit student learning. In that time, three patterns have emerged.

First, when schools are required to close as a result of environmental disasters (e.g. poor air quality due to fires), sociological upheavals (e.g. unsafe political protests), or health risks (e.g. local epidemics or global pandemics), then teachers often have no choice but to employ distance education. In these instances, it is difficult to argue against the use of computers: any form of learning is better than no form of learning. With that said, the issues of digital distractions, diminished impact, and socioeconomic divide still persist during distance learning.

Second, computers can prove a godsend for individuals with specific learning disabilities. Students with auditory impairments can use computers to transcribe speech; students with motor impairments can use computers to type; students with visual impairments can use computers to alter text presentation, etc.

Though these benefits cannot be overstated, it's important to recognize that one person's scaffold can become another person's crutch. Quite often, students with no underlying disability will exploit computers to indulge personal learning preferences and avoid the often difficult process of learning. Accordingly, when

disability is not a factor, teachers must determine when it's acceptable to cater to preference, and when computers hinder the push into more difficult, less fluent realms.

Third, computer simulation appears to be effective when practising motor skills that otherwise would be too difficult or dangerous to train for in 'real' life, for example, airline pilots practising mid-air emergency manoeuvres; surgeons practising invasive procedures; or Formula One drivers practising city-street courses.

However, though simulation may benefit motor skills, the same cannot be said for knowledge of facts, dates, events, etc. As an example, a Greek school in Australia recently invested in virtual reality so that students could learn to speak Greek by conversing with an adaptive avatar projected in front of a digital Acropolis. Though well meaning, there's a far more effective and adaptive technique proven to yield better results: have students converse with an actual Greek-speaking person (of which, you'd imagine, there would be several within a Greek school). Sure, chatting in front of the Acropolis is a nice touch, but it's unlikely that a primary impediment for students learning to speak a second language is the lack of nearby ancient architecture. When simulations transition from motor skills into declarative realms, the same learning issues that plague more traditional computer programs come into play.

In the end, it's been roundly demonstrated that computers, by and large, hinder learning. Once arguments for potential, ubiquity, and intention are abandoned, and computers are considered for what they are (rather than what we desire them to be), it becomes questionable whether or not digital technologies should continue to play such a large role in education. Moving forward, we must rationally debate the merits of all emerging tools and consider adopting only those that unambiguously demonstrate benefits to learning.