Impact of learning from home on educational outcomes for disadvantaged children

Brief assessment

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Young Australians disadvantaged in learning from home

The onset of the Coronavirus pandemic has required schools to establish learning from home for the majority of children across Australia, bringing rapid rollout of online education. At this time, the main goal is to ensure that all children are able to continue to access learning and to move student learning forward. But not all children are equally well placed to do this. Some children are already at risk of school failure for a variety of reasons and having to learn from home brings with it some major additional challenges for them. Those at risk include a wide variety of students such as those who live in poverty, often characterized by low socioeconomic status, those with a disability or additional learning needs, students in rural or remote parts of Australia, and those who are indigenous.

What will the effects on outcomes be for more vulnerable children of learning from home? Research to date gives us some clues and also points to why some children are more vulnerable in the home learning context, the numbers affected and what will need to be considered in working out what needs to be done in supporting the students who are most likely to struggle in the online setting.

Which students are vulnerable in the context of learning from home?

Across Australia, numbers of young children are affected by one or more risk factors that have been linked to academic failure and poor outcomes. Table 1 reports on some of the main groups at risk in terms of gaps in skills at key milestones in schooling. The first key milestone is at the point of entry to school with estimates of the proportion of children who according to national data on development are not yet ready for school based on teacher assessment of their language and cognitive skills[1]. The second is at the beginning of high school and provides an estimate of the percentage of students who are struggling and are behind in reading skills—at or below the national minimum standard. The third milestone is school completion and reports the percentage of students who fail to attain a Year 12 certificate.

Chief among the risk factors associated with poor outcomes is family socioeconomic status (SES), which is consistently associated with negative outcomes. Various studies have demonstrated that SES is a significant predictor of educational failure (for example, OECD, 2018; Lamb et al., 2015). Moreover, it is increasingly apparent that performance gaps by SES take root in the earliest years of children's lives and are present at entry to school. Table 1 shows that while nationally 13.4 per cent of children are not developmentally ready at entry to school, as measured by their language and cognitive skills, the rate is much higher for those from low SES families—23.1 per cent—a rate more than three times higher than for high SES

[1] These are children who experience a number of challenges in reading, writing and with numbers, unable to read and write simple words, uninterested in trying, often unable to attach sounds to letters, and have difficulty remembering things, counting to 20, and recognising and comparing numbers (AEDC, 2020).

children (7.0 per cent). The gaps are much greater by Year 7—36.3 per cent of low SES students are at or below the minimum standard expected at this stage of schooling, a rate ten times that for high SES students (3.4 per cent). School completion is also much lower for children from poorer families with 29.6 per cent not attaining a Year 12 certificate, according to the national census, compared to a national average of 18.4 per cent and a rate for high SES students of 9.7 per cent.

Table 1 Gaps in skills at key milestones, by student characteristics (%)

	Key milestone		
	Language and cognitive skills at entry to school—not developmentally ready[1]	Reading skills in Year 7—at or below national minimum standard[2]	School completion—doesn't attain Year 12[3]
National average	13.4	16.3	18.4
SES (quintile)			
Low	23.1	36.3	29.6
Lower middle	15.8	20.2	22.1
Middle	12.4	13.0	18.8
Upper middle	9.7	6.8	14.7
High	7.0	3.4	9.7
Indigenous status			
Indigenous	33.6	49.8	44.2
Location			
Very remote	41.8	71.6	51.6
Remote	20.7	34.5	35.0
Outer regional	17.0	25.5	29.1
Inner regional	14.2	19.6	28.0
Major city	12.3	13.6	14.9
Language background			
Other than English	19.1	18.2	11.7
Special Needs			
Disability	44.6	na	35.5

1. Derived from the national collection of AEDC data for 2018
2. Derived from NAPLAN data for 2018
3. Derived from the 2016 Census of Population and Housing

Other groups of students are also at risk of not achieving key milestones in school. Overall, about half of all indigenous students (49.8 per cent) perform below the basic level of proficiency in reading in Year 7, and about 44 percent do not attain a Year 12 certificate. Compared with other students, a larger percentage of students living in remote and very remote areas of Australia, and students with special needs associated with disability, were well behind in language and reading skills at entry to school and at Year 7.

What challenges does home learning present for these groups of vulnerable students?

The challenges students face

In order to minimize the disruption to student learning during the current period, school system authorities around Australia have advised schools to help support students learn from home by creating online approaches to classroom programs. Theoretically, online learning offers the promise of access regardless of where students live, potentially providing opportunities for learning for all students. For some schools, it will be business as normal because their students have internet connections at home, laptops they can work from, and teachers with some experience and knowledge of how to engage and teach students online. For students at these schools, learning from home will be a simple transition and extension of what they do routinely.

But the reality is, these schools and students are not the norm. Most schools across Australia were completely unprepared for the coronavirus and for moving to virtual learning. Unequal internet access is just the tip of the iceberg of the challenges some students face in doing their schooling online. A number of studies show that while online courses work well for some and offer little disruption, for others there are major challenges and the disruption is likely to lead to widening gaps in school learning over what would have occurred had they remained in face to face classrooms (see, for example, Hart et al., 2019).

The issues that schools confront when it comes to home learning for those who face challenges relate to five key factors:

1. The gaps in basic resources of families needed to support home learning—***the material divide***
2. The gaps in Information and Communications Technology (ICT) resources and knowhow—***the digital divide***
3. Students not equally equipped personally for home learning—***the skills and dispositions divide***
4. Some parents not well prepared and not able to manage or cope—***the parental support divide***
5. Learning adjustments schools use for some students are not suited to home learning arrangements—***the adjustments divide***

1. Gaps in basic resources needed to support learning

Today, about one in six Australian children and young people live in low-income households, where life's basics are hard to come by (Davidson et al., 2020). In addition to the fact that parents of disadvantaged children may not have the skills or experience to support their child in home learning, children and young people living in low-income households have access to fewer books and learning materials in the home and more limited access to support and resources that help form a foundation for learning. The dimensions of this are partly revealed in the most recent PISA assessment of 15-year-olds. From a national survey of 14,273 students, extensive information was collected on a raft of items related to student education experiences, and the influences on them, including family life.

Table 2 Differences in home resources and student skills, by social background: Australian 15-year-olds (%)

	Socio-economic status (quintiles)*				
	Low	Lower middle	Middle	Upper middle	High
Material divide					
No desk to study at	25.3	11.5	9.3	4.4	1.4
No room of own	13.4	7.1	6.4	5.1	3.6
No quiet place to study	23.4	13.6	10.2	9.6	3.5
No books to help with schoolwork	44.3	28.8	21.2	14.9	6.2
No dictionary	27.4	16.2	12.4	7.9	1.8
Digital divide					
No computer for schoolwork	18.0	5.6	3.5	2.6	0.4
No educational software	33.9	18.2	13.3	11.4	4.2
No link to internet	6.2	2.1	1.0	0.6	0.1
No more than one computer or laptop in household	31.1	13.4	7.9	4.6	0.4
Low interest in ICT**	27.3	23.6	22.1	18.5	17.8
Weak skills in ICT**	24.8	22.7	18.9	18.7	15.5
Little capacity for working independently with ICT**	26.3	22.9	19.5	19.1	16.0
Skills and disposition divide					
Weak language skills (reading)**	33.8	23.6	18.3	12.8	9.2
Not motivated to learn**	22.0	16.2	14.7	11.0	7.8
Low level of perseverance**	17.7	13.0	11.9	9.6	6.5
Parental support divide					
Less supportive of school efforts and achievements	11.7	8.3	6.6	6.4	4.0
Across year, hasn't worked with mother on schoolwork	47.0	36.8	30.8	27.5	23.6
Across year, hasn't worked with father on schoolwork	56.3	45.3	40.2	34.1	27.7
Mother hasn't completed school	41.6	16.0	7.2	3.7	1.9
Father hasn't completed school	44.4	21.0	12.7	7.0	3.9

Note: Derived from PISA 2018.

* Socioeconomic status is measured by an index of economic, social and cultural status (ESCS) created from measures of parental occupational status, highest level of parental education, and family wealth (including home resources and cultural possessions).

** Low levels of interest, skills, dispositions and autonomous capacity are identified as those in the lowest quintile.

In PISA 2018, students reported the availability of various household items at home which are types of educational resources such as and books (OECD, 2019b). For Australian students, the results, presented in Table 2, show that low SES children are least likely to have a separate study desk, to have a room of their own in which to work, and a quiet area in which to do

their learning from home. While only 6.2 per cent of high SES students reported not having any books to help with schoolwork, the rate for low SES students was 44.3 per cent. Low SES students were also least likely to possess a dictionary.

2. Gaps in Technology and ICT resources

Levels of access to ICT and the internet in Australia are generally high, with around 95 per cent of families having access to the internet at home. As well as access, Australian households have on average two computers, 2.5 smartphones and 1.6 tablets in the household (ABS, 2018. However there remains significant variability in the distribution and the effective use of that technology, based on a range of socioeconomic and demographic factors. And while access to technology is an important measure, the ability to deploy it effectively to support learning is also critical.

According to the PISA survey of 15 year-olds, while virtually all high SES households have the internet at home and a computer available for school work, about 6 per cent of low SES households do not have the internet at home, and 18.0 per cent don't have a computer for schoolwork (see Table 2). The number of available computers also varies, with almost a third (31.1 per cent) of low SES families possessing only one computer or laptop. Higher SES families have multiple pieces of equipment, by comparison. This is matched by differences in ownership of educational software, pointing to differences in the ways that computers are usually used.

It is not just physical ICT resources that matter. The digital divide is a divide not only in terms of equipment and connectivity (access and affordability) but also in terms of how technology is used and the confidence and skills with which it is used (digital ability and literacy). 'Digital inclusion' is more than just access to a device and the internet. It's also about having the right environment, capability and disposition to effectively utilise resources, and the more human aspects of technology use are influenced by socioeconomic and demographic circumstances.

PISA 2018 recorded skills in ICT along with levels of interest in using ICT and, maybe more importantly in the current context, the capacity students feel they have for working independently with ICT. On all three measures there is a social divide. Students from low SES families record more frequently the lowest levels of interest in ICT (27.3 per cent), the weakest skills in using ICT (24.8 per cent), and the lowest levels of capacity for working independently with ICT.

There are also gaps in experience with ICT as measured by the frequency of use both at home and school. In an international survey of how well students are prepared for study, work, and life in a digital world, Fraillon et al. (2014) reported that in Australia, while 93 per cent of students from high SES families (highest quintile) use a home computer at least once a week, about 80 per cent of those from low SES families (lowest quintile) do. Eighty-five per cent of students of high SES students have regular access to computers at school compared with 78 per cent of low SES students (Fraillon et al., 2013). Students with more years of experience in using ICT are more likely to have higher levels of digital literacy (Fraillon et al. 2014; ACARA 2018). Several studies have shown a positive association between computer ownership and educational attainment, and a correlation between low levels of access to ICT ownership and

lower educational attainment (Schmitt and Wadsworth, 2004; Valentine et al., 2005; Spiezia, 2011; Bowers and Berland, 2013).

The situation for indigenous Australians also presents challenges. ICT inclusion of indigenous Australians remains lower than the national average and while it has risen in the past year, the rate of this rise is slower than the national average (Thomas et al., 2019). Indigenous students tend to have less experience with ICT, with only 37 per cent of indigenous students reporting more than seven years of computer experience, compared with 51 per cent of non-Indigenous students (Fraillon et al., 2013). Fewer indigenous students report using computers at least weekly at school compared with non-indigenous students (ACER, 2013).

3. Some students are not equipped personally for home learning

A number of studies conducted in the US and Canada have identified that success in learning from home depends in part on specific qualities of the learners (see, for example, Bernard et al., 2004; Bettinger et al., 2017; Heppen et al. 2017; Roblyer & Marshall, 2002). Successful online students tend to have an interest or basic skills in technology and have strong language skills necessary for making best use of the visual medium associated with online learning. They also tend to be motivated, independent, and self-directed. Students who have the capacity to persevere towards a goal despite adverse circumstances, displaying resilience to complete tasks even when they are difficult and, sometimes, not always interesting, particularly when being pursued on one's own, are more likely to succeed (Duckworth et al., 2007; Duckworth and Quinn; 2009).

When looking at Australian school-age students there are numbers who do not possess these qualities, at least not as strongly as other students, and may therefore struggle or not be as successful with learning from home (see Table 2). In terms of language skills, PISA 2018 shows that the impact of social background on reading varies greatly. A third of all low SES students have weak skills in reading (in the lowest quintile of reading achievement), compared to 9.2 per cent of high SES students. The result is particularly relevant to the context of online learning because the 2018 reading assessment placed greater emphasis on the ability to find, compare, contrast and integrate information across multiple sources. It was focused on reading skills in the context of digital technology (OECD, 2019b).

Disadvantaged students also display lower levels of motivation to learn and low levels of resilience or perseverance, characteristics which are considered important qualities for successful online learning. Being self-motivated and self-disciplined with an ability to work independently are repeatedly listed as critical skills to effective learning from home in an online arrangement (Weiner, 2003; Bettinger & Loeb, 2017). For many disadvantaged students, including those with special needs, these characteristics present a major challenge.

4. Not all parents feel able to manage or be as supportive

One of the challenges in moving to online learning arrangements on a wide scale is the variability in the capacity of parents to support their children's learning. While all parents may want to see their children succeed, the reality is that many may not be well placed to support their children for a variety of reasons. For one thing, not all parents feel equally well equipped to assist with their child's learning, particularly those with older or more senior students.

While the vast majority of high SES parents, those who are wealthier and those who are in professions, have themselves completed school and in many cases tertiary study, many low SES parents (41.6 per cent of mothers and 44.4 per cent of fathers, according to PISA estimates reported in Table 2) have not completed secondary school or even reached the upper secondary level. This may explain why many students from low SES families in 2018 reported that across the school year they hadn't worked with their mother (47.0 per cent) or their father (56.3 per cent) on schoolwork. These were rates more than double that for high SES students. It indicates that support for learning from home is much more of a challenge for them.

This doesn't mean that all parents don't want to help and support their children in their schooling, particularly during this period. It simply means that not all parents are equally well placed to do so, or feel well placed to do so. This may be particularly true for parents of children with special needs who often rely on schools to deliver the adjustments that are needed to promote learning, or for parents who do not speak English or have weak English-language skills and are uncertain how to assist.

5. Learning adjustments required for some students are not suited to home learning

The Commonwealth Government, and State and Territory governments, annually commit substantial amounts of needs-based funding in support of students who are disadvantaged and have additional needs associated with disability, low SES disadvantage, indigenous status, low English proficiency and living in rural and remote parts of Australia. The additional funding supports a wide range of learner supports and adjustments, everything from breakfast programs, cultural enrichment experiences, reduced class sizes, personalised learning plans, and targeted teaching strategies through to intensive one on one programs such as Reading Recovery and personal care support. However, the locus of most of these adjustments is school and it is just not at all clear that the strategies and investments can work in the same way or with the same effect in an online learning arrangement.

This may be particularly the case for students with disabilities who rely on specialist facilities and programs and integration support offered in special school settings as well as many mainstream classrooms. Delivering differentiated content in a well-equipped classroom may be difficult on any day, but trying to do so online may be impossible. One of the main issues is how to keep students on track to reach their individualized learning plan goals and objectives without the focused face-to-face efforts of classroom teachers and support staff. Teachers may need to be working much more closely with parents and carers to support learning at home. But, students are accustomed to having aides, and specialists in addition to teachers, in the classroom. The learning adjustments may just not be able to work the same for these students.

The challenges teachers face

The impact on student learning and outcomes for Australian children who are disadvantaged will depend in part on how well teachers are able to adapt to working effectively in the new landscape. There is a simple reality. Classroom teachers have never had to teach in an online arrangement on the scale now required, particularly the online teaching of students with high and additional needs. Are all teachers equally equipped to be able to design and implement effective practices in the online environment? In looking at the issue in an earlier time, Wood (2005) remarked that 'a good classroom teacher is not necessarily a good online teacher'. Other studies have questioned whether teacher classroom skills are transferable into the virtual space (Bartley et al., 2018). The way that teaching and learning is organised and delivered in the online context is intrinsic to how students engage in learning during confinement and mass school closures. Poor quality online instruction could diminish student engagement and learning and discourage persistence.

Australian teacher skills in digital technologies and their ability to use online pedagogies are uneven. International data collections, including the OECD's Teaching and Learning International Survey in 2018, found many Australian teachers face challenges in adopting innovative pedagogies for the online context, with just under two in five (39 per cent) teachers feeling well prepared or very well prepared in how they use ICT for teaching (OECD, 2019b). Other studies identify that teachers worldwide tend to over-estimate their students' digital competence (OECD, 2018). This is supported by results from a survey of Australian staff in schools which identified a need for teacher professional development in ICT, particularly amongst more experienced staff at the primary and secondary level (McKenzie et al., 2014). A lesser need for professional learning in ICT was expressed by early career teachers (McKenzie et al., 2014). According to the NAP ICT Literacy assessment, Australian students report that the majority of teachers simply use ICT as a tool to present information to their class rather than utilise creatively in teaching (ACARA, 2018). This suggests that new online pedagogies which extend or indeed transform student learning are not used frequently.

Teachers across Australia have had to transition into the online environment without a strong evidence base to inform their approach. Fundamentally there is a lack of international and national research on the best ways to undertake a full program of online learning for students in primary and secondary schools (Di Pietro et al., 2008). The majority of Australian research into online learning focuses on graduate students (AITSL, 2020; Brennan, 2003; Stone, 2016). Studies from the United States also identify a lack of research into best practice concerning online learning for primary and secondary students (Means et al., 2010). This omission is important to acknowledge as graduate students, compared with primary and secondary students, have entirely different learning needs. Existing studies into online learning for secondary school students have tended to be focused on one discrete online subject or unit, rather than digital delivery across every curriculum area (Heinrich et al., 2019; Heppen et al., 2017).

Australia does have a history of non-classroom provision using online pedagogies through the School of the Air and Distance Education that operate in various states and territories. However, it is difficult to make comparisons with these programs as they can have different

staffing and resourcing compared to regular schools. The teachers in distance education are experienced in planning and delivering lessons in a digital environment, class sizes are smaller and families are positioned to provide regular parental support or they employ a 'home tutor' (ACARA, n.d., Rivalland et al., 2001).

The communication and pedagogical demands required to be able to deliver teaching and learning online are similar in some ways to classroom practice, but in other ways they are very different. As part of the transition to an online model, teachers have had to collect and seek out a whole new set of online learning and teaching resources. Effective online pedagogies necessitate multimodal activities, where language is used across written, audio and visual forms which interconnect with one another. To do this, teachers have to be able to introduce their students to various technologies, software and learning management platforms (Rivalland et al., 2001). Online delivery requires an adaptation of curriculum content, an adjustment of sequencing and alteration in the pace of delivery (Heppen et al., 2017).

Arguably the biggest difference between instruction in the classroom and instruction in the online context is associated with timing. Online teaching and pedagogies are designed to be used in either real time (synchronous) or at a later time (asynchronous). There are positive and negatives associated with both approaches (Murphy et al., 2011). For instance, asynchronous instruction is less interactive. Yet despite its high interactivity, synchronous instruction over Zoom or Skype is more susceptible to technological outages and one-way communication. Adjusting pedagogical approaches through time is a unique aspect of online delivery, as the classroom is inherently based on synchronous instruction.

Good teachers are able to use a range of approaches to cater for the distinctive abilities and learning styles within any physical classroom. The same pedagogical principle is essential to be able to deliver effective teaching in the online environment. However, the mechanics and 'art' of teaching in the digital environment are different (Brennan, 2003). Teachers do not have a lot of experience in delivering online programs for primary or secondary students, particularly those who are disadvantaged. Without the daily interaction within the classroom or school, teachers may have less capacity to see how their students are coping and adjust their practices accordingly.

The issues in relation to online teaching are compounded in dealing with disadvantaged students. An initial difficulty which many teachers have not had to address previously is associated with digital access. Teachers will need to know how students are accessing online learning, including whether students use broadband, limited data plans or mobile networks as well as the students' hardware such as the device or computer. Disadvantaged students who do not have regular access to their own computer or a reliable data connection may require more asynchronous delivery so that they can access the content when they are able to. Vulnerable students may require printed course materials or hard-copy resources to circumvent issues of digital access entirely. Teachers already face challenges in meeting the diverse set of student needs in any one classroom, now they have to further differentiate their practice to accommodate digital access.

Likely impact on outcomes

With schools around Australia now technically operating in term time, what will be the impact of learning from home on student progress and outcomes? Assuming schools continue to operate using online arrangements for the foreseeable future, how detrimental will this be to student learning?

There's a number of different sorts of studies that provide a guide. One type is from the large numbers of students, in Australia and overseas, doing online courses in higher education and vocational education. In the US, about one in three college students takes at least one course online (Bettinger & Loeb, 2017), while in Australia, about 13 per cent of VET subjects in 2017 were delivered online (Griffin and Mihelic, 2019). A number of studies have compared the outcomes for students undertaking online courses against students doing the same courses on campus (see, for example, Bettinger et al., 2017; Hart, Friedmann, & Hill, 2018; Means et al., 2013; Xu & Jaggars, 2014; Misko, 2000; Griffin & Mihelic, 2019). The evidence provided is contrary, with some studies finding a small positive impact of online learning while others reporting negative effects, and others showing no differences at all. Even if the results were more clear-cut, though, this research is not necessarily a good guide for the current situation because the different organisation of learning and greater autonomy of learners in tertiary education makes it difficult to apply results from the impact of online learning in tertiary education to school students.

Other types of studies that provide a guide are those associated with measuring the effects of temporary school closures and extended breaks from school. In the US and Canada, research has been conducted on the impact on student learning of having extended periods away from school due to emergency closures (from fires and weather conditions) or long summer breaks. According to the results, students fare worse on exams in years with more weather-related closures (e.g. Marcotte and Hemelt, 2008), and the average student loses about one month's worth of learning over the course of a summer break, though the loss is much more for disadvantaged students who have access to fewer resources and learning opportunities while away from school (Cooper et al., 1996; Atteberry, & McEachin, 2016). These studies, also, are not necessarily a good guide for estimating the impact of moving all students from classrooms to learning from home. Technically, the studies are measuring learning during a break from school rather than a situation of online learning. What the studies do highlight is the variability in effects of home environments on student learning, rather than what effect moving to online learning will have.

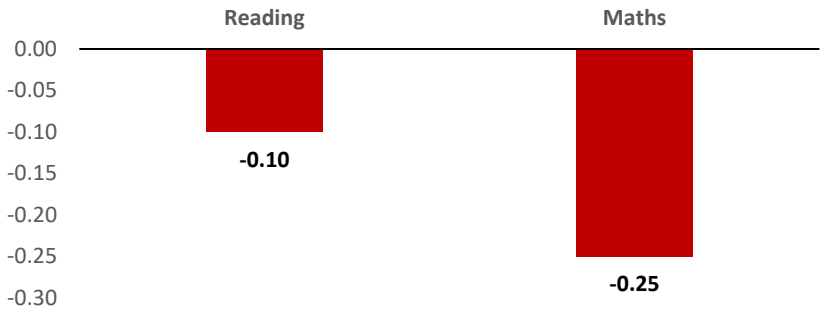
There are other studies, though, that do provide a good guide. One set of studies have compared the academic outcomes of school students (P-12) who take courses online against the outcomes for students who take the same courses in face-to-face teaching in school classrooms. Another set of studies have compared the outcomes of matched students doing all of their learning in virtual classrooms (through online learning from home) against the outcomes of students doing all of their learning in traditional classrooms. While both types of studies do not use the "gold standard" evaluation method of comparing the results for students assigned randomly to online or in-person courses, they do use large-scale

administrative data looking at the learning progress of otherwise similar students in the two settings.

The emerging view from the results of the research is that, for children, virtual learning is less effective than face-to-face learning in school (Molnar, 2019). Most of the studies have been conducted in the United States, where virtual schools are common in some states (e.g. Ohio, Michigan, North Carolina and Colorado) and taking an online course in high school can be a study requirement to be awarded the high school certificate. Where online versus face-to-face comparisons have been made, most focus on high school students, though there are some also involving learners in the primary school years.

One key study was that conducted by the Center for Research on Education Outcomes (CREDO) at Stanford University. CREDO performed state-by-state and United States-wide analyses on charter schools, comparing learning progress for students in traditional schools against learning progress for students in virtual schools (E-schools). The study of students in 128 online schools across 17 states estimated the average impact of online learning on student outcomes in reading and mathematics in grades 3 to 8, after controlling for demographic and educational differences between the two groups by matching online learning students with comparable students in face-to-face schools. The study found a consistent negative impact of online delivery on learning gains across 14 of the 17 states in reading and across all 17 states in mathematics. The average United States-wide impact of online learning in charter schools is shown in Figure 1.

Figure 1 Effect of online enrolment on student learning gains in reading and maths in 2015: United States online charter schools compared against traditional schools (standard deviation units of annual learning gains in grades 3 to 8)



Source: (Woodworth et al., 2015).

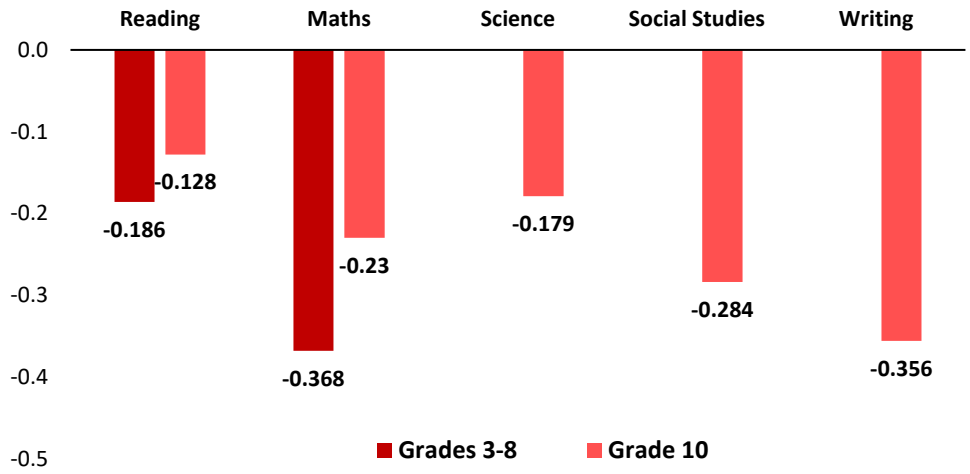
The results from comparisons of student learning in online versus traditional schools indicate that the negative impact of online learning for a full year of school is significant in both reading and mathematics, with the impact being more significant in mathematics. This finding has been confirmed by subsequent state-by-state studies in Texas (CREDO, 2019e), South Carolina (CREDO, 2019d), Ohio (CREDO, 2019b), New Mexico (CREDO, 2019a) and Pennsylvania (CREDO, 2019c). CREDO's 2015 report also found that disadvantaged students—i.e. students in poverty, those with language efficiency issues, and students with a disability—are all more negatively impacted by online delivery than are students in general (Woodworth et al., 2015).

Another major and important study was published in 2017 and reported results for primary and secondary school students in Ohio, comparing the academic outcomes of over 35,000 students in 'E-schools' (i.e. online learning schools) against those of their peers in traditional schools (Ahn & McEachin, 2017). Student outcomes were measured using annual standardised tests (Ohio Achievement Assessments) for students in grades 3 to 8 and results of graduation exams (the Ohio Graduation Test) for students in grade 10. The authors controlled for a range of student- and school-related factors, including prior achievement.

The E-schools in Ohio are useful to look at the effects of online learning on disadvantaged students. E-schools are more likely to enrol lower-achieving students (Ahn, 2016). E-schools are also more likely to enrol other groups of disadvantaged students: in the Ohio study, 11 per cent of E-school students are African-American, 16 per cent are 'special education' students (those with a disability) and 60 per cent qualify for free or reduced lunch (a low SES marker) (Ahn & McEachin, 2017). Given that the main group of students enrolled in E-schools is those who are eligible for free or reduced lunch, the estimates of the impact of E-schooling on learning outcomes may be representative of the impact online learning could have on low-SES students in Australia.

The estimates presented in Figure 2 show that students do less well in online learning than in traditional classrooms across all areas that were tested, and particularly in mathematics, but also in writing. It also suggests that the impact on student learning is greater in the earlier years than in the later years.

Figure 2 Impact of virtual school enrolment on student outcomes (in standard deviations of student scores) (2017)



Source: (Ahn & McEachin, 2017).

As a guide for the current online arrangements in Australia, the results from the 2017 Ohio study can be used to estimate the impact online delivery may have on student learning for Australian children, particularly for those from disadvantaged and low SES families. Using the distribution of student scores in 2019 NAPLAN reading and numeracy (ACARA, 2019), it is possible to convert the expected impact of online delivery on student learning outcomes into

NAPLAN scores for Years 3, 5, 7 and 9. For simulating effects for NAPLAN Years 3-7, the estimates based on the Grade 3-8 Ohio Achievement Assessments can be used. For simulating effects for NAPLAN Year 9, the estimates based on the Grade 10 Ohio Graduation Test can be used. Because it is still unknown how long students will be learning online in Australia, the results can be applied for four hypothetical durations of online delivery: for 1 term, 2 terms, 3 terms and the full school year.

The results of this simulation are presented in Table 3. It applies the potential weaker learning in online arrangements to NAPLAN scores based on the length of time students are exposed to online learning—one term through to the full school year. It measures this based on the reported estimates of NAPLAN gains made by students between testing (e.g. from NAPLAN Year 3 to Year 5 between 2017 and 2019) apportioned for the different lengths of time of being required to do online learning. It is possible to do this to estimate the percentage of learning taking place in a given year that disadvantaged Australian students can expect to lose for each school term.

Table 3 Estimated impact of online learning on NAPLAN Year 3, 5, 7 and 9 reading and numeracy for disadvantaged students: measured in NAPLAN scores

	Length of time in online learning							
	1 term		2 terms		3 terms		Full school year	
	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy
Year 3	-2.0	-3.4	-4.0	-6.8	-6.0	-10.2	-8.0	-13.6
Year 5	-1.6	-3.1	-3.3	-6.2	-4.9	-9.3	-6.6	-12.3
Year 7	-1.6	-3.5	-3.1	-6.9	-4.7	-10.4	-6.3	-13.9
Year 9	-1.1	-1.8	-2.2	-3.7	-3.2	-5.5	-4.3	-7.3

Note: The estimates assume a linear impact of online delivery on student learning until Year 7. Additional research may reveal that the impact is in fact greater in Year 3 than in Year 7.

Table 4 Estimates of the loss due to online delivery in NAPLAN expressed as percentages (%)

	1 term		2 terms		3 terms		1 year	
	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy
Year 5	3.8	6.7	7.6	13.4	11.5	20.0	15.3	26.7
Year 9	5.7	8.3	11.5	16.7	17.2	25.0	22.9	33.3

Note: these estimates are calculated by converting the estimates of absolute NAPLAN points lost into percentages of learning taking placed in the year leading up to the NAPLAN test by taking the NAPLAN learning gains made between two consecutive NAPLAN tests (e.g. gains made between NAPLAN Year 3 and NAPLAN Year 5 tests for the Year 5 estimates) as the reference of NAPLAN gains (see ACARA, 2019).

Table 5 Estimates of the loss due to online delivery in NAPLAN expressed in weeks of learning for Year 5 and Year 9 students

	1 term		2 terms		3 terms		1 year	
	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy
Year 5	1.5	2.7	3.1	5.3	4.6	8.0	6.1	10.7
Year 9	2.3	3.3	4.6	6.7	6.9	10.0	9.2	13.3

Table 4 presents the NAPLAN score estimates from Table 3 as percentages. The estimates in Table 4 suggest that if online learning were to last for a full school year, the learning gains that low SES students typically make in face-to-face classrooms would be reduced by 15-23 per cent in reading and as much as 27-33 per cent in numeracy depending on the year levels.

Based on an estimated average of 40 school weeks per year (OECD, 2019a), the predicted loss in learning that would take place due to online delivery can be converted into equivalent school weeks. Table 5 indicates that if the online delivery were to last for four terms (one full school year), disadvantaged Australian Year 5 students may lose the equivalent of 6.1 weeks of learning in reading and 10.7 weeks of learning in numeracy. For Year 9 students, the estimated loss of weeks of learning could amount to 9.2 weeks in reading and as much as 13.3 weeks in numeracy.

Estimates for different groups of disadvantaged learners were not reported in the US research, so it is difficult to generate specific estimates of the impact of online leaning for various groups of disadvantaged learners in Australia. It is possible by using some indirect measures. If the impact of home learning environments on classroom learning is known, it is then possible to estimate the impact of home-based online learning on various groups of disadvantaged students by examining (1) the extent to which the home resources available to other groups disadvantaged are more or less limited compared to those available to low-SES students (i.e. the group for which, using US research, we have estimates of impact of online delivery), and (2) the extent to which this variation in level of home resources is associated with a change in learning outcomes. This can be done using a three-step method:

1. quantifying the difference in home learning environments between low SES students and other groups of disadvantaged students
2. estimating the extent to which differences in home learning environments drive differences in learning outcomes
3. using the first two estimates to generate a measure of the impact of online delivery on other groups of disadvantaged students

Measures of Australian students' home learning environment are available in PISA 2018. We hypothesise that the following six home learning environment measures will have an effect on learning outcomes in a context of online delivery:

- Home educational resources
- ICT resources
- Use of ICT outside of school (for school-work activities)
- Perceived ICT competence
- Perceived autonomy related to ICT use
- Parents' emotional support perceived by student

Table 6 shows that students living in remote and very remote parts of Australia, Indigenous students and low SES students have the lowest levels of achievement in reading and mathematics at age 15. It also shows that the home learning environment available to different groups of students varies, with low SES students, Indigenous students and

remote/very remote students having the least amount of home learning environment resources.

Table 6 PISA 2018 reading and mathematics achievement and home learning environment scores, by category of disadvantage (in standard deviation units of PISA scores, 2018)

	Achievement		Home learning environment					
	Maths	Reading	Education resources	ICT Resources	Use of ICT	ICT skills	ICT autonomy	Parent support
SES quintile								
Low-SES	-0.48	-0.44	-0.77	-0.64	-0.28	-0.16	-0.17	-0.27
Indigenous status								
Indigenous	-0.71	-0.66	-0.52	-0.42	-0.17	-0.17	-0.17	-0.22
Language Background								
LBOTE	-0.11	-0.18	0.06	-0.14	0.20	-0.04	0.08	-0.05
Location								
Remote Australia	-0.48	-0.42	-0.32	-0.25	-0.12	-0.26	-0.27	-0.34
Very remote Australia	-0.49	-0.36	-0.27	-0.65	-0.17	-0.16	-0.24	-0.02
Standardised coefficients								
Outcome: reading			0.15	0.06	-0.10	0.02	0.11	0.12
Outcome: maths			0.16	0.08	-0.07	-0.01	0.15	0.07

Using the standard deviation in NAPLAN Year 9 reading and numeracy achievement as a reference, the impact of differences in home learning environment resources available to various groups of disadvantaged students on differences in their achievement can be converted into an estimate of NAPLAN Year 9 points lost by disadvantaged students. The estimates in NAPLAN points are presented in Table 7 for low SES students, Indigenous students, for students with a language background other than English and for students in remote and very remote parts of Australia.

Estimates of NAPLAN score points were converted into equivalent weeks of learning for three groups of disadvantaged students: low-SES students, Indigenous students and LBOTE students. The results are presented in Table 8.

The estimates presented in Table 8 suggest that low SES students and Indigenous students are most at risk of weaker learning outcomes in reading and numeracy due to online delivery under COVID19, and that the impact on their achievement is likely to be comparable and significant. If online delivery were to last for 2 terms, low SES and Indigenous students could lose more than 6 weeks of learning in numeracy and in excess of 4 weeks of learning in reading. The impact on students with home language other than English (LBOTE) is likely to be smaller at around one-and-a-half week of learning in reading and 3 weeks of learning in numeracy for two terms of COVID19-induced online schooling.

The results of the estimations presented in this section suggest that the loss of learning due to online delivery during COVID19 could be substantial for disadvantaged students.

Table 7 Estimated NAPLAN Year 9 reading and numeracy score point impact of online delivery on disadvantaged students (NAPLAN 2019 score points)

	1 term		2 terms		3 terms		Full school year	
	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy
Low-SES	-1.1	-1.8	-2.2	-3.7	-3.2	-5.5	-4.3	-7.3
Indigenous	-1.2	-2.0	-2.5	-4.0	-3.7	-6.1	-5.0	-8.1
LBOTE	-0.4	-0.7	-0.8	-1.4	-1.2	-2.2	-1.6	-2.9
Remote Australia	-1.1	-1.8	-2.1	-3.7	-3.2	-5.5	-4.2	-7.3
Very remote Australia	-1.0	-1.8	-1.9	-3.7	-2.9	-5.5	-3.8	-7.3

Table 8 Equivalent school week estimates of loss due to online delivery in NAPLAN learning gains typically made by disadvantaged students by Year 9

	1 term		2 terms		3 terms		Full school year	
	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy	Reading	Numeracy
Low-SES	2.3	3.3	4.6	6.7	6.9	10.0	9.2	13.3
Indigenous	2.3	3.2	4.7	6.5	7.0	9.7	9.4	13.0
LBOTE	0.8	1.6	1.6	3.2	2.4	4.8	3.1	6.4

Note: learning gain estimates for Indigenous students and LBOTE students are provided in NAPLAN annual reports (ACARA, 2019). Learning gain estimates use the source previously cited. Since no information on the NAPLAN Years 7-9 learning gains made by students in remote or very remote schools is available, this group is omitted from the table.

Stages of learning

The results from the main studies conducted and presented in this section suggest that there may well be differences in the impact of online learning for disadvantaged students based on the stage of learning. The OHIO study, for example, reveals that disadvantaged leaners in the primary school years record the weakest learning gains and most losses under online learning (Ahn & McEachin, 2017). This may not be surprising. In moving entirely online, what can schools expect of children in the early years? Younger children don't have the independent learning skills, attention spans or social-emotional maturity to succeed in virtual learning environments for very long, let alone the troubleshooting skills they will inevitably need to manage whatever technology they're using. Many older learners may also struggle.

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