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IMPLEMENTATION OF ONE-TO-ONE DEVICE PROGRAMS

Free for all: A case for investigating implementation models of one-to-one
device programs

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Abstract

Despite significant investment in school one-to-one device programs, little is known about which aspects of program implementation work and why. Through a comparison of two implementation models, adopter-diffusion and saturation, using existing data from the One Laptop per Child Australia laptop program, we explore how factors of implementation may impact on device diffusion, learning and educational outcomes, and program sustainability in schools. The paper argues that more focused research into implementation of one-to-one device programs, moving beyond comparisons of ‘devices versus without devices,’ is needed to provide reliable data to inform future program funding and advance this area of research.
Introduction

One-to-one device initiatives continue to be a curious and controversial topic in education. These programs have been pursued at the state-level, such as Maine and Michigan in the United States, across Australia in national and school-level initiatives, through the One Laptop per Child (OLPC) program as it occurs internationally, as well as numerous other smaller programs around the globe. The goal of most one-to-one device programs is to provide young people and teachers with access to up-to-date learning tools that will support the development of critical thinking and information skills (see Department of Education Employment and Workplace Relations [DEEWR], 2012; Lowther, Inan, Ross, & Strahl, 2012; One Laptop per Child, 2012; Silvernail & Gritter, 2007). Such initiatives have typically focused on access to devices, such as desktop computers, laptops and, more recently, tablets. While there is considerable support for these types of programs in education, as demonstrated by significant investment in the area, there is little evidence on how one-to-one programs are best implemented in schools.

Implementation is the methodological strategy of a technology intervention (Rodríguez, Nussbaum, & Dombrovskia, 2012, p. 297). In this paper, we use this term to describe the practical aspects of access to and integration of devices in schools, such as factors of saturation, teacher participation and training requirements, device distribution, etc. Implementation is an important concern not only for improvements in learning and teaching, but also in ensuring that the affordances of digital technologies are available to all school students. The issue takes on growing importance as the landscape of one-to-one computing shifts to incorporate ‘bring your own device’ (BYOD) programs, raising new questions of equity, effective practice and integration. Specifically, it is unknown how factors of implementation relate to learning.
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outcomes, such as gains in standardised test scores or development of critical thinking skills, or educational outcomes, such as attendance and engagement.

In this paper we examine the qualities of one particular approach to implementation, which we call the adopter-diffusion model, to demonstrate the importance of implementation as a site for research. Using existing data from One Laptop Per Child (OLPC) Australia, we identify how particular factors of this model may be affecting adoption and use of devices across schools. Although this paper only attempts to scope research into implementation, when conducted on a large scale such a research focus may help inform where future investment in devices should be directed – for instance, on student access or on teachers’ use and training (e.g. Penuel, 2006; Rodríguez et al., 2012; Warschauer, Cotten, & Ames, 2011).

The case study, OLPC Australia, recently received $11.7 million to deploy laptops in disadvantaged primary schools across Australia. The organisation employs what we have classified as a bottom-up adopter-diffusion approach support device use and saturation in schools through voluntary engaged teacher participation and mandatory teacher training, with the option to give students custodial access to laptops. The program provides a natural investigation of implementation factors in a large-scale national initiative. The case study reveals that the adopter-diffusion approach to implementation seems to promote a high frequency of classroom use, yet raises significant questions around whole-school saturation and sustained engagement with the device.

To explore these issues, we first present existing research of one-to-one device programs. This is followed by a description of the OLPC Australia program and early analysis of implementation. The primary data in this paper draws on teacher interviews collected by OLPC Australia and online discussions. Our analysis contributes an early examination of one-to-one
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device implementation through the alternative bottom-up adopter-diffusion model. Although interesting aspects of the adopter-diffusion model were revealed in this research, we argue that experimental research, requiring a narrow focus on implementation, is necessary to fully understand the outcomes of the various components of the approach. In the conclusion we suggest a program for structuring future research.

Adopter-diffusion versus saturation

The designs of one-to-one laptop programs can vary enormously, even where the intended outcomes of programs are the same. For instance, different approaches to implementation are actively debated within the One Laptop per Child international forums, where programs share common values and goals yet differ in practice according to national settings (http://blog.laptop.org/). As there is no room here to detail the various approaches, we focus instead on two extremes: The adopter-diffusion model is bottom-up in its design, in that implementation and diffusion of devices is reliant on teacher engagement and practice; the opposite approach, saturation, is top-down, in that implementation is conducted as a public program and all students are provided with devices regardless of teacher use and integration in practice.

The saturation model, commonly used in one-to-one programs, addresses students’ access to achieve a one-to-one ratio of students to devices, often including custodianship of the device. Custodianship, whereby students have a level of ownership and control over an allocated device, assumes that continuous access to appropriate information and communication technologies (ICTs) is necessary for success in modern schooling (e.g. Ministerial Council on Education Employment Training and Youth Affairs [MCEETYA], 2008).
The adopter-diffusion approach is less popular across large systems. The model focuses instead on individual teachers’ take-up and integration of devices to stimulate *grassroots* diffusion and integration in learning, and to other teachers throughout a school. Devices are provided to teachers to support a one-to-one ratio in the classroom. The primary focus of this approach is *teachers’ use* of the devices to support learning. Students may or may not have custodianship of a device to take it home. These two approaches reflect the two digital divides observed in education today: access to ICTs and use of ICTs (see Warschauer & Matuchniak, 2010). The goal of both approaches is full saturation and diffusion of devices, across schools or school districts.

The issue of top-down or bottom-up change initiatives has been well researched in educational and organizational change literature, but analysis of one-to-one programs implementation and its relation to outcomes has not been conducted. The use of these categorizations here is not intended to be absolute. In this discussion, the framework of ‘top and bottom’ provides a way to conceptually differentiate the *point of entry* of device implementation. *Top-down* focuses on laws and structure from leadership, while *bottom-up* is rooted in cultural practices and social norms. Interestingly, ‘change in the bottom-up view is always gradual, evolutionary rather than revolutionary’ (Easterly, 2008, p. 95). Change from this approach has not resulted in large-scale changes in practice; rather, innovation, change and ‘good practice’ have created ‘exemplary settings’ that do not diffuse to the wider organization (Elmore, 1996). However, top-down approaches have often failed because of low engagement and minimal sustainability of change in the long term. Many large-scale educational change projects are beginning to incorporate aspects of both approaches. Programs have started from a top-down policy and ‘national vision’ approach, but have increasingly shown more consideration and
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inclusion of bottom-up approaches, at the school level, focusing on professional improvement and engagement (Fullan, 2009).

The spectrum of implementation approaches demonstrates ongoing adaptation and experimentation within the education field. However, research into one-to-one device programs, discussed below, has mostly failed to account for the different approaches to implementation, or to understand how programs respond to changes within the social and educational system. The evaluative nature of research in the area, and its primary concern with proving program success or failure, has produced contradictory and convoluted results. A narrower focus that tests implementation models is more likely to reveal how programs perform within a given social and educational system, and ultimately whether investment, time and attention to laptop programs is warranted.

Existing studies in laptop programs

The perplexing fact of one-to-one laptop programs is that, despite numerous studies, there are no clear guidelines for how programs should be implemented for best results. This knowledge is critical as one-to-one BYOD hybrid programs will need to justify investment to families able to afford devices, as well as provide equity of access to, and benefits of, ICTs to all students. In an effort to narrow the research, we have defined two main factors of the adopter-diffusion and saturation implementation - student access (including custodianship) and teacher use (training and engagement). These are significant factors, but they have not been directly compared and contrasted in existing studies, making it difficult to ascertain whether one or the other may lead to positive learning and educational outcomes.

Teacher use, teacher training and engagement are frequently addressed in observation-based studies of one-to-one laptop programs, typically focusing on what is being used and
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frequency of use. Research has shown that students and teachers participating in one-to-one device programs use computers more frequently, and teachers report being able to integrate technology more easily (Warschauer et al., 2011). The most commonly reported uses of laptops in one-to-one programs have been independent tasks, such as ‘drill and practice’, simple internet research, communication and productivity (Dunleavy, Dexter, & Heinecke, 2007; Howard, Thurtell, & Gigliotti, 2012; Lei & Zhao, 2008). In some studies students have shown gains in writing and they have been more likely to receive individualised and differentiated instruction (e.g. Silvernail & Gritter, 2007). Yet these tasks tended to be more teacher-centred and were unlikely to engage students in higher cognitive activities, such as problem solving or critical thinking (e.g. Lowther et al., 2012). Some studies have reported positive gains in educational outcomes, such as higher engagement, increased enrolment in schools, decreased absenteeism, increased discipline, and more participation in classrooms. While it is possible, there is no evidence that these improvements are due to use of one-to-one devices (Kraemer, Dedrick, & Sharma, 2009). Further, these improvements have not resulted in measurable gains in student learning.

Student access and custodianship have not been widely researched. Yet, a primary aim of one-to-one device programs has been to put technology directly in the hands of all students. This strategy is thought to ‘compensate for unequal access to technologies in the home environment and thus help bridge educational and social gaps’ (Warschauer & Matuchniak, 2010, p. 180). Research in the area of economics has shown that young people without access to computers at home are at a disadvantage. A comprehensive analysis of US datasets by Fairlie, Beltran and Das (2010) found a significant relationship between home ownership of computers and high school graduation rate. When controlling for income, race and parent’s education, those with a home
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computer were 6–8% more likely to graduate from high school than teens that did not have home computer. This difference supports the implementation approach of providing devices directly to the students, focusing on access rather than teacher engagement, adoption and use, a finding that seems to contradict the emphasis on teacher training in the majority of qualitative studies.

These findings collectively highlight the importance of the two factors of implementation, but it is unclear which, or what combination of the two, is more likely to produce positive gains in learning and educational outcomes. The field of development economics has encountered a similar conundrum, where competing theories and observations have failed to provide policy direction. One of the most widely researched and debated areas is that of insecticide-treated bed nets (ITNs) as a preventative solution to malaria. Some economists have argued that bed nets should be given away to prevent spread of the disease (Sachs, 2005), while others argue that free bed nets are not valued and are less likely to be used (see Cohen & Easterly, 2009). The debate over bed nets is an example of where theory and qualitative observation have failed to come to an agreement. Some resolution was eventually reached through field experiments. Cohen and Dupas (2008) tested the two approaches by randomising the price at which prenatal clinics could sell bed nets to pregnant women, finding that free distribution could save more lives than cost-sharing programs.

Similar theoretical questions surround one-to-one programs in schools. Arguments can be made that devices should be provided or subsidised for students most in need, or only to teachers that are likely to use them, yet there are also arguments for general distribution within a public school system. As demonstrated through the bed nets debate, field experiment trials at the level of implementation can provide a robust method for resolving policy questions about program
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implementation. At its core, implementation involves the classic Hayekian question of what kinds of knowledge are needed in deciding how to allocate resources (Hayek, 1945). Hayek argues that we cannot fully know the circumstances of social and economic orders due to the particular circumstances of a time and place, meaning that that policy-makers will forever struggle to make sense of the efficacy of programs in advance. Yet policy-making requires that such decisions be made. Trials which identify through theory or preliminary qualitative research the components that require testing, and then undertake iterative experiments to test those components, are a means to understand not just whether programs work but why they work or fail (Grissmer, Subotnik, & Orland, 2009). Research of this kind involves a process of creative experimentation, whereby ‘policymakers and researchers work together to think out of the box and learn from successes and failures’ (Banerjee & Duflo, 2009, p. 174).

When it comes to acquiring knowledge to determine effective resource allocation in the field of one-to-one device programs, policy-making is hindered by the fact that the vast majority of studies into these programs are qualitative in nature. Qualitative studies are favoured due to the complexity of schools and the difficulty of isolating variables, yet fail to provide evidence from which generalizable findings can be built. As economists Banerjee and Duflo (2009, p. 153) explain:

… observational data on the educational production function often comes from school systems that have adopted a given model, which consists of more than one input. The variation in school inputs we observe therefore comes from attempts to change the model, which, for good reasons, involves making multiple changes at the same time. Although there are exceptions, this means that a lot of the policy-relevant knowledge that requires
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observing the effects of variation in individual components of a package may not be available in observational data.

Even within controlled quantitative studies, the issue of variation can arise. Tamim, Bernard, Borokhovski, Abrami, & Schmid’s (2011) meta-analysis of 40 years of controlled studies on computer assisted instruction found a 12% increase in student achievement when technology was integrated into the classroom. However, they suggest that the variability within studies, including ‘instruction, pedagogy, teacher effectiveness, subject matter, age level, fidelity of technology implementation, and possibly other factors… may represent more powerful influences on effect sites than the nature of the technology intervention’ (p. 17), and argue that it is incumbent on researchers to sort out these nuances.

Moreover, quantitative studies have tended to compare treatment groups with the absence of technology rather than isolating factors within programs (e.g. Angrist, 2004; Cristia, Cueto, Ibarraran, Santiago, & Severin, 2012; Fairlie & London, 2011). While these studies can tell us whether an overall treatment works they tell us little about the strengths of various parts within complex programs. The field is therefore left none the wiser about which type of approach is likely to produce better results.

Banerjee and Duflo (2009) argue that the only way to improve policy-making is by observing the behaviour of comparable groups of people facing different levels of treatments through randomised controlled trials. For one-to-one device program research, this type of investigation would enable researchers to focus on implementation factors that influence outcomes, such as standardised tests or attendance, and to see where the possible failures are occurring. Our discussion of the OLPC Australia program below is intended to illustrate the two
factors within implementation models that require testing and that can take us further towards improved educational outcomes.

**One Laptop per Child - background**

The question of how best to implement one-to-one laptop programs should be a major concern for Australia. In recent years, Australia’s federal government has invested in two national one-to-one device programs: 1) The National School Computing Fund, which is the funding component of the Digital Education Revolution (DEEWR, 2012), and 2) One Laptop per Child, Australia (One Laptop per Child Australia, 2012). In the Digital Education Revolution, laptops and/or computers were deployed, by the states, using a top-down saturation model. This initiative has provided over $1 billion for secondary schools to purchase devices, as well as improve network infrastructures, with the aim of achieving a one-to-one student to computer ratio across the country. The second significant investment, which is the focus of this discussion, was at the primary school level. In 2012, the federal government budgeted $11.7 million to subsidise the purchasing of 50,000 OLPC Australia XO laptops for disadvantaged primary schools across the country, for two years (2013-2014).

The organization of One Laptop per Child is an international non-profit program that has provided durable, child-sized laptops (XOs) to over 2.5 million children and teachers in 40 countries. Nicholas Negroponte at the Massachusetts Institute of Technology initially created the OLPC program for developing countries as a means to improve education for young children (Kindergarten [age 5] - 6th grade [age 12]). OLPC International works according to five principles (One Laptop per Child Australia, 2012):

i) children are owners of the laptops,

ii) children are aged 6 to 12,
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iii) every child and teacher receives a laptop,
iv) children are connected through a local network or the internet,
v) software is open source and free.

Compared with other devices, XOs are cheap and robust, designed to withstand heat, dust and children. The XO laptop is also tailored for educational use. The brain of the XO, the Sugar operating system and educational software, is freely available and open source. It provides flexible programs designed around the ‘studio thinking’ model (e.g. demonstrations, projects, critiques), as well as studio habits of mind such as craft, engagement, persistence, expression, observation, reflection, and exploration (see Project Zero, 2010). While an international endeavour, OLPC programs develop in line with national settings, resulting in diverse strategies.

OLPC Australia has been in operation since 2008, with the first laptops distributed to primary schools early in 2009. The objectives guiding OLPC Australia include teaching practice, community engagement and professional development – factors absent from OLPC international’s core principles. The program also aims to build sustainability through training student to provide technology support. Due to OLPC Australia’s unique model and

1 An example of the technology-centred saturation approach is a recent deployment in Ethiopia, where the group issued instruction-free gifts of solar-powered XO tablets to children who did not have access to schooling, to test whether children ‘can learn to read on their own’ (Negroponte, 2012).

2 Information on student training and technology support was not available in the OLPC data set, and therefore not reported on in this paper.
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circumstances, studies and critiques of OLPC in other countries are not directly transferable to
the Australian experience. For instance, the OLPC program is considered an expensive
investment in developing countries in relation to overall education expenditure, where a single
laptop is, on average, the equivalent of 60% of government spending per student for primary
education. The inverse is true in Australia where, at a conservative estimate, the full price of an
XO ($400) costs less than 0.6% of the total government spending on the average primary school
child’s education, a price which includes OLPC Australia’s training programs. Australian
schools that meet certain socio-economic criteria, including low-income areas, remote areas and
percentage of Indigenous students, are eligible for a subsidy (philanthropic and government
derived) that allows them to access the program and acquire the hardware for $100 per XO. The
opportunity cost of the program is therefore minimal in Australia compared to developing
countries.

The first large-scale evaluation of OLPC was funded by the Inter-American Development
Bank (IDB) in 2012. Although the most comprehensive study to date, its relevance to OLPC
Australia is limited due to important factors involved in the different implementation models.
IDB conducted a randomised evaluation of a top-down saturation model program in Peru,
measuring the outcomes in 209 treatment schools against a control group of 110 schools (Cristia
et al., 2012). The study found no evidence of effects on standard measures such as enrolment or
test scores in Mathematics and Language, which is similar to findings from other one-to-one
programs (e.g. Lowther et al., 2012). However, effects on home use were large: ‘42% of
treatment students using a computer at home in the previous week versus 4% in the control
group’ (Cristia et al., 2012, p. 2). The study also found improvements in cognitive skills, with the
estimated impact on the verbal fluency measure being the equivalent of ‘the progression
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expected in six months for a child’ (p. 3). The IDB team recognised that ‘pedagogical integration of laptops into classrooms, combining specific software with a strong component of teacher professional development’ (p. 19) as an alternative route with the potential to yield different results for Mathematics and literacy outcomes. As outlined below, OLPC Australia has the potential to be the exception that produces different results, strengthening our argument for comparative implementation research.

Method

Our case study of the OLPC Australia program is based on an explanatory model, which provides the scope to identify and investigate influential factors in a system. Data sources included in the study were primarily teacher interviews and online discussion board posts. The interviews, undertaken by OLPC and de-identified by OLPC staff for the purposes of our research, addressed specific questions about XO implementation, including who was using the laptops, how often, and issues related to the training requirement. The questions also covered more basic evaluative questions, such as impact on attendance, perceived impact on Mathematics and literacy results, and common uses of the devices. Interviews took place over one month in 2012. The interviews were conducted using skype by research assistants external to OLPC, and consisted of structured episodic interviews. Discussion board posts were taken from the OLPC Australia Yammer site. Teachers are given access to the social networking service when they join the program. Between 2010 and 2012, teachers were expected, as part of the training, to log into the site and make an initial posting. Posts were collected for this research between July 2011 and November 2012. All data from these sources has been de-identified.

Case study sample
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At the time of data collection, OLPC was working with 113 schools in 5 states, across Australia, with over 6000 laptops distributed to classrooms. The majority of schools are located in ‘very remote areas’ ($n = 69$), followed by ‘remote areas’ ($n = 19$), ‘provincial’ ($n = 16$) and ‘metropolitan’ ($n = 9$). The OLPC program is not run specifically for Indigenous schools; however, almost 60% of schools ($n = 67$) in the program are in areas where the Indigenous population is over 75%, with 70% ($n = 80$) having an Indigenous population over 50%. A subset of 20 teachers, participating in the OLPC Australia program, from nine randomly selected schools, participated in the interview phase of the data collection (see Table 1).

Table 1
*Sample participating in teacher interviews, derived from OLPC data and MySchool website, 2*

<table>
<thead>
<tr>
<th>School</th>
<th># Teachers</th>
<th>Grades taught</th>
<th>Entered the program</th>
<th>Remoteness</th>
<th>% Indigenous</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>2</td>
<td>6-7</td>
<td>2011</td>
<td>Provincial</td>
<td>5%</td>
</tr>
<tr>
<td>School 2</td>
<td>3</td>
<td>EY-10</td>
<td>2011</td>
<td>Very Remote</td>
<td>36%</td>
</tr>
<tr>
<td>School 3</td>
<td>2</td>
<td>EY &amp; ICT</td>
<td>2010</td>
<td>Very Remote</td>
<td>100%</td>
</tr>
<tr>
<td>School 4</td>
<td>2</td>
<td>EY &amp; 4</td>
<td>2010</td>
<td>Very Remote</td>
<td>24%</td>
</tr>
<tr>
<td>School 5</td>
<td>3</td>
<td>EY- 8</td>
<td>2010</td>
<td>Provincial</td>
<td>28%</td>
</tr>
<tr>
<td>School 6</td>
<td>2</td>
<td>EY</td>
<td>2010</td>
<td>Metropolitan</td>
<td>65%</td>
</tr>
<tr>
<td>School 7</td>
<td>3</td>
<td>1, 6-7</td>
<td>2010</td>
<td>Very Remote</td>
<td>97%</td>
</tr>
<tr>
<td>School 8</td>
<td>1</td>
<td>EY</td>
<td>2010</td>
<td>Metropolitan</td>
<td>58%</td>
</tr>
</tbody>
</table>

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3 Using the Accessibility/Remoteness Index of Australia (ARIA) classification.
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<table>
<thead>
<tr>
<th>School 9</th>
<th>1</th>
<th>ICT</th>
<th>2010</th>
<th>Remote</th>
<th>58%</th>
</tr>
</thead>
</table>

Note. Remoteness and % Indigenous collected from ACARA (http://www.myschool.edu.au/) by OLPC Australia

Of the 20 participating teachers, three identified themselves as having an ‘IT focus.’ The participants represented an even range of teaching experience, from one year in the classroom to over 30 years (under 5 years, \( n = 7 \); 5-15 years, \( n = 5 \); over 15 years, \( n = 8 \)). There was also a full representation of grade levels, from Preparatory 1 (age 5) to grade 6 (age 12), with a slight emphasis on the Preparatory level (\( n = 6 \)). Participating teachers represent a full range of time participating in the OLPC program, with the majority being in the program for less than one year (less than one year, \( n = 10 \); 1-2 years, \( n = 8 \); more than 2 years, \( n = 1 \)). Actual start of participation, and receipt of class-set of XOs, would depend on when the teacher completed their XO training.

**Teacher training and the adopter-diffusion model**

OLPC Australia has named the adopter-diffusion model ‘One Education’. One Education is OLPC Australia’s (OLPC Australia, 2012):

- comprehensive training, development and support program is included with the delivery of every XO laptop. We believe it takes a village to raise a child and that’s why we have a role for everyone at school and at home to make learning with the XO fun.

The package includes access to online training (One Academy, Table 2), online community networking and integration support (e.g. Yammer and One News), as well as access to online technical support. To receive a classroom-set of laptops, teachers must complete initial XO
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certification training. To complete the training, they need access to the internet, a one gigabyte USB key and two XO laptops (provided by OLPC Australia). Advanced teacher training, training and recognition for students, and maintenance training for school or community members is also available, but not mandatory. Although the entry requirement potentially acts as a barrier to complete saturation, OLPC’s expectation was that teachers are more likely to use the laptops, and use them for educational rather than recreational purposes in the classroom, if they have completed training.

The training works through a community-of-practice model whereby teachers share knowledge and encourage others to participate. As a result, take-up of the program is expected to occur through a somewhat viral grassroots method that is opt-in as opposed to a requirement of the job. The extent to which this occurs is discussed further below. To incentivise teacher participation, XO-certified and expert modules have been accredited and can contribute towards a tertiary education degree or counted towards state-mandated professional development obligations. Groups of 10 or more may apply to host a workshop in their school or community, where OLPC staff will deliver the courseware face-to-face.

XO-cert: Required teacher training

The XO certified (XO-cert) training course is the main component of the adopter-diffusion model and a possible site for comparative research. Our initial research indicates that training produces positive results for adopters, but can exclude others from participation.

The XO-cert training course covers essential aspects of the XO use and integration in the classroom (see Table 2), as well as introducing the teachers to the online community (e.g. Yammer) and other resources. The course has been designed to be completed in 15 hours. It is
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primarily delivered in an online format through Moodle, and when possible, offered face-to-face. As of September 2012, 161 educators had completed the online training. Teacher posts in the online Yammer ‘Australian XO Teacher’ community discussion boards have been positive about the online training. Generally, teachers’ posts mentioned that training introduced them to use the XO in teaching and helped them to think about how they would integrate the XOs in the classroom. One example is:

I found that the certificate was really good to make you play around with the different activities and also find out about some basic troubleshooting. The lesson planning activities also help you to think about how you will use the XO in the classroom to help students achieve learning outcomes. – User discussion board post, Yammer

The comment suggests excitement about learning what can be done with the XO in teaching, as well as anticipation of applying the tool in their own context. It should be noted that teachers’ engaging in an online community space tend to have positive beliefs about technology, online training and technology integration. They are more likely to be motivated to participate in, and complete, an online course.

One teacher believed the online training course was a way to get less engaged teachers involved in the program:

You are forced to get right into lots of great activities! We have even got other teachers, who weren’t necessarily going to do it, on to the course because it was so helpful! – User discussion board post, Yammer

Teachers already engaged were encouraging their local peers to participate, thus increasing the number of teachers in the program at their school. This is a fundamental aspect of the adopter-
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diffusion model. More typically, other teachers observed it was difficult for less engaged colleagues to allot time for online study. At some schools, the online training was perceived as a barrier to ‘getting the laptops in the classroom’:

I think [the XOs] are a fantastic little thing. Like I said I just would like to get [teachers] around the place to actually finish the course and get them in the classrooms and get the other units that we're supposed to have. Yeah it takes support from the top to do that and I'm not the boss. – Teacher 7, School 3

The comment suggests that the training requirement can limit the rate at which the laptops are brought into the school and integrated into learning. While the training program is only 15 hours, the time it takes teachers to complete the course varies from just weeks to several months. Teachers who are less engaged in the program and less confident in their teaching, will be less motivated to complete the training.

Diffusion of training and expertise in OLPC schools

A further component of the adopter-diffusion approach that requires testing is the extent to which adopters encourage others to participate. Educators that wish to extend their knowledge can undertake the XO-expert (XO-pert) course, also 15-20 hours. Completion of this course certifies teachers to deliver the XO-cert to new teachers. The course uses a train the trainer model. It is intended to build capacity and support structures at school and region levels to provide more substantial face-to-face training, as well as building local communities of practice. Teacher participation in this course is an important component in the adopter-diffusion model. This provides more opportunity for teachers to complete the XO-cert course and receive classroom sets of XO-laptops, thus moving schools closer to one-to-one saturation of laptops.
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In the same platform as the XO-cert online course, there are three extension modules for teachers to work towards XO-pert (see Table 2). At the time of data collection, the course was relatively new and only four teachers had completed the training, although 95 teachers and five teacher aides were undertaking the training. A small number of IT coordinators, administrators and school principals have also completed or were enrolled in OLPC training (less than 20 in total). So far, the four XO-pert trained teachers have delivered 5 courses to approximately 45 participants.

The interview data suggests that, in some cases, the face-to-face options are much better suited to teachers’ ways of working and learning:

I think this might be a better model for my school as well - it seems the only time the teachers are using the XOs and completing the online sessions is when I run my weekly training session... Leadership and team support is key in motivating teachers with an ever increasing workload when we are all tired! – User
discussion board post, Yammer

As much as everyone can see the value of the XOs I find that most people are only motivated to integrate them into classroom use around training sessions and PDs. I would be very interested to see how [others] run [their] regular training sessions to get some ideas on boosting engagement throughout the school! – User
discussion board post, Yammer

Development of the XO-pert certification allows for attention to school culture and teachers’ work and learning habits that can be lost in generic online learning training modules. This attention to culture and context is a key aspect of bottom-up implementation, as it provides relevance and support for individuals who may be less likely to engage on their own. Therefore,
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providing both online and face-to-face training make it more likely that teachers will complete training and be able to effectively use and integrate the XOs in teaching and learning.

A second channel of capacity building and shared practice is the OLPC Australia Yammer social networking site. The site was launched in July 2011. The two most popular groups and number of messages posted as of November 2012 are: XO support (153 members, 104 messages), XO teaching resources (181 members, 93 messages). Accessing appropriate support and knowledge is a key element in maintaining teacher engagement in change, particularly relating to technology-related initiatives. Use of online tools, such as Moodle and Yammer, provides teachers with a level of access to training and expertise that would have been previously resources intensive to support across many schools. These methods support the adopter-diffusion approach by providing online communities of practice in the tools, thus creating some culture of change and sharing of experiences and teaching strategies. Availability of this type of interaction can support increased engagement for some teachers, but as it was pointed out previously, many teachers still need face-to-face interaction to become engaged and keep up motivation.

This approach seems to be producing a reasonably high level of use within the classroom (see Table 3). Table 3 presents case study teachers’ reported frequency of XO use in lessons and by students independently. The duration or quality of use was not measured.

Table 3

*Teachers’ frequency of XO use*

<table>
<thead>
<tr>
<th></th>
<th>Once a day or more</th>
<th>2-4 times a week</th>
<th>Once a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>in lessons (teacher+)</td>
<td>11</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>
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| students) | independent use\(^a\) (students) | 9 | 7 | 0 |

\(^a\)Four teachers were unable to make this judgment. All four used the laptops in their lessons 2-3 times a week or less.

Frequency of use was often related to what was being taught, with mathematics or literacy being the most common foci. Use of laptops in lessons is higher than reported in comparable studies (typically 20% daily use; e.g. Warschauer et al., 2011). These may be inflated due to interviewer effect; although, higher use could also be a function of the adopter-diffusion model and higher teacher engagement. This is a significant question for future research is the extent to which greater outcomes for a few (adopters and their students) outweighs outcomes for all in the saturation model.

**After training: Deployment in the classroom**

A further area for investigation is the sustainability of the model in individual schools. After XO-cert training is completed, teachers receive their classroom set of XO laptops. In their first year of program participation, OLPC Australia requires the class-set of XOs to stay with the trained teacher. After one year, the school can manage the laptops as they wish. The teacher and their school determine actual deployment of the XOs in the classroom, such as how they are allocated and custodianship.
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One of the problems of the adopter-diffusion model, highlighted by OLPC Australia, has been teacher attrition in rural and remote schools\(^4\). In some instances, teachers with high levels of engagement in the program have taken their classroom-set of laptops to other schools. It has been more common that when a teacher leaves a school, the laptops stay in the classroom. As teachers voluntarily participate in the OLPC program, it is not certain whether replacing teachers will take the opportunity. In the event that the replacement teacher does not participate in the program, the laptops can go unused. One participant made the following comment regarding this issue:

Ultimately it is up to the [replacing] classroom teacher and while he is aware that the XO\s exist he has shown no desire to engage with them in the classroom.

Again there is very little that can be done regarding this and it is a matter of personal choice for the classroom teacher whether or not they want to learn how to use the XO\s and deliver educational outcomes. – *User discussion board post, Yammer*

The above comment reinforces principles of the adopter-diffusion model, in that teacher participation in the program is voluntary. Teachers entering schools with high levels of technology use and developing communities of practice are more likely to integrate technology in their practice (Zhao & Frank, 2003). This effect was suggested earlier in regard to teachers encouraging less engaged colleagues to participate in online training.

\(^4\) Teachers in remote Indigenous communities in the Northern Territory average 8 months in length of service with 40% attrition (DEEWR, 2011).
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The possibility of teacher adoption of technology is further increased if students expect to use it (Windschitl & Sahl, 2002), such as if students had used the devices in their previous school year. However, in all nine schools, the XOs did not go with the student as they progressed through the grades. One teacher expressed the belief that students would benefit from keeping the laptop as they progressed through school:

I'll be suggesting that the XOs actually go up with the kids... I really think the kids would benefit from having them for lots of years. I'll be suggesting in our school that we send them with the kids, so that those kids become XO experts and mechanics and all that. – Teacher 10, School 5

The feasibility of supporting students to use the laptops in sequential years appears to be limited by the adopter-diffusion model. If all teachers in the school have not completed the training, then students would not necessarily have access to a classroom-set of laptops as they progressed. If the school independently switched to a saturation model, where students had custodianship of the laptop, all teachers would not necessarily be trained to use the XO effectively in learning and teaching. This opens the possibility of teachers having low engagement and limited use of laptops in the classroom, potentially risking any financial investment in the devices.

Further, growing parent expectations of their child’s laptop use may complicate the issue. One participating teacher reported that parents had noticed ‘[their children] weren’t using the XOs as much as they were last year and wanted to know why’ (Teacher 5, School 5). They explained to the parents that, as students moved from grade to grade, they would have different opportunities to engage with XOs, which depended on the teacher. OLPC Australia hopes to develop sustainability, and teacher student use through training students to provide local technical support.
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**Student custodianship**

The adopter-diffusion model places less emphasis on home use than the saturation model. Student custodianship of the laptop through sequential years of schooling has been encouraged by OLPC Australia, but not required. Actual presence of student custodianship varied between schools, as well as in individual classrooms, but was overall quite limited. Of the 20 teachers interviewed, 12 did not have the students take the laptops home, six did allow the student to take it home with consideration and two reported that students could take their laptops home. A teacher in School 5 reported that students were able to take their laptops home, at the discretion of the student and dependent on their level of responsibility:

> A couple depending on their trust. Like if they can bring back a library book, [or] they can't bring back a library book they're not going to get an XO. Yeah so I guess a couple of families have taken up the opportunity to take it home so they can show Dad as rewards and things, their own personal one, or show work that they've done on them but not everyone and not regularly. – *Teacher 10, School 5*

Several practical limitations to student custodianship were identified. One teacher reported letting their 4th and 5th grade students take the laptops home, while the other two teachers (P and grade 1) did not. One teacher explained why her Preparatory students did not take the laptops home:

> At the moment because we're still getting used to the handling. We've only had it dropped once so yeah it's a little bit of that caring which we've got to teach 'cause they're five years old only. – *Teacher 13, School 8*

Some teachers had reservations about students taking the laptops home because of students’ living arrangements:
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No, mainly because being the demographic… we did not allow the children to take them home. Many of them live in overcrowded housing, with many people and we were frightened that the XOs would go missing. – Teacher 3, School 3

In both of these comments, the primary concern limiting custodianship has been loss or damage of the laptop. These choices reflect a prioritization of use in the classroom over continuous student access. This could be related to teachers’ use of the laptops being classroom and lesson-oriented. Comparison of custodianship and non-custodianship across OLPC Australia schools requires further investigation, including analysis of standardised test scores between the two groups.

Conclusion and further research

In their second-level meta-analysis of existing studies of computer-assisted instruction, Tamin et al. write: ‘we feel that we are at a place where a shift from technology versus no technology studies to more nuanced studies comparing different conditions… would help the field progress’ (2011, p. 16). Our examination of OLPC Australia arrived at a similar conclusion, finding that focused research into implementation is required in order to understand the nuances of what works and why. The OLPC Australia case is an interesting example of a program that has developed a reasonably elaborate method of technology diffusion. While other studies have attempted to measure the success or failure of one-to-one device programs either through qualitative observation or controlled studies, on close investigation it is not clear how the findings from these studies can inform other programs, such as OLPC Australia. We argue that studies that seek only to know outcomes of one model, even with a control group, provide only a partial picture of what is occurring. Research into these types of programs has thus failed to
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deliver information that can assist organisations, governments and schools in finding the best pathway for education outcomes.

The challenge of arriving at reliable results will require trials to be conducted within programs using varied treatments and iterative design, rather than comparing across different projects. To conduct this type of research, solid data enabling standardised outcomes to be measured are required. Australia has been administering standardised tests in literacy and numeracy across all schools since 2009, through the National Assessment Program - Literacy and Numeracy. The data is publicly available for the grade levels within the range of OLPC deployment. While such tests do not assess the full range of skills associated with using digital media (Warschauer & Matuchniak, 2010, p. 219), literacy and numeracy standards are correlated with overall long-term education outcomes (Hughes & Hughes, 2012, p. 7) and are a useful means of assessing broad outcomes.

At the time of the research, it was not possible to analyse whether the OLPC program was having an impact on the test results in participating schools. Test score data is only publicly available at the grade level and OLPC did not possess reliable information on what classrooms were using XO laptops. Without saturation of laptops across schools, it was not possible to isolate OLPC participating classrooms to assess impact. Further, schools that had achieved full saturation were often in very remote small schools that were below the reporting threshold or not submitting data. We were therefore unable to establish a large enough sample to investigate whether there was a correlation between standardised test results across OLPC schools. OLPC is currently working to resolve these gaps in data collection for its own evaluation purposes.

Our initial investigation of OLPC Australia raised more questions than answers. However, the research method – in particular, the qualitative interview data – provided a useful
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starting point for understanding the model and developing specific research questions. A close look at the adopter-diffusion model has revealed that teacher use (engagement and training) and student access are key factors of implementation requiring further investigation. The specific research questions that emerged from OLPC’s existing data include: To what extent does the required training component limit teacher participation? Can the community of practice forums and viral diffusion method achieve saturation across schools? If the adopter-diffusion approach possesses an inherent limit by relying on teacher engagement, do the benefits outweigh the costs? Furthermore, student access to laptops in the classroom was an issue noted by teachers and parents when students progressed to a classroom where the laptops were not used.

Longitudinal research is required to determine how changes in access to XOs, year to year, impacts on students’ learning and the overall success of programs. Moreover, while access in the classroom seemed to be valued by teachers, they did not place great emphasis on student having custodial access to the laptops. Although we can glean some insights through qualitative data, we were not able to compare gains in ICT skills or learning classroom-centred use with students that use their laptop. Other issues worthy of study not discussed here include differences across grade levels at which laptops are implemented, impact on attendance, as well as investigation of student engagement, including outcomes of student accreditation and student training programs. Ideally, all of these components could be tested through randomised controlled trials within large-scale projects, moving away from a ‘with computers versus without computers’ analysis to a narrower focus on project components.
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Table 2  
*OLPC Australia training courses (One Academy)*

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Participants</th>
<th>Modules</th>
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</table>
| XO-certified | Teachers are required to complete the XO-certified program before students in their class are sent XOs. | Teachers, Assistant, Teachers, School, Principals | 1. Course introduction  
  2. The XO  
  3. Sugar Basics  
  4. More Sugar  
  5. Learning with Activities  
  6. Sharing and Collaborating with Activities  
  7. XO Troubleshooting. |
| XO-expert   | This online program follows on from the XO-certified program and is designed to allow schools to run local professional development to certify new teachers in XO usage. | Teachers                      | 8. XO Deployment and Evaluation  
  9. Monitoring and Reporting on your Deployment Plan  
  10. Being an OLCP Trainer |
| XO-basics   | An introduction to the XO.                                                   | Open to any adult (e.g. Parents, Assistant) | 1. XO hardware  
  2. XO software  
  3. Basic troubleshooting |
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<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
<th>Audience</th>
<th>Additional Training Opportunities</th>
</tr>
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</table>
| XO-technician         | Teaches participants how to diagnose, repair, re-flash and answer technical questions about the XO. XO-technicians can endorse XO-mechanics. | IT coordinator, Teachers, Other adults | 1. Advanced troubleshooting  
|                       |                                                                            |                   | 2. Repairs                       |
| XO-champion           | Enables children to become more proficient at using the XO and would like to become classroom leaders. | Student           | 1. XO hardware  
|                       |                                                                            |                   | 2. XO software  
|                       |                                                                            |                   | 3. Basic troubleshooting       |
| XO-mechanic           | Enables children to become official repairers of the XO.                    | Student           | 1. XO hardware  
|                       |                                                                            |                   | 2. Basic troubleshooting  
|                       |                                                                            |                   | 3. Repairs                    |

*Note. Courseware in this table was implemented in 2010-2012. In 2013 OLPC Australia One Academy training was redesigned.*