# Revisiting Turing's imitation game: a commentary on replacing teachers with Internet devices

By: Ravi S. Sharma, Nir Kshetri, and Trevor Nesbit

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**Abstract:**

Researchers have long studied the prevalence of poverty and inequality throughout the world. Much of this poverty has resulted from a lack of opportunities for socio-economic growth and development. In this commentary, we conjecture that bridging knowledge disparities through mass education would reduce wealth and income disparities. Specifically, we investigate whether educating underprivileged individuals (who otherwise would have little access to education) via an inexpensive tablet device would bring about access to digital content and social networks and, thus, result in development opportunities for them. We draw from lessons from the pathfinding one-laptop-per-child (OLPC) initiative and several other field experiences. Through adopting a method of dialectic enquiry that Alan Turing first posed in his seminal investigation into whether machines could replace people, we first pose arguments against our postulate and then consider opposing points of view. Specifically, we address: what are the positive and negative effects of the BYOD approach to learning? How does the BYOD approach bridge knowledge disparities across the socio-economic divide? What impact does the BYOD approach have on different forms of student engagement? Are the digitally less connected also less literate? We conclude with some thoughts on whether content and devices should or could replace teachers.

**Keywords:** online learning | computers in education | internet devices

**Article:**

## 1 The Socio-economic Context

Researchers have lamented that "bad neighborhoods and bad teachers rob poor children of the chance to climb into the middle class" (Davis, 2015) and that "good teachers do not want to go where they are needed most…[; namely,] where trouble comes from" (Mitra, 2010). A lack of infrastructure and other support may constitute one primary reason why (Rahuman, Wikramanayake & Hegwagamage, 2011). Other oft-cited issues that have "affected the quality

of education in developing countries include high rate of teacher absenteeism, the role of political patronage in the hiring of teachers, low technical quality, and the ineffectiveness of teacher training" (Kshetri, Fredriksson, & Rojas, 2017, p. 85). If indeed the case, could not the era of the ubiquitous Internet provide affordable devices, networks, and content to the educationally malnourished in order to level the playing field? We consider this proposition in this commentary. Building on an earlier examination of knowledge disparities (Chandrasekar & Sharma, 2010), we consider whether an inexpensive, Internet-enabled device could bridge current inequities in terms of access to information, knowledge, and education and, thus, bridge socio-economic disparities. In essence, this approach represents the bring-your-own-device (BYOD) approach to mass education: 1) access to personalized content, 2) support from cloud-based services such as social networks of teachers, and 3) guidance from interactions with other learners (cf. Sipior, Bierstaker, Chung, & Lee, 2017).

Based on various pathfinding approaches such as Negroponte's (2006) one-laptop-per-child (OLPC) trials (see also Warschauer & Ames, 2010; Ames, 2016), MIT's Project Athena (cited in Turkle, 2015), Mitra's (2010) hole-in-the-wall experiments, and other more recent trials (Kraemer, Dedrick & Sharma, 2009; French, Guo, & Shim, 2014; Nord, Lee, Cetin, Atay, & Paliszkiewicz, 2016), we can reasonably conjecture that providing digital opportunities to children who otherwise have no access to formal education through the BYOD approach could bridge such disparities (Kshetri et al., 2017). In this scenario, one could provide inexpensive (less than US$50), open (e.g., Android) devices to allow people to access freemium content through community access (i.e., Wi-Fi hot-spots). In other words, by providing near universal access to content and collaboration, an Internet-enabled infrastructure could make up for the lack of a quality classroom experience in "bad neighborhoods" and "alleviate trouble" (Mitra, 2010).

However, the question of whether an online learning environment of devices, networks, and content should (or could) replace teachers is a controversial one. A recent report on students, computers, and learning by the Organization of Economic Development and Cooperation (OECD, 2015) makes the point that too much exposure to information and communications technologies (ICTs) in the classroom leads to lower learning outcomes as measured by standardized testing. Could we attribute these lower learning outcomes to a lack of learner engagement? The literature has identified three forms of student engagement: behavioral, emotional, and cognitive engagement (Fredricks, Blumenfeld, & Paris, 2004). Can an online approach then holistically engage learners as well as teachers in classrooms would? Is there part of this debate that reduces some forms of student engagement while increasing other forms?

In the centennial year of the birth of the English computational scientist Alan Turing, the I-Slate project[1] was launched to provide an Internet-enabled learning device that could be rolled out to support the poor state of mass education for children in the underdeveloped world. From developing a low-cost, "good enough", seven-inch Android tablet to deliver content (e.g., from Khan Academy and Coursera) that could provide personalized learning pathways for children

[1] The Institute for Sustainable and Applied Info-Dynamics, headed by Professor Krishna Palem, was jointly established in 2012 by the Nanyang Technological University and Rice University to develop a platform of technologies that exploit frugal innovation so as to provide mass impact. The first author collaborated with Palem on addressing this question.

currently deprived of an education, the project allowed insights and observations that we did not previously understand.

## 2 The Case Against BYOD

As a tribute to Turing, after whom computer science's highest award takes its name, we adopt the style of dialectic inquiry he used when considering whether machine intelligence could plausibly replace human intelligence in non-trivial tasks. In his seminal paper (1950), he constructed and then deconstructed the various arguments before arriving at his conclusion. Therefore, on the question of whether the BYOD approach could replicate and, hence, replace teacher-led classrooms, we now proceed to consider opinions opposed to our initial conjecture.

### 2.1 The "We Can do Much More for Less" Objection (Objection 1)

This argument posits that, with price of tablets and associated Internet infrastructure, we could build schools, train teachers, and develop local curriculum (Warschauer & Ames, 2010). If the cost of setting up and maintaining Internet-enabled mass education outweighs the opportunity cost of building better infrastructure and training qualified teachers, the premise of the BYOD program becomes questionable. The apparent lack of success of the earlier OLPC initiative provides much fuel for this argument (Kraemer, Dedrick, & Sharma, 2009). A sustainable online learning initiative requires significant and persistent investments. The ongoing operating costs of maintaining the BYOD devices and managing the IT infrastructure would require regular and consistent attention, and that the risk of downtime could interfere with learning given the possibility of inadequate or unreliable infrastructure in developing countries. In order to emulate the classroom environment, the BYOD approach must also contain a structured curriculum and activities that encourage interaction, communication and engagement. Such things require qualified, local educationalists to participate in the approach. Training them to use ICT-enabled mass education is a challenge, but empirical studies show that developing computational thinking is more critical than using ICTs per se (Dias & Brewer, 2009).

### 2.2 The "We Can Take a Horse to Water But You Cannot Make it Drink" Objection (Objection 2)

This argument posits that, even if tablets and Internet access were universal, one has no assurance that children will learn on their own or from peers with little adult supervision (Dolnicar, Prevodnik & Vehovar, 2014; Schleicher 2012). Establishing virtual classroom infrastructure with the required hardware and software is the trivial part; the program's success depends on how effectively children from less privileged backgrounds can be educated to a level similar to their peers across the socio-economic divide (Sharma, Malone, Guan, & Dattakumar, 2018). Simply providing laptops or tablets to children does not motivate them to learn. If they choose to use it, they may not explore many functions due to a lack of guidance (Warschauer & Ames, 2010). The OECD (2015) report cautions as much in suggesting that computers and learning do not share an obvious link. From a "forms of engagement" perspective (Fredricks et al., 2004), students' lacking motivation to learn has strong connections to the concept of emotional engagement (Fredricks et al., 2004). Indeed, devices lack the empathy and ability to recognize signs of apprehension, reluctance, or insecurities in a child; thus, one cannot discount

human recognition (Steiner-Adair & Barker, 2013). Failing to address the need for encouragement could possibly result in young learners' completely abandoning any attempts to learn.

### 2.3 The "a Fool with a Tool is Still a Fool" Objection (Objection 3)

This argument posits that tablets and Internet without holistic learning environments provide only shallow learning in the same way a search engine does not necessarily lead to understanding (Ames 2016; Nord et al., 2016). ICT infrastructure and enormous amounts of online resources alone cannot create an environment conducive to building learners' capabilities and confidence. Providing a child with an Internet-based learning device opens up a world of both positive and negative opportunities (OECD, 2015). If one does not restrict the content they can access, this freedom can lead to unintended consequences that range from mild addiction to serious criminal activities (Steiner-Adair & Barker, 2013). Further, searching and browsing does not equate to learning. A child may become familiar with or recognize content, but that does not equate to knowing how to solve problems (Kraemer et al., 2009). Therefore, we return to the fundamental point about the need for good teachers who create effective classroom experiences. A child needs authentic learning activities (Reeves, Herrington & Oliver, 2002) that encourage cognitive engagement (Fredricks et al., 2004) to develop the skills for knowing and solving problems. Given that an essential part of education involves developing a moral compass based on human contact and guidance (Custer, 2017), eliminating any human role model for children would hinder their emotional and mental development. Uncontrolled, unfiltered exposure to unlimited sources of information to a child is socially irresponsible for the community from an ethical and moral lens.

### 2.4 The "Technology Does not Belong in Traditional Communities" Objection (Objection 4)

This argument posits that technology could disrupt societal relationships and ties in rural communities in a manner more damaging than in urban areas (Steiner-Adair & Barker, 2013). In urban areas, too much technology usage disrupts social cohesion, especially in families. The child psychologist Catherine Steiner-Adder and her coworkers have noted that children, when increasingly drawn into the online world that deprives them of their family's time and attention, lose an important facet of building strong, healthy relationships and that "they struggle and don't do very well" (Steiner-Adder, 2013, p 16). In the OLPC project, children displayed "addiction to using computers, neglecting physical games and spending most of their off-school time with OLPC" (Rahuman et al., 2011). As such, BYOD approach could bring about similar negative effects on children who live in rural areas where living in the outdoors and establishing community relationships constitute critical life skills. Computers may also take away time from the activities of inculcating survival skills such as "deep attention" and "open-ended conversations" (Turkle, 2015). From a forms of engagement perspective, it appears that this view would concur with a reduction in behavioral engagement (Fredricks et al., 2004). One could also argue that being online would affect the skills of communicating on the very basic level of speech considering that Internet devices do not encourage verbal engagement at any level close to the quality of conversations among people (Turkle, 2015). Deterioration in children's communication skills could compromise their function and place in their community because

individuals need such skills to engage effectively with their social setting. Communicative isolation leads to emotional distress and frustration and is not conducive to positive learning outcomes.

### 2.5 The "Does It Even Work in the First Place?" Objection (Objection 5)

This argument posits that standardized testing has not shown the efficacy of BYOD as a worthy substitute for the teacher-led classroom model (Warschauer & Ames, 2010; Schleicher, 2012; Nord et al., 2016). The OECD's (2015) study on computers in the classroom stresses that ICTs do not improve student performance; on the contrary, they lead to worse learning outcomes in standardized testing. Of particular concern, the study found no significant improvement in reading, mathematics, or science in countries that highly invest in technology. In fact, beyond a given threshold, ICTs led to lower scores in standardized tests ostensibly because children spent time away from reflection and deep engagement. A plausible reason for this observation could be that, while motivated children could learn from the Internet, mutual engagement is reduced (Fredricks et al., 2004). Most teachers become teachers because they personally love teaching, which ensures their continued dedication to ensuring that learners positively engage with learning material. One might argue the BYOD approach fails to administer an awareness of progress in a student and that it provides only a flat level of information that lacks the reflection and deep engagement that learners need to learn.

## 3 Contrarian Viewpoints

We now return to the initial question of whether a BYOD approach to mass education can replicate the classroom experience where none exists and provide meaningful opportunities for socio-economic growth and development. In this section, we argue against each one of the above five objections.

### 3.1 Response to Objection 1

If we can do more for less, then why are 59 million children out of school (UNESCO, 2015)? Of the 193 members of the United Nations, 96 have an acute shortage of teachers, and, of those, 34 percent will still not have enough teachers by the year 2030 (UNESCO, 2015). Based on this evidence, the shortage of teachers is a long-term problem. Because upper-level teachers have expertise in specific disciplines, this shortage occurs particularly in science, technology, engineering, and mathematics (STEM) subjects that significantly drive economic growth and development (Rahuman et al., 2011). The BYOD approach opens up a world of knowledge-sharing opportunities (French et al., 2014; Sipior, et al., 2017). The anecdote that Tamil-speaking children living in rural India would learn about DNA replication by using the resources available online (Mitra, 2010) suggests a means to address knowledge and resource inequities (Ames, 2016; Sharma et al., 2016). A teacher with the expertise to teach complex topics may be hard to find in rural and underdeveloped areas. In such cases, the BYOD approach may be the "silver standard".

### 3.2 Response to Objection 2

A key finding from 10 years of OLPC in various developing countries is that children's natural curiosity serves as their main motivation (Negroponte, 2006), which concurs with the idea of cognitive engagement (Fredricks et al., 2004). Children will explore these devices and consider its novelty in providing multiple platforms for exploration. Children are also not afraid of using technology and the outcomes of trying various functions. Negroponte (2006 also observed that the device instilled curiosity and few children expressed boredom. While such an observation may seem overly positivist, other fields studies have corroborated the observation (Kshetri et al., 2017). Making a device look attractive, designing its interface to cater to its target audience (a key design philosophy that Negroponte's OLPC project adopted), and enabling collaborative-social learning (a key design philosophy adopted by Mitra's hole-in-the-wall experiment) engages children in pursuing education. The I-Slate project has shown that children do not settle for good-enough devices and ad hoc, aid-driven, do-it-yourself programs. In other words, frugal innovation and satisficing were not success factors. In the global, internetworked age, children aspire for branded devices, content, and the engagement of teachers and parents. Thus, introducing Internet devices in classrooms has the potential to enhance cognitive engagement while concurrently discouraging emotional engagement (Fredricks et al., 2004).

### 3.3 Response to Objection 3

We can restate this nuanced objection as: a tool is only as effective as the extent to which it engenders positive experiences that transform users. Nord et al. (2016) and others' work reinforces the view that carefully nurturing positive experiences and outcomes represents the key to effective participation in ICT. Hence, a sandboxed or walled-garden approach would make sense to protect the vulnerable. With the host of issues (e.g., cyberbullying, grooming, radicalization, fraud, surveillance, etc.) that surround the misuse of the Internet, particularly by the vulnerable, children need careful guidance when using the BYOD approach (OECD, 2015). With adequate adult supervision, children can browse and explore content and later receive context-specific information in the form of lessons. The technology in terms of firewalls, filters, and demilitarized zones (DMZs) already exist to prevent access to illicit material. Further, to make these initiatives more effective, children, parents, and educators need sufficient literacy in information media (Ames 2016). As Sharma et al. (2018) explore, such digital skills will serve as the foundations of effective participation, inclusion, and citizenship.

### 3.4 Response to Objection 4

Too much of a good thing can be detrimental and, from a forms of engagement perspective, may reduce emotional engagement (Fredricks et al., 2004). The urban-rural divide with respect to ICT access could result in too much usage in urban families in the developed economies but too little in the rural, underdeveloped world (OECD, 2015), where it could arguably have the most impact (Mitra, 2010). One may say the same about the rich-poor divide among countries. Devices and content meant for educational purposes can enable collaboration and learning regardless of demographics. In his hole-in-the-wall experiments, Mitra (2010) found that, when presented with an educational challenge, children came together to explore and engage in peer-learning with minimal adult supervision. He suggests that, in such a self-organizing learning environment (SOLE), children, with some non-expert monitoring, could share content and insights with their peers. These characteristics could help strengthen social ties and, subsequently, diffuse

knowledge throughout society (Sharma et al, 2016). Thus, rather than weaken the social fabric of a village, the BYOD approach could actually improve relationships across socio-economic and time-space barriers (Drapper, 1998; Dolničar et al., 2014).

### 3.5 Response to Objection 5

One can mitigate this objection, which rests on the observation that PISA-standardized tests show a marked decrease in grades among children who used Internet devices in school (OECD, 2015), by considering the context. As Andreas Schleicher (2012), the OECD Director of Education and Skills, has suggested in a TED talk, the future of mass-education lies not so much in learning outcomes from standardized tests but in "whether we are prepared for jobs that haven't been created and to use technology that haven't been invented to solve problems we just can't anticipate today". Researchers have presented numerous other potential benefits from using ICT in education (cf. French et al., 2014; Sipior et al., 2017), which fall outside of what traditional tests can measure—sometimes categorized as "niche outcomes" (Drapper, 1998). In other words, current standardized tests do not have much relevance in BYOD approaches, which seek to expose the digital "have nots" to future opportunities of the Internet era. One cannot anticipate what digital participation would spawn as value-added outcomes, much like Turing (1950) himself could only speculate whether or not artificial intelligence (AI) could one day replace human intelligence.

## 4 Can Internet Devices Replace Teachers?

In this section, we summarize the arguments and present our view. Similar to how Turing (1950, p. 460) conjectures about whether "machines will eventually compete with men in all purely intellectual fields", we ask whether the BYOD approach can replace teachers and traditional classrooms. More fundamentally, should devices, networks, and applications replace teachers? After all, as the late futurist Arthur C. Clarke nonchalantly declared in an interview with Mitra (2010): if a machine can replace a teacher, he [sic] should". However, the challenge concerns not whether education as a service (EaaS) is technically feasible but whether it would be responsible to deliver it to underprivileged children in the world.

For the present time, we concede that the BYOD approach is not a panacea to the world's problems with mass education and that it cannot impact learning in a manner equivalent to teacher-led classrooms. Teachers are invaluable resources and play a crucial role in a child's development. Teachers do not simply follow a fixed curriculum but also instill values in children, serve as role models, and provide the social context for learning. Consider numerous current topics of interest (e.g., sustainability, GMO, AI, etc.), and one can see how difficult it would be to replicate a lively classroom with Internet-enabled devices.

On the other hand, given that the Internet serves as the fabric of our lives today, one would not exaggerate in suggesting that early exposure to ICT and the Internet is as critical as reading, writing, and arithmetic. Depriving children of exposure to the Internet and digital literacy skills may hinder their ability to learn and think and to engage cognitively beyond the classroom. At a macro level, it could deprive segments of our information society the tools with which to bridge socio-economic gaps (Sharma, Fantin, Prabhu, Guan, & Dattakumar, 2016).

We may also find it useful to revisit the issue through the lens that Draper (1998) provides. He highlights that ICTs that have increased learning quality have addressed a deficiency or a (niche) problem in a teaching-learning scenario. In this line of reasoning, a BYOD solution needs to address specific challenges such as a lack of infrastructure, teachers, learning resources, and so on without creating side-effects.

What then solves the original problem: a lack of good teachers in places that need them the most? The BYOD approach offers disenfranchised children the opportunity to engage in digital worlds, which can open economic opportunities for them. It can empower them and change their lives (Dolničar et al., 2014). If we imagine the outcome of this approach on a bell curve, too little time on Internet-enabled devices will not lead to a favorable outcome (learning). Too much time on the Internet can lead to undesirable outcomes such as addiction and other forms of emotional engagement. However, a point on the curve could be optimal—a point that varies across different contexts. Such a point would represent the blended approach to learning: adult supervised classroom time with online activities focused on engaging learners. Longitudinally, it may also be prudent to delay introducing Internet devices in classrooms. Turkle (2015) may be right in her observation that children who begin school with Internet devices seem well versed in "skimming, scanning, and scrolling" but not in paying "deep attention".

What could be a middle path that draws on both teachers and devices? A solution from Bridge International provides an example in which teachers and devices complement each other's strengths (Kshetri et al., 2017). The solution provides a platform that offers three years of early childhood education and seven years of primary education. The solution uses big data, algorithms, and a scripted-learning education methodology. Recognizing the centrality of the teacher, Bridge's protocols ensure 100 percent teacher attendance with a pool on-call substitutes and other measures. In contrast, in Kenya, teachers have an absenteeism rate of 47.3 percent in government schools and more than 30 percent in in private schools. As of September, 2015, Bridge has served about 120,000 students across Africa, offering economies of scale and scope.

If one measured performance on a holistic scale rather than with standardized tests, one could also argue that a well-designed and well-implemented BYOD approach to mass education should lead to positive long-term effects. Outcomes such as children maturing to become more self-reliant and confident; consequently, to take control of their own learning as well as mentoring others in their communities. As that occurs, an eco-system develops in which ICTs serve as the starting point for an ongoing conversation centered on a learner-centered education system. Globally, BYOD education could adopt a design that bridges existing knowledge disparities between rural and urban, between socio-economic classes, and between digital natives and immigrants. But, as the OECD (2015) report concludes, "technology can amplify great teaching but great technology cannot replace poor teaching" (p. 191). Similarly, we conclude with the conjecture that the hallmark of a good BYOD design may be that an "interrogator", performing a blind review, cannot distinguish between classroom and online learning. As Turing (1950, p. 460) concluded: "we can only see a short distance ahead, but we can see plenty there that needs to be done". Today, we note research efforts in AI and big data analytics that offer the prospect of blended learning pathways that one can personalize to the needs of individual learners. As well, a host of developments that leverage cloud computing and social networks have opened

new frontiers in collaborative, participative engagement in learning. If we can accept that it takes a village to raise a child, could the era of crowdsourcing and collective intelligence bring about "virtual villages"?

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**About the Authors**

**Ravi Sharma** is currently the Chair of Information Systems at the University of Canterbury Business School where he also leads the Centre for Inclusive Digital Enterprise. He received the BSc (Com Sci, Math & Econ) from Brandon, MSc (Com Sci) from Regina and PhD (Management Sciences) from Waterloo. He has held academic appointments for over two decades at NTU, St FX and visiting appointments at ITB, USC Marshall School, IIT-Bombay, IMD, ESSEC and SP Jain. He has also spent 10 years in industry as Asean Communications Industry Principal at IBM Global Services and Director of the Multimedia Competency Centre of Deutsche Telekom Asia. His current research interests are in applying ICT for inclusive growth and development.

**Nir Kshetri** is Professor at University of North Carolina-Greensboro (UNCG). He has authored eight books and about 120 articles in various journals. Nir was the winner of 2016 UNCG Bryan School Senior Research Excellence Award. Nir has been quoted/interviewed and/or his work has been featured by hundreds of media outlets worldwide. In March, 2018, he gave a TED Talk about the potential roles of cryptocurrencies in fighting poverty.

**Trevor Nesbit** has over 25 years teaching across information technology and business disciplines in the tertiary education sector in New Zealand including the polytechnic and university sectors. His PhD is in the use of educational technologies, with other research interests including the adoption of cloud based accounting systems. Trevor is currently a Senior Lecturer in Accounting at Ara Institute of Canterbury and is mainly teaching management accounting and accounting information systems.