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Global Literacy and Socially Excluded Peoples*

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From ongoing research about early brain development, cognition, and education, we know that the acquisition of reading changes the brain; in the process, it transforms how the child thinks, and it propels the personal, social-emotional, and economic trajectory of that individual over time (Wolf, 2007). When a child acquires literacy, both the life of the child and the surrounding society are affected. Within that context, the fact that close to 200 million children, through no fault of their own, will never become fully literate has immutable implications for them and for our world. Quite simply, these children and, more than likely, their children will never reach their full potential for cognitive and social transformation. It is a tragedy that is a key factor in the seemingly unchangeable lives of many socially excluded peoples. We believe it is changeable.

Kant described three questions that will be used to structure this chapter: *What do we know? What should we do? How can we hope?* (See discussion in J. Dunne, 2006) This chapter will be organized around each of these questions. In the first more theoretical section, a brief depiction of what it means to have a reading brain will be presented. The second section will describe our own response to Kant's difficult question about what one should do with the knowledge we have. Tolstoi asked a similar question, and his response , paraphrased here, has guided our own: "Do what is in front of you to do". Our way of implementing Tolstoy's response has been to combine

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Note: This chapter is one of two papers written for the Pontifical Academies that describe our work from different perspectives: the present chapter emphasizes implications for socially excluded peoples; the other chapter represents a longer version of this paper with emphases on cognition and educational methods (see the companion volume, *Proceedings of the Pontifical Academy of Science, Bread and Brain Meeting*).

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our collective fields in cognitive neuroscience, technology, data analysis, and child development to develop a digital learning experience for children that will promote learning to read wherever they are, whatever their circumstances.

As will be detailed in the second section, we are involved in a new way to promote global literacy in both remote regions of the world, and also in the unknown places in our own backyards in the United States where poverty and social exclusion can arrest a child's potential as thoroughly as in Bangladesh or Mumbai. Although this technology-driven initiative is a radical departure from traditional modes of teaching, we do not aim to replace any teacher or to suggest that good schools and teachers are not critical to every society. Rather, our major goal is to create digital materials and learning experiences that become part of an open-source platform that supports literacy development for millions of children – whether they are in areas where there are no schools, or in schools where there are insufficient resources. We want, therefore, to provide a platform that can help promote the untapped potential of young human beings who would otherwise never become fully literate.

In the third section – which asks *what may we hope* – we will argue that global literacy represents one of the most intrinsically hopeful antidotes to the transformation of the lives of socially excluded peoples.

What do we know?

The Origins of the Reading Brain

One of the more surprising discoveries in the science of reading is the disarmingly simple fact that human beings were never meant to read. We humans are biologically programmed to speak, see, think, and remember, but not to read. Each of these other basic processes requires vast neuronal networks that are genetically given. Very pertinent to literacy, many of these other processes are the component parts for the development of a new *reading circuit* in the brain of every literate person. The reading circuit represents one of the most powerful examples of the brain's semi-miraculous ability to form new circuits from the neuronal networks used for older, genetically programmed processes (see Dehaene, 2009; Wolf, 2007). . Numeracy (see Dehaene, 2011) and writing represent other examples. In the case of reading, the networks for vision, language, cognition, affect, memory, and attention are all brought together for something outside our basic repertoire of abilities. Pascal once wrote that there is nothing new under this earth, but that there is "rearrangement". The reading brain circuit is, from our perspective, the physiological instantiation of Pascal's principle of *rearrangement*.

The beginnings of this circuit begin slowly as young children develop each of the genetically preprogrammed parts of the circuit, particularly processes underlying language, hearing, cognition, and vision. For most individuals, about five years are required for the development of each of these individual component parts before children gradually learn how to integrate the separate parts into one wholly new circuit for the purpose of reading. This integration, which is the basis of the reading circuit, never simply emerges without exposure to a writing system or without the nurturance of the environment or culture around the child. In this sense reading is neither natural nor easily acquired, in the way that oral language is.

Indeed most children learn to associate what they see, hear, and know with symbolic characters through varying amounts of teaching assistance. Although some children might be able to induce the alphabetic principle themselves, the alphabetic principle requires highly demanding cognitive insights into the nature of a symbolic function. Whether the child is learning the alphabetic principle or concepts underlying other writing systems, the child must learn that a visual symbol corresponds to a specific sound, syllable, word, or concept. While this cognitive leap may sound simple enough, one has only to think about Helen Keller. Specifically, recall the moment in which Helen Keller, deaf and blind, discovered with her tutor that the feeling of water had a word attached to it, and further, that there was a sign possible to communicate this word. Learning the alphabetic principle in the child's early years can well be likened to Helen Keller's epiphany. A major question that is a leitmotiv in our work is whether we can create conditions in which the child is led to these insights about the alphabetic principle on her or his own, or whether some intervention by a literate person is needed by most individuals. There are varied permutations possible for such an intervention: for example, varying amounts of time and assistance needed.

To understand why the reading acquisition process is so complex, even before learning the alphabetic principle, consider the circus! The linguistic, perceptual, and cognitive hoops that every child has to move through to learn to read are much like a three-ring circus in the brain. In the first ring, various "acts" representing each aspect of the entire language system must be developed: from the outset, children must be exquisitely attuned to the unique individual "phonemes" or sounds of their language, that make up the sound structure of each word. Equally importantly, they must know the meanings and grammatical functions of hundreds and ultimately thousands of words, so that when they eventually read the word, they know what it means in a sentence. There are many more linguistic "acts" in the first ring

of language processes (like grammar itself!), but for now let us be content with a somewhat more metaphorical level of description for what happens in the first linguistic ring.

The second ring is comprised of the fine-tuned perceptual processes that allow the child to detect the often subtle visual features of individual letters or characters. There are very specific groups of neurons responsible for the particular features that letters are comprised of, but only if the child is sufficiently exposed to those features and letters (Dehaene, 2009). In similar fashion, with sufficient exposures, other "working groups" of neurons become specialists for recognizing the longer letter patterns, and highly used words in any writing system. The visual areas of the brain of a child have to become like little repositories of all the letters, letter patterns, and eventually morphemes of that writing system. The more they are seen, the better and faster they can be activated when seen in a book or text on the screen.

The third ring involves the continuum of increasingly sophisticated and abstract cognitive processes that allow the child first to learn that a letter (or character) symbolizes a sound; second, that in an alphabetic system these sounds are blended to make words; and third, that words come together to give meaningful thoughts and information that ultimately propel their own thoughts. This last set of acts is developmentally extended over the life span and requires ever more complex processes over time like inference, analogical and deductive thinking, insight and sometimes novel thought, all of which contribute to what we call "deep reading" (Wolf & Barzillai, 2009).

Finally, the circus performance is ready when each ring's basic "acts" are learned individually and can be performed in tandem – flawlessly and synchronously – as a group of seemingly effortless performances. In other words, what we do when we read is very much like what a ringmaster does while conducting a three- ring performance. In terms of development, in a young reader, huge portions of the brain's visual, linguistic, cognitive and motoric areas are activated when first reading a single word or sentence. Later in development, a great deal more is added to this circuit: for example, the readers' feelings, affective associations, and background knowledge, which often propel insights and new thoughts for the reader. The older and more we know about words and concepts, the more and more elaborated this circuit becomes. From a physiological perspective, it is one of the most impressive displays of activated cortex that represents the most difficult feat the young brain is ever called upon to perform at so early an age.

Understanding exactly which specific processes and underlying areas of the brain are activated at different stages of reading's development has been one of the foci of our work and that of many of our colleagues. It is a crit-

ical basis for our group's efforts to create new approaches for helping children learn to read. Indeed it is this theoretical knowledge that undergirds our approach to digital learning and propels our hope that we can eventually create better and better iterations of a learning experience that simulate the reading brain.

More specifically, in our work just previous to the present global literacy initiative, we created innovative reading methodologies that were designed to systematically target each component part of the developing reading circuit for children struggling to learn to read for reasons like dyslexia (Wolf, Bowers, & Biddle, 2000; Wolf, Barzillai, Gottwald, *et al.*, 2009; Wolf, Ullman-Shade, & Gottwald, 2012). Along with colleagues Robin Morris in Atlanta and Maureen Lovett in Toronto, we demonstrated through more than a decade of systematic, randomized treatment – control design studies how carefully targeted emphases in reading methods can help young and particularly young readers with difficulties, learn to read with fluency and comprehension (see Morris, Lovett, Wolf *et al.*, 2012). From these studies, and related studies by other researchers, we have learned how to model the reading brain and to apply this knowledge to the teaching of the young in traditional school settings. We have had considerable success with changing the trajectory of learning for countless children who receive these interventions. The question, however, was whether this knowledge base could be translated to digital learning experiences.

What should we do?

In the process of our work on intervention with struggling readers, we became increasingly aware of literacy issues outside our traditional research base in classrooms in the United States. Although our work originally focussed on children who cannot read because of underlying learning challenges like dyslexia, we asked whether our work might have implications for children who were unable to read because of their environments, not their physiological differences. The realities of these children are even more daunting: 72 million children worldwide will never become literate because they have no school. At least another 100 million children have such insufficient resources in their schools that they will never become functionally literate. The great majority of these children live in environments that are home to masses of socially excluded peoples, most especially in Sub-Saharan Africa and India. The realities of these 172 million illiterate children pose staggering challenges and questions.

It was within this context that we were originally approached by Nicholas Negroponte, founder of the MIT Media Lab and the One Laptop Per Child

initiative. He asked questions concerning whether the acquisition of literacy was possible in remote regions around the globe – that is, in places where there are neither schools nor teachers. Negroponte had become concerned about these issues because of what he discovered during his leadership of the One Laptop Per Child initiative. During this time 2.4 million laptops were distributed in varied regions of the world to children, many of whom were not literate and were, therefore, unable to derive full use of the laptop.

With him we began to ask a new set of questions: Can our insights into the formation of the young reading brain and our research on methods for teaching children with dyslexia and other learning differences provide the basis for a completely new application of this knowledge base in mobile technologies? For example, can we select and/or create apps and activities that target the important areas in the reading brain circuit? Will children with no schools be able to teach themselves and each other with no adult instruction or help? Can mobile technologies prove capable of delivering these apps and also assessment tools to ensure the efficacy of the approach? How can we implement these technologies and evaluate the children in the remote regions where most of these 172 million children live? In other words, we asked ourselves *whether it is possible to create a digital learning experience capable of combating illiteracy through mobile technology devices like tablets and smart phones in places and situations where schools and teachers are either unavailable or insufficient*.

Three factors convinced us that we ***should begin*** to use our collective knowledge bases to approach illiteracy in a new way on a global scale, particularly for children who are the next generation of the socially excluded peoples. First, our increased understanding of the young reading brain and how to teach it makes the curation and development of innovative digital content a conceivable goal. Second, within technology there are increasing breakthroughs that make new mobile computer technologies affordable and available around the world, thus making the financial basis of digital learning possible for large numbers of children, something that would have been heretofore impossible. Moreover, wirelessly connected mobile computing devices have become a cost-effective platform for delivering learning content through multiple experiences (e.g., apps, videos, e-books, games, and online communities) to children across varied knowledge bases and skill domains, and most importantly, across all economic strata. In other words, the increasing access to mobile devices like cell phones, even in the most economically distressed environments like the slums of Mumbai and refugee camps in Sudan, makes mobile technologies a truly possible vehicle of learning around the globe for the children of socially excluded peoples.

Third, the growing ubiquity of connectivity, along with cloud computing and big data analytics, enable completely new forms of assessment, both of individual children's progress and also of the performance of large populations (e.g., from the village to the country to the global levels). More specifically, by creating a tightly iterative design in which a child's performance can be immediately assessed, we could eventually provide ever more targeted individualized instruction on the specific areas of need for a given individual. Such a design could provide one of the most important means for advancing learning on digital technologies, particularly in remote areas where many of the world's socially forgotten peoples live.

These three factors became the context for our research consortium. Members of the Tufts Center for Reading and Language Research, MIT Media Lab, Georgia State University, and most recently the Dalai Lama Center for Ethics and Transformative Values came together to work towards one overarching goal: to investigate whether our evolving knowledge of the young reading brain, big data analytics, child development (particularly child-driven learning), and new technologies can be applied on mobile technologies. Specifically, we sought to understand whether theoretically based content on affordable tablets could help children learn to read by helping themselves and each other, even in the absence of a teacher or literate adult.

First Deployment: Ethiopia

In the fall of 2011, our Global Literacy Project began an extraordinary, ongoing study in two remote regions of Ethiopia. Ethiopia represents one of the ten countries with the highest rates of illiteracy. Over half of its population of 91,196,000 people are illiterate. Two thirds of the women are not literate. The government spends approximately $86 per person a year on education, making it one of the lowest rates in the world. These particular sites were selected because of the infrastructure provided by the earlier OLPC initiative. Through these existing contacts with the Ethiopian government, and the critical support of the government and local leadership, the particular villages were chosen as representative of most of Ethiopia's inaccessible populations. The government refers to children in these regions as "pastoralist children" who will have almost no opportunity for any form of traditional education in their area. The first village, Wonchi, is found on the rim of a volcanic crater at 11,000 feet and is an agrarian community with relatively good access to well water, but little access to main roads. To reach the village requires transportation by foot or animal in the last segments.

The second village, Wolonchete, is located at the edge of the Great Rift Valley. There is no easy access to water in this second, tiny village, where chil-

dren and adults walk daily a total of five hours to and from the nearest source of water for their village. There is little vegetation in the arid, harsh living conditions surrounding Wolonchete, and access to the village is extremely difficult. To assure that the investigators could reach their village by overland vehicle, the elders of the village removed almost one -half mile of large volcanic rocks to allow passage from the nearest road to their settlement.

Children and the adults in these two villages have neither electricity nor running water nor sanitation nor easy access to any form of transportation or communication. To the best of our knowledge, the children have not seen books or paper or pencils; they have not seen any form of technology, although this has not been independently confirmed. Perhaps most importantly for this work, the children speak Oromo, one of several languages in Ethiopia, and have never, or very rarely, heard English, or seen written language in either Oromo (which uses a Latin script) or English .

The four major hurdles that the children face are individually and collectively massive. First, they have had no exposure to any technology and must become computer literate at a basic level for any digital learning to occur. Second, many of the concepts that would appear on any of the varied apps and activities would be unknown by the children (for example, even the verb "swim" is a foreign concept to children who have no easy access to water). Third, the children have no exposure to the English language, and there were no appropriate apps or digital activities available in the children's native Oromo language. Fourth, although Oromo possesses a writing system, the children have had no exposure to it or to any other form of symbolic representation. No adults in these villages have had formal education or read in any language. Any one of these hurdles, much less all four, could prove insurmountable. The reason, however, for such a radical choice for our first deployment was that if we are able to demonstrate that children in these most difficult of conditions can make progress towards literacy, then there is a reasonable rationale to believe that the millions of children in similar, seemingly impossible conditions for learning can also learn to read, using digital devices with carefully curated and/or designed learning applications.

Despite these large impediments, there are two counteracting, powerful forces that mitigate against the acknowledgedly difficult hurdles these children face. The first is what we refer to as "Child-Driven learning". We believe that children everywhere around the world learn best when motivated by their own curiosity and desire to understand and "figure things out" for themselves. Child-Driven Learning involves learning that occurs alongside one's peers, almost all of whom share similar interests and have a drive to discover together. We believe that this additional factor is a key aide in ed-

ucation in areas where children do not have access to teachers. This form of learning has been the focus of some ground-breaking work in India by Sugata Mitra, who served as a consultant to our project in its earliest conceptualization. We sought from the start to study whether children would share their knowledge (which we conceptualize as a form of "teaching") with each other in this intrinsically peer-learning setting. This is not to ignore an earlier question as to whether some limited intervention by a literate person or even non-literate adult might prove helpful. Sugata Mitra (2012, personal correspondence), for example, suggests that the added effect of what he calls a "granny" is often critical to the children's progress.

The second powerful force that we encountered from the outset involves the desire of the children's parents for their children to learn English. Indeed it is more important to the parents that the children are learning English than literacy, because they know that their children have more opportunities for future employment if they know English. The parents feel that the ability to speak English in Ethiopia is a virtual pass to higher paying jobs. From the perspective of the Ethiopian government, if the children begin to learn English, this factor might enhance some of the children's chances for future educational opportunities in Ethiopian schools, where English is typically taught. Based on these reasons, in our sites to this point, we have focused on the deployment of an English language-based literacy curriculum.

Although there were and are good reasons for this initial choice in our sites, it is one that we hope to shift gradually to include more of the native Oromo language as described below. Indeed in future deployments we will hope to have templates for learning to read that, while based initially on English, can be the basis for apps to be developed in whatever native language is used. The points here are several: it is extremely useful for the social, economic, and educational development of the children to learn English; it is usually easier to learn to read in one's first language; it is often impossible to find apps in the languages of children in many of the more remote areas of the world; we hope to use our first iterations of apps on our tablets as templates for their development in different languages, which will be elaborated shortly.

Directly corresponding to the four seemingly insurmountable hurdles that the children embody, we set four seemingly impossible goals for our work with them. The first goal of the project is to propel the children to a level of computer literacy, without human direction or instruction, that enables digital learning to occur. Without it, the rest of our work would be meaningless. The second goal involves helping the children to understand basic concepts of child development that may not be known in their cul-

ture, for example, basic categories around time, nature, colors, number knowledge (etc) are not necessarily known in remote villages like Wonchi or Wolonchete. Because our apps employ many of the basic concepts in their content, it is important to ensure sufficient exposure to these categories of conceptual knowledge so that the apps will be effective in teaching more abstract pre-literacy skills.

Our third goal is comprised of activities to help the children begin to gain an understanding of oral English. For example, we have begun to create the first Oromo-English vocabulary apps that are based on the principle that children learn words most easily when they represent things (animate and inanimate) in their immediate environments. Thus, we asked our Ethiopian counterparts to take pictures of the children holding their own personal objects with the words *spoken and written* in both Oromo, the children's language, and English. For example, a boy from Wonchi is holding up a very thin chicken, while a girl from Wolonchete points to a very dusty, furry donkey. In the newest app, the words for the objects will appear on the side in both English and Oromo, and are audible when the viewer touches the word on the screen, a technique the children have mastered already from other existing apps on the tablet .

Ultimately, we seek to build a set of more *universal templates* for learning to read across various languages and writing systems. Towards that end, we are attempting to construct principles for the choice and/or creation of all apps, regardless of language. For example, from a linguistic viewpoint, we want children to know the full repertoire of the phonemes in whatever language they are learning to read, as well as the meanings of the basic concepts in early child development, regardless of culture. We want to provide apps, therefore, that present the more universal perceptual, linguistic, and cognitive principles that are needed for the development of the reading circuit, whatever language is being read. Similarly, we want all apps embedded within a design that arouses children's intrinsic curiosity and allows them to learn on their own initiative. This design will be agnostic of content and curriculum and even mobile device.

Our fourth and most difficult goal is to introduce the children to the *precursors of literacy*. These include the important elements of alphabetic knowledge, such as 1) learning the alphabet and being able to "recite the alphabet" in a group or as an individual; 2) learning to identify letters by pointing to a letter that is heard; 3) learning to give the name of the letters in both serial and mixed arrays of letters ; 4) knowledge of letter-sound correspondences (e.g., being able to give the sound or sounds associated with each letter of the alphabet); 5) writing letters to dictation; and 6) ac-

quiring very basic sight word recognition (e.g., reading – though *not yet decoding* – the most common early words like *mother, father, baby*).

Our thinking throughout this early phase of our deployment is that if we can someday achieve all of the first four goals, the immediately subsequent goals will involve basic decoding of simple words and basic reading comprehension of brief passages. We will then be able to introduce several other curricular domains, such as numeracy, health and hygiene, and ethical development. For example, for the last year we have taught two student seminars at Tufts and MIT, with auditors from the Rochester Institute for Technology, to create apps that will begin to extend learning into these domains.

An old maxim in reading research used by the late renowned reading researcher Jeanne Chall is that children must "learn to read", so that they can "read to learn" (Chall, 1983). Our ultimate objective for these children is to enable them to move along a continuum of literacy from pre-reading precursors to reading acquisition to that critical reading transition from learning to read to reading to learn. In other words we want two Helen Keller experiences for our children: first to decode words in print; second to decode sufficiently to begin to understand whole new areas of knowledge. If we can propel them to this second stage, we can also introduce them to learning across multiple domains from numeracy to history to science. Indeed we hope to write early stories that embody principles of STEM and ethical development for even the earliest of readers.

If, over time, we can help the children in the two tremendously challenging Ethiopian environments to attain first or even second grade levels of reading comprehension, this level of early reading development is sufficient to serve as a platform for true literacy in the children. Such a level involves fluent decoding and what we are calling "deep reading" (Wolf & Barzillai, 2009). As noted earlier, the latter form of reading represents a hierarchy of skills that are necessary for more sophisticated forms of thought including: inference, analogy, inductive and deductive reasoning, and finally insight and novel thought. These skills, in turn, become the foundation for the equally abstract thought necessary to develop more heightened understanding of concepts like empathy, perspective-taking, and moral problem-solving.

If we can we reach the stage of learning in which children are reading fluently across varied domains, our very ambitious goal is to have developed a global open-source platform that is a repository of many different apps from around that world that can introduce children to multiple areas of learning and whole different cultures and languages. We are already receiving requests from Ethiopia for content in health and hygiene. We wish to ensure the opportunity for all types of learning to occur on our platform,

particularly in numeracy, math, science, and ethical development. We envision that such a platform will also include data collection and data analytics to be able to measure and assess what children are doing with the tablets or other devices, their level of engagement, and their level of mastery of the materials and activities in each of these areas.

A key dimension of this platform involves harnessing the power of Child-Driven Learning as a social force that propels how children explore, discover, share and learn together. Our vision is not only to support child-driven learning within each local community of children, but also to connect these learning communities eventually across the globe. In this way, children from different deployment sites will be able to discover, share and communicate with each other through specially designed apps that support children's desire to create, communicate, and share with one another. For instance, something as simple as a dictionary of culturally relevant concepts (e.g., the concept of "home") could be co-created with children in different locations via a specially designed app that grows as children add contributions. Children can take pictures or videos of what constitutes a "home" in their culture, describe it with written words, recorded voices, or their personal drawings, and then share them with each other. Over time, children all over the globe could contribute what "home" means to them. This not only serves to build children's conceptual knowledge and vocabulary in a rich multi-modal format, it also helps to build empathy and understanding across different cultures, a parallel goal of our work.

Summary of Results

We have now collected our first round of behavioral testing in both villages. We will collect a second round in the very near future. The results from our first formal assessments of the four goals for the children in Ethiopia after one year are promising (i.e., technological familiarity; basic conceptual growth and vocabulary development; and literacy precursor skills).

First, in the domain of computer knowledge, almost all the children are completely "computer-literate" with the tablets. The earliest data indicated that in Wonchi, all the children were able to turn on their laptops within the first day without instruction or direction; in Wolonchete, by the second day all were engaged. By the end of the first month every app had been activated. The children are totally "at home" with these technologies.

With regard to our second and third goals for growth in concepts and vocabulary, all of the children in Wonchi knew some of the tested English vocabulary words in a receptive vocabulary task created by us (a brief test with a format like the well-known Peabody Picture Vocabulary Test, Dunn

& Dunn,2007); over half of the children knew the meaning of over half of the words. This result is encouraging when one takes into account two facts: 1) the words on the assessment were randomly chosen from the apps on the tablet; and 2) the children had no environment to practice their knowledge of these words. Despite the fact they speak no English, most of the children learned some basic vocabulary words.

The "precursors of literacy" goal is both the most challenging and the most surprising. The children are achieving remarkable precursor literacy skills with the tablets. Almost all of the children were able to recite the letters of the alphabet. Indeed without direction from anyone, the older girls in each village regularly conduct alphabet drills that would rival any 1950s Kindergarten! Most of the children recognize most letters in any array – serial or mixed. Most were able to write their letters, despite not having had paper or pencil before the testing (although we have pictures of them writing letters in the dirt with sticks). In other words, they were able to generalize motoric skills from tablet and ground to paper. A smaller group knew letter-sound correspondence rules. This group can recognize almost all English letters in any array, can write letters from memory, and most importantly can read a group of sight words. The children who were the best performers, therefore, were and remain on the cusp of beginning to read. No child in either village was able to decode the words in the decoding task. They are for all purposes in the moment **before** the first Helen Keller experience. It remains to be learned whether this next step can be accomplished with no human intervention, or whether a delimited intervention by a literate adult needs to occur.

It is noteworthy that in both villages, the older girls are among the most advanced readers and are actively teaching the other children: the "creation of a teacher" , from a village in which there had been no teacher ever before, is to us an important discovery. It is akin to watching the emergence of the "first school".

This latter observation suggests at the present moment that with improvements to the platform and the applications and media that are to be delivered in the coming year, some portion of the children in the two villages will be able to make the next critical step to learn to decode and to comprehend what they are reading. To help them connect this textual knowledge to their own knowledge, we are presently creating stories and apps that are based on Ethiopian village life and also on these first analyses of the engagement data.

We have also begun to analyze some of the massive data we have to date on multiple dimensions of the children's usage of the tablet. At the most

general level, data collected over the last year indicate that children used the tablets about 6 hours a day, often sharing the multiple apps and educational media on the tablets with each other. As the year progressed, quantitatively, children opened less apps, but qualitatively, they spent much more time using a specific app, thus indicating more in-depth engagement with apps over time.

When taken as a whole, the behavioral data in this early deployment provide a vehicle for studying the emergence of literacy in a group of children who have never seen symbolic text. They also demonstrate a first proof of concept to show how mobile devices like the tablet can give children access to the precursors to literacy and to beginning to learn another language. What they have not proven is whether true decoding can take place with no intervention outside of what is provided on the tablets to date. It remains to be seen whether new apps that are being added by us and that will be custom designed by us will change the equation.

There are observational data that are less formal, but that require note. As described both by the first author and by the two computer engineers in the bi-weekly site visits, the child-driven learning dynamic that emerged in both groups of children in Ethiopia has created a natural collaborative atmosphere in which kids of greater ability appear compelled and excited to help the other children by taking a leadership role. If expanded and reinforced over time, we believe that such positive, collaborative exchanges among children will create a natural environment for the development of such interactional abilities as empathy, a sense of interconnectedness, and a stronger awareness of self and other. They may also contribute to facilitating heretofore unknown leadership capacities. Certainly the young boy who taught everyone how to use the tablets initially became the unlikely hero of the village and took on the role of teacher over the last year. Similarly the older girls were clear teachers for the younger children in both villages.

The collective pilot data and our insights into them are still ongoing in the deployments in Ethiopia. The children of Wonchi and Wolonchete have given us a never expected petri dish for literacy and a still unfolding story. The government of Ethiopia has a particular concern for children whom they refer to as the "pastoralist" children who remain outside the capacity of the government to teach. By and large, these are the most socially excluded people in their country who live outside of any reach. The government has, therefore, asked us to deploy in a new site that is 750 kilometers outside of Addis Ababa. This third deployment will indeed be our most challenging in Ethiopia. Together the three sites in Ethiopia with all their different insights provide a new chapter in our society's collective under-

standing of what literacy and child-driven learning mean in the life-course of a young human being, wherever and whatever the circumstances.

What can we hope?

We know that literacy can open the child to a potential lifetime of knowledge, to creativity, personal growth, and critical thought. In a society we know that literacy can fuel discovery, productivity, and innovation, which, in turn, can drive economic growth, public health, and the well-being of that group of people. But what of the socially excluded peoples? Will literacy in the harsh conditions that govern the lives of the socially forgotten be sufficient to help children overcome those conditions? Can we replicate the same early learning curves we find for the relatively well-nourished children in two Ethiopian rural villages with children whose environments require survival as the first priority? Although the parents of the children in both Ethiopian villages could not have been more supportive, what of the parents of children in a Mumbai undercity, like those described so eloquently by Katherine Boo (2012), who have no such supportive families and whose basic goal must be to eat? What of children who have schools, but schools which are so overpopulated and understaffed that 60 to 100 children may be taught in a single classroom by one insufficiently prepared teacher? And what of children in our own "backyard" in rural United States, where poverty and inadequate language environments render them at risk for school failure before they even enter the Kindergarten door? What are we to hope for these different populations of children, each of whom represents a different face of the socially excluded in our world?

To address these and related questions of generalizability, we plan or have begun new deployments in each of the above situations: in undercity populations in Bangladesh and in India; in settlement schools in South Africa;in day care centers in Uganda; and in language-impoverished populations in rural Georgia and Alabama. Each of these deployments bring unique challenges to our work and for testing the utility of our platform for increased numbers of children. We have already encountered the limits of our work when funding and personpower are insufficient; we have, however, seen what is possible when factors like local supervision, better content, and sufficient funding and maintenance are aligned.

A more global hope is to use our collective insights about the present content on our tablets to foster the development of more carefully constructed, language and literacy-relevant content on an international scale. This can be done by empowering app developers to work with experts in various schol-

arly domains on the creation of content directly related to language and reading development. Such a process, we believe, will enable teachers, researchers, and facilitators to contribute socially and culturally relevant material: For example, the development of photographs and picture collections that represent vocabulary in the local context, or the creation of local myths, fables, and stories that can be uploaded into interactive storybooks.

One can also imagine in some settings for socially excluded peoples the enlisting of older, literate children, not only to interact with younger children on such apps as the Wolonchete, but also to propel their own development. One important activity for such groups of youngsters would be to write stories using particular vocabulary words that could become developed into "local" apps for the younger children. This has several benefits beyond providing content that is contextualized and relevant to the local population. It creates a community of creators that keeps evolving the material over time, allowing the system to react to the growing and changing population of users. It also allows the project to cross -pollinate different populations and to continue to develop the skills of older children.

As one present example in our most recent deployment, we hope to inspire children in the rural US to create material for vocabulary and stories that can be sent to Ethiopia, and vice versa in an exchange. This would not only expand and reinforce their understanding of the vocabulary by showing variations in new physical and social contexts, but, just as importantly, it fosters curiosity and understanding about another culture. We believe that these children will become far better prepared to understand and empathize with other children from all over the world, and will have a new perspective on who is "other". Thus the development of apps for literacy to us is, in fact, a potential vehicle for the conceptualization of a far broader learning experience that can embody principles of ethical and character development.

Indeed, based on our ongoing work to date, we envision three primary vehicles for how ethical development curriculum could be extended within the present platform in the near future: 1) weaving aspects of character and ethical development into future language -literacy curricula through stories that portray empathy and leadership qualities among characters, as well as that provide moral problems and dilemmas to solve; 2) leveraging the connections between different learning communities to inspire greater understanding and connectedness with people outside children's immediate environs; and 3) adapting and/or developing specific apps in ethics curricula for older ages (Note: an ongoing area of work in the Dalai Lama Center for Ethics and Transformative Values) for use with younger populations.

In his *Evangelii Gaudium*, Pope Frances wrote:

> We are living in an information-driven society which bombards us indiscriminately with data – all treated as being of equal importance – and which leads to remarkable superficiality in the area of moral discernment. In response, we need to provide an education which teaches critical thinking and encourages the development of mature moral values.

It is our hope that as the children learn to read, they simultaneously learn to think critically about what they read. In addition, we are planning to develop a new series of stories that are written to encourage the development of ethical thinking and a sense of being part of the large human family.

The ultimately envisioned platform is conceptualized as a global hub to foster a new, intellectual/technological movement in which an international community of users, developers, technologists, scientists, education practitioners, policy makers, and families work together to create a place where the digital assets, findings, and methods of best practice can be shared by all to help all children have their best chances to reach their potential. We think of this future entity as a kind of place where interactive educational content can be deployed on mobile devices to any corner of the globe, and become an investment in all the individuals and communities reached.

Summary

At the end of both our papers for the Pontifical Academy meetings, we ask what are the implications for the future generations? In particular in this chapter, we ask what are the implications for the future children of the socially excluded peoples of our world? If our combination of a theoretically based, digital- learning experience and child-driven learning can prove even moderately successful across diverse cultures and settings, we estimate that millions of children could have the potential to become literate in the next generation. The implications of such an advance in literacy and its sequelae would be extraordinary, beginning with decreasing poverty and mortality rates, and extending, it is our hope, to increased understanding and connections across vastly different cultures. Literacy does not insure a conflict-free world; but its absence ineluctably assures the existence of conflicts between the literate and the non-literate.

At the most basic level, literacy changes the brain of every literate person through new circuitry, which allows new forms of thinking and learning. At the level of society, literacy rates translate into greater community involvement and civic participation. Further, each new generation of readers passes these skills and their accompanying expectations on to their children

and grandchildren, thus potentially ending the cycle of illiteracy and, very importantly, changing its insidious correlate—– poverty. Poverty is the major marker of the socially excluded peoples. It is the major target of much of the directives by Pope Frances. In his *Evangelii Gaudium,* quoted earlier, he described the plight, indeed the emergency, of the poor and the moral imperative involved in helping the poor have truly equal access to education, human rights, and the dignity of economic employment.

It is our belief that at a minimum higher rates of literacy empower young women to seek greater educational, economic, and even entrepreneurial challenges, which, in turn, make them more likely to raise healthy, literate, economically independent children. With the most basic of tools, individuals with an adequate to advanced level of literacy can become full-fledged members of society and can become involved on an equal basis in social and political discourse. As the world around us changes the way information can become available to anyone with access and the ability to read and understand it, there is a potentially revolutionary leap forward possible for the citizens of our world, wherever and whoever they are. There has never been a time in human history when literacy has been more important to a child's future, or more possible.

Until we demonstrate that children in our villages can learn to read, our acknowledgedly bold hope at the time of this chapter's writing is that the unfolding story of a literacy initiative in two tiny villages in remote Ethiopia will inspire us all to keep trying until they do. We are both elevated and humbled by the possibilities and the impediments to be faced in meeting that challenge and the future challenges in our next phase of deployments in India, South Africa, Uganda, and Bangladesh. We hope to bring to the collective consciousness around the world the profound, intellectual generativity that lies at the heart of reading and the great waste when children never enter the worlds of knowledge opened for them by literacy.

In so doing, we seek to release the potential of children who might otherwise be exploited, underutilized, or completely excluded from the ever changing societies in our own world. If we achieve even some part of our goals, we predict that whole new forms of literacy will emerge that will increase connectedness among children and individuals around the world and, in the process, usher in new dimensions of empathy and compassion for human beings they would never otherwise have encountered in their lives in Mumbai, Wonchi, Wolonchete, Johannesburg, Bangladesh, Uganda, urban Los Angeles, and the little forgotten towns in American backyards.

Our final thought comes from John Steinbeck's great American novel, *East of Eden*:

> The greatest terror a child can have is that he is not loved, and rejection is the hell he fears. I think everyone in the world to a large or small extent has felt rejection. And with rejection comes anger, and with anger some kind of crime in revenge for the rejection, and with the crime – guilt – and there is the story of mankind. I think that if rejection could be amputated, the human would be not what he is. Maybe there would be fewer crazy people I am sure in myself there would not be many jails. It is all there – in the start, the beginning. (Steinbeck, 1952, pp 271-272)

It is our best hope that literacy, which is at the "start" of the education of our young, will give the world one of its best, simplest weapons against "rejection" and its twin isotope, *exclusion* – of children, of families, of peoples.

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