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Answers for Nigerian Farmers: A Mobile Phone Service for Nigerian Farmers

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Abstract. *In this document we describe the design and development of mobile phone-based question and answer service for Nigerian farmers and its planned deployment in two pilots in Nigeria, one in Sokoto and the other in Abuja. The service is intended to provide farmers with the opportunity to receive answers to their questions about what crops to plant, how to care for their crops and to help them bring their excess produce to market. The work is the result of a three-way partnership involving experts in Agriculture and Computer Science at Usmanu Danfodiyo University in Sokoto and at the Digital Bridge Institute in Abuja and researchers from IBM's Social Computing Group at the TJ Watson Research Center in New York.*

Keywords: *farming, mobile phones, social computing*

INTRODUCTION

The Answers for Nigerian Farmers (MobileAnswers, for short) service has been designed to enable smallholder (subsistence and medium scale) farmers in Nigeria to ask questions from local farming experts over mobile phones and receive within a brief period of time the expert's reply through a voice

message. The goal of the project is to help bridge the gap that exists between providers and consumers of agricultural information and thus support farmers in making timely and informed decisions. The hope is that the information provided will help Nigerian Farmers to improve their agricultural practices and thus improve their livelihoods. We are planning pilot deployments of the MobileAnswers service to two groups of 25 farmers each in the Sokoto and the Abuja areas to begin in March of 2011. The plan is to run the pilots for six months each. During that period we will observe usage and modify the service as needed in response to problems and opportunities that arise with the farmers' use of the service. In this paper we describe how the service was designed and developed in a partnership among three institutions – the Digital Bridge Institute (DBI) in Abuja, International Business Machines Corporation (IBM) in New York and Usmanu Danfodiyo University ((UDUS) in Sokoto.

The first question we must address is why a service such as MobileAnswers might be needed. After all, as many domain experts and researchers have pointed out (e.g., Iyegha, 2000; Sharma, Stewart, and Lubensky, 2009), traditional farming knowledge in agricultural communities is handed down through the generations and consequently farmers know a great deal about the practices that have proven successful in their region in the past. One answer we might suggest is that farming practices must evolve and adapt in response to changing environmental conditions, and as large parts of the world appear to be currently undergoing rapid environmental change, information needs to be dynamic to be most useful. This project aims to take advantage of the most up-to-date knowledge that can be sourced from agricultural experts at university and Ministry of Agriculture offices located in the areas where the pilots will be deployed. Environmental changes have implications not only for what crop varieties are best suited to a particular region, but also for the types of diseases and pests that might infect the crops after they have been planted. Thus, we recognize the importance of providing access to information over the entire production lifecycle. This is one determinant of the planned six-month duration of our pilots. Another reason an information service for farmers might be useful is that one can expect there to be a range of agricultural expertise among farmers. Some, because of inexperience or lack of access to knowledgeable mentors, might be expected to be lacking sufficient knowledge to be successful. Providing an easy method for such farmers to ask questions and receive relevant, knowledgeable responses may be expected to be especially helpful for them.

The second question we consider is why use mobile phones as the medium through which to supply information. After all, in many rural communities information has traditionally been provided through face-to face interactions and the attempt to provide information through information and communication technologies (ICTs) may not be readily accepted (e.g., Molony, 2007). One widespread face-to-face practice is for agricultural extension workers to travel to meet with farmers in a central village location and engage the villagers and their leaders in discussions about some germane agricultural topic. The mobile phone, an example of ICTs, has been explored in recent years as an alternative to face-to-face interaction for information provision (e.g., Patel, Chittamuru, Jain, Dave, and Parikh, 2010). Mobile phone technology addresses several problems that affect the current extension worker model. First, since many rural areas are quite remote and roads are often poor, travel in support of face-to-face interactions is difficult. Consequently, any given farmer typically has few opportunities to meet with extension workers. A mobile phone will give a farmer who has network coverage access to anyone anywhere. Secondly, because the face-to-face visits to a particular locale are so infrequent, the individual farmer has little control over the topics. Instead these are usually selected by the information provider to address expected information needs of groups. A mobile phone-based information service enables the individual to request information that addresses his or her particular need. In addition, not only will the individual have control of the content of the interaction, but also of the time when the interaction will take place.

However, as we noted above, the use of mobile phones raises issues that may limit acceptance of the service. Foremost amongst these is the issue of trust: Will farmers accept the validity of information provided by unseen experts through voice recordings? This is a complex issue about which much has

been written (e.g., Gopakumar, 2006; Molony, 2007) and while some case studies have described mechanisms whereby trust can be extended to "unseen others" accessible through technology (e.g., Gopakumar, 2006), whether our ICT service will be accepted is an open question. A second question is whether the farmers will be able to adjust their information seeking behavior to the relatively brief question and answer mode of interaction that will be implemented in our service. We expect questions and answers to be approximately two minutes in duration, though participants will be able to string together multiple questions or answers to explore a topic further.

Team Composition and Method

The design of any system requires a thorough understanding of the expected user, the tasks the users will try to accomplish with the system and the context in which the system will be used (Jacko & Stephanidis, 2003) in addition to an understanding of the technology that will be used in the design. Our task to develop a common understanding of the problem we planned to address and to explore the opportunities for a mobile phone solution have been challenging in part because we are an inter-disciplinary team of agriculturalists, computer scientists, designers and social scientists and thus often "speak a different language," but also because we are an international team whose members are distributed in two locations in Nigeria and one location in the United States.

We began our collaboration on the design of the MobileAnswers service with a face-to-face meeting at the Abuja campus of the Digital Bridge Institute in late August of 2010. During an intense four-day working meeting, we met each other in person for the first time and came to appreciate the differences in our backgrounds and began to establish ways to profitably utilize the complementarity of our backgrounds and skills. We had established our focus on agriculture during weekly telephone calls prior to the meeting in Abuja. Team members came prepared to the face-to-face meeting to share their particular knowledge and expertise with other team members and to establish a means of continuing the exchange after the initial joint working sessions were completed. In our face-to-face meeting we focused both on the agricultural domain and on the technologies we would use to build the information service.

With respect to our domain focus, Dr. Ala from UDUS presented a half-day tutorial on agriculture in Nigeria to acquaint the team with the major issues that face the smallholder farmer in Nigeria. To follow up, the DBI team composed of Mr. Ugwoke and Mr. Faskari arranged for three visits to agricultural stakeholders in the Abuja area. These included a visit to a local produce market where smallholder farmers sell their excess produce, a very important meeting with more than one hundred leaders in agricultural cooperatives in the Gwagwalada Local Government Areas (LGA) in Abuja Federal Capital Territory and a visit to a farm nearby the LGA. While brief, these very informative activities served as the basis upon which we have subsequently continued to build a common understanding of the context of the Nigerian smallholder farmer. We have done this through weekly conference calls of the Content and User Experience (UX) team, supported by a web-based meeting space (LotusLive) and a shared document repository (GoogleDocs). We developed a plan for the project during our face-to-face meeting and have been setting our weekly agenda activities to effect the plan. One of the most important activities we engaged in was to develop a farmer's yearly calendar for each of the planned pilot locations that enumerated the principal activities of the farmer during each month. These efforts were lead by Dr. Ala and Mr. Faskari for the Sokoto and the Abuja areas respectively, and were critical for helping educate the US team about the everyday life of the Nigerian smallholder farmer.

We also devoted part of the face-to-face meeting to establish a common understanding of some of the major technology issues relevant to building the farmers' information service. Dr. Kellogg lead us in an examination of ICT systems that have been deployed with rural populations in non-industrialized countries. Mr. Christensen made a preliminary proposal for a system design that could be used to address the needs of the population of rural farmers we hope to target. The DBI team gave the larger team a tour

of the technology infrastructure (telephony gateway and internet servers) available at DBI which would be capable of supporting the pilot in Abuja and could be replicated at UDUS. The Technology team has carried forward the work of building a prototype service and installing it in both the DBI and the UDUS locations. They have utilized the same communication technologies as described above for the Context/UX team.

MOBILEANSWERS SERVICE DESIGN DECISIONS

Once the decision to provide the information service through ICTs was made, the decision to use mobile phones was an obvious one. The number of mobile phone users in Africa grew from 49 million in 2002 to 280 million in 2007 and is projected to approach 600 million by 2012 (Blycroft Limited, 2008). This widespread adoption combined with the relative dearth of wired network infrastructure and computers means that many Africans' first contact with a networked computing device is the mobile phone.

The Mobile Answers service is designed as an asynchronous information provision model whereby the exchange of information occurs sequentially rather than through synchronous interaction. The farmer sends a question to the information provider, who subsequently records an answer and sends the reply to the farmer. Both participants in this asynchronous conversation have control over when they engage in their portion of a transaction. Such a model gives the information provider the opportunity to consult reference materials or other experts before formulating a response. Control over when to interact is also important for the farmer who can not only select the time when to ask a question, but also when to receive the response. After recording a response, the expert submits it to the system, which then makes a call to the farmer. The farmer may either listen to the response immediately or retrieve it any time thereafter, and as often as he or she desires.

Given the complexity of the agricultural domain, and the limited literacy of many of the farmers, the opportunity to refer back to a recorded answer is expected to be quite useful. Schmidt, Gorman, Gary and Bayor (2010) have shown this to be true for subsistence farmers in Ghana who returned multiple times to particular passages of pre-recorded agricultural information made available to them through a custom device called "the talking book." The ability to review an answer is also useful when the validity of a response – for example the recommendation of a treatment for a failing plant – can only be tested with the passage of time. The review capability may also support multi-part conversations: A farmer may will be able to return to a question he asked on an earlier occasion (or answer he received earlier), review it and submit a follow-up question directed to the author of the original response. Such multi-part questions may offer a bridge to the longer types of interactions farmers are used to in face-to-face settings.

Voice will be the primary mode of interaction for farmers, whereas agricultural experts will also have the ability to interact with each other and with the system through the short message system (SMS). The choice of voice is well suited to the population of farmers that is expected to be of low literacy. The availability of SMS will be used for coordinating the behavior of the agricultural experts, such as alerting them when a farmer has submitted a question.

THE TECHNOLOGY ENABLING THE SERVICE

Given our understanding of the technology landscape in the Abuja and Sokoto areas, the team developed a first-pass system design. The important characteristics of the solution are (1) a low-cost, server-based, voice-enabled computerized voice service that farmers and experts can reach from their existing mobile phones, (2) server-to-user notifications that alert users when new information is available (and obviate the need to poll for new information), (3) standard web-based access to the ongoing voice-based discussions between farmers and experts. Figure 1 shows a high-level diagram of information flowing through the

service, and Figure 2 shows a high-level system components diagram. The system components are shown as generic, and are available as both open source components, and also from well-known technology vendors.

Figure 1 illustrates how the asynchronous discussion between the two main stakeholders – the farmers and the agricultural experts - will be mediated through voice recordings denoted as "voice clips." The content created by farmer and the expert will be saved in the system as a voice recording and will be accessible to each through controls provided in the MobileAnswers service. Notifications automatically produced by the system will be used to advance the discussion: The expert will be notified (by SMS or in a web interface – diagram below) when a farmer has submitted a question (step 2) and the farmer will be notified through a voice call when his question has been answered (step 4). Notice that a discussion between a particular farmer and a specific expert can be composed of multiple recordings ("voice clips") as illustrated in Figure 1. The relationship among multiple voice clips will take place through meta data associated with each recording.

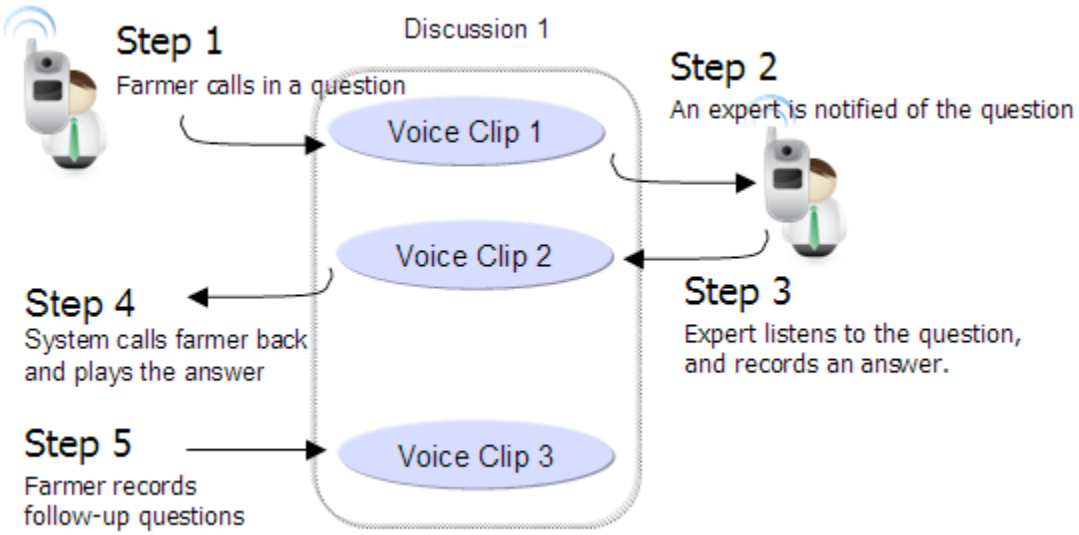

Figure 1: Information Flow

Figure 2 illustrates the system components necessary for the MobileAnswers service. The diagram indicates the two modes of interaction that will be possible in the service. First, use of a voice over internet protocol gateway (VoIP gateway) will enable both the farmer and the agricultural expert to access the system from a mobile phone. The functionality available through the phone will be limited because we expect that most participants in the pilots will be using low-function, "feature-phones" and thus we are limiting our design to what is commonly called an interactive voice response unit-type of interaction (IVR). In IVRs, action choice is mapped on to numbers and indicated by key presses (Sharma et al, 2008). In addition, the connection labeled "http session" indicates that the service will also be accessible through a web interface. Such access can of course provide a richer set of functionality than can easily be made available through access with a low-end mobile phone. We expect only the agricultural experts to use the web interface and based on our understanding of their work practices, they may only utilize the web interface about 50% of the time.

We created a video of the prototype system for easy sharing among the team members while the DBI and the UDUS sites were installing the full software stack necessary to run the MobileAnswers service (the UDUS install had been delayed because severe floods in early September prevented our colleagues from

travelling to the campus). Based on discussions with the team, we are currently completing a second design of the service. One of the necessary enhancements that we identified is a "monitoring" function to be used by project leaders to track the usage by both farmers and agricultural experts. This will provide the means for the project leaders at the two pilot sites to detect problems by tracking the usage of farmers (e.g., are some farmers not participating?) as well as to detect if there are any delays in the answer of questions.

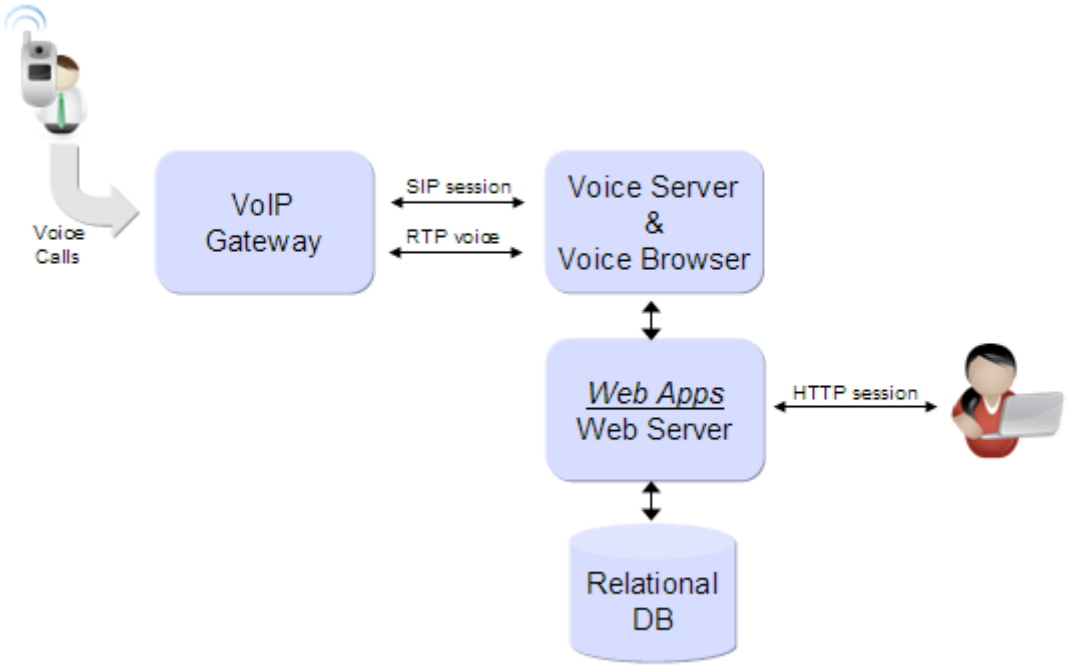

Figure 2: System Components Diagram

DESCRIPTION OF THE PILOTS

The main research question is "Can establishment of a close linkage and seamless communication mechanism among the key stakeholders in the agriculture system (i.e. agricultural extension worker, agricultural scientist, farmers, credit and marketing agencies) enhance farmers' utilization of extension services?

Although fundamental to the success of our planned pilot deployments, the technology solution is but one part of the planned engagement. Once we felt comfortable that as a team we shared a baseline understanding of the activities and challenges that constitute a "typical" year for the smallholder farmer in Sokoto and Abuja, we began to consider what would be required to field the MobileAnswers service we had been designing and developing. Focusing on the stakeholders – those categories of individuals who will play a fundamental role in the deployment of the pilot – is one way of organizing the myriad factors that need to be orchestrated in order for the pilot to be successful.

Stakeholders

In addition to the obvious two stakeholders we have already spoken of – the farmer and the agricultural expert – the other main stakeholders are the project managers and the trainers. While all the farmers who will participate are expected to be familiar with mobile phone usage (we are requiring that the farmers who will participate in the pilots will have their own mobile phones and that they reliably keep them charged) we will have to train them in at least the mechanics of the use of the MobileAnswers service (e.g., how to make calls, how to receive answers, how to follow up on a question or answer, etc.). How much additional training will have to be provided is still an open question. As has been repeatedly pointed out (e.g., Economist, 2009) there is a significant change in mind-set required for people to move from using a mobile phone primarily for communication purposes (i.e., social uses) to using it as an information device. We do not know if our sample of pilot participants will have undergone this transformation. The earlier discussion about the trust that people have with respect to interactions over the mobile phone is germane to this point.

We have already briefly mentioned one role of project managers when we spoke about the motivation for a monitoring function in the MobileAnswers service. The project mangers at each of the pilot sites (the two authors from each of the two Nigerian institutions) will be broadly responsible for the operational function of the pilot in their area. They will manage all aspects of the project; that is, define all aspects of both the MobileAnswers service and of the pilot, including tasks like preparing training materials, training the trainers, monitoring the pilot, and evaluating the pilot.

Evaluation is a major responsibility that will be ongoing throughout the project. As we noted earlier, we plan to iterate on the design and hope to deploy a refreshed service about three months into the pilot that addresses problems we encounter with the initial version we deploy. But the evaluation focus is broader since we are very interested in understanding whether the service (or some variant of it) can be deployed to a broader segment of the population in a sustainable manner. Thus the evaluation will focus not only on usage by the farmers (whether they are able to use it, whether it provides them value, what sorts of information is most useful to them, etc.) but also on how information provision, training and evaluation may be provided in a scalable manner. We will be drawing upon the personal connections of the extended team to engage the participation of agricultural experts and of suitable trainers for the pilot, but such informal efforts will not scale to support a broader service. We plan on using our learning from the pilots (if it turns out to be successful) to engage the appropriate people in discussions about how a service like MobileAnswers might be institutionalized to provide broader access to the population.

Study Area

The study areas are Sokoto and Abuja. In each study area five LGAs will be selected. On the whole, five farmers will be selected in each village giving a total of 25 farmers in each study area. We are considering whether we should select farmers with respect to their demonstrated level of farming expertise. As we noted earlier, we would expect information to be particularly important to the less knowledgeable members of a village. In addition, we will examine the gender distribution of farmers in the villages and would like to include women farmers in the pilots.

Purposive sampling technique will be used to select the farmers so as to ensure that those selected can operate mobile phones, have demonstrated ability to keep them charged and are keenly interested in the project. The service will allow questions about what to plant, how to care for what has been planted and local market conditions. Some of the questions expected to be asked by the farmers include: how to have access to production inputs (fertilizers, improved seeds, chemicals, etc)? What type of fertilizer, quantity, and time of application? Date of planting, spacing, weeding and harvesting periods for different crops? How to have linkage to credit facilities (Banks and non-banks)? Information on markets, storage and processing methods? Others could be information on the knowledge and experience of the experts.

During the pilot study, farmers will be trained on the use of the technology. We expect that a total of two trainings will be conducted for them. Mobile phone recharge card will be provided to each participant so as to keep him/her motivated in the project and cover their expenses with regard to participation in the pilot.

The evaluation of the service will include: data on the number of times farmers ask questions, the number of farmers having access to answers provided; data on response delay and frequency of responses to questions asked by the farmers and some evaluation of the quality of the answers provided by the experts.

Other evaluation questions include: the availability and coverage of the technology/network at all time and the ease of operation of the technology by the farmers. We will compile statistics on the number of times the technology fails to send, accept and convey messages to both farmers and experts. The pilot project will be carried out in a period of 3 – 6 months.

FUTURE WORK: EXTENDING THE SERVICE WITH SOCIAL COMPUTING CONTENT

As this work moves forward, we will explore the addition of new features that aim to further enrich the connections between farmers, experts, and monitors.

Each conversation between a farmer and expert is only immediately available to those two participants. This poses a challenge for experts since they may have to have the same or similar conversations with multiple farmers. In order to reduce the amount of work experts have to do and encourage information sharing, we are interested in providing a mechanism for users to share conversations they have found to be particularly valuable with others. We will explore providing a mechanism for explicitly sharing a useful conversation with another individual, with a group, or with their social network. We will also investigate allowing users to vote for their favorite conversations and make the most highly rated conversations available to all. Sharing through popularity provides a mechanism for broader information sharing while also providing an incentive to provide quality contributions (the best content is "showcased") and providing a model of what a quality conversation is like.

In the system described above, farmers receive a phone call when experts reply to their questions. However, there may be times when a farmer cannot take the call. Because of the lack of voicemail in many developing regions, it is usually not possible to leave a voice message for the recipient. Instead, we will explore sending a text message in situations when the voice call is not answered. Such text messages would serve as a more persistent reminder to farmers that information is waiting for them in the system. In situations where multiple messages have been received, it could indicate the number of messages and perhaps even from whom. The key is to make the system more "sticky" by developing new mechanisms to encourage users to participate more regularly.

While communication in the system is designed to be largely asynchronous (through the use of recorded messages), it needn't always be. Although, in general, we assume that farmers and experts will not be available to converse at the same time, we would nevertheless like to provide the opportunity for them to do a standard voice call if they are. The system might facilitate such communication by allowing experts to indicate times of the day when they are willing to take phone calls from farmers directly and routing calls to them appropriately during those times. The key with this approach is to allow experts to remain in control of the number of calls they get because they are the scarce resource in the system and avoiding overloading them is a central concern.

This last point raises the challenge of achieving balance in the system. As more farmers join the system, the number of questions they ask may overwhelm experts. In such a situation, new experts must be brought on quickly in order to avoid overload and subsequent burnout. Similarly, if too many experts are brought on initially, some may not receive enough questions to feel that their participation is justified. Thus, interactions between experts and farmers must be monitored to assure that "social balance" is achieved on an ongoing basis. One way to approach this challenge is to automatically monitor interactions between farmers and experts for signs of problems and alert human monitors (via voice or SMS) when issues arise. For example: reaching the point where each expert has to answer more than 5 questions per day or reaching the point where a number of experts are getting no questions at all. We might also look for imbalance within groups, for instance: when some experts are answering many questions while others answer none.

CONCLUSION

Given that we have not yet deployed our pilots, our conclusions are about process rather than about findings of the research. Foremost in our mind is the tremendous value we have all derived from this cross-domain, cross-institutional and cross-national collaboration. We have all been enriched by learning from each other in myriad ways we had not anticipated.

Our focus as we are about to begin the pilots is about sustainability. Not only on how to broaden project, but also how to support capacity building at the institutions and how the farmers might share their knowledge with those who we were unable to be involved in the study. On the university and technical training side, this project supports graduate students in Computer Science, Agriculture, and Social Science to develop skills in creating and deploying innovative mobile solutions that in the long run we hope will help to foster new avenues of knowledge work for Nigerian citizens. If farmers become skilled at using their mobile phones to interact with experts and information, and learn the value of providing information back out to their community (in digital or analog form), it opens the door in the longer run to a variety of positive societal outcomes, including broader educational opportunities and greater participation in civil society.

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