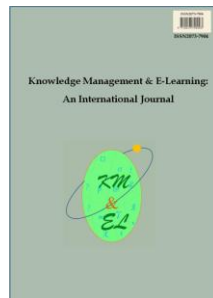

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Evaluation of spaced education as a learning methodology for in-service training of health workers in Ethiopia

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Abstract: Participation in in-service training can be a challenge for health workers, especially those stationed in remote areas. Spaced education is an innovative learning methodology that can be delivered electronically by Internet or mobile smartphone. This pilot study, which followed a convenience sample of 37 Ethiopian nationals enrolled in a spaced education course over a six-month period, attempted to determine the acceptability and effectiveness of the methodology in a low-resource context. The course content was co-developed by Ethiopian and international nutrition experts and focused on the recently revised Ethiopian Federal Ministry of Health (FMOH) guidelines on the feeding of infants of HIV-positive mothers. Conducted by the US Agency for International Development (USAID)-funded CapacityPlus project, led by IntraHealth International, the study suggests that the Internet-based spaced education methodology is acceptable and effective for the acquisition of knowledge in a low-resource context for course participants with a clinical or public health background and moderately reliable Internet access. More research is needed to test the feasibility, acceptability, and effectiveness of the methodology among a wider population of health workers in developing countries, and particularly among government and volunteer health workers in rural and remote settings.

Keywords: Spaced education; e-Learning; Continuing education; In-service training

Biographical notes: Kate Tulenko, MD, MPH, MPhil, has worked at the highest levels of health workforce, health financing, and health policy development. She has been an advisor to national governments on health policy and reform, and served on expert panels for the World Bank, World Health Organization, and other institutions.

Rebecca Bailey, MSPH, is a global health and education specialist with over 20 years of experience. She has contributed to key global health workforce initiatives, including the World Health Organization/Global Health Workforce Alliance task force on scaling up health workforce education and training.

1. Background

Health workforce development requires preservice education as well as sustained in-service training and continuing professional development to keep health workers up-to-date with the rapidly evolving knowledge base, including updated national policies and clinical guidelines. Without access to continuing education, health workers can rapidly become obsolete and incapable of delivering essential, life-saving care to individuals and populations. However, for busy health workers—especially those stationed in remote or rural areas—participation in face-to-face refresher courses can be difficult, due to the need to travel and be away from their health facilities, leaving patients without access to a health worker during their absence.

A number of innovative approaches have been developed to update health workers, especially in remote areas, using the Internet and mobile telephones. Spaced education is an innovative learning methodology that can be delivered electronically by Internet or mobile smartphone. The approach combines two core findings from educational psychology: the spacing effect and the testing effect (Kerfoot, Armstrong, & O'Sullivan, 2008; Kerfoot et al., 2007; Kerfoot, Kearney, Connelly, & Ritchey, 2009). The spacing effect refers to the finding that when information is repeated over spaced intervals, it is learned and retained more effectively than information presented only once. The testing effect refers to the finding that the long-term retention of information is significantly improved by testing learners on this information. Testing is not merely a means to measure a learner's level of knowledge but also assists in storing knowledge more effectively in long-term memory. Spaced education courses typically are composed of 20 to 25 questions (often case-based), each with its own explanation and learning points.

Harvard University developed an Internet-based platform for spaced education, using a computerized algorithm to select and deliver questions, and named the approach SpacedEd.com, later renamed QStream.com. This online methodology has proved, through more than 15 randomized controlled trials (RCTs), to improve retention of learned material (Kerfoot, 2010; Kerfoot, Armstrong, & O'Sullivan, 2008; Kerfoot, Kearney, Connelly, & Ritchey, 2009) and positively impact practice behaviors among health workers in developed countries (Kerfoot, 2009; Kerfoot et al., 2007; Kerfoot, Lawler, Sokolovskaya, Gagnon, & Conlin, 2010). For example, a 2009 study by Kerfoot et al. of over 400 urologists and urology residents showed that clinical guideline scores increased 56% more among the spaced education group than among the control group. In a 2010 randomized trial of 95 physicians at US veterans' hospitals, Kerfoot et al. found that a 36-week spaced education program reduced inappropriate screening for prostate cancer by 40%; this improvement was maintained for over a year after the spaced education program was completed. However, at the time of our study, Internet-based spaced education had not been tested in low- and middle-income countries, where the health workforce crisis is most acute. Conducted by the US Agency for International Development (USAID)-funded *CapacityPlus* project, led by IntraHealth International, this study was intended to test the effectiveness and acceptability of the spaced education methodology in a developing country context before creating a platform to deliver spaced education courses via standard mobile telephones (not smartphones) for use with health workers in remote health facilities.

2. Methods

The Ethiopian government had recently changed its guidelines on the feeding of infants of HIV-positive mothers, and the IntraHealth national staff needed updating on the new content. These staff members were asked to provide technical support and training to Ethiopian Federal Ministry of Health (FMOH) workers and to volunteer community health workers on a wide array of HIV/AIDS topics, including the new guidelines.

In order to test the effectiveness and acceptability of the spaced education methodology in a controlled environment in a low-resource setting, the study team worked with staff from IntraHealth's Ethiopia office. Effectiveness of a spaced education course on the feeding of infants born to HIV-positive mothers was measured through an increase in scores on knowledge-based exams administered before and after the course that focused on four overarching learning objectives. Effectiveness was defined by: 1) an average increase of at least 20 percentage points in the number of participants who responded correctly to pre- and post-test questions; and 2) agreement by more than two-thirds of course participants that the course objectives were clearly outlined, the course objectives were met, the course improved their knowledge of the subject, and the course was relevant to the Ethiopian context. Acceptability of the learning approach was defined as a composite of: 1) the proportion of participants completing the course; 2) the proportion of course participants who positively evaluated the course methodology; and 3) the proportion of course participants who indicated that they would like to take another spaced education course. Each participant was asked to respond to a survey that evaluated their opinions and experiences of taking the course and using the spaced education methodology. The pre- and post-course exams and surveys, which were administered through SurveyMonkey, gave participants an opportunity to explain their preferences and challenges related to spaced education in comparison with other learning methodologies.

The study was conducted among 37 participants in an Internet-based spaced education course on feeding of infants born to HIV-positive mothers in Ethiopia. The course content was co-developed by Ethiopian and international nutritional experts familiar with the new Ministry guidelines, adapted to the spaced education format, and uploaded to the SpacedEd.com website. The course content, which was developed and delivered in English, included information on breastfeeding, formula feeding, and weaning foods, with an emphasis on the changes in recent guidelines.

The director of the IntraHealth-led USAID-funded Ethiopia Community Prevention of Mother-to-Child Transmission (PMTCT) of HIV/AIDS project invited staff at the IntraHealth office in Addis Ababa to participate in the course. As a courtesy, staff in the United States Agency for International Development (USAID) offices in Addis Ababa and the Ethiopian Pediatric Association also was invited to enroll. The project director explained the methodology and the requirements to course participants.

Course participants then signed up and began taking the course online. This pilot study of the course, which ran for six months from December 2010 until May 2011, included 23 different questions in the SpacedEd.com format, which were delivered to course participants via e-mail. Because the course was highly focused on the topic of feeding infants of HIV-positive mothers, the course consisted of only one module. The SpacedEd.com format involves sending a learner an e-mail containing a case-based learning scenario and a multiple-choice question. Learners can choose to receive from

one to five questions per day. When participants click on “answer” in the e-mail, they are automatically routed to the SpacedEd.com website where the question reappears with a multiple-choice response (Fig. 1). Upon submitting their answer, the learner is immediately presented with the correct answer and learning points germane to the question. The learning points often include photos and illustrations embedded in the response to further the learning and to provide opportunities for students who learn more visually. Other materials and references were also accessible via clickable Internet links embedded in the response. Each question is presented over spaced intervals of time in a series of cycled reviews to take advantage of the spacing effect until it has been answered correctly a predetermined number of times. The number of repetitions depends on whether a course participant answers a question correctly or not. If the learner responds correctly to a question a predetermined number of times, then the question is retired. If the learner responds incorrectly to a question (Fig. 2), it is cycled back into the queue and presented to the learner in a future session. The course is completed when the learner responds correctly to all course questions a preset number of times. During the six-month course, a number of reminder e-mails were sent to participants to encourage them to continue answering the questions.

The screenshot shows a web browser window displaying the SpacedEd.com interface. The browser's address bar shows the URL: <http://capacityplus.qstream.com/rbailey/classes/144976/questions/109>. The page header includes the CapacityPlus logo, the tagline "Serving health workers, saving lives.", and user information for "Rebecca Bailey" in "English". Navigation links for "Browse courses", "How It Works", and "My Dashboard" are visible. The main content area features a question titled "Question from 'Feeding of Infants of HIV-positive mothers'". The question text is: "For HIV-positive mothers who receive no PMTCT interventions, what is the chance that their babies will become infected with HIV through breast milk alone?". Below the question, there are four radio button options under the heading "Choices":

- About 10-15% (Few of the babies)
- 30-40% (One out of 3 babies)
- Higher than 50% (More than half of the babies)
- 100% (All the babies)

 A blue "Submit" button with a right-pointing arrow is located below the choices. The Windows taskbar at the bottom shows the system clock as 11:20 PM on 8/20/2013.

Fig. 1. Sample question as presented on the SpacedEd.com interface

You	Key	Choices	Responses
	✓	About 10-15% (Few of the babies)	60%
▶	✗	30-40% (One out of 3 babies)	38%
	✗	Higher than 50% (More than half of the babies)	1%
	✗	100% (All the babies)	
			63 responses

Sorry, Your answer is incorrect!
This question will be resent on 08/21/13

Explanation

Breast milk contains all of the elements needed for perfect infant nutrition and good health for the infant up to six months of age. Breast milk also can transmit HIV infection. A baby is at risk of HIV transmission the entire time an HIV-positive mother breastfeeds her child. However, more babies become infected during the pregnancy and delivery periods than through breastfeeding. 20 out of 100 babies will be infected during pregnancy or delivery while 12 out of 100 babies will be infected during breastfeeding.

PMTCT interventions will decrease the risk of transmission. Counseling mothers to exclusively breastfeed in the first six months decreases HIV transmission, when compared to breast feeding and giving infants foods and other liquids including water. Exclusive breastfeeding means giving the infant nothing but breast milk (no water, no other liquids or foods) during the first 6 months of life. Giving other foods and/or liquids during the first six months of age can damage the lining of the stomach making it easier for HIV to be transmitted to the child. Also, when HIV-positive mothers exclusively breastfeed their infants in the first six months, fewer of these infants die in the first year of life, compared with infants who are not exclusively breastfed. The risk of HIV transmission also decreases when HIV-positive mothers and babies receive HIV prophylaxis (PMTCT medications).

Fig. 2. Sample feedback to a question that was answered incorrectly

2.1. Study limitations

The goal of the pilot study was to test the effectiveness and acceptability of the spaced education methodology in a low-resource setting. A number of study factors may have limited the strength of the findings in relation to the acceptability and effectiveness of spaced education, as well as their applicability to other health worker populations. These included the size and characteristics of the study population, the language in which the pilot course was conducted, irregular access to the Internet by study participants, and the absence of measures for behavior-change and long-term retention of knowledge in the evaluation of the effectiveness of the learning methodology. The study did not attempt to evaluate Internet feasibility. Internet access poses a barrier in low-resource settings and has potential to impact the overall effectiveness of the course. In order to justify the development of a platform to deliver spaced education through standard mobile phones (not smartphones), the pilot focused on evaluating the acceptability of the spaced education learning methodology and its effectiveness in increasing the level of knowledge among course participants within the Ethiopian context. Because access to the Internet is limited in rural areas of Ethiopia, the study participants were not representative of health practitioners in rural areas, nor were they representative of volunteer community health workers. A small convenience sample of clinicians, trainers, and health program managers, who had access to the Internet, participated in the study. Almost all of the participants were Ethiopian nationals employed by IntraHealth International and based in Addis Ababa. The participants had baseline knowledge and skills similar to that of rural health workers employed by the FMOH. Finally, the pilot was conducted in English, rather than the Ethiopian national language of Amharic, and did not attempt to assess long-term retention of knowledge nor behavior change among the study

participants. The pilot study tested the effectiveness of knowledge acquisition and retention six months after the beginning of the course.

3. Results

3.1. Study population

A total of 44 individuals signed up for the SpacedEd.com course. Of these, 37 successfully completed the course and the subsequent survey, which represents a completion rate of 84%. Of those successfully completing the course, 35 were Ethiopian nationals employed by IntraHealth, one participant was from the FMOH, and one was from the National Pediatric Association. No participants enrolled from USAID. All participants had a clinical and/or public health background.

3.2. Acceptability of spaced education as a learning methodology

Participants who completed the course and the online survey demonstrated great enthusiasm for the spaced education methodology. All but one of the participants indicated that they would like to take another spaced education course.

Most users indicated that spaced education was most appropriate as an education modality for refresher material, such as updates on revisions to clinical practice protocols, rather than for topics that they would learn for the first time (Fig. 3). Eighty-four percent stated that they would prefer spaced education to face-to-face courses and standard Internet-based courses for refresher material. In comparison, only 36% indicated a preference for spaced education for material that they would learn for the first time. Most users (61%) stated a preference for face-to-face courses in this situation. Most users (61%) stated a preference for face-to-face courses in this situation. A finding relevant to these observations is that 40% of those surveyed had never taken an Internet-based course in the past.

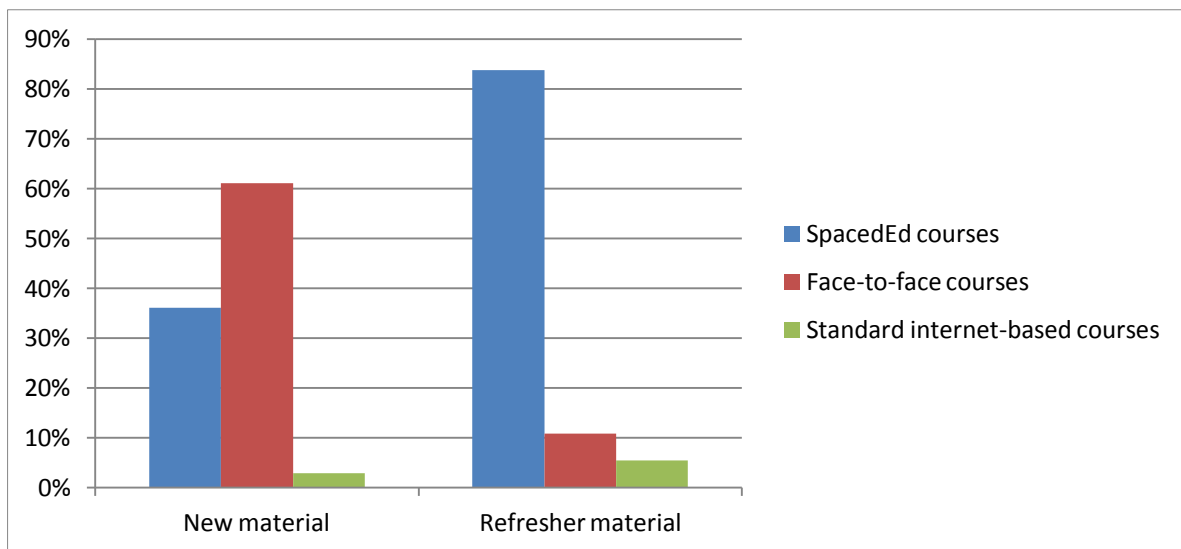


Fig. 3. Participants' preferences of different learning modalities for new and refresher material

One of the key features of SpacedEd.com is the flexibility that course participants have to make limited modifications to the frequency and number of questions delivered to their e-mail inboxes. A number of participants used this feature, with almost two-thirds of respondents (23 out of 36) changing the frequency of the questions to suit their needs, and a similar number (22 out of 37) changing the number of questions delivered each time. On comparing these two sets, it was found that 28 unique users (75.6%) chose to modify at least one of the two parameters.

Most users (94%) chose to receive their questions at intervals of between one and three days, with many users (43%) choosing to receive questions every two days. Almost two-thirds of participants (65%) indicated that they would like to receive three to five questions per e-mail, with another fifth (19%) stating that they would prefer two questions with every e-mail.

3.3. Participants' evaluation of course content

When asked about the difficulty of the questions presented during the course, almost two-thirds of the course participants, who all had clinical and/or public health backgrounds, noted that the questions were appropriately challenging. Over a third indicated that the questions were easy, and no one claimed to find the questions hard.

When asked about the effectiveness of the explanations provided, over half (57%) gave the explanations the top rating, calling them clear and concise. The rest indicated that improvements could be made in terms of quality and clarity of information.

Around 90% of course participants agreed with each of the items when asked whether the course objectives were clearly outlined (89%), the course objectives were met (92%), the course improved their knowledge of the subject (92%), and the course was relevant to the Ethiopian context (97%).

Many participants shared comments about the course. The majority of these comments were positive. Below is a sample of the comments received:

- “The course content was appropriate to the Ethiopian situation and the level of the majority audience.”
- “I agree with [the] content.”
- “I would like to appreciate and say thank you [to the] course organizer and please continue to support us by organizing similar programmatic related course[s] so as to enable us to achieve our organization mission.”

While there was strong appreciation for the course content, there were also a number of suggestions for improvement, including the following:

- “Please include reading materials that could be easily downloaded from the web after the question is being tried (usually in a .pdf format).”
- “It can include some questions that challenge the traditional practices affecting feeding practices positively or negatively.”
- “Include more of the contextual issues or experiences of Ethiopia.”

3.4. Effectiveness of spaced education as a learning methodology in a low-resource setting

Before starting the course, participants were asked a series of pre-test questions on the feeding of infants born to HIV-positive mothers to assess their baseline knowledge. After completing the course, participants were asked a second set of questions related to the same overarching learning principles as a post-test to assess any change in their knowledge. The pre- and post-course questions were administered online through the SurveyMonkey platform and linked to four learning principles: 1) the risk of mother-to-child HIV transmission in general and associated with breastfeeding, 2) optimal breastfeeding practices, 3) optimal complementary feeding practices, and 4) prevention of common breastfeeding problems. Unless the individual had an accurate understanding of the principle being tested, it was unlikely that they would answer the question correctly.

Course participants performed very well on these questions after completing the course, with almost 90% answering three of the four questions correctly, and over 80% answering the other question correctly. A total of 70% of course participants answered all four questions correctly.

The percentages of course participants who correctly answered questions before and after taking the SpacedEd.com course are depicted in Table 1 and Fig. 4. The data show significant increases in knowledge for the majority of the learning principles, with the knowledge of most learning principles increasing around 30 percentage points. There was no increase in knowledge in learning principle 4, for which participants' baseline scores were the highest out of all four learning principles. We hypothesize that the participants who scored low on learning principle 4 probably did so due to deeply held cultural beliefs that the brief spaced education course was not able to unseat.

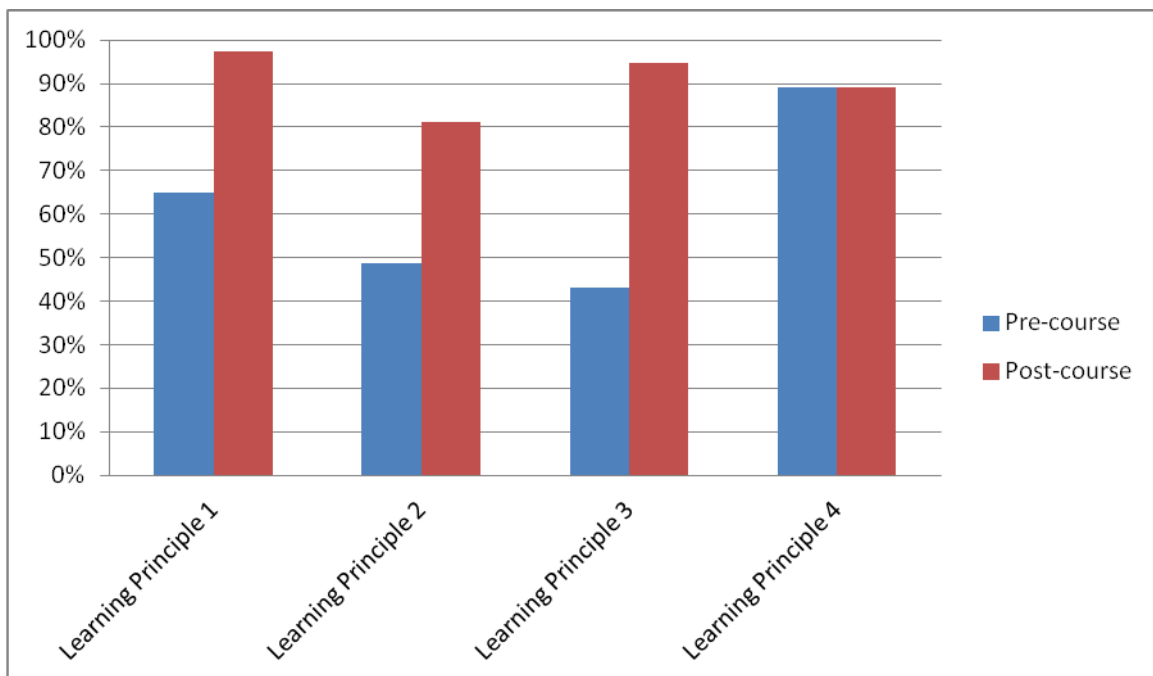


Fig. 4. Accuracy of participants' pre- and post-course answers to questions testing the same learning principle

Table 1

Percentage of participants correctly answering learning principle questions, pre- and post-course

	Learning principle 1: Risk of HIV transmission through breastfeeding	Learning principle 2: Optimal breastfeeding practices	Learning principle 3: Optimal complementary feeding practices	Learning principle 4: Prevention of breastfeeding problems
Pre-course	64.9%	48.6%	43.2%	89.2%
Post-course	97.3%	81.1%	94.6%	89.2%

3.5. Challenges with technology

At the time of the study, Ethiopia was a country of low Internet bandwidth. Although the participants were based in the capital city, where Internet is more widely available than in rural areas, 51% found irregular Internet access to be a barrier to consistently accessing the course content. Irregular access to the Internet could have disrupted the preferred timing of questions sent to course participants, extended the amount of time needed to complete the course, and caused frustration among the course participants. Yet even with irregular Internet connectivity, more than 80% of participants were able to complete the course on time and respond correctly to the post-course questions.

Additionally, 54% of participants had difficulty enrolling and were confused by the enrollment process. A likely reason was that 78% of users found the invitation to join the course had been erroneously delivered to the spam folder in their e-mail accounts. Other technological issues impacted the delivery of course content but were promptly identified and corrected. They included inconsistencies with time zones that were caused by servers located in the US, which led to inappropriately spaced delivery of questions and difficulties with multiple user accounts for the Ethiopia-based participants. All of these issues were communicated to the engineers at SpacedEd.com and subsequently rectified.

4. Conclusions

The Internet-based spaced education methodology is known to improve learning retention and adherence to clinical protocols among health workers in the developed world. However, the utility and effectiveness of the spaced education methodology in low- and middle- income countries has yet to be proven. This pilot study, which followed a convenience sample of 37 Ethiopian nationals enrolled in a SpacedEd.com course over a six-month period, was an attempt to determine the acceptability and effectiveness of the methodology in a low-resource context.

The high course completion rate (84%) among the study participants, combined with their expressed satisfaction with the course methodology and increased comprehension of the course material, indicate the utility of spaced education to low-resource settings. The course participants found the spaced education format, with questions spaced over time, to be acceptable and preferable to face-to-face sessions for updates or refresher courses on previously covered material (i.e., refresher training). It is not surprising that the participants preferred spaced education for updates or refresher courses rather than for initial learning of a subject; although SpacedEd.com does have interactive features, it is not as interactive as face-to-face learning or other forms of distance learning such as live webinars. The case-based question format also does not lend itself to the teaching of large volumes of information at a single time. For three of the four main content areas, the number of participants who responded correctly to post-course test questions increased by 30 to 40 percentage points from the pre-course test results. For the fourth main content area, 89% of course participants answered correctly in both the pre- and post-course exams.

This study also highlighted findings that are relevant to the optimal use of spaced education. For example, most users indicated a preference for receiving between two to five questions per e-mail, with a spacing of one to three days between each e-mail. The fact that most users chose to modify these parameters to suit their needs makes the case for retaining the customizable functionality of SpacedEd.com.

In order to fully benefit from the spaced education methodology, barriers to Internet access must be overcome. Development of a mobile phone platform to deliver spaced education using Interactive Voice Response (IVR) technology holds great promise for circumventing unreliable Internet connections and enhancing the reach of the learning approach, especially among health workers in rural and remote areas. *CapacityPlus* is in the process of testing a mobile phone IVR platform for spaced education through a pilot in Senegal with rural nurses and midwives using standard mobile phones.

The results of this study suggest that the Internet-based spaced education methodology is acceptable and effective for the acquisition of knowledge in a low-resource context for course participants with a clinical or public health background and moderately reliable Internet access. More research is needed to test the feasibility, acceptability, and effectiveness of the methodology among a wider population of health workers in developing countries, and particularly among government and volunteer health workers in rural and remote settings.

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