THE EDUPHONE: INTERACTIVE ELEARNING FOR DEVELOPING COUNTRIES

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Abstract

This paper reports an effort to make distance education in developing countries inclusive by introducing interactivity in an easily accessible manner. A Learning Management System used with communication enabled by mobiles has been developed. This is used in combination with video and innovative pedagogy to create a large-scale accessible interactive learning environment for students. The issues addressed by the work are (1) how to arrange accessible low-cost distance tuition requiring only minimal ICT infrastructure and (2) how to make education interactive. Goal 1 is achieved by building a learning management system using existing sms infrastructure and testing it in Bangladesh. Goal 2, much more complicated and a long-term effort, is addressed by the pedagogy developed and implemented in TV/video lessons to accompany, and guide, the electronic communication. This paper briefly describes the project which involves technology design, development and testing, curriculum development, teacher education for interactive learning, and a new business model for educators.

Keywords: e-learning, learning management system, LMS, education in developing countries, sms, mobile phones, distance education, interactive video, m-learning

1. Introduction

Because the Internet is not likely to be available on a large scale to people in developing countries much hope is put on mobile phone technology, a technology which already is quite readily available and, what is more, indeed used even in rural areas. In a recent demographic (Rahman, 2007) study at a particular village in Bangladesh it was shown that less than 1% households own a computer while 27% own a TV and 47% own a mobile phone. Clearly mobile phone technology is a less versatile and capable medium than the Internet so it is not clear just to what extent and how it can be used to replace it. How much of the activities that are offered online to people in the industrialized world can reasonably be made available to people in developing countries over mobile phones? Yes, mobile phones can access Internet, but not yet everywhere and Internet over mobile phones is not cheap. The eduPhone™ project, a joint effort between Örebro University, Sweden, and Soft-Ed Ltd, Bangladesh, develops various applications of basic mobile phone technology to address important problems in developing countries. We develop not only technology but also, and not least important, associated working methods which are necessary to make best use of the available technologies. The intertwovenness of technology and work methods is demonstrated by this paper which reports one of our applications, an effort to improve distance education by making it available to all by introducing interactivity in a way that people with low levels of literacy can also participate. This effort means two major challenges. The first one, availability, requires meaningful communication related to pedagogy and administration of education to be conveyed in a quite limited communication format. The second, interactive education, requires introduction of new ways of teaching delivery and learning into a long-standing tradition of one-way lecture teaching. This paper reports some success on both these challenges with a focus on the first.

1 eduPhone is Trademark 394743 issued by Swedish Patent Office (http://www.prv.se/)
Literature review

E-learning has been promoted as a way to overcome physical distances, availability problems and teacher shortages (UNESCO, 2006). Yet most m-learning (using mobile technologies for education) initiatives mainly use high end mobile technologies e.g. PDAs, Smartphones, WAP technologies (MobiLearn, 2008; M-Learning, 2008; Ericsson, 2002). These technologies focus on delivering content (Leung, 2003) through the mobile set, which has obvious limitations.

Many m-learning designers borrow from their e-learning experience, which basically means trying to fit e-learning methods and tools to small screens (David 2008). Our approach is rather to start from a pedagogical context and fit the technology to that.

Some applications are designed based on inspiration from games, e.g. the Mportal which includes a virtual tutor and skills-based learning materials (Mitchell, A. 2003), which is also a technically advanced approach. The approach taken by Librero, 2007, is that SMS (Short Message Service) messages inform students of the exercises to be attempted after completion of previous exercises. It was found that students become engaged as the SMS messages take on the form of personal intimation.

There is also a concern that “e-learning” is more about providing teaching material and less about improving teaching methods by means of interactivity, which has proven to be a main enabler for student retention, performance and satisfaction (Jiang & Ting, 2000; Zhang, et al, 2006; Eastmond, 2000). Podcasting involves downloading a series of audio or video broadcasts (files) onto a digital media player, via a computer, over a period of weeks. These can then be watched or listened to when, where and as often as students choose (Evans 2008). Podcasting includes delivering material but not interaction. Podcasts have been employed extensively in some countries and are now being tried at a number of universities in Australia. They allow ubiquitous learning whereby students can access a variety of educational material anywhere, anytime on iPods, MP3 players or even desktop computers (Nataatmadja et al. 2008). All these tools require relatively sophisticated end user equipment and Internet access.

Interactivity in the classroom using classroom response systems (Fies, 2006) is reported to promote a more active learning environment. Some tools are designed for classroom learning, integrating mobile devices into face-to-face learning situations, such as the ConcertStudeo which includes tools such as brainstorming, quiz and voting (Dawabi, et.al. 2003). Moving to simpler technical solutions, (Bollen, et al. 1999) allowed students to send SMS messages on various discussion topics which were aggregated and categorized by the instructor using an electronic whiteboard in the classroom. The categorization can be done by criteria such as sender, receiver, time, and others.

Recent research (Librero, 2006) includes using mobile phones and SMS within the classroom due to the ubiquity of mobile phones among students and the interactive potential of SMS. SMS is a low-threshold application used widely by students to quickly send concise, text-based personal messages at any time. The research presented involved students sending SMS in real-time, in class, via their personal mobile phones. Using a modem interfacing with customised software to produce SMS files, the lecturer could view the messages and verbally develop the interactive loop with students during class. The SMSs are available online after class, allowing interactive loops to further develop via threaded comments (Markett, et. al. 2006).

In summary, most m-learning applications use high end mobile technology, and often within class rather than at a distance. As high end mobile applications that require state of the art mobile phones are not readily available in developing countries our approach was to try to implement some of these tools, and some more, in distance tuition using only low-tech solution.

Case study background

As a complement to traditional education, distance tuition is established in many countries in an effort to increase access. In Bangladesh, the Bangladesh Open University (BOU) provides distance tuition to, currently, some 300 000 students all over Bangladesh since 1992. Education material is mainly printed in books and distributed to students. Some lectures are videotaped and made available on VHS at local tutorial centers; some of them are also broadcast on national TV. A well recognized problem is low throughput. Even though official statistics are missing it is clear that only a fraction (estimated around 12%) of the enrolled students sit exams. A hypothesis underlying our work, one that finds support in experiences form distance tuition in the industrialized world, is that at least some of the reasons for this low throughput are poor or no communication between teachers and students, traditional inefficient teaching methods and underdeveloped use of local learning centres. These are issues that have been given much attention in distance education in Sweden, and successfully so. Throughput at Swedish university level distance tuition is today over 60 % according to the Swedish
coordinating agency. Given this success, paralleled in other countries, our basic idea is to try to introduce some of this thinking in the environment of developing countries using the mobile phone medium as one important, enabling ingredient.

Existing infrastructure for mobile telephony is already very good in developing countries. The World Bank estimates that 77 per cent of the world’s population is within the reach of mobile phone network (Kenny & Keremane, 2008). In Bangladesh mobile network coverage has today reached about 97 percent of the country’s population and 82 percent of the land area (ASDB, 2007). Competition among mobile operators has significantly reduced tariff rates and availability of low-cost phone sets has attracted subscribers of financially constrained groups. Although nearly half of Bangladesh’s more than 140 million people still live on less than a dollar a day it had 39 million mobile phone subscribers by March, 2008 (BTRC, 2008). This means one out of four Bangladeshis has a mobile subscription and the number is forecast to increase (ASDB, 2007). Computer access, on the other hand is miniscule (Rahman, 2007), concentrated to urban areas, and is not expected to increase dramatically in the foreseeable future.

Based on these preconditions, the eduPhone application “Bangladesh Virtual Interactive Classroom” (BVIC) develops interactive teaching methods and technical tools designed for the infrastructure in developing countries. Many ICT aid programs invest a lot in expensive technology, such as putting computers in schools. This sometimes succeeds, sometimes fails, and the main factor distinguishing success from failure is to what extent the technology fits into the context in which it is to be utilized and maintained. BVIC uses existing technical infrastructure, video and SMS, together with a learning management system to implement innovative pedagogy and create a learning environment for students. We develop sustainable strategies for ICT use in education including curriculum development, teacher education for interactive learning, technical tools for large-scale interactive learning using existing mobile technology infrastructure, and a new business model.

This paper addresses the research question of, What is the potential of sms technology for education in developing countries. This question includes challenges relating to pedagogy and teaching methods, technical tools for learning and communication, and institutional arrangements. The paper discusses these challenges by means of the illustrative case of the BVIC. We present the technology we have developed, achievements in pedagogy and course delivery as well as intermediate research findings, and we discuss the challenges ahead.

Method

The BVIC, as all eduPhone applications, is basically an action research endeavour designed to follow the principles of Canonical Action Research (CAR; Davison et al, 2004). The CAR principles concern the cooperation between researchers and practitioners during a project and are designed to both ensure scientific quality and make the most of the researchers’ participation in the project. A CAR project is designed as a cyclical process involving five stages: diagnosis, planning, intervention, evaluation and reflection. This paper mainly reports stage three, although elements of evaluation are also touched upon.

The BVIC project involves both practitioners and researchers. The practitioner side was primarily Sida (Swedish International Development Cooperation Agency) through its affiliate SPIDER (Swedish Program for IT in Developing Regions), focusing on ICT4D and acting through a network of Swedish universities. The project was conceived by researchers in Sweden and Bangladesh. Ideas and prototypes were developed and project ideas were conveyed to practitioner organizations in Bangladesh. A partnership was set up with BOU and Soft-Ed, a local software company, in which roles were clearly distinguished. Research involved is done by Örebro University, Soft-Ed develops the interactive pedagogy and the software applications and provides teacher training, BOU supplies teachers, physical facilities, and administrative support. Video recording is done at BOU, by local technicians and with participation of interactivity expertise from Soft-Ed. The research parts of the project are clearly separated from the development work and come in three forms.

1. Preparatory grounding. All prototypes draw on research in several fields; information systems development, human-computer interaction, computer-supported cooperative work, e-learning, pedagogy, and development.

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http://www.hsv.se/reports/2005/reviewofswedensnetuniversityfinalreport2accessibilityrecruitmentandextrafundina 
g_5.539a949110f3d5914ec800074275.html
2. Underway research points are identified which require scientific methods; e.g. usability testing of prototypes, sociological investigations of local communication networks, and technology use patterns.

3. Following real-world implementation are effect studies, including e.g. effects on learning, uptake, and user satisfaction.

In summary, the findings are based on the following investigations:

<table>
<thead>
<tr>
<th>Study object</th>
<th>Test variables</th>
<th>Participants</th>
<th>Method(s)</th>
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<tbody>
<tr>
<td>Feasability of mobile</td>
<td>Use, Usability, Acceptance of</td>
<td>People in rural Bangladesh and Cameroon</td>
<td>Interviews, Tests of pilot systems followed by acceptance, usability and learning (objective) tests, as well as subjective experience (Grönlund &amp; Islam 2008; Razzaq &amp; Sayed 2008; Tambe 2008)</td>
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<td>technology</td>
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<td>Student role</td>
<td>View of education, Use of tools</td>
<td>People in rural Bangladesh and Cameroon</td>
<td>Qualitative interviews, Questionnaires (Andersson &amp; Hatakka, forthcoming)</td>
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<td>Students’ use of ICT/LMS</td>
<td>and resources, View on tools and resources</td>
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<tr>
<td>Prototype LMS tool</td>
<td>Usability</td>
<td>Individual students</td>
<td>Test and discussion / interview (Islam et al 2005)</td>
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<tr>
<td>Teaching</td>
<td>Usability, Feasibility, Learning</td>
<td>Students (classes in action),</td>
<td>Experiment (intervention group and control group), Questionnaire for usability and feasibility, Test of learning (Islam et al 2005)</td>
</tr>
<tr>
<td>Prototype TV lessons</td>
<td>Feasibility for teaching, Feasibility for implementation at BOU</td>
<td>Teachers (mainly at BOU), BOU management, BOU administrators, Students at BOU</td>
<td>Demonstration and discussion</td>
</tr>
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<td>“Sharp” TV lessons</td>
<td>Doability, Teacher acceptance,</td>
<td>Teachers Students</td>
<td>Recordings followed by technical and pedagogical evaluations, several iterations, Questionnaire to students, Interviews with students and teachers</td>
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<td></td>
<td>Economic feasibility</td>
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**The eduPhone ideas**

The most basic idea behind the eduPhone concept is availability to all, including those in rural areas with limited access to resources. Our investigations so far have led us to believe that mobile phone technology is not only widely available in most developing countries but also in fact used, also by poor people (Grönlund & Islam, forthcoming). We have seen that income is no predictor for mobile phone use but age is – younger people and people with children have phones, and they use them. We have seen that in developing countries, like in the industrialized world, this technology is a modernity factor. Young people want mobile phones. In our tests we have also seen that use of technology is not a problem. Not only young people but also Bangladeshi farmers who have never used a phone before, are quite able to quickly learn the basics. Clearly most use of mobile phone is social; people want to communicate with other people, but our enquiries and trials in rural areas in Bangladesh (Razzaq & Sayed, 2008) and Camerun (Tambe, 2008) have shown that people are also interested in information important to their profession, even if the information is not for free. Therefore we believe that although low cost is important the key is to make information useful and readily available. This led us to a “minimalist” approach. While most e-learning efforts are designed to provide as much information as possible so that the user can choose, our approach – clearly also strongly governed by the “narrowband” medium we use – is to provide only the most essential information. What is “essential” is decided by our design. In the case of the here presented BVIC, our idea is that good pedagogy is basically about a good communicative relation between teachers and students, and among students. Our design hence mimics an ordinary classroom where there is a benevolent teacher dedicated to make students understand, and where students have classmates to talk to and discuss with. This is in contrast to much e-learning which revolves around the strongly self-motivated student who, like a lone rider conquering the unknown, seeks and finds knowledge in a vast knowledge repository. The two ideas may not be altogether mutually exclusive, but they differ in that our model does not
seek to replace the teacher. We believe that even though students may be well motivated there is a strong need for structure, in particular at lower levels in the education system, and this structure is to a large extent given by the teacher (other factors include institutional and procedural arrangements). We also believe that because motivation level differs, structure is a means to retain also students with lower motivation.

But motivation is not all. We believe being part of a class is a social good that distance students often lack. Experiences from Swedish distance tuition clearly show that where students work more together there is less dropout. Hence our ambition to create a “virtual classroom” is also in the hope of making people feel more connected. Education is also a social activity.

The BVIC technology

In the Bangladesh Virtual Interactive Classroom project, SMS and voice communication is used together with TV/video to make lectures interactive. To support course delivery a Mobile Learning Management System has been developed. The mobile application as well as the whole concept has been tested in laboratory-style settings in physical classrooms as well as on national TV at BOU over two years. From this work we have arrived at a technical solution and a working method that works well. During 2008 BOU is running a first large-scale pilot course (English 2, second year) which involves some 70 000 registered students. Recordings were done in a BOU regional centre in Dhaka, including real students in the studio to give both students and teachers a live feel. Although the video is not live when it is ultimately aired, it gives the feeling of a ‘live’ classroom, as confirmed by interviews of students watching the videos.

The process change under implementation includes improving teachers’ skills on how to teach in an interactive manner and how to organize teaching material for interactivity as the subsequent video is played. Curriculums have to be revisited, lectures redesigned, and presentation and interaction practiced. This project develops both interactive technology and interactive teaching methods. Starting with the technology, behind the cartoon view we have built a quite comprehensive SMS-based system involving a number of tools for communication between students and teachers. There are basically three different sets of tools; for learning and communication, for administration, and for teacher support.

Learning management and communication tools

The basic thrust of our system and method is to bring the teacher and the students closer to each other, as far as this can be done given the distributed setting and the limited communication facilities available. The following tools have been implemented and tested to support and enhance learning.

Self Assessment Quiz: after finishing a chapter, a student can download a quiz based on the chapter. This is done by sending BOU Z <lesson number>. The students can take a quiz whenever they want, as many times as they want. The students are given random questions from a database.

Questions during class: students respond to questions by the teacher during class time by sending BOU Q <selected response>. The response is simply a, b, c or d. The students subsequently see a bar graph of the answers sent in. The teacher then discusses the responses and dials a student from among those who have answered wrongly. The conversation is heard by all the viewers.

Participatory Cards: The teacher on video asks a question like, “In your opinion, how can language learning be made easier?” The students respond by SMS sending keywords after BOU P <opinion>. The incoming opinions are displayed on a monitor as individual rectangular boxes as they come in. The students are then able to visualize the responses and group the ideas together to come up with collective strategies in response to the question. It has been found that students take ownership of the process and results. This is a workshop technique adapted to students watching a video lesson.

Homework/Assignments: Not mainly technical function but a task given to students which can be reported using other functions. Homework is coupled to the learning partner idea.

Learning partner: This is also not only a technical function but a pedagogical approach. It is well known from distance tuition research and practice that students who have a social network in class are less likely to drop out than those who work alone. Hence it is a good idea to group them together so they can share experiences and spur each other. The students have to register as a pair in the language BVIC class. They do this by sending an SMS as BOU LP <own ID> <partners ID> <partners mobile number>. When the partner confirms with a similar SMS the pair is registered. Tasks, such as “homework”, are designed to get the partners work together, e.g., they have to send in comments on each others work. Each comment will be recorded in a database. Each comment will be counted as one mark.
**Meaning:** Students can get the meaning of words given in their text as vocabulary by sending BOU D <word>. This returns the meaning and a sentence with the word. As a future development, students can also get the pronunciation of these words.

**Reading:** Students are encouraged to read and learn by texting BOU R. This returns a short (<160 character) paragraph from a story. In return for key words that express the main idea of the paragraph students get the next paragraph. This way, students can complete stories that are stored in the server.

**Administrative tools**

**Registration:** To participate in electronic course interactivity students must register. This is done by SMS and checked against BOU course registration files.

**Attendance:** Students can register for each class. Registration gives access to all the other tools. Students can just watch the TV show, but without registration they can not take part in activities. This function also gives the teacher a view of who is watching, and how many. Lesson by lesson attendance can also be monitored.

**Course information & rules:** Practical information about the course is disseminated over SMS, such as performance criteria, available tests, deadlines, etc (e.g. “You have to pass 8 out of 10 classes to pass the course”). These messages are not just one-way information, they also include feedback, such as reminders like “Don’t forget to take the quiz, you haven’t done that yet”.

**Results:** Results of each student’s answers to SMS questions are communicated individually to each student; “Congratulations, you attempted 10 out of 10 Q’s, 9 correct”.

**Teacher support**

The above functions are automated so the teacher only does preparatory work, such as preparing or updating the course dictionary, or follow-up analysis such to see how many students took the tests, what the results were, etc. Such statistics, provided by a report generator, give BOU teachers a new view of student activity and results. Previously they had no contact with the students before the final exam after the course is completed by the end of the year.

During class the teacher is busy as the allotted time during a TV show is very limited so s/he needs to be disciplined and informed for the interactive parts. To support a ‘live’ show our system provides a “dashboard” available during class on the computer. This provides results from SMS questions asked during class and numbers to call. The teacher can see the number of correct and incorrect answers and the telephone numbers corresponding to each answer. Based on this information s/he can call one of the students, by clicking on one of the telephone numbers, to discuss the answer. For example, if there are many incorrect answers the teacher may want to understand why so many people got it wrong. S/he might then choose to call someone who got it right so as to let that student provide an explanation which may help other students better understand the reasoning. Or s/he might call someone who did not get it right to learn just why people get it wrong. This interaction can take place during class or privately after.

To support the BVIC video lessons, the tutorial or learning centres would need to provide assistance in understanding assignments and provide feedback after the assignments are corrected. During a semester two or three such assignments with published guidelines and deadlines would be given. Final exams would be held at the learning centres at pre-announced dates. BVIC would then become part of distance tuition courses.

**Interactive teaching**

The mobile application as well as the concepts on how best to run the BVIC have been tested in various ways in physical classrooms and live on TV at Bangladesh Open University (BOU) over three years. Starting from the basic idea of interactivity we first developed a prototype for the mobile application as of above and tested it in a setting with two ordinary classrooms. The same teacher served both classes. In one he was physically present, in the other he was visible through TV and interacted through the SMS system. Learning in both classes was compared and found to be the same (Islam, et. al, 2005). This showed that the method of teacher-student interaction through SMS worked and that usability was satisfactory.

Next we developed a video showing an interactive TV-sent class to demonstrate our ideas to BOU in a hands-on way. Traditionally, BOU teachers do not work with students. They produce lectures based on literature and deliver them as speeches on (recorded) TV. Hence, both interaction in general and the specific technical implementation of it had to be clearly demonstrated. After successful demonstration BOU agreed to develop a
complete course in this fashion, “English 2”, which engages some 70 000 students starting in Spring 2008 and running throughout the year. 28 interactive lectures were produced and recorded with live classes. These are being shown on TV at a pace of one per week and are available on VHS/DVD (they can be watched at tutorial centers so students do not need technical equipment at home).

Technically the SMS applications as well as the TV recordings work well. Students quickly learn to use our course tools, and the mobile phone is already a familiar technology. A challenge of the large-scale test phase was to make teachers learn how to teach in an interactive manner and organize teaching material for interactivity during video recording. About a dozen BOU teachers were selected based on personal interest, knowledge and availability. They were given a one week workshop on interactive teaching in general and our specific method in particular in December 2007. In February 2008 two intensive weeks of test recordings took place. By then, teachers had, in cooperation with the project’s pedagogical expert, developed scripts for the lessons. Recordings were done with a live class present. After recordings, students’ and teachers’ opinions were investigated. Findings are in brief that the technical approach is much appreciated. Technology is found useful and usable, and interactivity is appreciated by students. However, beyond this practical approach there is a wider issue about teaching methods in general which this project addresses but which can only be solved gradually and by means of sustained change processes. Interactivity in teaching has since long been found to be a success factor essential for learning. Interactive teaching has developed since the late 1960s in the industrialized world but in most developing countries it is still a novelty. Interactive teaching puts new demands on teachers, teacher training and education organizers, and full scale implementation will require quite some effort. Our project has so far mainly addressed these issues by a practical approach so as to get started, but clearly this is only the beginning of a long development. We have opened the door to the benefits of interactive teaching in distance education using low-cost ICT tools; however addressing the demands for teacher training, change of pedagogical ideals, understanding the importance of enabling students rather than trying to fill them with information is a much more far-reaching endeavor.

Findings and Conclusions

The BVIC project has developed a comprehensive, while clearly not exhaustive, set of tools for large-scale distance tuition in developing countries including

1. interactive technology with a number of technical tools for learning and course administration,
2. a new pedagogical model designed for interactivity in a developing country context, replacing repetitious pedagogy with student centred learning; participation and ownership,
3. methods for focused teacher training in interactive e-learning, and
4. interactive curriculum development.

Clearly this is not enough to make the envisioned kind of education institutionalized, for that to happen there has to be a good business case for the education providers. Hence we are currently cooperating with BOU to develop and implement a new business model for distance tuition in Bangladesh. There is potentially huge economic and societal significance of this effort. Economic, because it is a low-cost scheme requiring no new technical infrastructure. Societal, because it allows the rural population in developing countries to take a significant step into the “e-society”. This said, there are a number of challenges which cannot be met by a single effort but need consistent and sustained change work. As evidenced by our project these include:

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Virtual classroom</th>
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<tr>
<td>Pilot tests (in test classes, during recordings), observations, questionnaires and interviews with students: students easily use the tools, they find them useful, they ask for more material being made available this way. SMS commands need some cognitive overhead, interface should be made more intuitive, likely graphical</td>
<td>While there is still a need to develop innovative and simple tools for education there are no major problems with technology use and access.</td>
</tr>
<tr>
<td>a) Interviews, observations, discussions with teachers, admin staff and management at BOU. BOU currently uses no interactive technology. They do, however have proficient TV recording staff</td>
<td>a) Organizing operation and technical support for the SMS server.</td>
</tr>
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</table>
Professional challenges

Teachers must learn to interact with students in new ways. Focus must be on learning, not teaching, and teachers must reformulate their role accordingly

Interviews, observations, discussions, teacher training, recordings and evaluations of these: New interaction modes need training and reconsideration of the teacher’s role and practices

Social challenges

The student role changes. Students must become more independent in their search for knowledge. However, technology may help as the mode of interaction that comes with ICT is readily taken up by students.

Interviews, observations, discussions, teacher training, recordings, questionnaires: Students are familiar with the technology but less familiar with an active role in education

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