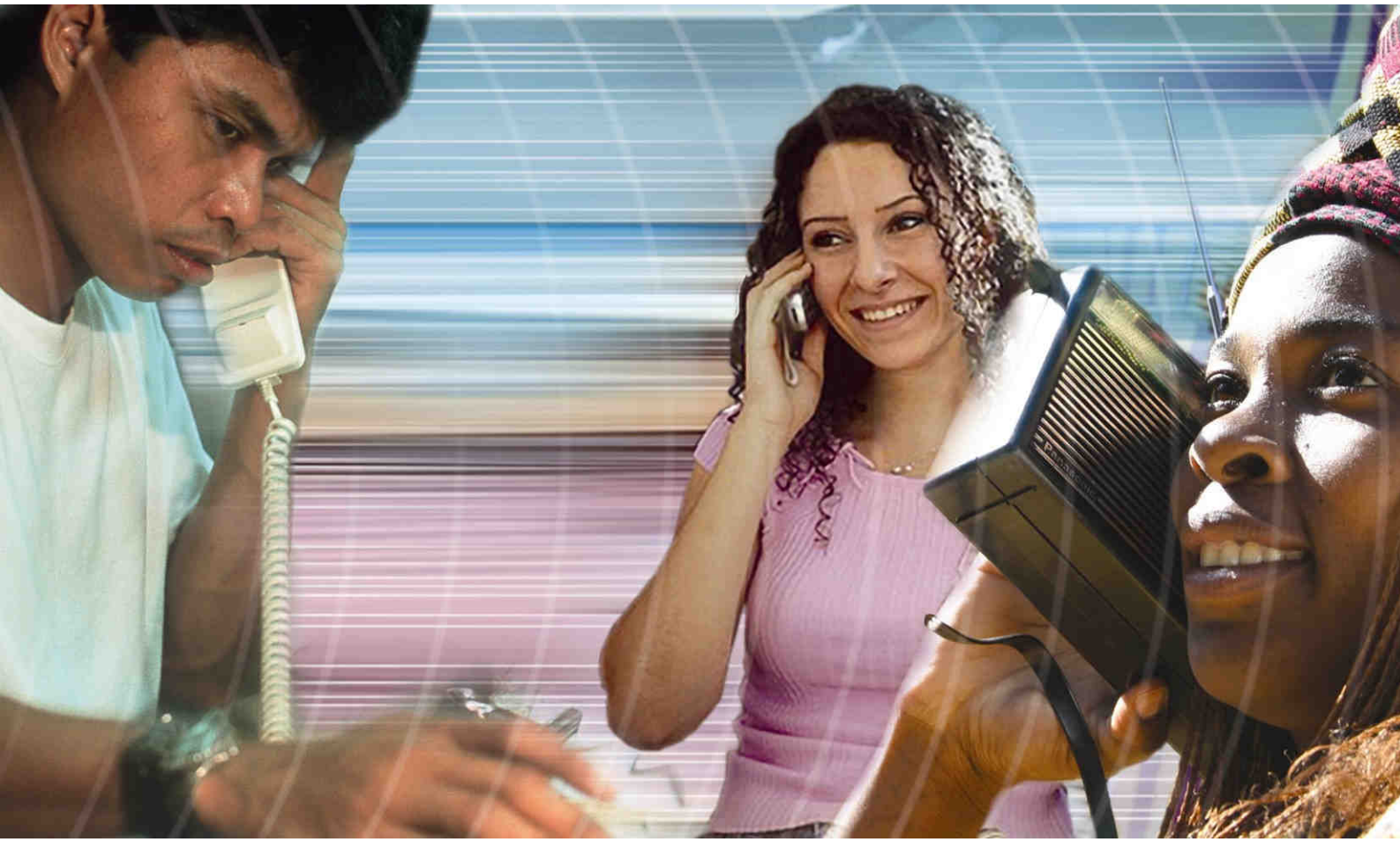

Low-cost devices in educational systems: The use of the “XO-Laptop” in the Ethiopian Educational System

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Foreword

GTZ employs Information and Communication Technology (ICT) in German Development Cooperation as a tool to enhance the effectiveness of its activities. ICT has a crucial role to play in optimising working procedures, improving communication and networking and providing information quickly and at low cost. This holds true especially for educational partner institutions that want to transfer learning methods and knowledge.

The education sector in many of our partner countries has to deal with a shortage of schools, qualified teachers and educational resources. Hence, in some countries, formal classroom teaching reaches only a fraction of children and youth.

With the availability and use of ICT in the education sector, educational resources can be updated and distributed quickly and cost-effectively to a high number of learners. In addition, the use of learning management systems can improve teaching as well as administrative tasks. GTZ supports and employs such innovative technologies as an instrument towards the achievement of educational objectives, embedding it in appropriated measures and frameworks.

As prices of ICT hardware are decreasing, low-cost computing devices are spreading rapidly in schools, not just in industrialised countries, but increasingly in developing ones as well. There are many projects and programs currently underway that focus on the use of low-cost ICT devices for developing countries[1].

Only a few months ago the “One Laptop Per Child (OLPC) Initiative” (originally a group at the Media Lab of MIT, now an independent organisation) developed the so-called “100$ Laptop” (or XO-Laptop). The main goal of OLPC is to introduce a low cost laptop that “is poised to empower and educate children through the use of technology, and connect the world's next generation of thinkers.”[2]

On this account GTZ conducted a pilot-test of the XO-Laptops in two Ethiopian schools. GTZ commissioned Dr. Herman Härtel, a long-time staff member at IPN - Leibniz-Institute for Science Education at the Physics Department, University Kiel, in order to analyse the resulting opportunities and to develop appropriate implementation strategies for the use of the XO-Laptop.

This report gives a first overview on possible use and impact of low-cost computing devices to poor people in developing countries.

GTZ would like to thank everybody involved in this documentation. In particular, we acknowledge the positive collaboration with the Ethiopian Capacity Building Program (ECBP) and its on.e-Team[3] that made the first XO-Laptops available to Ethiopian students[4].

[1] More information on low-cost ICT devices: http://www.infodev.org/en/Publication.279.html
[2] More information on OLPC: http://www.olpc.com/quick-facts.html
[3] More information on on.e: http://www.ecbp.biz/one.html
[4] Video on “OLPC in Ethiopia”: http://www.youtube.com/watch?v=Bj3DSCwfOfs

Content

Low-cost devices in educational systems: The use of the “XO-Laptop” in the Ethiopian Educational System

By Hermann Härtel

Abstract

On the assumption that some preconditions are in place (as listed in chapter 5), a pilot use (of up to 50.000 XO-laptops - based on an Italian donation) can be recommended.

This pilot-project, when planned with a thorough evaluation can deliver the necessary information for a decision about further activities to be taken by the government.

During the initial phase of implementation, it is desirable to focus on the introduction of interactive Ethiopian textbooks and related material. Aspects of computer, internet and media literacy and material related to learning theories like constructivism and new teaching methods such as “learning to learn” can be postponed to a second phase. This concentration on interactive learning material in the first stage will have the effect of meeting the teachers on common ground. Even a limited investment in time and training should have an immediate positive effect on their daily teaching practice. At the same time an increase in the quality of their teaching can be expected.

A teacher training programme aimed at imparting deeper understanding of computer and media literacy, learning how to make use of the Internet for better learning, or gaining security in applying more flexible teaching methods could be developed, accompanied by formative evaluation measures, and could be implemented later within a reasonable time period.

For the pilot project it is advisable that at least for two or three specific areas saturation is reached, which means that every child will have access to an XO-laptop. Only under such conditions, the promised benefit in respect to out-of-school activities can be tested.

To satisfy the demand of the Ethiopian government that all 10 regions in Ethiopia have to be involved in the pilot phase it may be acceptable that in some regions the distribution of XO-laptops is limited to grade 5 to 8.

It may also be of interest to include some teachers of secondary schools (grade 9 and 10), which are equipped with plasma screens, into the pilot phase. The XO-laptops can be connected to these plasma screens and allow the teachers to mix the actual tele-teaching programs with lessons on computer and media literacy.

As mentioned in the appendix, the tele-teaching program based on plasma screens could also profit from new technological developments, which would transform the actual non-interactive program to an interactive format, where the teachers regain full classroom control. A rather promising application is seen in an extension of out-of-school activity (e.g. *Melepo* application). In addition to school books, an agrarian and/or a medical information system could be set up and brought to local farmers through the laptops of their children when at home.

1. Laptops as a medium for learning in developed countries

It has sometimes been argued that the fact that computers have not taken root in formal education at a large scale in developed countries implies that any attempts to introduce them in developing countries, where conditions are much worse, are bound for failure. However, this argument is flawed.

In Germany, laptop classes in primary schools are unknown; they are also unusual in lower secondary schools. The reasons may be manifold. The normally available laptops are rather expensive, rather heavy for smaller children, rather sensitive and rather complicated.

Computer laboratories are available in most schools; however, they are most of the time occupied by students of higher grades or by science and mathematics classes. Teachers with their younger students seldom go there because the teachers themselves have not much experience with these complex machines and their children risk to "get lost" within this complex environment.

The same holds for those schools which have been equipped with laptops instead or in addition to computer laboratories with normal PCs. Again the unresolved technical problems as for instance in respect to weight and complexity are blocking any regular use.

A well documented and rather successful exceptional example of laptop classes, beginning at grade 7, was instituted at the Evangelisch Stiftisches Gymnasium in Gütersloh in 1999 and still continues today[5]. This project was possible due to additional external support in respect to hard- and software. Experience in this project, documented in an evaluation report by the Bertelsmann Foundation, has been rather positive. By comparison with control groups, the results - achieved in computer and media literacy as well as in general learning objectives - have been shown to be superior in many respects. Laptops are not introduced before grade 7 in Gütersloh and this may well be because the existing laptops are too large and complicated for younger students.

Since now smaller and simpler laptops are available, it needs to be discussed if laptops in addition to the existing environment with books, toys and other concrete learning materials would not result in an added value, especially in respect to the necessity to satisfy the different needs in quite diverse classes.

In developing countries, where often there is a shortcut of books or other concrete learning material, it is easier to argue in favour of introducing laptops even at quite early grades. With a laptop like the XO all technical problems are avoided and positive results like in Gütersloh can be expected.

Lately some counter-arguments were known from some of the more technically advanced schools in the USA which have returned to laptop-free classrooms. The director of that school argued that they had flooded the classrooms with technology and did not think enough about what is meaningful. Now they want to concentrate more on academics and content than on technology.

Such experiences demonstrate that technology alone cannot guarantee success. A well developed didactical context, well trained teachers and a process of innovation which is driven by pedagogy, not technology, are all required.

[5] http://www.ev-stift-gymn.guetersloh.de/index.php

Furthermore the experiences and problems encountered in a highly developed country like the USA can hardly be compared with the situation in developing countries.

2. The Ethiopian Educational System

In recent years the Ethiopian Ministry of Education has placed a high priority on raising the enrolment in primary schools and reducing the student drop-out rate. Combined with an annual population increase of about 2.5% this has led to serious overcrowding of existing schools and classrooms, a lack of qualified teachers, and inadequate provision of school books.

School books are often delayed for months, or even a full school year, and because of their limited numbers up to five students may have to share a book. The average number of students per class is 60 to 65. In a secondary school at Wollisso, 90 10th grade students were observed being taught in a room designed to accommodate 40 students.

The Ministry of Education has also tried to enhance the quality of education practice in the light of the high percentage of non-academically qualified teachers. As a solution, a larger tele-teaching project has been put in place for secondary schools, in which many classrooms are equipped with large plasma screens that can be used to present video-taped lectures given by highly qualified lecturers.

In this setting, the role of the classroom teacher is more that of an assistant following the advice of the expert on the screen. According to the director of the secondary school inspected during this visit, all teaching was carried out by this method, apart from a few specific topics like geography and local language.

There are differing views about how successful this project is. Certainly no video teacher can outperform a lively and competent teacher in the classroom, so student opinion is often negative. On the other hand, with no better alternative available, the director of the school tended towards a more positive view.

As will be described in the appendix, an improvement of this situation is possible with a modest investment per school, where through modern technology the existing tele-programs can be transformed to an interactive format.

The following sections explain why the proposed OLPC pilot-project stands in clear contrast to this approach. OLPC is an educational project in which the teacher can play an essential role; this role will grow in professional quality parallel with the integration of ICT - Information-Communication-Technology - into the normal curriculum.

3. First classroom experiences with the XO-laptop at primary schools

3.1. Previous activities

Some weeks before the period of observation, a pre-launch was carried out with one class of 8th grade students and a teacher with good university level qualifications; XO- machines of version beta 2 were used. These rather slow machines showed some instability and lacked the ability to build an automatic network (mesh-net). The objective of this pre-launch was mainly to test some basic technical functionality under classroom conditions, while the students under the guidance of the teacher mainly worked with e-toys. This e-toy application is focused on programming methods and related knowledge. The progress made by students in this programming environment was judged to be encouraging.

However, no normal curriculum-based teaching/learning activities, supported by computers, were covered during this pre-launch.

3.2. Activities during a first observation phase

When signing the terms of reference (TOR) for this report it was assumed that for a second pre-launch - the period of observation to which this report relates - new and stable XO-machines would be in use with mesh-network capabilities so that this new and unique feature could be explored in practice.

It was assumed that the teachers involved in the project would have received sufficient training to be able to introduce the XO-machines to their students and to follow some prepared lesson plan where curriculum based teaching/learning sequences, supported by XO- laptops, could be observed.

Finally it was hoped that some measures against theft would be in place so that the laptops could be handed over to the students for out-of-school activities, thus making it possible to observe at least some initial results.

In reality, none of these assumptions were met during the whole period of observation. The new and stable machines, which had arrived two months earlier, were still impounded by customs authorities. It is not known how much time will be needed before the necessary customs-exception declaration is provided. With no new machines at hand, the old machines from the first pre-launch had to be used for teacher training and for the classroom activities.

Training was given to 11 teachers, half from each primary school taking part (Menelik II ~1400 students, and Atze Naot ~1000 students), and lasted for five sessions of about three hours each. During these sessions some basic applications such as read, write, browse, camera, etc. were covered. During a further two sessions the teachers were asked to develop a plan for a first classroom activity with their students, which was then discussed by the group.

The concept followed by the local experts is strongly oriented towards the OLPC idea that teachers should develop their own lesson plans and not follow previously constructed plans.

As a consequence, no plan was developed during the following days but one should be developed by the teachers on a daily basis taking account of their growing experience and competence in handling the different computer applications.

The school authorities of the two primary schools were co-operative. When it became clear after two days that effective teaching would be difficult with just 20 computers per school, and over 40 and 60 students respectively per class of 2nd grade at Menelik and Atze Naot, it was decided to split the classes. The same cooperative spirit was found during a visit to one secondary and two primary schools in Wollisso, a town of about 50,000 inhabitants, southwest of Addis Ababa.

When discussing the potential of the OLPC pilot-project with school authorities, teachers and a representative of parents, it became quite obvious that an interest in change and a desire for improvement of the quality of education does exist and anything like the OPLC pilot-project would be highly welcomed.

After splitting the class in both schools, most students were able to work with a laptop on their own. Nevertheless, considerable support from three or four teachers or project members assisting per class was needed to help the students cope with these rather unstable machines. The track pads, which often did not function correctly, caused the greatest difficulty.

Under these circumstances no observations could be gathered which would allow any reliable conclusions to be reached about the feasibility of the OLPC pilot-concept at this school level.

With the help of the teacher and her assisting colleagues, together with two or three other project members who were always available, the pupils succeeded in opening the intended applications, such as read or write. Since they had already learned the Latin alphabet, some student groups finished the given task of typing the complete list of letters.

In another lesson, the task was to open the draw application and to produce some sort of picture. None of the groups succeeded, however, due mainly to the instability of the track pads. The camera function excited the students, but no kind of systematic learning could be observed. A lack of an appropriate lesson plan could be stated as one of the reasons for this unsatisfactory result.

3.3. Activities during a second observation phase

When the new machines had been released from custom, the classes had to be kept divided to provide each student with an own laptop. To reduce the extra effort on the side of the school (doubling teaching time and use of classrooms) the teaching periods with laptops were reduced to two hours per week.

In the meantime some observation sheets for a formative evaluation had been developed and were used to document all laptop classes for a period of about 6 weeks (see appendix).

In reference to the Munich attention inventory, the emphasis in this evaluation was laid on the learning behaviour of students. Are they visibly on-task or off-task when either working

with or without the computer? Studies have shown that the time-on-task correlates strongly with positive learning results.[6]

The actual data base with only two classes, two teachers, 20 documented hours with beta2-machines and 6 documented hours with beta4-machines is so small that only quite preliminary conclusions can be drawn.

Without exception the existing observation sheets demonstrate a rather high percentage of on-task behaviour, whenever the students were asked to work with the computer. However, only a longer observation period will show, if this high attention will stabilize.

It became obvious that the 2nd graders were able to handle the machine – to move the mouse, to draw a picture, to use the keyboard, to take a picture with the built-in camera, etc. It is not clear whether they were able to understand more computer related concepts like the concept of a file, how to name, save or open it and how to interact via the mesh-net. This needs to be carefully observed in the future.

The actual content of the laptop lessons had to be decided by the teachers without any support from outside. The didactical value of these lessons, as far as they could be observed, was rather poor. This is quite understandable because these teachers are still quite insecure in handling the computer and have not been provided with some model laptop lessons or any content-related support.

On demand of the involved teachers, a training of 1 1/2 days over a weekend with the new beta4 machines was organized. Again most of the time was devoted to the handling of some computer applications like paint and write and not about lesson plans and content-related questions.

Some consequences to be drawn for the intended pilot phase will be presented in the appendix where the idea of interactive textbooks as basis for lessons planning will play an important role.

3.4. Interactive textbooks automatically transmitted to any XO-laptop

Two members of the Swiss company EDUVISION (http://www.eduvision.ch) have joined the local experts; their product is seen to be of great interest for the pilot-project in two respects:

First, EDUVISION provides the possibility of distributing via satellite any kind of digital information to local receiver stations which might be installed at schools.

This transmission is done via a geo-stationary satellite, which is operated by WORLDSPACE and is usually used for audio signals. The receiver is composed of components from the consumer market. As a maintenance-free and sealed unit with solar panel, battery, antenna and base station with a storage capacity of ~ 40 GB text books and any other relevant information can be automatically downloaded to all XO-laptops within the reach of the schools mesh-net.

A second aspect of the *Melepo* application is important. The digitised Ethiopian school books are not only transmitted one to one, but will be made interactive.

[6] Helmke, A. & Renkl, A. (1993). Munich attention inventory (MAI): An instrument for the systematic observation of students' attentional behavior. The German Journal of Psychology, 17, 48-49.

Questions inserted by the author into these books are indicated by icons (specific question marks) which can be activated to open a small window for written inputs by students. The teachers and students can enter notes or questions anywhere in the book or highlight any part of the text. Pop-up menus allow easy access to chapters and sub- chapters or let the students jump to all questions or notes within the books in sequence.

4. Consequences for the introduction of the XO machines to the Ethiopian school system

Interactive books first, computer literacy and advanced learning methods later

A major aspect of the philosophy of the OLPC pilot-project is a focus on computer and media literacy as a basic learning objective. This objective includes as a first priority a connection to the Internet, followed by access to such common applications as a word processor, presentation software, spreadsheet, browser, image processing, calculator, etc.

The advantages of such objectives, however, are accompanied by distinct risks, particularly in developing countries. One of the major drawbacks is that in such countries the teachers may not be able to cope with the challenges and achieve the objectives.

In the light of their rather high teaching load and rather low payment, the implied demands on their professional qualifications and demands for intensive in-service training are unlikely to be met without some gratifications. Such gratifications from the government cannot generally be expected in these countries. As a consequence, projects may not proceed because of a lack of support from the teacher community.

However, support from teachers can be expected if the implementation of a new project is accompanied by a reduction in teaching load and an increase in the professional qualification of teachers.

Both conditions can be accomplished if the objectives of the OLPC pilot-project with respect to computer and media literacy are postponed to a second phase, while the possibilities related to an application like *Melepo* are given priority during the first part of the project.

If connection to the Internet and intensive use of standard computer applications is postponed while the distribution of interactive schoolbooks is given first priority, two major advantages would follow.

1. A restriction to using existing Ethiopian textbooks will limit concerns within the country about an intrusion of foreign cultural influences, fears about children possibly encountering undesirable content, a loss of status on the part of the teacher, etc.
2. The certainty that each student has access to each schoolbook at any time, the possibility for them to annotate existing textbooks, to add questions with input for answers, will facilitate the preparation of lessons for the teachers and the daily teaching routine as well as the quality of their teaching.

As mentioned above, at present school books are often not available or are only available in limited numbers; it is difficult to replace any books which are lost or damaged.

With an application like *Melepo* in place, all these difficulties can be avoided. Every student will have access to every book or additional item of learning material provided by the Ministry of Education for every subject and every school year. In addition the students will learn to work with these materials in an active way.

Specific advantages for teachers

The advantages for the teacher and in correspondence for the learning experience of their students are manifold:

- Teachers can prepare their lessons by complementing the books with current notes or pictures and can prepare individualised exercise phases by adding corresponding assignments for fast and slow learners.
- While teaching, the teachers do not have to present every text or content on the blackboard or orally, but only those parts that are didactically meaningful. Otherwise the students can concentrate on the screen of their laptop where, if necessary, the same content is shown, while all other activities are blocked.
- At any moment the students can be asked to work on some prepared questions or answers instead of a single student - frequently one of the fast learners - being called to the blackboard. In this way, overall learning time is increased.
- When asking the students to work on prepared assignments, either alone or in small groups, the teachers are free to cope with the non-homogeneity of normal classes by helping the slow and challenging the fast learners.
- Within an application like *Melepo* a tool can be offered to allow teachers to develop multiple-choice tests which can be attached to every chapter in a book. The results of such tests are graded automatically for the teacher. With such a tool, assessment, which is of course another important part of the daily routine for teachers, will be facilitated and this should help increase motivation and support through the community of teachers.
- As an example of wider use, the entire set of *Wikipedia* pages could be downloaded and permanently upgraded. This material could serve as an exercise field to develop and train capabilities for investigation and inquiry and therefore prepare students of higher grades for later when Internet connectivity is available.

5. Pre-conditions for meaningful use of the XO-laptop within the classroom and for successful large-scale implementation within the Ethiopian school system

When introducing the XO-machine to an educational system within a developing country, two conflicting interests have to be met: The OLPC initiative must commission large numbers of XO-laptops in order to keep the price per unit down and to reach the pre-announced price tag of 100$ as closely as possible.

By contrast, school authorities with responsibility for an educational system tend to proceed in small steps and under controlled conditions. They may be more comfortable implementing major changes only after careful observation and evaluation of pilot projects encompassing small and medium-sized experimental groups, accompanied by a thorough in- service and pre-service teacher training programme.

The situation in Ethiopia is different. Here a donation from Italy in the order of 50.000 laptops is promised. The question if a pilot phase with a smaller number of laptops would not be sufficient does not need to be answered.

A role-out of 40,000 to 50,000 XO laptops to the Ethiopian school system should be organised as a pilot project, accompanied by an extended formative and summative assessment. The result of this pilot project, for instance in respect to the change of drop-out rates, results in region wide tests or change in transition rates to the secondary level should serve as a decision base for further actions in this field.

Some pre-conditions for this role-out should be in place:

- All or most of the Ethiopian textbooks should be made available for satellite transmission to all involved schools and consequently to all XO-machines within the school neighbourhood, based on the implemented mesh-net technology.
- The technology for automatic satellite transmission of information has proven to be reliable and ready to be installed at all involved schools.
- Security measures are in place to prevent any misuse of XO-laptops
- A teacher training programme is in place to offer basic knowledge about computer technology and handling. The use of interactive books and authoring tools for developing test or worksheets must be mastered as well as handling mesh-network communication.
- The main objective of the innovation is restricted to the use of interactive books. All objectives with respect to computer and media literacy are postponed in respect to in-school activities. Such objectives can be set up later based on the results of extended and evaluated tryouts.
- Sufficient financial support is provided for the distribution, installation and maintenance of the related technology as well as for the administration of the necessary assessment procedures.

6. Risks and opportunities

6.1. Ownership

Any innovation for the educational sector needs strong support from the higher levels of government. If no one on this level will take responsibility or ownership for an innovative project, a successful outcome is unlikely.

In Ethiopia such support has been clearly expressed at the level of the prime minister and minister of state, as well as from the minister of education and the minister of capacity building.

A master plan has been sketched out comprising five components: E-book, E-library, Interactive learning, Innovative learning and teacher training, while indicating strong ownership for the OLPC pilot-project at this high administrative level.

This strong ownership on the side of the minister of capacity building was reinforced during a demonstration on the OLPC idea, December 13. 2007. The OLPC idea and the didactical potential of the XO-laptop were judged as a "revolution in learning" and full support was promised for the planned pilot implementation. Restrictive remarks related only to the concern that no new legal or financial bodies should be installed besides the existing Ethiopian ones to avoid internal frictions and doubling of work.

6.2. Cultural aspects and the digital gap

Another crucial factor determining success or failure of any innovation within the educational sector is the reaction of the community of teachers. If the innovation fails to motivate teachers in the long term, the chance of failure is high. Teachers must gain some clear advantage by following the proposed innovation and should for instance not be expected to invest more time and effort than usual over the medium term.

With a rather high probability it can be expected that the introduction of the OLPC pilot-project will have an immediate positive effect for the teachers. Only a brief investment in time will be needed to learn basic facts about the computer and how to handle some basic tools like interactive books (application *Melepo*), multiple choice tests etc. Subsequently, the daily routine work of teachers will be facilitated by the availability of interactive books for all students, possibly accompanied by additional valuable information. Further, they will experience an increase in their professional qualification, especially when aspects of computer and media literacy are integrated into the curriculum during the following years.

Another risk of innovation is fear within the population of an intrusion of foreign culture. The primary school sector is especially sensitive where foreign innovations are met with strong scepticism. Again the OLPC innovation can overcome these potential difficulties if it concentrates on the distribution of existing textbooks first.

By doing this, there can be no complaint about foreign cultural influence entering the school, although a later more general use of computers with access to the Internet may and will act as an agent for change within the society.

Any developing country should see such changes as an opportunity rather than a danger. It is recognised worldwide that the increasing digital divide between the northern industrialised nations and developing countries is an issue which needs serious action.

Studies of the success of laptop classes like that by Bertelsmann mentioned above and the prospect of closing the digital gap for their own country have led many governments to commit or strongly consider a commitment to the XO-laptop; these countries include Brazil, Uruguay, Peru, Ghana, Rwanda, Ethiopia, Asia-Pacific Islands (Solomon Islands, Fiji etc.), Pakistan, Libya, Argentina, and Nigeria.

6.3. Employment at different grades in primary and secondary schools

In the original OLPC concept it was stated that the full potential of the project will unfold only if a community is saturated with XO-laptops, which means that at least a large majority of students within a specific community should be owners of such a machine and take it home regularly.

During a pilot phase at least two or three regions (especially rural areas) should be selected where such saturation can be reached. The effects of such saturation are of high importance to reach a full understanding of the validity and quality of the OLPC approach.

In a later implementation phase it may well be that such saturation of complete regions has to be postponed because only restricted numbers of laptops will be available. This would imply that a decision must be made concerning the sequence in which the different schools and grades should be selected for equipment.

For elementary schools of grades 5 to 8, the focus may shift gradually from traditional teaching to the integration of objectives aimed at computer and media literacy, while for grades 1 to 4 the basic skills like reading, writing and maths are the main objectives where the laptop will be of help.

6.4. Employment outside school

The XO-laptop of OLPC is designed in look, feel and size for children. A powerful laptop of wider applicability at “university” level might seem to be more appropriate for adult education. In its absence, however, the XO-laptop in combination with a projector (beamer) or a plasma screen could support lectures for larger groups in such systems.

The fact that the XO-laptop can be taken home by the students will have a special positive effect for so-called fast as well as for so-called slow learners. The former, often not enough challenged in school, will have an excellent opportunity to exploit the different more complex applications within the area of *etoys*. For the latter various exercise applications offer the possibility for additional training, if possible with the support from parents, elder siblings or friends.

A major field for employment of the XO-laptop could, however, lie in an extension of specific learning applications. In addition to textbooks, agrarian or health information systems could be set up and brought to local farmers through the laptops of their children when at home.

7. Conclusion

It may be that the OLPC project and its XO-laptop will spread world-wide and serve as an excellent tool to enhance the quality of education and to close or narrow the digital gap for the developing countries.

Even without data from pilot projects, investment of development aid in an Ethiopian OLPC pilot-project seems to be justified in the light of the positive factors such as the support of the government, the immediate improvement of the classroom environment through the provision of interactive e-books and the future potential in increased computer and media literacy.

The risks seem to be acceptable if the pre-conditions listed in chapter 5 are met. This could be verified by surveying a short term tryout where the new machines are used at different grade levels and a teacher training programme is sketched out, accompanied by an intensified effort to digitise the existing Ethiopian textbooks.

The opportunities outweigh the risks.

Closing the digital gap between the industrialised and the developing countries is an important and urgent objective. Integration of the OLPC approach into the traditional curriculum and the realisation of "One Laptop Per Child" seem to be necessary and suitable for reaching this goal.

Appendix

1. Comments about a formative and summative assessment

1.1. Formative assessment

From September till December 2007 two students, studying „media and computing“ (also called „media informatics“) at University Dresden, have been employed by GTZ to developed a system of tools for a formative assessment of the planned rollout.

As part of their diploma thesis Michal Fleck and Stefan Arnold will complete the system during the next months.

A classroom observation sheet is the central part of the tool set (see next page), a further development and refinement, based on the Munich attention inventory.

This observation sheet has been tested with different observers with a high score of agreement.

The input of the collected data to a database is facilitated by a graphical user interface. An interface to access the database is under development.

1.1. Summative assessment

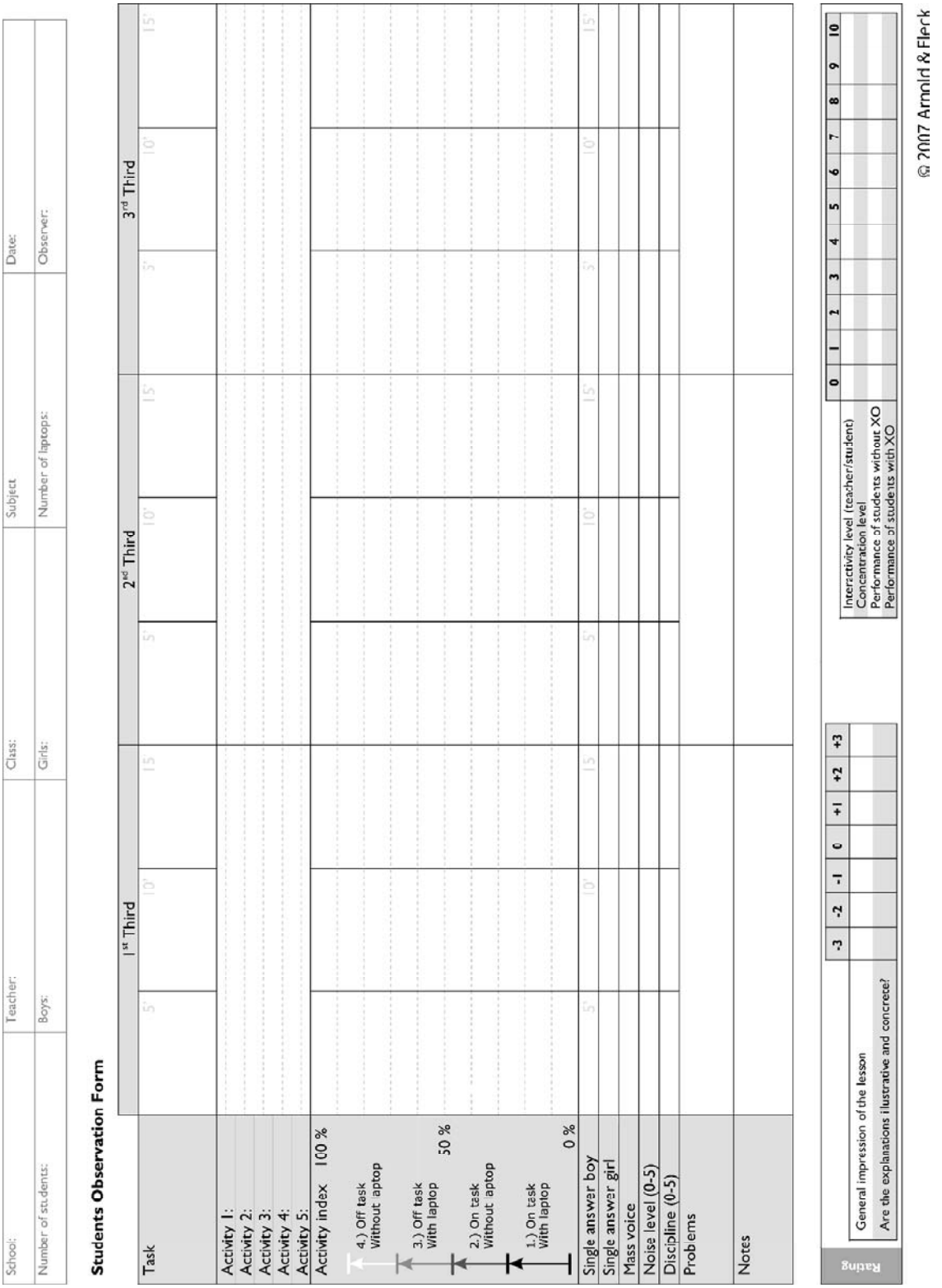
Important indicators to judge the success or failure of the intended pilot phase will be:

- results in standard tests between laptop-classes and normal classes
- possible change in the dropout rate
- possible change in the transition rate from grade 8 to grade 9 (secondary level)

Furthermore it seems meaningful to develop questionnaires and guidelines to document the opinion of school authorities, teachers and representatives of parents.

Adequate tests and guidelines still need to be developed.

Classroom observation sheet



2. Critical remarks on the OPLC learning concept

The development of the XO-laptop at MIT is embedded in an approach to learning called constructivism. In sharp contrast to the early ideas of behaviourism, constructivism stresses pupils’ commitment to learning, learning as construction of knowledge, the importance of self-controlled learning, group work, dialogue and justification of pupils’ own opinions in social settings.

The role of the teacher here is expected to change from that of instructor to tutor and organiser of learning environments, where explorative and self-controlled learning can unfold.

In the papers published by OLPC about learning, it is stated that under certain circumstances instruction may be necessary. However, the overall message is that whenever possible, instruction should be reduced in favour of exploration and self-controlled learning.[7]

In a nutshell the OLPC approach can be characterised as follows:

1. Learning corresponds to construction of knowledge, passive learning is not possible.
2. Self-determined and self-controlled learning is better than learning by instruction.
3. A teacher as tutor and provider of learning arrangements is better than a teacher as instructor.
4. Learning in projects and in social settings is better than following individually a systematic course in a teacher-controlled classroom environment.

2.1. Learning as construction of knowledge

It is generally accepted that meaningful learning is only established through a mental activity on the part of the learner. It is also unquestionable that exploratory learning is valuable and should be supported whenever possible. However, it is questionable why no activity should be needed on the part of the learner to follow instruction about a challenging topic, why the successful reconstruction of a presented piece of knowledge (repeat in your own words what you have been told) should not be regarded as an intellectual performance of high value, and why it is not seen that the construction of new knowledge on one’s own is the peak of intellectual performance, hardly reached by the average student at university level.

[7] This general attitude may explain why no technical support has been provided for a teacher to instruct a laptop class. Normally a projector should be available to focus the attention of a class on a screen display and to explain specific activities, tasks to be worked on or questions to be answered, before the students are told to work on their own. Since in general no projectors are available, some feature could have been provided to send the commands of the teacher’s laptop to all the others so that all laptop screens in the classroom show the same content.

2.2. Self-determined and self-controlled learning versus instruction

Self determined and self-control learning is a final goal of teaching and learning at school or university; it should not be confused with its prerequisites. To reach this goal different capabilities have to be acquired:

- The learners not only have to experience their own motivation to learn, but must also actively design and control it. They must be able to choose adequate learning goals; they must generate realistic explanations for success or failure and must develop a positive self-awareness of their proficiency.
- Volitional attitudes, strategies and regulation techniques are necessary preconditions for transforming a cognitive interest into a stable learning activity, which is sufficiently immunised against competing and possibly tempting stimuli.
- The development of meta-cognitive competencies and a knowledge-based supervision of goal-oriented learning activities is the most important individual precondition for successful self-controlled learning.
- The effectiveness of self-controlled learning is enhanced if more or less content-specific problem solving strategies are available and can partly be applied automatically.

Two conclusions can be drawn:

- If challenging contents and assignments have to be mastered without the necessary preconditions on the part of the learner, the chances of ending with learning deficiencies, error-prone results and experiences of failure are high.
- Self-controlled learning must be learned. This difficult but necessary task cannot be mastered with a few general training programs. It needs the guidance of a competent teacher and the execution of a multitude of small, more or less content-specific exercises.

2.3. Teacher as tutor or instructor

It is not true that an actively instructing teacher puts his or her students in a passive state. It is not true that students are always motivated to learn, and a teacher-controlled learning process need not be authoritarian but can be very helpful for the learners.

A teacher can guide the learning process in a student-oriented manner by choosing adequate learning objectives, dividing the content into small, manageable parts, providing the necessary knowledge, posing questions of different difficulty so that the individual students can find the correct answers - not without a certain amount of effort - taking care to provide sufficient time and opportunities for repetitive exercise, permanently monitoring the learning progress of the different students, and helping in an inconspicuous but effective manner to avoid or overcome learning difficulties.

The effectiveness of this methodological approach has not only been proven in corresponding studies, but corresponds with our recollections of good teachers during our own school time.

2.4. Project learning in social settings versus systematic instruction and individualised learning

There a numerous reports about surprisingly successful projects accomplished by students. Positive effects can be stated in respect of motivation, learning results, ability to work in teams and so on.

However, there are also reports about negative effects, especially when this social and project-oriented teaching mode dominates. At the latest when an examination - especially the final one with pre-defined learning objectives - has to be mastered, only the results of individual learning oriented to these objectives can be helpful.

Therefore any project-based learning needs to be accompanied by sequences in which individual learning takes place in a teacher-controlled classroom environment.

3. Proposals for a teacher training program

In addition to some introductory computer cources it is proposed to develop a sequence of videos where the use of all XO-application is demonstrated.

A major topic for future teacher training programs should be based on a series of prepaired model lessons where the didactical value of computer use is demonstrated. In addition some suitable tools should be presented which enable teachers to change or re-construct such lessons according to their own teaching style and needs.

3.1. User interfaces as topic

Experience has shown that computer courses for adults have to be organized in a different way than for younger students. To memorize quite simple but more or less non-related facts (clicking on this button will have this result, selecting that sub-menu will have that result, etc) is something children or young students will nearly learn by themselves while adults encounter some difficulties and will most probably need more time and repetitive training.

This learning barrier is even higher for teachers. Due to their professional status they are supposed to know more than their students. How to handle a specific user interface on a computer screen, however, will be an area, where some students will soon know more than their teachers, causing possibly an uncomfortable situation for the latter.

To overcome this difficulty a sequence of short videos could be developed where all major procedures for the XO-applications are shown8. If available on an USB stick at home every teacher could load such videos repetitively when ever some specific information is needed. This seems to be more efficient than participating at special courses where often too many details are presented and not enough time is left for extensive exercise.

In addition teachers should be encouraged to rely on their students for help if questions about some user interfaces have to be answered. Some one who knows how to work with a

[8] To demonstrate this idea some private video prototypes have been developed which are accessible under: http://www.astrophysik.uni-kiel.de/~hhaertel/olpc/index.html

specific user interface is an expert in a rather specific and limited field and usually very willing and eager to help.

3.2. The didactical potential of computers as topic

It needs to be emphasised, that there are more important fields of expertise which a teacher will have to work on than just to get an expertise in handling a specific user interface.

A certain minimum amount of this expertise is necessary to get started. However the most important questions for a teacher to work on are related to the didactical potential of the computer. How can the computer and its implemented learning programs be integrated into the curriculum and classroom activity and how can home work be arranged so that the ultimate goal can be reached: organizing successful learning sequences, stabilizing interest in learning and finally enhancing the quality of education.

As a prerequisite for such a discussion a series of model lessons for all relevant school topics need to be available. In addition tools should be ready for uses which allow the teachers to adapt, change or re-construct such model lessons according to their own teaching style and needs.

The application *Melepo* can serve as an example for such a tool. If all textbooks would be available on the XO-machines, parts of each textbook could be prepared by some experts with notes, questions and exercises.

Further examples for such tools are applications to prepare multi-choice tests or worksheets. For higher grades some templates could be offered to support the use of applets.

The use of such tools and the preparation of lesson plans should be the main discussion points for any teacher training program in OLPC projects.

4. Proposal for the improvement of the tele-teaching program at secondary schools

4.1. Actual situation

The teaching at secondary schools in Ethiopia (grade 9 and 10) is organized on the basis of a tele-teaching program. The content and sequence of the lessons follow the Ethiopian curriculum. The classrooms are equipped with large plasma screens where the lessons, transmitted via satellite, are displayed.

The actual technical setup is shown in figure 1, based on the assumption that 8 channels are received and 6 plasma screens are available in the school

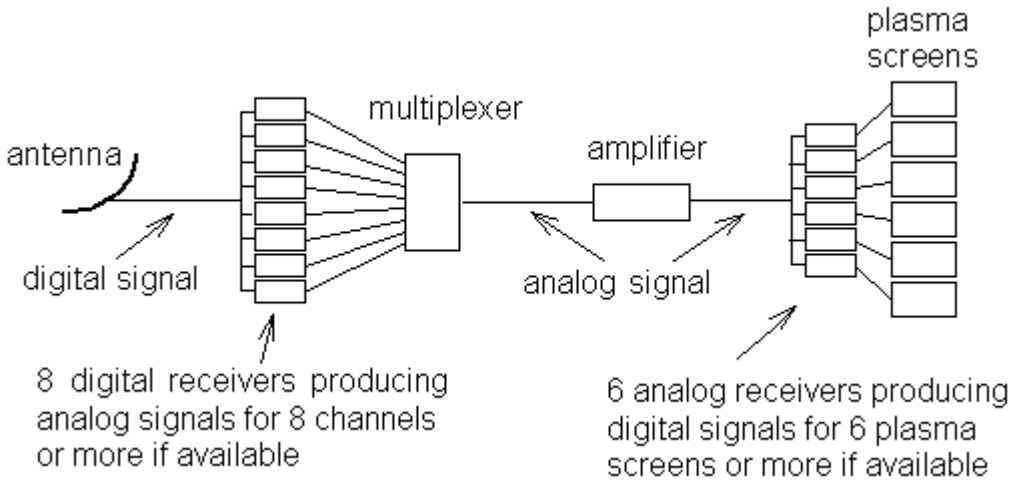


Fig. 1: Structure of the actual tele-teaching setup in secondary schools

Based on the actual state of the art it cannot be seen why at the time of design and development of this system this rather complex set-up with a double conversion of digital to analogue and reverse has been preferred.

The didactical advantages of this system are:

- A controlled quality of content and presentation for each lesson is guaranteed
- Lessons can be surveyed by tutors with minor teaching qualifications
- For teachers with limited physical strength, for instance due to age, tele-teaching may be welcomed as some kind of support.

Disadvantages are:

- Qualified teachers are reduced to tutors, depending on an anonymous expert on the screen. This may lead to frustration and lack of motivation.
- The ability on the side of the students to learn by themselves and to motivate themselves for the topics, presented on the screen, must have been further developed than with a lively and competent teacher in the classroom. The question is how well this ability is

developed among the majority of the students and how much so-called slow learners will profit from the actual tele-teaching program.

- When ever there is some interruption of transmission, for instance due to power failure, the content of the lesson is lost and cannot be recovered.

- The quality of the display on the plasma screens is below standard due to the doubling of conversion from digital to analogue and vice versa.

4.2. Possible improvements due to modern technology

4.2.1. Tele- teaching and interactivity

The most severe disadvantages of the actual system is seen in the fact, that qualified teachers have to take on the role as a tutor and cannot act according to their professional qualification and that so-called slow learners may be left behind.

Both difficulties can be overcome by a setup as shown in figure 2.

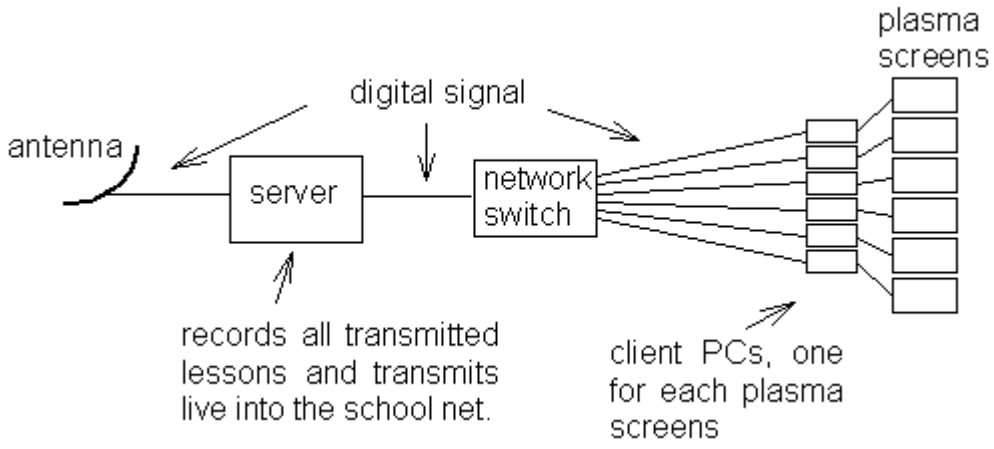


Fig. 2: Improved setup for the tele-teaching program in secondary schools

Each teacher within each classroom regains full control over the display. Via a remote control device the program can be started, paused, and restarted at any moment in time and stepwise controlled in forward or backward direction.

This system allows keeping all the advantages listed above but avoids practically all the listed disadvantages. Especially the role of the qualified teacher is substantially upgraded which will most probably have positive effect on the learning results of the students, especially of the so-called slow learners.

Further advantages:

- Educational programs from any sender could be recorded.
- Instead of plasma screens projectors (larger pictures, less expensive) or larger LCD-screens (less expensive, larger life-time) could be used.

The necessary investment per school is about 1500 to 2000 €, depending on the number of plasma screens (~150 € per client PC, ~500€ per server and network switch).

4.2.2. Local distribution instead of satellite transmission

Provided that the transmitted lectures are available in electronic form, the satellite transmission could be totally abandoned.

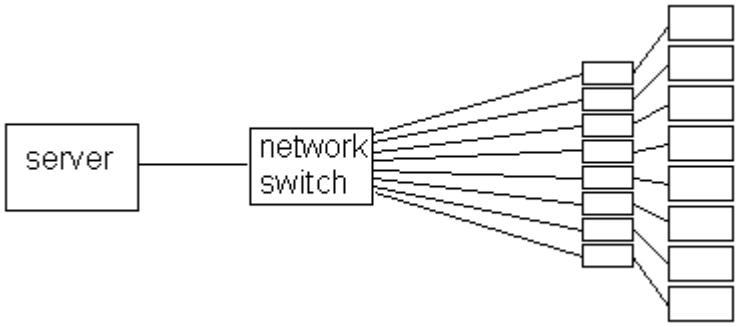


Fig. 3: Locally available content with interactive access

Once the content of the lessons for a certain period is saved on the server, any part can be started and controlled by the teacher in front of the plasma screen at any moment in time.

In addition to the improvements, mentioned above, any payments for satellite transmission could be saved.

Contact

All improvements mentioned above are based on the ideas and expertise of Bernhard Rosenkränzer[9], chief programmer of EDUVISION. He successfully installed a temporary prototype at the Black Lion School, Addis Ababa.

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