EFFECTIVE AND EFFICIENT INSTRUCTIONAL TOOLS FOR TRAINING DEVELOPERS OF ICT-BASED LESSONS

DÉSIRÉ BAARTMAN
Consultant in ICT and Education, Maputo, Mozambique
deespol@teledata.mz

This study presents an experiment in which 16 teacher-trainers and teachers were trained to design and develop innovative ICT-based educational material for different subject areas at grade 6 and 7 level in Mozambique. The term innovative refers to the instruction methods rather than the use of ICT itself. The research focuses on the factors and activities that contributed to or hindered the design and development of ICT-based material. Noticeable outcomes were (1) the value of collaboratively defined criteria for evaluation, (2) the important role of worksheets, (3) the value of test sessions and (4) the disparity between the perception of the participants and the actual innovativeness of the material.

INTRODUCTION
It is widely recognised that the Digital Divide between affluent countries and developing countries should be bridged. One pillar of that bridge is the availability of the technology in particular in education. In many developing countries computers have to some extent become available in educational institutions. In some Southern African countries Computer Studies has been introduced as a subject within the curriculum. However, ICT education stretches much further than a subject in itself.

The Information Age is supported by technology and involves a change in learning and working styles. Searching for information, but also using, combining, analysing, processing, producing and disseminating information in many different ways is part of the new era. Therefore ICT and innovative didactics are two inseparable aspects of education in order to prepare students for the information society (Voogt and Plomp 2001). Only when ICT is integrated in the teaching and learning process of basically all subjects, it becomes a tool and a means in education. This integrated approach towards ICT in education requires the development of exemplary ICT-based lessons and the training of teachers on instructional skills for these lessons (Thomas and Emereole 2002).

Designing ICT-based lessons involves many more skills than just ICT skills. Skills for developing ICT-based lessons are (1) ICT skills, (2) planning student activities, (3) writing texts at student level, (4) designing worksheets, and (5) testing and evaluating trial versions. During the design and development of ICT-based lessons, it becomes obvious that the classroom organisation changes and that a paradigm shift from teacher-centred to student-centred learning should take place. This mind shift is necessary to benefit from the new technology, although it turns out to be much more difficult than to adopt technology itself.

The current study was carried out in Mozambique. In this country less than 20% of the primary school teachers are qualified. The Mozambican curriculum is academic, reflects teacher-centred instruction, and students are merely asked to reproduce knowledge. Computer Studies or basic computer skills are not offered within the curriculum of primary, secondary or teacher-training level. Very few primary schools have access to computers. The workshop, on which the study is based, is part of a larger project aiming at making computers and ICT-based lessons available to teachers and students of grade 6 and 7. The current research studied which instructional tools can be effective and efficient, and which contribute to a minor extent or can be left out in training developers of material for ICT-based innovative lessons.
RESEARCH DESIGN
The research used an experimental design. A workshop was conducted for sixteen prospective developers of ICT-based lessons. The objective of the workshop was to provide the participants with information, skills, knowledge and a conceptual framework to develop and design ICT-based lessons. A cyclic conceptual framework was used consisting of four phases: Analysis, Design, Development and Implementation. This framework is also used within Software Development processes and derived from Dynamic Systems Development Methodology (Stapleton 1997). Thus, the materials evolved in stages and underwent significant changes because of discussions, formative evaluations and the testing sessions. The participants were selected based on their experience in teaching or curriculum development at the aimed level (grade 6 and 7). Four subject areas were selected: mathematics, arts, social sciences (geography and history) and natural sciences (biology). For every area four participants were selected. Limitations in the selection were the relatively small group of teachers with a degree in education and with ICT skills. Another limitation was the distance. The participants would have to be within a reasonable distance of the capital Maputo in order to be able to participate and work together with colleagues. In practice, participants came from within a range of 70 km of Maputo.

Advanced computer skills were required in every group. These skills comprised advanced word processing, drawing and spreadsheet skills, searching the internet, managing folders and files, copy and insert images, graphs and texts. Experience with instructional development was virtually absent in each group, as these competencies are still very scarce in Mozambique. The workshop was conducted on Saturdays during eight consecutive weeks. A workload of a minimum of sixteen hours per week was anticipated: eight hours during the workshop and at least eight hours during the week.

Every group of participants had to develop sixteen ICT lessons. Each lesson involved three components: the ICT component, a worksheet for the students and a teacher-guide. The ICT component could be in the form of an existing computer program, a newly developed or translated application (e.g. Java-applet) or a web site. The aims were high, as within the experiment the ICT-based lessons should also be examples of innovative teaching and learning methodologies.

During the workshop different instructional tools were applied. Among these were:

1. Hands-on experience with worksheets of ICT-based lessons;
2. Presentations with titles such as: ICT in Education, Selection and Evaluation of web sites, ICT and Instructional Methodology, A Cyclic Approach towards Development;
3. Discussions initiated by the above-mentioned presentations and discussions on classroom organisation and management;
4. Selection and definition of design principles in round table discussions in order to establish common criteria for the material that would be developed by the participants (van den Akker 1999);
5. Prototyping of the ICT component of the lessons. This work involved drafting a design for a an animation, a HTML page, or a Java-applet later to be programmed by a programmer;
6. Formative evaluation of material against the design principles (see 4), against Bloom’s Taxonomy (Bloom 1956) and in empirical test sessions with grade 6/7 students.

INSTRUMENTS
In order to measure the effectiveness and efficiency of the instructional tools the following instruments were used: (1) observations, (2) a questionnaire, and (3) evaluation of the material developed by the participants. The observations were carried out during the time that the participants were working on the development of their materials and during the midweek test sessions with students. The aspects of observation pertained (1) instruction according to the design principles and (2) variation in questions and tasks based on Bloom’s Taxonomy in such a way that knowledge, comprehension, application, analysis, syntheses and evaluation were addressed. Observations were logged in field notes.
The questionnaire was developed for this particular group. The objective of the questions was to receive information from the participants pertaining factors contributing to or hindering the development of the ICT-based lessons. The first three questions asked the participants to indicate a preference. Each of these questions comprised eight items, which had to be marked with numbers 8,7,6 …1, whereby every number was to be used once. This forced the respondents to indicate preference even if several or all aspects were considered of importance. The reason to choose this format is that from experience respondents in Mozambique tend to be very positive in their answers and Likert-type questions often result in very little variance. The preference-type items result in more discrete outcomes. Some questions were of the preference-type others of the Likert-type.

The final materials developed by the participants were evaluated in such a way that the combination of the ICT component and the worksheet was considered. The criteria were that the materials should be (1) innovative within the Mozambican context, (2) comply with the design principles defined by the participants, and (3) reach beyond the reproduction of knowledge in the traditional way. The combination of the ICT component and the worksheet was considered and not the separate two components, because sometimes the ICT component itself appears as rather traditional, but the instruction and the tasks on the worksheet turn it into innovative material. Likewise some ICT components seem sophisticated, but the instruction and tasks destroy all creativity and do hardly stretch beyond conventional teaching.

RESEARCH OUTCOMES

During the workshop the participants were asked to define design principles, which would serve as criteria for evaluation during the development of material. The design principles were based on the general consensus that the material and the resulting lessons should be student-centred. However, other research revealed that the notion of student-centred is often ambiguous (Kasanda 2003). Therefore, this starting point was discussed with the participants and the following design principles emerged: the material should (1) be based on the curriculum, (2) model and visualise concepts, presenting concepts at different levels of abstraction, (3) stimulate discussion between students and foster reflection, (4) enhance creativity, experimentation and discovery, (5) be challenging for different levels and interests and include open-ended question, (6) guide the students and offer a logical sequence of tasks using a worksheet. In addition, the participants agreed that it should be encouraged to integrate different subject areas.

Observations

One of the noticeable outcomes in the observations was, that the participants had abundant knowledge of cognitive theories for example, they recognised aspects of constructivism, but this was not transferred to the materials. Their initial materials reflected the Mozambican educational system. Most participants had the curriculum and the instruction for rote-learning engraved in their minds. Observations of the ICT component showed that the content of the subject-area remained academic and the instruction remained conventional.

The participants were not familiar with developing educational material. This did not only pertain the ICT component, the participants also had great difficulty to translate their own knowledge into accessible texts and other representations at student level. Many participants were initially unable to phrase subject concepts in a way that grade 6 and 7 students were able to grasp the meaning. The participants also had great difficulty and little experience transferring their theoretical knowledge on instruction into the tasks of the worksheets (open-ended questions, encouraging discovery and discussion).

The groups of Social Sciences and Natural Sciences copied texts, maps, and images from textbooks and from the internet, wrote texts and created their own web site. An existing interactive training program for geography was incorporated. However, the initial tasks and questions in the Social Sciences were all of the type: reproduction of knowledge. There was a noticeable exception with two new topics recently introduced to the curriculum of Natural Sciences (1. sexuality, adolescence & gender. 2. drugs and drug addiction). The new topics were addressed with much more openness and creativity than the established topics, resulting in lively discussions and questions by the students during the first test session.
The test sessions offered a learning environment for the participants. The tests made the participants realise the importance of (1) translating academic knowledge to students’ life, (2) variation of questions at different levels, (3) simplification of the texts and (4) improvement and extension of visualisation. The test sessions enabled reflection and resulted in improvement of the ICT component as well as of the tasks and questions on the worksheets. A side effect of the test sessions was that they motivated the participants more than anything else to continue and improve their materials. Because of the test sessions the majority of the participants started to appreciate the use of worksheets.

Questionnaire
At the end of the workshop, during Session Eight, the participants were asked to fill in a questionnaire. By that time not all the materials were completed. Sixteen out of the eighteen participants (89 %) were present and filled in the questionnaire.

Figure 1. Activities and their contribution to the realisation of the materials.

Figure 1 shows the outcome of the item: Indicate to what extent the following activities contributed most to the realisation of the materials in order of preference. The respondents indicated that the assistance by the conductor of the workshop contributed most, although they possibly wished to please the conductor of the workshop. However, earlier research supports the fact that the success of a workshop is mainly dependent on the conductor (Mason 2003). The respondents indicated that the test sessions contributed second most to the realisation of the materials.

Figure 2. Obstacles encountered in the real isation of the materials.
Figure 2 shows the outcome of item 2: Indicate which obstacles you encountered during the process of developing educational material in order of (8) major obstacle up to (1) minor obstacle. The respondents indicate that there was shortage of time and that they lacked experience with design and development of educational material. They also indicated that they had enough opportunity to test.

**Figure 3. Design Principles and their application in the materials.**

Figure 3 shows the outcome of item 4: *Indicate which Design Principles you incorporated into your material.* The results show that the scores on the different items were all high > 3.0 on a scale from 1 to 4. The respondents indicate that they based their materials largely on the curriculum. The second most important design principle, according to the participants, is creativity, experimentation and discovery. Least incorporated was the design principle of differentiation for heterogeneous groups.

**Evaluation of the materials**

The developed materials were evaluated against the design principles. During the development process, the repetitive evaluation of the material against the design principles and against Blooms’ Taxonomy changed and improved the tasks considerably. The evaluation shows that visualisation was to a large extent integrated in the ICT components, thus turning the lessons into much more lively than conventional lessons. The worksheets, however, remained mainly text-based. There is a disparity between the perception of the participants reflected in the outcomes of the questionnaire and the outcomes of the evaluation. In the questionnaire the respondents indicated that the design principle of creativity, experimentation and discovery was applied second-most, evaluation of the material shows that only a minority of the tasks involved open-ended questions. The evaluation shows that the materials do not match most criteria. On the other hand, the developed lessons were to a large extent innovative within the Mozambican context. The scope of this paper does not leave room for the description of the analysis and classification of tasks against Blooms’ Taxonomy, but this is a revealing and valuable instrument for evaluation (Kandjeo-Marenga 2003).

**CONCLUSIONS**

The study meant to identify useful tools for developers of ICT-based lessons. The first tool that proved important for a change in instruction was the use of worksheets, which were required as part of the ICT-based lessons. The worksheet, along with a computer program, allowed the students to work more or less independent of the teacher. This is a world of difference from the standard instruction. The second factor that proved invaluable for the development process of the materials and for the final results was the test sessions. They offered feedback for the developers of the materials at different levels and motivated both the students and the participants. Finally, the examples of ICT-based lessons proved helpful to most participants. In addition, it can be concluded that introducing ICT in the classroom proved to offer an
excellent opportunity to initiate active learning. However, ICT does not automatically lead to innovative instruction.

REFERENCES


