Development and implementation of a web-based resource for multilingual ICT education

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Abstract—The language barrier limits the access to the study of ICT-related subjects for speakers of an African language, both at Undergraduate and postgraduate level. In response to the need to create competent African graduates in these fields, in this paper we discuss an application which uses such students' mother tongue (as well as English) to increase access. The development and implementation of such application are described. data are provided on its use and impact on the attitudes of a group of African students in the foundation course at Rhodes University.

Index Terms—Open-source, e-learning, African languages.

I. INTRODUCTION

The language barrier is recognised as one of the factors determining low access to Information and Communication Technology (ICT) and ICT education for many members of marginalised communities [1]. At tertiary level, African students with low levels of English proficiency struggle to cope with the use of English as the sole Language of learning and Teaching (LoLT). This entails low throughput at both undergraduate and postgraduate level, which frustrates demands by the industry for more African postgraduates in ICT-related fields [2]. Various scholars [3] advocate that a partial use of African languages as LoLT could help address this problem.

At the 2004 edition of SATNAC, we presented a paper on a proof-of-concept application to increase access to the study of ICT-related subjects for speakers of an African language with low levels of English proficiency [4]. Such an application envisaged the use of both English and African languages, and the active participation of students in the creation of multilingual resources by working collaboratively on-line. Its target users were African students in the foundation programme at Rhodes University. Inter alia, we sought to explore how the use of the new technologies could address some of the issues associated with the use of African languages in education.

In this paper we describe the development and fielding of this application and its successors. For a more extensive discussion of the rationale, context and evaluation of our intervention the reader can refer to recent PhD research [5] of which this paper is an extract. We will describe the three phases of software and content development and conclude with some evaluation and reflections on our intervention.

II. PHASE 1: AN AD HOC APPLICATION

A. Features and components

The application we used in our intervention had to have specific features. First of all, it had to allow for the integration of multimedia. The use of images, audio and video explanations together with text addressed the problem of low proficiency in the written variety of African languages among their speakers [6]. Secondly, it had to be Web-based, to allow students to work collaboratively and access the application from any machine on campus. Thirdly, it had to be instrumented to inform research, i.e. collect data about its usage and allow for feedback. Finally, it had to be developed using open-source tools. From the practical point of view, this saved the costs of using proprietary software, and ensured that the application could be freely distributed once developed. From the ideological point of view, the open-source community subscribes to the values of collaboration and sharing which informed this intervention [7].

A proof-of-concept application was ready by September 2004 [1]. It had three main components: a glossary, a chat room and a knowledge base. The glossary was the core component of the system. It allowed students to search an English computer term and retrieve a definition in the African language of their choice. It recorded terms students looked for in order to inform research and future development. Although the glossary was mainly text-based, it allowed for the linking of images, audio and video files which could be streamed over the network. The chat room allowed for real-time interaction in the classroom. This enabled tutors to save time by assisting several students simultaneously. It also allowed students who completed their tasks to help others, without moving around the classroom. Perhaps most importantly, students were allowed to use any language. The envisaged use of the chat room was based on the existing practice, confirmed by classroom observation. The records were stored and could be later analysed for research purposes. The knowledge base allowed for asynchronous communication between students and tutors/lecturers. Students could ask questions and the answers would become part of a database available to all other students.
This initial application had several limitations and was never actually used in the classroom. First of all, although it had most of the necessary functionality, it was not an integrated system. Different features formed part of different applications and were not integrated in a consistent user interface. The glossary did not allow for easy switching between languages, which made it hard to use. The use of real-time communication in the public computer laboratories is heavily restricted by Rhodes’ Information Technology Division to limit bandwidth use. Moreover, lecturers discourage the use of such tools during lectures, for reasons of class management. As a result, even though it featured in all versions of the application, the chat room component could never be used. The knowledge base feature, though viable from a technical point of view, was not implemented because there was no clear commitment from the lecturer or tutors to answer students’ questions. Also, the application was ready late in the year when students were beginning to prepare for exams, and there was little time for experimentation with new tools.

C. New tools

The constraints mentioned above prompted the development of an ad hoc application [8]. Tools freely available on the Web were taken as a starting point and customised. The result was a new system running from a server in one of the authors’ office. Students could access it from any computer on the Rhodes network, although for security reasons it was not accessible from outside Rhodes. The URL students had to enter was linked to a personal machine (i.e. “g01d0010.ict.ru.ac.za”). This made it difficult to remember, but gave us and the developer (a PhD student in Computer Science) complete control over the server.

The whole system was now integrated and all the envisaged functionalities were there. In the glossary, students could easily switch between languages through a drop-down box. The chat room worked properly and allowed for direct copying and pasting of images, such as screen shots, etc., which could integrate explanations. The knowledge base was indexed by topic and allowed students to submit questions by email. All interactions between the students and the system were recorded in a MySQL database. The interface was Java-based. Although Java is not open-source, this means the application could be easily modified and it could be redistributed without cost and with no restrictions. Most computers in the public computer laboratories had the necessary plug-ins (Java Runtime Environment 4), and the application would work from any Web browser.

However, the application was rather resource-intensive. This made it slow and, in the case of a lab with 20 or more students connected, almost unusable. Moreover, the application was “foreign” to all other class activities, and became an additional tool that students were not actively encouraged to use. This problem was addressed by the use of Moodle in subsequent years. The ad hoc application was used only for testing by the group of five volunteers mentioned above. In spite of positive feedback about the general idea, its practical implementation was problematic.

D. Content development

In the initial stages of our intervention, We experimented with getting students to develop their own material on a voluntary basis [9]. They were encouraged to meet with fellow native speakers of their language in their own time, and help to translate and develop material to teach computer literacy in their mother tongue. We hoped that reliance on volunteers would enable us to tackle some of the issues commonly associated with the use of African languages, i.e. their supposed underdevelopment, issues of costs and possible tensions arising from giving prominence to one African language over others.

During the sessions, students were encouraged to use a variety as close as possible to the one they spoke. Although they were encouraged to create new indigenous terminology, code-switching was allowed. We hoped that, given a sufficient number of volunteers, this would ensure that a wide range of varieties would be represented, and that the language used would be a reasonable compromise that everybody could understand. Reliance on volunteers was intended to address the issue of costs of professional translation [10]. This is particularly important if one considers that, in order to avoid tensions, material would have to be translated into all African languages at the same time, multiplying the costs by ten.

III. PHASE 2: EXISTING WEB-BASED APPLICATIONS

A. Moodle

In order to allow contributors to work collaboratively online, we relied on two existing Web-based applications. To facilitate participation of foundation students we used the Moodle server of Rhodes University (http://ruconnected.ru.ac.za). Although working on a server maintained by the university posed some restrictions, we managed to combine all desired functionalities of the application described above into one “course”. Moodle, being a Learning Management System (LMS), is primarily designed to support teaching and assessment; for this reason, it only allows power users (called “teachers”) to create and maintain “courses”. We found that, because of its sound social-constructivist orientation, Moodle is flexible enough to be used as a community-building portal [11]. This can be done using its most interactive modules, such as chat rooms, forums and wikis.

Throughout 2006, we developed various versions of the resource. After a few trials, the first usable version was ready by the end of the first term. It catered for all languages and had different sections for interactions, collaborative work, etc. As a consequence, it had a rather convoluted structure. A chat room and a contributors’ forum were hosted in the top section, common to every language. This was motivated by the expectation that not many would use them, and that those who did would benefit from communication across language groups. Each language section had three subsections: course note, glossary and additional resources.

The course notes were based on the handbook and were implemented using a wiki. This is a tool that allows users to
edit a document collaboratively on-line. It also keeps track of past changes and allows for backtracking. Once the resource was set up for one language, we replicated it for all the others. We integrated all the terms defined in the handbook into the glossary. The glossary was implemented through the glossary feature of Moodle, which offers all the desired functions. The only limit was the recording of the terms users look for, but that was fixed by a “patch” and used in the following version. The last section, titled “additional resources”, consisted of an index of on-line resources available for each language (e.g. on-line dictionaries, interest group websites, etc.).

For the isiXhosa section, we used part of the material produced in the first phase. Since Rhodes is based in a predominantly isiXhosa-speaking area, this language took prominence and we ultimately decided to focus only on the development of an English/isiXhosa resource as a model which could be replicated for all other African languages.

B. Poootle and glossary expansion

The development of the glossary, which eventually became the main component of the system, received a major boost through the input of a Computer Science Honours student at Fort Hare as part of his research project [12]. He worked on it using mainly Pootle (Portable Object-based, On-line Translation and Localisation Engine). This is a tool developed by Translate.org.za, a Non-Governmental Organisation committed to the localisation of open source software in all 11 South African languages, for collaborative on-line translation. The tool developed during the course of the research, and by the end of 2006 was capable of suggesting translations from a database of previous work. This allowed the translation of definitions from the foundation handbook to proceed relatively quickly, and guaranteed some level of consistency. The student could also rely on the help of an on-line community of translators attached to Translate.org.za. He made extensive use of the mailing list for isiXhosa in order to propose translations and ask for suggestions and feedback.

A second Honours project focused on the creation of multimedia material to integrate explanations. This used a variety of tools which did not allow for direct integration into the glossary.

IV. PHASE 3: IMPLEMENTATION IN THE FOUNDATION COURSE

A. Moodle glossary implementation

During implementation, the glossary became the core feature of our intervention. It was both distributed in print (the format most foundation students were still more comfortable with) and implemented as a glossary module within the Moodle course for foundation students. From early 2007, students used the course in class during lectures and tutorials. This solved a problem common to the applications we used in previous years, i.e. the fact that these were not integrated into classroom practice and into the course. Throughout 2007, the glossary was immediately available to the students within an application they were familiar with and they used every day.

The chat room module could not be used, as the lecturer was concerned that it would distract students from lectures. In such a small group, making the chat room available only outside lectures and tutorials times would have been pointless, since few students would normally use the application at the same time. The knowledge-base was implemented as a Moodle forum. Although a few students experimented with it and this yielded input for the glossary, it never really became popular in the class.

In this phase, the glossary was developed and expanded by a dedicated multi-disciplinary team within the South Africa – Norway tertiary Education Development (SANTED) programme hosted by the Rhodes African Language Studies Section. The starting point for content development was the glossary developed as part of an Honours project in the previous phase. Definitions and new entries were modified and added according to feedback collected from the students through the glossary itself.

B. Moodle glossary features

Moodle glossaries can be exported in Extensible Markup Language (XML) format. This makes it possible to import a glossary into another Moodle course. This is a useful feature in the case of multiple implementations of the same glossary, as each implementation can be “copied” and merged with another. Moreover, this makes it easy to change settings for all entries at the same time, e.g., require a “whole word matching” for all of them. Exporting and importing through XML, however, comes at the cost of losing formatting (i.e. bold, underline, italics etc.). This means that, once entries are created, modifying them (either one by one though the interface or through the export/import method with subsequent reformatting) can be rather time-consuming.

The glossary module has most of the functionalities envisaged since the initial application. It allows students to rate existing entries and make comments. With appropriate settings, it also allows students to add new entries. Although this is relatively easy for someone who is familiar with the system, the interface can be confusing for new users. There is also an option to hyperlink entries. If one of the terms included in the glossary appears in the definition for another term, it is automatically hyperlinked; by following the link, students are taken directly to the definition for that term. This allows students to browse around interrelated terms, showing the semantic links between them. Another interesting feature of the Moodle glossary is a block displaying a random entry on the front page. This can be used to attract students’ attention by displaying a new “isiXhosa entry of the day” every time they access the course.

Moodle keeps logs and is capable of generating simple reports for each activity. Unfortunately for the glossary, these record only terms that are hyperlinked from the definition of other terms and that students click on. This is not very useful as, in most cases, students would search directly for the term they were interested in. In this case, the logs would reflect only that a search had been completed (marked as “glossary view”). In order to have more accurate logs we wrote a “patch” to the Moodle code using the $owrite statement in PHP. This records every word students look for into a text file.
V. PHASE 4: EVALUATION

A. Glossary feedback

Students in the foundation course could provide feedback on the glossary either on-line or on the printed version. The latter proved difficult to retrieve and time-consuming to analyse, so students were encouraged to upload their written comments and ratings using the on-line version. Only feedback obtained through the two on-line implementations of the glossary is discussed here.

The glossary received 517 “hits”. Most of them (502) refer to March 2007, the month in which the students were first exposed to the glossary. The rest of the records are concentrated closer to the mid-year exams, although some students accessed the glossary during the June/July holidays.

Analysis of the records stopped at this point, since the glossary covered only material covered in the first semester. Subsequent logs indicate activity in the period immediately before the interviews, towards the end of the year. A possible explanation for such low usage is that, besides the initial interest for the novelty of the on-line version, students preferred to use the printed version of the glossary. One must also consider that only isiXhosa speakers, i.e. 31 students, could actually use the glossary. This means an average of 17 interactions with the glossary for each isiXhosa-speaking student.

Analysis of the records suggest that students followed links from within a definition to see other terms 38 times. These records refer mainly to terms which are part of complex and interrelated systems, e.g. “ALU”, “CPU”, “RAM” and “ROM”. Definitions for two terms (“documentation” and “technical support”) were added by the students themselves. They also used the forum feature to ask for definitions of five terms (“system clock”, “microprocessor speed”, “CMOS battery”, “peer to peer” and “client/server”). Entries for these terms were promptly developed within the SANTED team and included in the glossary.

Students looked for terms 334 times, of which 114 were during the lecture in which they were introduced to the glossary for the first time. Terms looked for included acronyms (e.g. “ALU”), compounds (e.g. “cell address”), sentences (“e.g. “click to add title”), functions (e.g. “countif”), etc. Students searched for common words (e.g. “essay”) and product names (e.g. “Excel”) as well as non-existent words (e.g. “chomi”). Swearwords (e.g. “pussy” and “isibhanxa”, which means “fool”) were present but not common.

A considerable portion (44) of the terms students looked for were isiXhosa words. These included isiXhosa-ised English terms (e.g. “imonitha” - “monitor”) as well as common isiXhosa words (e.g. “isonka”, which means “bread” and “ingalo”, which means “arm”). With respect to the latter, in developing isiXhosa equivalents of computer terms we relied heavily on body parts as metaphors. For example, “ingqondo yeckhompiyutha”, which literally means “the brain of the computer” was used for “CPU”. It is reasonable to assume that most such terms were intended to test the resource rather than genuine searches. The on-line version of the glossary could perform a full-text search, which would find isiXhosa words in the definition of English terms. However, isiXhosa words would be difficult to find in the printed version. This would require a duplicate glossary, indexed according to the isiXhosa terms.

Students did not give any direct comments, but rated 36 of the 150 entries. Each entry was rated by a minimum of one to a maximum of three students, although only 13 entries received more than one rating. Entries on the first page, being more readily available, received a proportionally higher rating than the rest of the glossary. The average rating was 4.41 on a scale from 1 (very poor) to 5 (very good). For entries that received more than one rating, standard deviation between the marks was taken into account. Values varied from 0 to 2.83. This means that, while there was considerable agreement about the quality of some entries (i.e. “Keyboard”, which scored 5), opinions differed for others (e.g. “directory”, which ranged from 1 to 5), even within such a small sample.

B. Questionnaire feedback

In an attempt to gauge the impact of our intervention, foundation students were administered two questionnaires: one before and one after the intervention. Out of the 42 students enrolled in the course, 38 filled in the first, 21-item questionnaire. The second questionnaire included a subset of questions from the first one as well as new questions, mainly related to the glossary. This questionnaire yielded a response rate of 33 out of 42 students. The majority (17, i.e. 74%) of the students spoke isiXhosa.

Comparison between the two questionnaires points to a positive shift in attitudes towards African languages. The number of those who believed they could speak about computers in their mother tongue increased from 6 (i.e. 21%) in the first questionnaire to 14 (i.e. 44%) in the second. The number of those who believed their language should be used more in education increased from 17 (i.e. 58%) to 21 (i.e. 67%).

Actual use of the glossary was difficult to assess. Out of a total of 33 respondents to the follow-up questionnaire, 24 answered questions for those who used the glossary and 12 answered questions on why they did not use the glossary. While the vast majority (24 out of 31 respondents, i.e. 80%) agreed that the glossary we developed was a good idea, only two-thirds of those who used it (16 out of 24, i.e. 66%) agreed it was of good quality and easy to use. Among students who claimed they did use the glossary, only 7 out of 23 (i.e. 30%) believed that the glossary could help them, while 16 (i.e. 70%) agreed it would be useful for others.

VI. CONCLUSIONS

In this paper we described the development and implementation of a web-based resource to support access to multilingual (English and African languages) ICT education in the foundation programme at Rhodes University. The different phases are described, discussing how each phase informed the next. We believe the lessons learnt and the findings on usage and impact can guide similar research in future.
ACKNOWLEDGEMENT

We would like to acknowledge the sponsors of the Telkom Centre of Excellence of Rhodes University and of the SANTED programme. We would also like to thank the Opera Universitaria di Trento, the Carnegie-Mellon foundation.

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