Dr Math moves to C³TO: Chatter Call Center/Tutoring Online

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Abstract

Dr Math is a mobile tutoring system which has been running in South Africa for three years. It links primary and secondary school pupils to tutors in mathematics. The pupils use the popular Mxit chat client on their cell phones. The tutors use full size computer work stations connected to the internet. Dr Math has grown from strength to strength with over 6000 pupils having been assisted with mathematics homework. It was time, however, to redesign and rewrite Dr Math to use a more scalable enterprise architecture. This paper describes the redesign and rewrite of Dr Math to use the Mobicents telecommunications platform under Jboss (the open source J2EE application server). This new framework is called C³TO: Chatter Call Centre/Tutoring Online.

1. Introduction

Shocking statistics in a recent draft report (the report should be made final by October, 2009) show that only seven percent of South Africa's first year university students have sufficient competency in mathematics [1]. Prior international research which measured the mathematics and science skills of pupils in Grade 8, placed South Africa last among the 50 participating nations [2].

Seemingly unrelated statistics show that even among low-income South African youth, cell phone usage is often as high as 97% with teenagers often sharing cell phones[3, 4].

Dr Math is a project which attempts to use the high cell phone usage statistics to help solve the appalling statistics about mathematics. Dr Math allows primary and secondary school pupils to use Mxit on their cell phones and to link up with tutors from a local university in order to get assistance with their mathematics homework.

Dr Math, however, has grown far beyond any initial expectations about the project. This paper describes a complete redesign and reimplementation of Dr Math using Mobicents running under Jboss.

This redesigned framework is C³TO, Chatter Call Centre/Tutoring Online. C³TO is an open source platform which provides a wide range of information and services over chat protocols including person to person communication, static lookups, competitions, games, quizes, questionnaires, and links to selected internet websites.

2. Brief History of Dr Math

Dr Math was an action research project hosted at Meraka Institute and initiated at the beginning of the 2007 academic year in South Africa. It was piloted at one high school in North West province of South Africa. The initial research objective was to determine whether or not secondary school pupils would use their own cell phones and their own airtime in order to get assistance with mathematics homework.

During the various cycles of the action research, the author interacted with the pupils and solicited their opinions about what facilities a good tutoring system should have. Dr Math has grown to include competitions, static lookups, and games [5].

As of today, more than 6000 pupils have used Dr Math being assisted by over 100 tutors.

3. MXit

The term “Mxit” is often confusing It can refer to three different things: the company, the chat service, and the application on a cell phone.

Mxit Lifestyle (Pty) Ltd is a South African company based Stellenbosch. The company has its origins in 2000 when the founders attempted to create an SMS based Massive Multiplayer Mobile game. Although that original game was not successful, the game's functionality was reassessed and transformed into a mobile instant messenger. In 2006 Mxit Lifestyle (Pty) Ltd was formed to market and support the instant messagener [6].

The instant messenger service and program developed is also called “Mxit”. A Mxit user must

download a small client application onto his or her cell phone. This client application (which is also called "Mxit") connects to the servers to allow instant messaging. According to press releases on the corporate website, Mxit currently boasts more than fourteen million users.

One of the reasons of Mxit's popularity (especially among teenagers) is the inexpensive costs of messages sent over Mxit. Because they are sent over GPRS and not over SMS, costs of messages are less than one cent.

4. Minor Children, Ethics and Safety

A quick Google search of the two terms "Mxit" and "Teenagers" will produce numerous articles with a negative connotation about Mxit. Because of this and because of legislation regarding research with minor children, the Dr Math project went through an ethics assessment to ensure that all participants were dealt with ethically.

Participation on Dr Math is completely voluntary. Participants are free to withdraw from the Dr Math project at any time. Participants are given a description of the project about the project with references to our website for further information.

Perhaps more important than ethics, however, is safety. Dr Math goes to great length to ensure the safety of all the participants. All tutors must sign a code of conduct before being allowed to assist participants. All conversations between participants and tutors are recorded for quality and security reasons. All tutors must physically come into the premises of Meraka Institute in order to access the tutoring software.

5. Mathematics Education

Over the 2 ½ years in which Dr Math has been running, pupils have been assisted in a full range of mathematics topics up through trigonometry. Although the original Dr Math project was aimed at helping secondary school pupils, the number of pupils from primary schools has increased and pupils also get help with basic arithmetic skills.

The normal operating hours of Dr Math are from 14:00 until 20:00 on Sundays – Thursdays. Very few pupils contacted Dr Math for assistance on Fridays and Saturdays.

The quality of the tutors is extremely important. Dr Math is fortunate to have a good working relationship with the University of Pretoria and most of the tutors currently come from the Built Environment (engineering) department.

From anecdotal evidence found in the log files of the Dr Math conversations, it is clear that the pupils who use Dr Math appreciate the help given by the tutors and believe that the assistance has been helpful. For example:

Peter: I completed metric last year and attained 97per in higher grade maths, i would lyk to thank yourl 4 helping me during the exam period , becoz wheneva i got stuck wid a problem u guys helped me out(*)

Although MXit is not a graphical environment, Dr Math tutors have succeeded in tutoring pupils in arithmetic, geometry, algebra, trigonometry, and financial mathematics. Pupils and tutors often negotiate required symbols. For example if an expression such as $ax^2 + bx + c = 0$ needs to communicated, the tutors will explain say something like

*Dr Math: I wil us ^ for xpnt n * 4 mltpy do u mn a*x^2 + b*x +c = 0?*

6. The Problem

The problem eventually arose, however, that Dr Math was growing far beyond any expectations. Dr Math needed to have facilities where tutors could safely tutor from home or from university labs. Dr Math needed to be able to scale the software to handle increased numbers. Dr Math also needed to expand the protocol sets so that Dr Math could also communicate with pupils who did not use Mxit but used other chat systems such as Google Chat, Jabber, or Nok-Nok. Multiple Dr Math servers needed to be available in different areas to handle the future load. In addition, the platform needed to be more generic so it could used to assist in other domains such as dispensing information about HIV/AID or other health issues.

These problems prompted us to do a complete redesign and rewrite of Dr Math using Jboss, Mobicents, and Seam.

7. New Architecture

A design and creation research project as defined by [7] was initiated in early 2009 to determine how best to redesign and rewrite Dr Math using all open source products in order to solve these problems.

The new framework under which the Dr Math service is running is C³TO, Chatter Call Centre/Tutoring Online. C³TO is an open source platform developed at Meraka Institute during 2009. The architecture for C³TO is subdivided into two sections because C³TO, itself, has two dramatically different facilities. There is the instant messaging

chat facilities (which are architected using Jboss and Mobicents). And there is the web based tutoring system and administration system (which are architected using Jboss and Seam).

Jboss is an open source implementation of the J2EE standard [8, 9]. J2EE (Java 2, Enterprise Edition) is a model for developing distributed applications with particular emphasis on reliability and scalability [10].

The JAIN (Java APIs for Integrated Networks) initiative is an attempt to provide Java developers with standardised Java APIs for network applications. JAIN SLEE (Service Logic Execution Environment) defines an environment very similar to J2EE but designed specifically for telecommunications applications [11]. The Jboss Mobicents Platform is an open source implementation of JAIN SLEE [12] and was the first open source platform to be certified as JAIN SLEE compliant [13]. Mobicents is used for the instant messaging component of Dr Math.

Typical web applications are three-tiered applications consisting of a presentation layer, a business logic layer, and a persistence layer [14]. Jboss Seam provides for these three layers of architecture with the navigation between the layers being simplified by the use of Java annotations [15]. Jboss Seam is used for the tutoring web component and the administration web component of C³TO.

8. New Functionality

By redesigning and rewriting the underlying framework for Dr Math, we opened up many possibilities for enhancements. Some of the enhancements include:

1. People being able to register to become a tutor and (depending on authorisation from an administrator) being able to tutor from home, from an internet cafe, or from a lab at a university.
2. Administrators being able to manage tutors via a web interface.
3. Web configurable competitions
4. Web configurable quizes
5. Web configurable questionnaires
6. Web configurable static lookups such as definitions and formulae
7. Web configurable links to other selected internet websites
8. A plugable mechanism to handle different chat protocols such as Mxit or XMPP.
9. A plugable mechanism to also allow communication via SMS
10. A plugable mechanism to also allow communication via MMS
11. Web configurable connections to various chat servers.
12. Extraction of log files and time sheets via a web interface.

These C³TO features now allow Dr Math to be easily administered and more widely used. In addition, it is no longer only a mathematics tutoring system since quizes and competitions can be configured over the web in different domains.

9. Current Status

At the time of writing this document, the redesign and rewriting of Dr Math under C³TO is in progress. The time frame is such that the new configuration of Dr Math using the new C³TO architecture will go live in October, 2009. The plans are to run the C³TO implementation of Dr Math in parallel with the original implementation of Dr Math. We will be able to report on the success or lessons learned at the time of the presentation of this paper.

10. C³TO In Africa

With cell phone usage sky-rocketing in Africa (as in the rest of the developing world), an open source platform such as C³TO can be used to provide information inexpensively on a wide range of topics. By using C³TO, a domain expert such as a nursing sister, teacher, counsellor, or government representative will be able to set up a chat service (similar to Dr Math) which could be used to dispense information on a wide variety of topics. A number of organisations have expressed interested in using C³TO after our initial test period.

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