Towards a Sustainable Volunteer Mobile, Online Tutoring Model for Mathematics

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Abstract: Volunteer workers contribute to many aspects of society. There are volunteer organisations which formally assist in many areas such as health, education, housing, safety and security. Virtual volunteering is less common. Virtual volunteering is the phenomenon of people volunteering their services and expertise via the Internet. This paper describes work towards a sustainable model of sourcing volunteers for a mobile, online tutoring environment. This is a work in progress.

Keywords: Virtual volunteer, Dr Math, cell phone, sustainability

1.   Introduction

Virtual volunteering is a new phenomenon of people volunteering their services and expertise via the Internet [1]. Organisations which could benefit by the use of volunteers often find that the potential volunteers' time is constrained by other obligations such as employment, family, and physical limitations. By enabling virtual volunteering, an organisation can allow potential volunteers to donate their time and energy from the comfort of their home, office, Internet cafe, or school laboratory. Virtual volunteers use any Internet based workstation and donate their services and expertise to an organisation.

There are a number of extremely successful virtual volunteering projects. Project Gutenberg and the LibriVox project are two such projects [2-4]. These two projects source out-of-copyright books. In the case of Project Gutenberg, a world wide group of volunteers compile a digital written library of books, proofread the books, burn CDs and DVDs, and promote the project. In the case of LibriVox, the world wide group of volunteers create audio content by recording books, plays and poetry in audio format.

Sourcing of volunteers is important to such projects. This paper describes work towards a sustainable model for sourcing virtual volunteers for an mobile online mathematics tutoring environment.

2.   Delineation

For the scope of this paper, the expression *sustainable model* is used only to refer to the sustainable model for sourcing virtual volunteer tutors. The sustainability model described in this paper does not present any financial model for a virtual volunteer project. The sustainability model herein presented describes a model for sourcing volunteer tutors in a sustainable manner.

3. History of Dr Math

Dr Math[TM] is a mobile online mathematics tutoring environment [5-8]. Pupils use chat protocols on their cell phones. Tutors use traditional Internet workstations. The Dr Math tutoring platform links the pupils with the tutors keeping all identities hidden from participants.

Dr Math was started in 2007 as a small pilot project investigating whether or not teenagers would actually want to chat about their mathematics homework on their cell phones. At that point in the time, the researchers wondered whether any pupils would actually take part in the project. A cell phone is such a personal device that researchers worried that teenagers might consider mathematics homework to "contaminate" their cell phones. Unexpectedly hundreds of pupils started asking for help with their mathematics homework. Then thousands of pupils started asking for help. Currently, tens of thousands of pupils have asked Dr Math for help with their mathematics homework.

The limiting factor of the Dr Math project, however, is the number of volunteer tutors who answer the questions from the pupils. A tutor for Dr Math is often chatting to twenty to fifty pupils concurrently using a web interface where each pupil conversation has a separate text box for input. In many ways, tutoring for Dr Math is similar to being an air traffic controller. It is a very fast paced environment with tutors communicating with many pupils.

From its early days, the Dr Math project cultivated a good relationship with a number of local tertiary educational institutions. University students from the faculty of Engineering, Built Environment and information Technology at the University of Pretoria were the first to regularly volunteer to act as Dr Math and answer questions about mathematics homework. The African Institute of Mathematical Sciences also encouraged its students to volunteer to tutor for Dr Math.

In this original configuration, tutors were university students and the pupils who received help were primary and secondary school pupils. However, a number of incidents and remarks have encouraged the authors to work towards a different type of virtual volunteering model. These incidents and/or remarks include:

1. The university students who tutor often remark that they have learned a lot while being a Dr Math tutor. They have explained how they had forgotten so much about various aspects of mathematics and that they had been forced to relearn many such aspects in order to successfully act as Dr Math.
2. Many of the pupils who have been helped by Dr Math have graduated from secondary school and are now in university themselves. They have asked for help with mathematics at a higher level than the current tutors are equiped to handle.
3. Many of secondary school pupils who chat with Dr Math comment that it must be "fun" being Dr Math and chatting to so many pupils at the same time.

The authors considered these three situations and decided to implement a research project to investigate this.

4. Research Question, Objective, Methodology, and Ethics

4.1 Paradigmatic Perspective

Garcia and Quek point to the difficulty of defining the actual object of information technology systems research "*Is the object of research in information systems of a technological or social nature?*" [9]. The proposed research encompasses two disciplines, Information Technology Research (engineering endeavour) and Educational Research (social endeavour). The development and feedback from one domain will influence and

report success in the other. There is thus a trans-discipline interaction that needs to be navigated in order to achieve the desired results. The research needs to acknowledge the existence of two worlds, an intransitive world (natural) in which the engineering endeavour would take place and is relatively unchanging, and a transitive world where the social endeavour would be placed and is social and historical [10, 11].

The research approaches the nature of being from a critical realist perspective. The critical realists position is that "there is a world existing independently of our knowledge of it" [12]. From a critical realist view "there is no conflict between seeing scientific views as being about objectively given real words, and understanding our beliefs about them as subject to all kinds of historical and other determinations" [13]. Critical realism accepts "the relativism of knowledge as socially and historically conditioned" [14].

5. Theoretical Assumptions on Learning

The research approaches learning as taking place when learners actively participate in the process of knowledge acquisition. By reflecting on experiences, learners construct their own understanding of the world they live in. Learning is a search for meaning; this implies an understanding of the whole as well as the parts that constitute the whole [15-17].

From these views the following outlines the research aim:

The main aim of this study is to explore the potential of a sustainable pipeline of volunteer tutors to support online math tutoring service within a South African context.

In order to reach this aim a development research approach will be implemented [18-21].

Van den Akker [21] describes educational design research as the systematic study of designing, developing and evaluating educational interventions (programs, processes and products) as solutions to address complex problems in educational practice. Reeves holds forth that "it investigates the development of solutions to practical problems in learning environments with the identification of reusable design principles" [22]. He argues that design research aims at developing optimal solutions for problems in context rather than comparing methods in artificial contexts [18]. Cobb, Confrey, di Sessa and Shauble see the aim as " to investigate the possibilities for educational improvement by bringing about new forms of learning in order to study them" [23].

As such it is argued that research of this nature can result in context-specific knowledge, serve a problem solving function and can change reality rather than just study it. Mead eloquently expresses this element of change: "In society, we are the forces that are investigated, and if we advance beyond the mere description of the phenomena of the social world to attempt reform, we seem to involve the possibility of changing what at the same time we assume to be necessarily fixed" [24].

The authors of this paper were acutely aware that they were dealing with minor children as well as with adults. The project communicated with the minor children without obtaining permission for parents or guardians. The original Dr Math project has an ethics clearance issued by the Tshwane University of Technology. The technology platform which hosts the project takes great care to hide all identities from participants. All conversations were recorded for quality, safety, and security reasons. For the scope of this sustainability project, an additional ethics approval was also obtained to cater for additional participation by the minor children.

The welfare and interest of the participants and institutions where the Mathlete pilot iterations will be done will be constantly being kept in mind and the research will adhere to the following principals:

Confidentiality and anonymity. Participants will remain anonymous and their rights, interests and their privacy will be protected.

Informed consent. The participants and institutions will be informed about the role of the researcher and the objectives of the research. Where written consent will not compromise confidentiality and anonymity, permission will be obtained with regards to observation, recordings and publication.

Voluntary participation. *All institutions and participants will be advised of their right to at any time disengage from the research as participation will be voluntary.*

Analysis and reporting. This research will strive to report observations and data accurately and disclose all methods and techniques used while. Shortcomings will be acknowledged and objectivity and integrity will be driving tenets of the research.

Researcher bias. The beliefs, value system and limitations of the researcher is acknowledged and declared will be declared in all reporting.

5.1 Ensuring Trustworthiness

The design experiment will make use of a wide variety of approaches in order to maximize objectivity, validity and the potential application of research [25, 26].

The researcher used the following strategies to increase the trustworthiness of this study:

Credibility. The researcher will undertake a prolonged engagement in the research setting. This will increase the possibility that the researcher's interpretations are more likely to be correct. The credibility of findings will further enhanced by the triangulation of data collected by other means.

Transferability. "Instructional technologists engaged in development research are above all reflective and humble, cognizant that their designs and conclusions are tentative in even the best of situations" [27]. The conclusions of this specific proposed research may be transferable to other situations and conditions and the researcher's methodology and the aims of the study may indeed be used in other educational contexts.

Dependability. The researcher increased the likelihood of dependability of the study by collecting data in different ways and at different stages during the study. This will be done to compensate for possible inadequacies in individual data collection methods. The researcher will also exposes the research to critical colleague's peer reviews that included scrutiny of the research plan and the methods of implementation. Such activities constitute an accepted way of improving the likelihood of dependability in research.

6. Sustainability Model

Dr Math was originally configured to use university students as tutors to help primary and secondary school pupils with their mathematics homework. This sustainabilty model augments that original model with two more facilities giving the greater Dr Math project three sub-projects. These three sub-projects are:

1. Mathlete – a new sub-project of the original Dr Math project where mature grade elevens (often called "Juniors" in the United States) are used to tutor younger pupils in the school.
2. Dr Math – a continuation of the existing project
3. Prof Math – a new sub-project of the original Dr Math project where graduate students (Masters and Phd students) in mathematics are used to tutor university level students.

By linking these three facilities together, a sustainable model can be created leveraging some of the characteristics which were described above in section 3. Many Grade 11s or Juniors have volunteered to become tutors because of the perceived "fun" at chatting with so many other pupils concurrently. It is envisioned that these Grade 11 tutors will have an opportunity to review or revise their entire curriculum and be prepared for Grade 12 exit

exams. In addition, it is expected that these Grade 11 tutors will subsequently volunteer to become tutors for Dr Math and continue to assist primary and secondary school pupils. Once the ethos of volunteerism is firmly established, if these same tutors continue on to post-graduate studies, it is hoped they will continue to volunteer for Prof Math and assist university level students.

The Dr Math project itself has been reported in numerous publications. The Mathlete project and the Prof Math project will each be described in a separate section

7. Mathlete

Mathlete targets middle school learners tutored by grade 11 and grade 12 learners at secondary schools. It is envisaged that the tutors will learn just as much as the learners that are being tutored. The tutoring will take place within the school ambit and it is envisaged that it can become a school outreach program. Mathematics teachers would facilitate a tutoring session and tutors will work in groups of two. Training and facilitation will be supplied to the tutors and the teachers.

Traditionally, South Africa school pupils wear school uniforms and their school blazers are adorned with achievement badges and pins. In order to fit in with the school tradition, the Mathlete project includes a pin system where participating Mathlete tutors can obtain pins to put onto their school blazer. A white pin is awarded when the Mathlete tutor has finished initial Mathlete training and has tutored for two hours. A silver pin is awarded after twenty hours of tutoring. A gold pin is awarded after forty hours of tutoring.

In addition to the pins, because Mathlete tutors are minor children, extensive manuals were created for the tutors, for their parents, and for participating school's administration.

Currently one private high school in South Africa is actively participating in the Mathlete project. Twelve mature grade 11 learners have volunteered to tutoring younger learners.

8. Prof Math

As mentioned before, the original Dr Math project used university students to assist primary and secondary school pupils. The advertised upper limit of the Dr Math tutoring facilities was trigonometry. Tutors were expected to be able to assist up through Grade 12 ("matric" or "senior" level) trigonometry. Dr Math was started in 2007 and more and more pupils who have obtained help from Dr Math are now at university and wish to obtain help with higher level mathematics including calculus.

As more and more volunteers became available, a growing trend was that many of the volunteers (especially from the African Institute of Mathematical Sciences) were graduate students. In addition, many pupils or "tutees" who had used the Dr Math project previously were now in first year university needing assistance with higher level mathematics.

Prof Math was implemented to allow graduate students (Masters level and PhD level) to assist with first year university mathematics. This is a brand new project and, as such, there are only two or three tutors who are willing to tutor mathematics at this level.

As of the start of the 2012 academic year, a few previous Dr Math tutors along with a few university lecturers have volunteered to tutor as Prof Math.

9. Business Benefits

To move the Dr Math initiative from a relatively localised research endeavour to a large-scale service would require a multipronged investment as the addressing the management and recruiting of tutors for the service. A larger pool of available tutors would enable, not only a prolonged association with the service, but also grow a culture of community engagement.

With the challenge that mobile technology presents the education environment is changes from access to one of meaningful engagement. The new challenge in South Africa is to provide appropriate educational services through technology that is already in the hands of the students and that they are already familiar with, thus eliminating the barrier to meaningful participation, engagement and sustainability.

The objectives of the expanded Dr Math service are to deliver the following results and show their value particularly in the educational context:

- Access to subject experts: University students and secondary school learners under supervision of lecturers and teachers provide live interactive tutoring.
- Sustainability: The Tutoring is integrated into the pilot Universities and secondary school culture as part of a community outreach module thus ensuring sustainability.
- Wide uptake and participation: Tutoring and use are not limited by physical locality.

10. Conclusions

This paper presented work towards a sustainable model for tutoring mathematics in an online mobile environment. The original Dr Math project used (and still does use) volunteer tutors. The volunteers are expected to be able to assist primary and secondary school pupils with their mathematics homework up through Grade 12 or senior level high school mathematics. This paper describes two additions to the Dr Math project. Prof Math uses graduate students (such as students working towards a Masters or PhD) to tutor university level mathematics. The Mathlete program uses mature Grade 11s or Juniors to tutors younger pupils

Although the Dr Math project has been running since 2007, these additions have only been running for a few months. We hope to report positively about this project at the presentation of this paper.

Acknowledgements

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