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INTERDISCIPLINARY LEARNING USING LOW COST MOBILE PLATFORMS: PROPOSAL IN GEOMETRY AND ARTS

Alexandre Antonino Gonçalves Martinazzo[(1)], André Nascimento Mossinato[(1)], Rafael Barbolo Lopes[(1)], Joyce Alessandra Saul[(1)], Nathalia Sautchuk Patrício[(1)], Irene Karaguilla Ficheman[(1)], Roseli de Deus Lopes[(1)]

Laboratório de Sistemas Integráveis – Escola Politécnica da Universidade de São Paulo (USP)
Av. Prof. Luciano Gualberto, travessa 3, nº 158 – 05508-970 – São Paulo – SP - Brasil

ABSTRACT

With the increase in volume and ease of access to information, authoring tools running on mobile platforms take an important role in society. Considering that for each region of the planet people have different needs, the development of any mobile project should cover these variables. Lately, low cost laptops have been developed to attend children in developing countries. These laptops distributed on the 1-to-1 basis create new learning environments, where learners and their teachers use mobile platforms in classrooms, outside classrooms and on field trips. New tools need to be developed to enrich learning experiences.

This paper presents the Oficina software, a collaborative drawing activity developed to run on XOs educational laptops produced on large scale and low cost by the non-profitable organization OLPC (One Laptop Per Child). The laptops work in mesh network and are signal repeaters, so if one laptop is very far from the other, but other laptops are in between them, everyone can exchange information. The use of Oficina is within this mobile context so that the student is free to create individually, with friends or with unknown people in a near area.

A student can begin drawing alone in his home and continue it during his way to school. There, he can share the drawing with his friends, who can finish it collaboratively, even if the first student who began the drawing is no longer participating. If any student wants to continue the drawing on his own, there is also this possibility. Thus, at the final process of this mobile drawing, there will be variations of the original drawing.

One of the innovations in XO laptops that interfere with the user experience when working with Oficina, is the possibility for the student to read the source code of the program and modify it, to make his own version. This is possible because every laptop activity is interpreted in Python, and the proposal is to convert the Python syntax to written native language. So any student will be able to write a program without much effort.

We believe that the Oficina software is a powerful tool and can be used to support learning activities in mobile learning environments.

KEYWORDS

Low-Cost Laptops, Free Software, Drawing Tool, Arts, Geometry, Python.

1. INTRODUCTION

New low-cost laptops, like the OLPC's XO, have appeared in the last two years aiming to provide a new resource for Education. According to Lehner and Nösekabel (2002), mobile learning is "any service or facility that supplies a learner with general electronic information and educational content that aids in the acquisition of knowledge regardless of location and time". The OLPC's XO introduces the "anytime, anywhere" paradigm, especially in developing countries. Mobile benefits are expected to improve learning results, as well as being a means for students to "learn learning" (OLPC (b); Lehner and Nösekabel, 2002).

The Brazilian Government has recently created a project named UCA (Um Computador por Aluno – One Computer per Student), which goal is to distribute a mobile computer for public school students, "as a form of improving education quality and reducing of the digital divide" (Franco et al., 2007). The students attended by the program are those in Basic Education: from 1st to 8th grade, normally children between 6 to

14 years old. National Curricular Parameters (PCN – Parâmetros Curriculares Nacionais) synthesize the curricular reform principles for Brazilian schools, and was created by the Education Ministry in 1997. These parameters are not a set of rules schools are forced to adopt, they are a set of orientations to help schools' Pedagogical actions and to support teachers' planning (Moreira, 2004), according to which the learning process is the most important part of Education. Students should play the main role in scholar activities, as active and curious actors in their learning process (Brasil, 1997). Also, basic education must provide ways for autonomous knowledge acquisition, assuring a permanent learning process. Therefore the teaching and learning process should explore: hypothesis verification methodologies for knowledge construction, arguing power to control this process results, judgment able to improve creativity and capability to recognize explanations' logic limits (*ibidem*).

According to Almeida (2001), computer-aided activities create a better relationship between students and teachers by increasing students' interest in their studies as well as increasing their self-esteem. The need of experimentation and the new available technologies lead us to the use of computer-based drawing, providing a wide range of possibilities for Arts and Geometry integration. This kind of integration is also encouraged in Brazilian Curricula, pointing to Geometry and measuring as fundamental cognition developers, which is enhanced when studying spatial representation and shapes' relationship with the real world (Brasil, 1998b). In addition, Arts' students should be able to express ideas, articulating their perception and memory (Brasil, 1998a), relating world's representation to Geometry.

From the exposed above, we conclude that expression tools are important in the basic education context. Available open-source drawing software like GIMP (www.gimp.org) and Inkscape (www.inkscape.org) are very powerful and provide many drawing features, like filtering in GIMP and vectorial image creating in Inkscape, but require large space for installation (43MB for GIMP and 47MB for Inkscape). These numbers do not consider XO's operating system, which has few graphic libraries; the most important is GTK 2 – GIMP Toolkit (OLPC (c)). Hence, regular software library dependencies could not be installed, since the overall goal is to use only 200MB for the whole operating system (*idem*).

This paper describes the experience of developing Oficina, a new authoring tool focused on integrating Arts and Geometry. The application provides extended options for geometric representation, like regular and free form polygons. Still, the main development focused on a simple interface and a lightweight application. The solution proposed is an ongoing work, an open-source software distributed with the OLPC base system.

2. DESCRIPTION

This section describes a short-list of Geometry-related features available in the application. Other expression tools available are pencil, paintbrush, eraser and selection. Oficina is an authoring tool, which enables users to represent the world in two dimensions in an innovative way with 2D representations, uncommon shapes and a free-form tool. Unlike other open-source programs, with Oficina users can see and modify the source code, because it is written in Python and the XO operating system encourages users to see what is behind the applications. The application requires less than 500kB of free space to be installed.

User interface shows also a new approach: simple and intuitive, no matter how much computer fluency the user has. For example, the pencil tool is automatically selected when the application starts. Each tool has a set of options embedded in its palette, which provides advanced controls like filling or not a closed shape and determining line thickness. Further on we describe the most important geometry-related tools.

2.1 Free-form Polygon

This tool allows users to draw a combination of free hand and polygon shape. When the mouse button is pressed and held, the tool draws free hand forms and when the mouse is clicked moved and clicked again, a straight line is drawn between the two points. When the student clicks again on the starting point, the drawing is completed and closed. Thus, irregularities can be put into shapes, creating a large universe of possible drawings, extremely useful for non-regular shapes of world representations. The illustration bellow shows a completed free form drawing; it has a filled image, but it could have outline only.

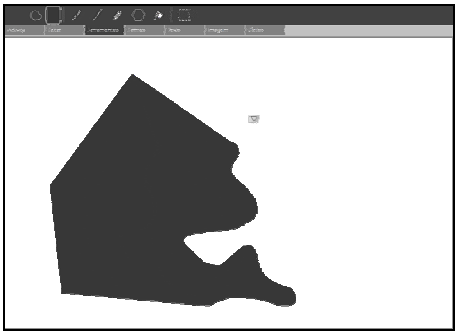

Figure 1. Example of free-form polygon, user is able to draw lines and free-hand curves in the same shape.

2.2 Regular Shapes

With the "Shapes" tab, it is possible to choose between several predefined forms, with the possibility to define the border and the filling colors, or even whether or not fill the shape. During the creation of the figure users can define its size and also rotate it in some cases. The following illustration shows the advanced controls available for the regular polygon: line thickness, number of sides and filling.

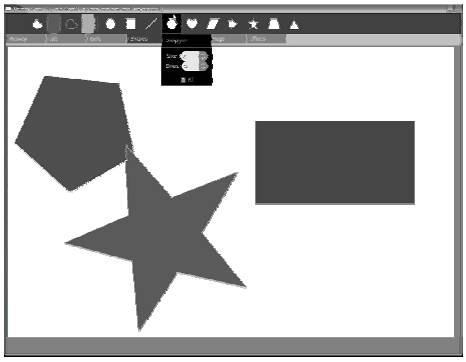

Figure 2. Advanced controls accessed through a palette for regular polygons

Shapes are drawn when the user presses the mouse button, holds and drags it. The combination of special keys while drawing a shape allows more flexibility. If the user presses the ALT key while drawing a shape, the system moves it to anther position. If the user presses the CTRL key, it will be rotated. If the user presses the SHIFT key, the application will draw a regular form: a circle (not an ellipse), a square (not a rectangle). Basic shapes the Oficina offers are: circle, rectangle, line, regular polygon (user chooses the number of sides), heart, parallelogram, arrow, star (user defines the number of vertices), trapezoid and triangle.

3. IMPLEMENTATION METHODOLOGY

Initially, Oficina was implemented using the Java programming language (Sun, 2007) as part of Saul's Final Graduation Project. When the development of the OLPC XO (One Laptop Per Child, 2007) began, we decided to make Oficina available for this kind of platform as part of the UCA project. OLPC's decision was to develop all operating system graphical interfaces (named Sugar) using the Python programming language. For a complete integration between our software and Sugar, Oficina was implemented using this language.

Python is an object oriented programming language with a very simple and comprehensive syntax, facilitating code programming and understanding. To run software in python it is necessary to have an interpreter. One peculiar characteristic of this language is the obligation of indentation, because this serves as a delimiter of code blocks. In other languages, despite the indentation is recommended, it is not a

requirement. One of the advantages of python is the great amount of existing. In our case the PyGTK library was used, as it provides many kinds of visual elements and utilities for it (PyGTK, 2007).

The development team adopted Extreme Programming practices, especially those that are focused on teamwork and communication. According to Jeffrey (1999), communication is very important to agile software development. Thus, person-to-person communication was encouraged and weekly meetings were conducted. As of documentation, main functions are commented and explained in a class diagram.

Coding standard is another inheritance from extreme programming, as all development is done using Python, every programmer in the team uses the same indentation and naming conventions. This is important because of the collective coder ownership, which means everyone is allowed to change the code anywhere. To avoid conflicts, the team has to be constantly updated. A key practice used to write Oficina is pair programming, developers do not solve problems and create new features alone, and this helps improving communication and uniform programming styles. As tests are also important, Oficina receives bug reporting on a public system from all over the world, since the OLPC testing team is worldwide.

Finally, we used a distributed version control system, named GIT. It maintains the development history inside of each local copy, proving an easy way to merge local and remote branches (Baudis). Although it has associated learning difficulties, GIT's version control capabilities make it the right tool.

4. PRELIMINARY TESTS

To evaluate the first Oficina version some preliminary tests have been conducted with teachers in a Brazilian public school. These experiments were intended to collect some first impressions and suggestions of improvements and new functionalities. In the first step, the XO laptops were given to the teachers and they ran and explored the Oficina by themselves. This exploration took about 30 minutes and during it some notes were taken. In the second step, a questionnaire was applied with the following questions: (1) How is drawing expression related to your discipline? (2) Did you find the software interface simple/intuitive? Did you have any difficulty while using a tool or a feature? (3) Is this application adequate to your discipline? If positive, give some examples. (4) Do you consider this application adequate to the platform? (5) What kind of activity would you suggest to the students if they take the laptops home or elsewhere the school? (6) Suggest improvements and new features you would like to see in the platform drawing application.

These tests evidenced that the software is adequate for an educational use, especially for supporting different knowledge areas and allowing interdisciplinary activities. Another example of interdisciplinary activity, is the conception of a product advertisement, including planning, text elaboration, and final art. In this case, children would work three skills: artistic, textual expression and logical thinking.

Tests also revealed some potential difficulties users found. For example, the color selection and the free polygon were reported as non-intuitive features. Teachers mentioned they liked geometric shapes because of the options that can be explored with the kids, not only in Mathematics; a teacher mentioned the two-dimensional representation of solid objects (3D) as a possible activity. Another use case suggestion would take advantage of platform's mobility. If children take laptops home, the required homework would be to take pictures of the environment and modify them to build new scenarios.

5. FUTURE WORK

We need to do more tests with end users, principally with children to verify usability, desirability and to collect more suggestions of improvements and new features. Also more alternatives of educational uses, especially in classroom utilization, will be explored and searched with the teachers. As the XO laptops connect to each other using the Mesh Network then, we plan to develop a collaborative mode of the Oficina.

6. CONCLUSION

This paper presented Oficina, a simple interface drawing application for the XO. The main objective of this research is to make available free software that supports learning on low cost mobile platforms, not only

stimulating art education but also supporting other sciences.

From the technological point of view, Oficina made possible advances in the development of graphical programming techniques using the Python programming language. The major software's differential is to have been developed for low cost educational laptops which has many limitations in terms of its computational power, being a very light weight application. Still, Oficina brings a new way of working with Geometry, giving students and teachers possibilities to more powerful world representations as well as new expression tools. Oficina can also empower world representation by integrating with it the embedded camera present in the XO; it can amplify exploration possibilities by adding a picture to a drawing. In the pedagogical area, the importance of this program is to stimulate children's creativity (Lopes and Krüger, 2001) and to provide users' social and digital inclusion (Ficheman, 2002).

This kind of software can reach a large number of users among students and teachers, since governments of different countries want to distribute low cost laptops in large quantities. We believe that the Oficina software is a powerful tool and can be used to support learning activities in mobile learning environments.

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REFERENCES

Almeida, F.J (Org). Aprendizagem colaborativa: o professor e o aluno ressignificados. In: *Educação a distância: formação de professores em ambientes virtuais e colaborativos de aprendizagem – Projeto NAVE*; 2001; p. 9-56.

Brasil. Ministério da Educação. Secretaria de Educação Fundamental. *Parâmetros curriculares nacionais: introdução aos parâmetros curriculares*. Brasília: MEC/SEF, 1997. 126 p.

Brasil. Ministério da Educação. Secretaria de Educação Fundamental. *Parâmetros curriculares nacionais : Arte*. Brasília: MEC/SEF, 1998a. 116 p.

Brasil. Ministério da Educação. Secretaria de Educação Fundamental. *Parâmetros curriculares nacionais: Matemática*. Brasília MEC/SEF, 1998b. 148 p.

Baudis, P. *Git - Fast Version Control System*. URL: http://git.or.cz/. Accessed on: Nov 10th, 2007.

Ficheman, I.K., 2002. *Aprendizagem colaborativa a distância apoiada por meios eletrônicos interativos: um estudo de caso em educação musical*. Dissertação (Mestrado em Sistemas Eletrônicos), Escola Politécnica da USP. São Paulo, Brazil.

Franco, J. et al. Using Information Visualization in the Logic of Building an Interactive Knowledge Based Learning Network for Social Development. Congress of Logic Applied to Technology, 2007.

Lehner, F.; Nosekabel, H., The role of mobile devices in E-Learning first experiences with a wireless E-Learning environment. *Wireless and Mobile Technologies in Education*, 2002. Proceedings. IEEE International Workshop on, pp. 103-106, 2002.

Lopes R.D. and Krüger, S.E, 2001. O Estímulo à Criatividade e as Novas Tecnologias. *IV Congresso Arte e Ciência – Mito e Razão*. Centro Mario Schenberg, São Paulo, Brazil, p.188-194.

Moreira, A. *Parâmetros Curriculares Nacionais para o Ensino Médio (PCNEM)*. SEB/MEC. http://portal.mec.gov.br/seb/index.php?option=content&task=view&id=265&Itemid=255

OLPC (a) – One Laptop per Child. *Hardware Specification*. URL: http://wiki.laptop.org/go/Hardware_specification. Access in November 15th, 2007.

OLPC (b) – One Laptop per Child. *Mission*. URL: http://www.laptop.org/vision/mission/. Accessed on: Nov 14th, 2007.

OLPC (c) – One Laptop per Child. *Software Components*. URL: http://wiki.laptop.org/go/Software_components. Access in November 15th, 2007.

PyGTK. *GTK+ for Python*, 2007, http://www.pygtk.org, Accessed on: Nov, 16th, 2007.

Sun Microsystems. *Java* , 2007, http://www.java.com, Accessed on: Nov, 15th, 2007.