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The strength of the community: how GeoGebra can inspire technology integration in mathematics teaching

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Introduction

During the past decades, it has been demonstrated that a large number of enthusiasts can alter conventional thinking and models of development and innovation. The success of open source projects like Linux, Firefox, Moodle, and Wikipedia shows that collaboration and sharing can produce valuable resources in a variety of areas of life. With the increased accessibility of affordable computing technologies in the 1980s and 90s there was overly enthusiastic sentiment that computers would become rapidly integrated into education, in particular to mathematics teaching and learning [8]. However, numerous studies showed only a marginal uptake of technology in classrooms after more than two decades [2]. There were many attempts and projects to encourage wider technology integration, but many of these attempts led to only marginal changes in classroom teaching [1]. While working on the open source project GeoGebra, we are witnessing the emergence of an enthusiastic international community around the software. It will be interesting to see whether or not this community approach could penetrate the difficulties posed by technology use in mathematics teaching. Although the community around GeoGebra is growing astonishingly fast, we realised that both members of the community and teachers considering starting using GeoGebra need extensive support. To be able to offer such assistance, we have established the International GeoGebra Institute (IGI) last year. In this paper, we will offer a brief outline of the current state of both GeoGebra and its community as well as we hope to encourage colleagues to join and contribute to this community.

GeoGebra

The software GeoGebra originated in the master's thesis project of Markus Hohenwarter at the University of Salzburg in 2002. It was designed to combine features of dynamic geometry software (e.g. Cabri Geometry, Geometer's Sketchpad) and computer algebra systems (e.g. Derive, Maple) in a single, integrated, and easy-to-use system for teaching and learning mathematics [6]. During the past years, GeoGebra has developed into an open-source project with a group of 15 developers and over 100 translators all over the world. The newest version of GeoGebra offers dynamically linked multiple representations for mathematical objects [3] through its graphical, algebraic, and spreadsheet views. Under the hood, we are already using a computer algebra system which will be made fully accessible for users through a new CAS view in the near future. GeoGebra, which is currently available in 45 languages, has received several educational software awards in Europe and the USA (e.g. EASA 2002, digita 2004, Comenius 2004, eTwinning 2006, AECT

2008, BETT 2009 finalist, eureleA 2009 finalist). Apart from the standalone application, GeoGebra also allows the creation of interactive web pages with embedded applets [5]. These targeted learning and demonstration environments are freely shared by mathematics educators on collaborative online platforms like the GeoGebraWiki (**http://www.geogebra.org/wiki**). The number of visitors to the GeoGebra website has increased since 2004 from 2000 per month to over 300,000 per month (Fig 1) coming from over 180 countries.

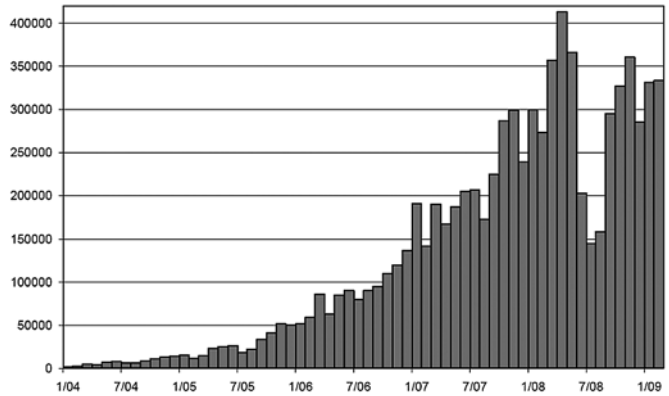

Fig 1 – Visitors per month to http://www.geogebra.org

"GeoGebra was designed to combine features of dynamic geometry software and computer algebra systems in a single, integrated, and easy-to-use system for teaching and learning mathematics."

International GeoGebra Institute

The growing presence of open-source tools in mathematics classrooms on an international scale is necessitating in-depth research on the instructional design of GeoGebra-based curricular modules and the corresponding impact of its dynamic mathematics resources on teaching and learning [4]. Thus, we have gathered active members of the GeoGebra community from various countries at a conference in Cambridge in May 2008, and founded an international research and professional development network: the International GeoGebra Institute (**http://www.geogebra.org/igi**). This not-for-profit organization intends to coordinate international research and professional development efforts around the free software. The main goals of the International GeoGebra Institute are to:

- establish self-sustaining local user groups;
- develop and share open educational materials;
- organize and offer workshops for educators;
- improve and extend the features of the software GeoGebra;
- design and implement research projects both on GeoGebra and IGI; and,
- deliver presentations at national and international conferences.

Future and vision

In order to provide adequate support and training, we are trying to establish local groups of teachers, mathematicians, and mathematics educators who work together in developing and adapting the software as well as educational and professional development materials to their local needs. For example, through a recent project funded by the National Centre for Excellence in Teaching Mathematics (NCETM), we have been collaborating with nine mathematics teachers in England to embed GeoGebra-based activities into the English curriculum and develop adequate professional development programs [7]. This project aspired to nurture communities of teachers and researchers in England who are interested in developing and using open-source technology in schools and in teacher education.

As part of the IGI, already eight local GeoGebra Institutes have been established at universities in Austria, Denmark, Hungary, Norway, Poland, Spain, Turkey, and the USA since May 2008. For example, the Norwegian GeoGebra Institute in Trondheim involves more than 50 people in a nation-wide network (Fig 2) of GeoGebra trainers, mathematicians, and mathematics educators to provide support for teachers and collaborate on research projects in relation to the use of free educational resources. In Poland, mathematicians in Warsaw are using web-conferencing tools to engage in discussions and projects with teachers at professional development centres across the country (Fig 3). Recently, members of the Norwegian and Polish group met in Warsaw to share their experiences in establishing such local support networks for teachers. More information on the different GeoGebra Institute sites can be found on **http://www.geogebra.org/igi**.

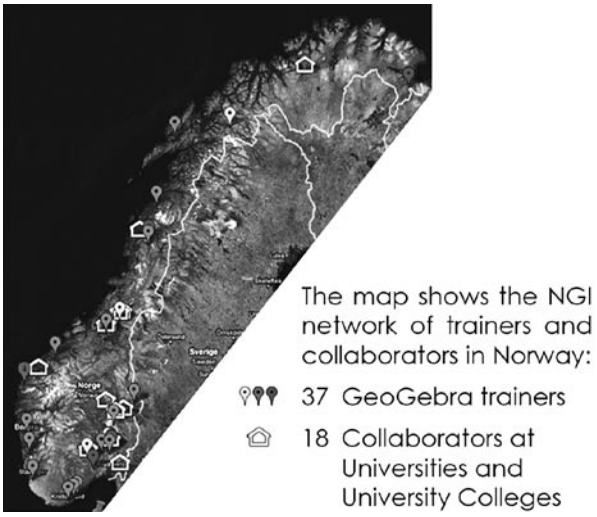

Fig 2 – Norwegian GeoGebra Institute

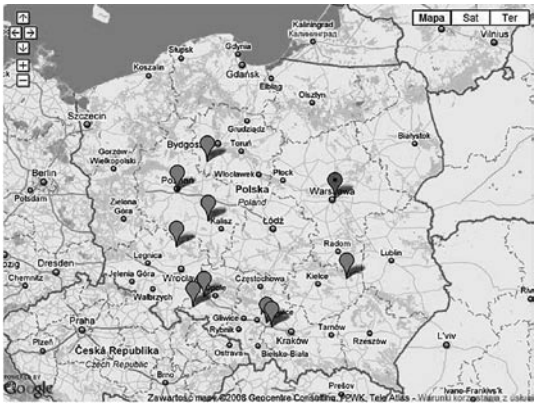

Fig 3 – Polish GeoGebra Centres

Development

On the international GeoGebraWiki (**http://www.geogebra.org/wiki**) website, users have already shared thousands of free applets and worksheets that can be remixed and adapted to specific local or individual needs. In order to better support the sharing of local materials in the future, we will soon set up a wiki-family with separate online platforms for user groups of a certain language or country. Concerning the software development of GeoGebra, we are always looking for talented Java programmers with good ideas for new features and extensions. With the recent addition of a spreadsheet view, GeoGebra is now ready for more statistics charts, commands, and tools. The upcoming computer algebra view will provide even more applications of the software at the university level. With all these planned new features, it will be crucial to focus on keeping the software's user interface simple and easy-to-use. Thus, we are also working on a highly customizable new interface where users can easily change perspectives (e.g. from "geometry" to "statistics") and rearrange different parts of the screen using drag and drop.

Outreach

As an open source project, GeoGebra tries to specifically reach out to users in developing countries who may not be able to afford to pay for software. Together with colleagues in Costa Rica, Egypt, the Philippines, and South Africa we are currently investigating possibilities of setting up local user groups, GeoGebra Institutes, and how to best support local projects. Involving colleagues in our international network could open new opportunities for supporting countries with limited resources and exchange educational resources and experiences.

Summary

We hope that with this paper we were able to raise attention to the GeoGebra community and encourage some colleagues to contribute to our efforts to enhance mathematics education for students at all levels. This special issue of the *MSOR Connections* is a great opportunity to share ideas and learn about each others' work. It is fascinating to read about the various approaches colleagues are taking to contribute to the GeoGebra project. If you are interested in getting involved in this open source endeavour, please visit the GeoGebra/IGI websites, contact us, or come to the first GeoGebra conference on 14-15 July 2009 in Linz, Austria, where we will discuss together which directions the GeoGebra community should take in the future.

Acknowledgements

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