

MATHEMATICS TEACHER DEVELOPMENT WITH ICT: TOWARDS AN INTERNATIONAL GEOGEBRA INSTITUTE

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Research indicates that despite the numerous benefits of using ICT in mathematics education, the process of embedding ICT in classrooms is a slow and complex process. Most teachers need more than just being provided with technology if the benefits of ICT are to be substantially realised. GeoGebra is free open-source dynamic software for mathematics teaching and learning that offers geometry and algebra features in a fully connected software environment. In this paper, we outline the emergence of the GeoGebra software as well as ideas and plans for establishing an International GeoGebra Institute to provide training and support for teachers and to coordinate research in relation to GeoGebra.

INTRODUCTION

Research suggests that, for the majority of teachers, solely providing technology is insufficient for the successful integration of technology into their teaching (Cuban, Kilpatrick, & Peck, 2001). It has been suggested that adequate training and collegial support boost teachers' willingness to integrate technology into their teaching and to develop successful technology-assisted teaching practices (Becker, Ravitz, & Wong, 1999). Our aim is to establish an International GeoGebra Institute (IGI) to be able to offer structured training and support for teachers who are ready to integrate GeoGebra into their classrooms. In addition, we will organise and coordinate research projects in relation to GeoGebra to enhance the development of training and support materials. While our initial plan is to establish an IGI site at Florida Atlantic University (USA), in the long run our goal is to collaborate with colleagues and set up other institutes in various locations around the world.

History of GeoGebra

GeoGebra (www.geogebra.org) is open-source dynamic mathematics software with rapidly growing worldwide popularity, especially in Europe and North America (Hohenwarter & Preiner 2007a). The software was conceived as Markus Hohenwarter's Master's thesis project at the University of Salzburg, Austria. The basic idea of the software development was to create a dynamic software that incorporates

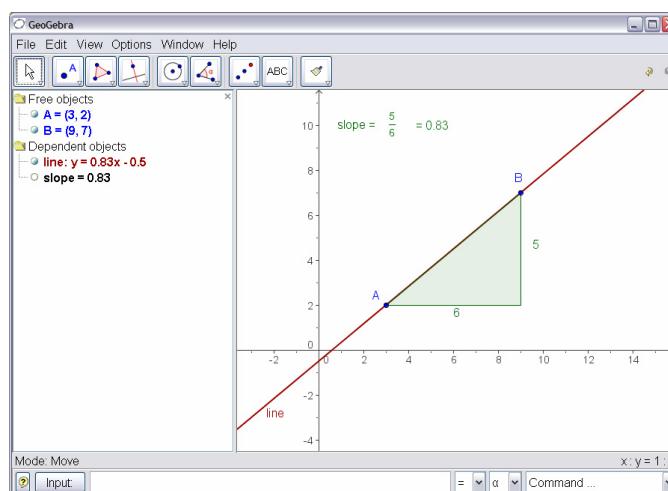


Figure 1: Algebra and graphics window of GeoGebra

geometry, algebra, and calculus, which other packages treat separately (spreadsheet and computer algebra extensions are soon to be added to the software), into a single easy-to-use package (see Figure 1).

After publishing the software on the Internet in 2002, unexpectedly, numerous teachers contacted Hohenwarter to share their enthusiasm in using GeoGebra in their classrooms. The immensely positive feedback from teachers was further confirmed by several educational software awards, including the European Academic Software Award 2002. Inspired, Hohenwarter continued developing GeoGebra and earned his PhD with a project on examining pedagogical applications of GeoGebra in Austrian schools. In August 2006, Hohenwarter became a visiting professor at Florida Atlantic University (FAU) and began working in a teacher training project funded by the National Science Foundation's (NSF) Mathematics and Science Partnership (MSP) initiative. Within the project his research focuses on enhancing teachers' mathematics content knowledge and teaching practices through technology-enriched environments. The MSP partnership with local schools allows him to continue developing GeoGebra according to the feedback and experience gained while collaborating with middle and high-school mathematics teachers.

Since 2002, Hohenwarter has been invited by teacher associations, universities, and academic conferences to deliver talks and offer workshops on GeoGebra in Europe and North America. In addition, highly regarded researchers have begun using GeoGebra in their projects and textbooks are being published with GeoGebra supplements. Furthermore, volunteers have translated GeoGebra into 35 languages. Currently, www.geogebra.org receives about 300,000 visitors per month from 188 countries (see Figure 2) and it can be estimated that more than 100,000 teachers use GeoGebra worldwide.

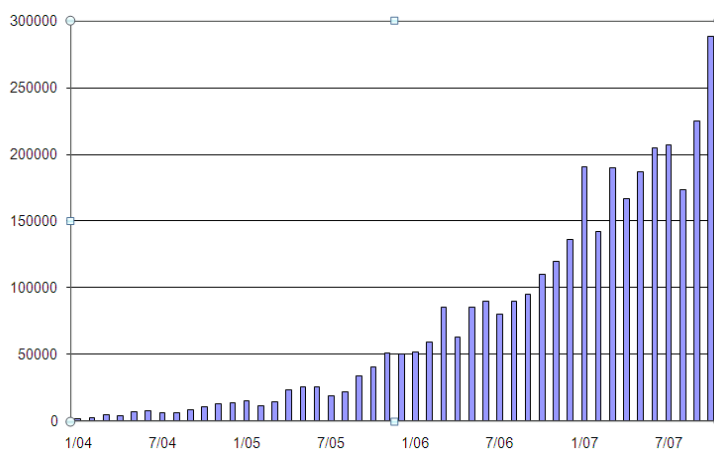


Figure 2: Visitors on GeoGebra website per month

In order to handle the pouring requests from teachers Hohenwarter established the GeoGebra user forum and GeoGebraWiki, a pool of free material, which currently include thousands of postings and dynamic mathematics worksheets. Despite this rapid growth GeoGebra remains primarily a project led by Hohenwarter and the project reached a point where its continued success can no longer be sustained only by one person and an informal user community. Based on feedback and data from the website, most teachers who are currently using GeoGebra have not received any training in the use of the software, but have begun using it due to their enthusiasm or encouragement by their colleagues.

Besides clusters of workshop activities at different locations there is no, or at least none that we could trace, organised GeoGebra-related professional development programme for in-service teachers. There are several universities that are starting to integrate GeoGebra into their teacher training programmes, but there is little coordination and communication among these programmes. To be able to reach teachers who require support and provide free professional development for GeoGebra, ensure the continuation of the technical development of GeoGebra, and coordinate research in relation to GeoGebra, we decided to create an umbrella organisation, the International GeoGebra Institute.

INTERNATIONAL GEOGEBRA INSTITUTE

The unanticipated success of GeoGebra has demonstrated that non-commercial software packages have the potential to impact mathematics teaching and learning worldwide. There is an extensive self-supporting user community that shares free interactive teaching materials on the GeoGebraWiki and supports fellow users through the user forum. Volunteers from the user community have translated GeoGebra to numerous languages offering the great opportunity to use the software in local languages and in multicultural environments. The software runs on virtually any operating system as it requires only a Java plug-in and, unlike commercial products, students and teachers are not constrained by licenses to run the software on only a limited number of computers. Moreover, GeoGebra offers the powerful opportunity for teachers to create interactive online learning environments by supplying not only interactive worksheets, but also the entire software package for their students through the Internet. Such customised interactive worksheets have led many teachers to foster experimental and discovery learning for their students and to share thousands of such worksheets on GeoGebraWiki.

These developments have encouraged us involve more people working on open-source resources in an International GeoGebra Institute. The IGI, regardless of location, aims to promote the learning and teaching of mathematics by supporting and coordinating the following activities:

1. offer free software for teachers, students, and anyone with non-commercial interest,
2. continue to enhance GeoGebra's capabilities and ease-of-use based on feedback from teachers and researchers,
3. offer free workshops, professional development, and teaching materials,
4. develop an organised structure to train and support (and maybe certify) teachers who wish to participate in GeoGebra-related activities in their local school area, conferences, and within IGI, and
5. design and support research projects in relation to GeoGebra and nurture a network of researchers who wish to contribute to any aspects of GeoGebra.

The first IGI site is going to be established at Florida Atlantic University in the spring of 2008, which will be followed by other sites in the US and Europe. Although IGI sites will have specific locations, the idea of working together on open-source software is more important than the actual location of IGI sites. We envision building an accommodating network of IGI sites with colleagues working on various aspects of GeoGebra. The overall goal of IGI is to develop a supportive environment and continuous communication among participants and sites. According to this philosophy every IGI site would adopt ideas and materials to serve their local needs. With respect to research we anticipate that researchers will contribute to GeoGebra according to their research interests. We also hope that IGI sites in different countries will create an invaluable opportunity for researchers to conduct international comparative research and for teachers to collaborate with colleagues across borders. Moreover, we will try to support any incentives and funding applications that contribute to the objectives of IGI.

The IGI website will be a central part of this project. Currently, we are designing a website which is likely to become available in the spring of 2008 (www.geogebra.org/IGI). The website will provide information about IGI sites, people associated with IGIs, and IGI related activities. Local IGI sites can set up and maintain their own websites, which will be linked to the main IGI website that we hope to become the main channel of communication of interested people.

IGI activities at Florida Atlantic University

With the support of NSF we will be able to set up the first IGI site at Florida Atlantic University. This site will develop materials and activities that may be adopted and further developed by other IGI sites. The FAU-IGI site will coordinate the following activities:

- develop GeoGebra workshop and certification materials
- offer workshops for teachers and future trainers throughout the US
- further develop GeoGebra and implement new features of the software
- develop an on-line support system for teachers
- evaluate and improve the professional development activities and materials
- design and implement research projects both on GeoGebra and IGI
- deliver presentations at national and international conferences

Other IGI sites will be able to base their activities on materials and experiences from the FAU-IGI site. However, these sites will be free to focus on specific elements or develop entirely new activities. One of the central aims of the FAU-IGI site is to develop workshop and certification materials. Teachers in Florida are required to participate in professional development programmes and based on their participation earn certification points. To address this local need, we must develop a system that

enables teachers to earn such points. The FAU-IGI team plans to work on this certification system together with local teachers during the upcoming year.

Training and certifying teachers at FAU-IGI

The FAU-IGI will likely offer four levels of certification:

1. *GeoGebra User*: demonstrate effective uses of GeoGebra in their own classrooms
2. *Creative GeoGebra Users*: have the ability to create and share innovative GeoGebra teaching materials. These participants will be prepared to offer workshops and support other teachers in their own schools or districts
3. *GeoGebra Trainers*: have the ability to carry out practitioner research on innovative practices and to deliver these results at the national level
4. *GeoGebra Institute Trainers*: are highly experienced GeoGebra presenters, trainers, and researches. They will provide support and offer training for participants in IGI

These levels are neither restrictive nor necessarily consecutive. Applicable certifications will be granted if participants demonstrate sufficient creativity and knowledge required for a particular level. We will negotiate with school districts to accept our workshops as professional development and for recertification. In the long run, we will develop on-line materials for workshops and submit accreditation of IGI to various teacher associations.

Evaluation and research activities in Florida

The activities of the FAU-IGI site will be constantly evaluated. The evaluation plan consists of four levels, the evaluation and review of

- 1) workshop and certification materials;
- 2) feedback from workshop participants;
- 3) workshop presenters;
- 4) the long term impact of the project.

The evaluation process will follow the principles of educational research methodologies, and serve as an instrument to continuously and constructively improve FAU-IGI activities. Based on research literature, the evaluation team will develop a framework to assess the quality and consistency of workshop and certification materials and periodically offer recommendations for improvements. The FAU-IGI team will develop an extensive questionnaire to gauge participants' experience and to obtain feedback from the workshops. The workshop sessions will be also videotaped and the evaluation team will conduct in-depth interviews with workshop presenters. Interviews will be analysed and video-segments will be selected for collaborative evaluation by researchers and trainers. Finally, towards the end of the first project cycle an on-line questionnaire will be sent to all participants and

personal/telephone interviews will be conducted with selected participants to assess the long term impact of workshops.

The primary goals of the FAU-IGI evaluation team is to establish standards for IGI activities and to provide constructive feedback for each member of the IGI team. In addition, we aim to encourage team members and participants to engage in educational research to be able to improve teaching practices in a systematic and informed manner. Furthermore, we endeavour that the FAU-IGI team will engage in other research activities in Florida and set up joint research projects with other IGI sites. Reports of all FAU-IGI activities, workshop materials, evaluation results, and research papers will be shared on the website of IGI. We hope that these materials will provide a foundation to assist activities at other IGI sites.

CONCLUSION

GeoGebra has been rapidly gaining popularity among teachers and researchers around the world, because it is easy-to-use dynamic mathematics software that combines many aspects of different mathematical packages. In addition, because of its open-source nature an extensive user community has developed around it. However, most users of GeoGebra are teachers or researchers who are keen to integrate technology into their work, and it is difficult to reach the ‘average’ teacher by providing free software without offering training and additional support. Hence, our aim is to develop a structure, which will manifest in GeoGebra Institutes around the world, to offer professional development for teachers and coordinate research activities in relation to GeoGebra. As the idea of the GeoGebra institute is fairly new, we are still looking for colleagues interested in participating in IGI related work in any way and at all levels.

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