Report of the

First International GeoGebra Conference 2009

July 14 and 15, 2009
at the RISC in Hagenberg near Linz, Austria

Abstract

The principal aim of the First International GeoGebra Conference 2009 was to discuss the direction and vision the GeoGebra community should take in the future. On July 14th and 15th, 2009, a group of 114 people from 35 countries met for the First International GeoGebra Conference in Hagenberg, Austria at the RISC institute of the Johannes Kepler University Linz. During these two days researchers, developers, and teachers discussed and shared their experiences and ideas concerning GeoGebra in five working groups: Software Development and Online Systems; Teaching Experiences in Primary and Secondary Schools; Creation of Instructional Materials; GeoGebra at Universities and in Teacher Education; GeoGebra Institutes and Research. This report summarizes the GeoGebra related experiences of the conference participants as well as outcomes of the working group discussions and future plans for the development of GeoGebra and its user community.

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March 8, 2010

Contents

1 Conference Program

Time	Tuesday, July 14, 2009	Wednesday, July 15, 2009
8:40 – 9:00	Welcome	Day Overview
9:00 – 9:40	Keynote: *Markus Hohenwarter* *GeoGebra Conference 2009 (pdf, ppt, zip)*	Keynote: *Zsolt Lavizca* *GeoGebra Institute and Research (pdf, ppt)*
9:40 – 10:00	Introduction of Working Groups	Networking Break
10:00 – 10:30	Coffee Break	Coffee Break
10:30 – 12:00	Working Groups: Session 1	Working Groups: Session 3
12:00 – 13:20	Lunch	Lunch
13:20 – 14:00	Keynote: *Tomas Recio* *The long journey from J. Nash to GeoGebra (html, zip)*	Keynote: *Damjan Kobal* *The use of GeoGebra to motivate, to present and to deepen the comprehension of math (pdf)*
14:00 – 15:30	Working Groups: Session 2	Working Groups: Session 4
15:30 – 16:00	Coffee Break	Coffee Break
16:00 – 16:40	Working Groups: Day Summary Session	Working Groups: Day Summary Session
16:40 – 18:00	Reports of Working Groups	Reports of Working Groups and Conclusion

2 Report of Working Group AB: Software Development and Online Systems

Working Group Chairs

Markus Hohenwarter, markus@geogebra.org (Austria)
Yves Kreis, yves@geogebra.org (Luxembourg)

2.1 Abstract

The primary aim of this working group was to exchange ideas and discuss plans for future extensions of GeoGebra and how to organise its developer community. As an open-source project with a large user base, the future development of GeoGebra will be substantially influenced by the needs and desires of the GeoGebra user community and by the strength and cohesiveness of the GeoGebra developers.

2.2 Participants

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2.3 Discussion Overview

This working group allowed several members of the GeoGebra developer community to meet for the first time in person. The other participants were experienced users with specific ideas for new features, improvements, and new projects. In this report, we want to summarise the main topics discussed as well as describe the main current and planned development projects related to GeoGebra. During the working group sessions, the participants presented a wide range of ideas. Please find details about the individual presentations on the working group's web page, http://ggbconference2009.pbworks.com/Working-Group-A

The discussions of the first day were mainly related to the current development project GeoGebraCAS. The goal of this project is to create a new view in GeoGebra that allows symbolic manipulation of expressions in a notebook style interface similar to many modern computer algebra systems. Participants agreed that the GeoGebraCAS view should be easier to use and closer to the requirements of educational use in schools than many existing systems. In particular, the CAS view should take advantage of the dynamic interconnection with the graphics view and spreadsheet view.

Several participants had a particular interest in a topic closely related to GeoGebraCAS: automatic proving and assessment. With the help of computer algebra technology, it could become possible to

add symbolic proving and discovering capabilities to GeoGebra. Such technology could also be used for step-wise checking of student input.

After discussing several more specific improvement ideas for the existing GeoGebra version, the second day was mainly devoted to the topic of online systems and GeoGebra's website. On the one hand, the importance of the integration of GeoGebra applets into widely used systems like Moodle, MediaWiki, Sage, or Webwork was highlighted. On the other hand, participants discussed possibilities of redesigning the GeoGebra website, GeoGebraWiki, and the online material manager to better support the quickly growing international user community.

2.4 Software Development Projects

As a result of the working group sessions and subsequent discussions within the GeoGebra developer group, several software development projects and new collaborations have been started. The following sections give an overview of the major current development efforts concerning the GeoGebra software itself.
If you would like to join or support one of these projects, please get in touch with markus@geogebra.org or the respective lead developer.

GeoGebraCAS

Extend the "computer algebra system" (CAS) features of GeoGebra to allow students to work with fractions, equations, and formulas that include variables. This new symbolic algebra view should be easy to use by students starting at age 12. In particular, we will need to develop and include an equation editor that allows easy input of fractions, square roots, etc.

- Lead developer: Markus Hohenwarter, markus@geogebra.org, Linz, Austria; Collaboration with the MathPiper developers in the USA, the University of Szeged in Hungary, and the TutorMates project in Spain.
- Status: first prototype under active developed; first classroom tests in Austria planned for 2010

GeoGebraTouch

Create a version of GeoGebra that can be used solely with a pen or your fingers on a touch screen computer or interactive whiteboard. A virtual keyboard needs to be added that can be used in many of our supported languages. Also, the current GeoGebra user interface needs to be adapted to allow easy control with a pen or finger.

- Lead developer: Michael Borcherds, michael@geogebra.org, Birmingham, UK
- Status: first prototype already developed, needs fine-tuning and integration into the new software release

GeoGebraSpreadsheet

Extend the capabilities of the existing GeoGebra spreadsheet view. In particular, create a specific toolbar for spreadsheet commands to allow easy use with the mouse and an additional tool to load the spreadsheet with data sets provided by teachers and textbook authors. For diagrams, we should have wizard dialogs that let you create diagrams like line graphs or bar charts by choosing from various options. These wizards would also take advantage of GeoGebra’s powerful statistical routines to analyze spreadsheet data. Another dialog box would present the user with hyperlinks to

data from external sources or local files. With this capability a simple mouse click could bring data from science and mathematics textbooks into GeoGebra, ready to be explored by students.

- Lead developer: George Sturr, george@geogebra.org, Santa Rosa, California
- Status: underlying statistics and graphing commands are implemented, needs work on the integration of tools for chart creation, statistical procedures and data input into the new software release

GeoGebra3D

Create a three dimensional geometry and graphics view in GeoGebra that is easy to use with the mouse. This view will allow the creation and interactive manipulation of 3D geometrical objects like points, lines, polygons, spheres, and polyhedrons as well as function plots of the form f(x,y).The 3D view should both be usable in the GeoGebra standalone application as well as offer the possibility to be embedded into interactive web pages.

- Lead developer: Mathieu Blossier, mathieu@geogebra.org, Rouen, France
- Status: alpha version of GeoGebra3D under active development

GeoGebraMobile

Create versions of GeoGebra that run on mobile devices. This is a huge effort that would bring interactive GeoGebra materials to students using smartphones or PDAs. We have started to first port GeoGebra to JavaScript which will let GeoGebra applets run in web browsers without Java. There are many connections to the open-source project JSXGraph and closer collaboration might be possible in the future. After a JavaScript port, the next step will then be to create specific apps for various smartphone platforms like the iPhone and Google's Android phones.

- Lead developer: Zoltán Kovács, zoltan@geogebra.org, Szeged, Hungary; supported by a team of local developers
- Status: experimental trials with JavaScript porting

GeoGebraStick

Develop a memory card or USB drive with portable versions of GeoGebra that runs on any computer even when Java is not installed. The GeoGebraStick should allow users to run GeoGebra under Windows, Linux, and Mac operating systems directly from the memory card or USB stick without any installations needed on the client computer. Furthermore, it should also be possible to boot from the GeoGebraStick and then have a pre-configured Linux version with GeoGebra, Firefox, and Java pre-installed that will allow users to use both GeoGebra as well as GeoGebra applets in Firefox.

- Project Leader: Zoltán Kovács, zoltan@geogebra.org, Szeged, Hungary; supported by a team of local developers
- Status: the version is under development and soon to be tested in various netbooks

2.5 Online Systems Projects

The following projects concern the GeoGebra website and the integration of GeoGebra applets into other online systems.

GeoGebraTube

Create an online platform to share, rate, and comment interactive GeoGebra web pages and constructions (a kind of YouTube for free GeoGebra materials). This will be the successor of the current GeoGebraWiki material pool. In GeoGebraTube, it should be possible to upload materials

directly from within GeoGebra to make it very easy for all our users to contribute free content under a Creative Commons license. Simple metadata should make it easy to find materials for different grade levels, topics, and languages. The metadata should be compatible with other platforms like OER Commons in order to allow automated sharing of content.

- Lead developer: Florian Sonner, florian@geogebra.org, Heidelberg, Germany; collaboration with the developer team at the University of Szeged in Hungary
- Status: basic framework of web interface started

GeoGebra Integration into other Systems

Independent of but in collaboration with the core GeoGebra developer group, other open-source developers have created plugins to integrate GeoGebra into other online systems:

- GeoGebra MediaWiki Extension, http://www.mediawiki.org/wiki/Extension:GeoGebra
- GeoGebra Moodle Filter, http://moodle.org/mod/data/view.php?d=13&rid=585
- DokuWiki Plugin, http://sites.google.com/site/jalomaac/plugin:geogebra

In order to make integration of GeoGebra applets easier into other online systems, GeoGebra now uses unsigned Java applets as its default for integration into web pages. In this way, users don't have to accept a certificate dialog and the GeoGebra construction is embedded within the html file. For details please see http://www.geogebra.org/en/wiki/index.php/Unsigned_GeoGebra_Applets

GeoGebra is also being integrated and used by several other projects like GeoGebraTutor, MathForum, MathRider, Sage, TutorMates, and WebWork. Also, work has been started to add a SCORM package export wizard to GeoGebra by a team at the University of Barcelona.

2.6 Developer Community

GeoGebra's developer community currently uses several online services and tools for collaboration:

- Sourceforge.net to host the software's Java source code
- pbworks.com for the developer wiki
- Google Code to track issues and enhancement ideas

In the future, we plan to merge these various tools into a single solution on one server. Most likely, we will use the system Trac to combine SVN code hosting, wikis, and issue tracking on a dedicated server at the University of Luxembourg.

2.7 Conclusion

The developer working group gave the opportunity to discuss various ideas for new features and extensions around GeoGebra. Thanks to the dedicated work of the GeoGebra developer group - in particular of Mathieu Blossier, Michael Borcherds, Zoltan Kovacs, Yves Kreis, Florian Sonner, George Sturr, and many others - several of these ideas are already becoming reality as part of several ambitious projects that have been started shortly after the conference. In order to continue these projects, we will need both financial support (e.g. to pay student programmers) as well as volunteered time from our user community (e.g. to test beta versions). We would like to take this opportunity to thank all participants of this working group as well as all active members of the GeoGebra user forum for their continued support and wealth of ideas and great feedback.

3 Report of Working Group C: Teaching Experiences in Primary and Secondary Schools

Working Group Chairs

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Alison Parish, alisonparish@gmail.com (UK)
Irene Chrysantou, i.chrysanthou@gmail.com (Cyprus)

3.1 Abstract

This working group aims to investigate the potential of GeoGebra for teaching and learning mathematics in primary and secondary schools (ages 6 - 18). Thereby, we will focus on the following topics:

- Collecting information about teaching experiences and ideas in the use of GeoGebra in primary and secondary schools;
- Discussing potential applications of GeoGebra in primary and secondary grades;
- Encouraging the creation and sharing of instructional resources (e.g., lesson plans, activities, dynamic worksheets, GeoGebra files) to create a usable pool of GeoGebra-related materials for primary and secondary grades;
- Investigating the use and applicability of other technological resources such as Interactive Whiteboards (IWB), voting systems, and learning managements system (e.g. Moodle);
- Discussing possible methods of facilitating the documentation of GeoGebra-related classroom activities;
- Discussing opportunities for international collaboration;
- Developing ideas for future projects and teaching ideas;
- Creating a wish list for features, tools and commands that support the use GeoGebra in primary and secondary schools;

3.2 Participants

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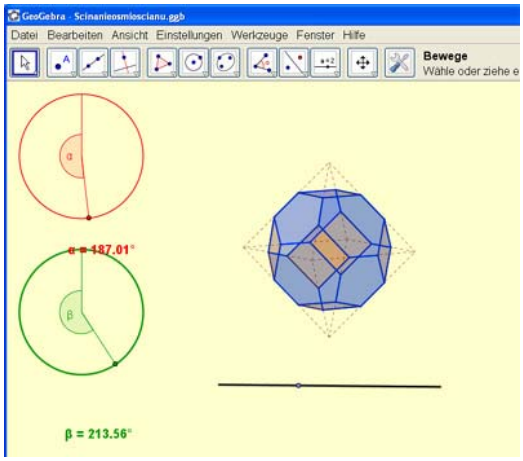
3.3 Presentations

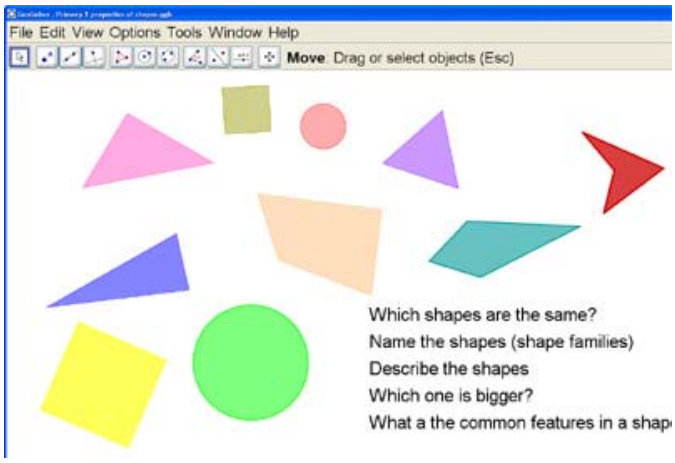
Adam Kominiak (Poland)

Adam Kominiak showed how he is using GeoGebra for constructing polyhedrons. Geometry is a very important part of his mathematics lessons in Poland.



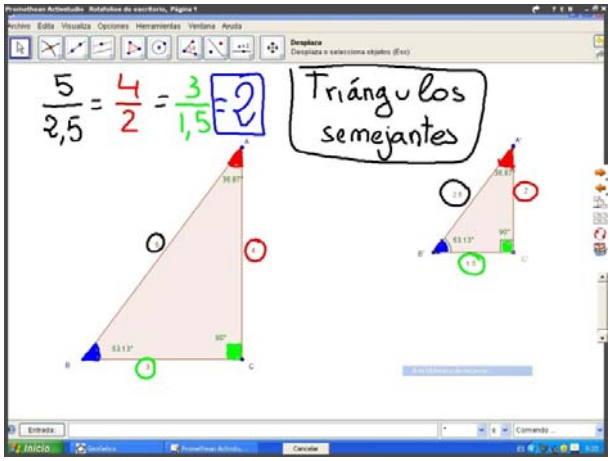
Alison Parish (UK)

Alison's presentation looks at the 'Shape, Space and Measures' requirements in the National Curriculum for England and Wales and investigates where GeoGebra might be used to support/enhance teaching and learning in primary and lower secondary years.
Initial stages might be activities on a whiteboard or an adult working with a small group on a computer. GeoGebra can be used by students (pupils) all age. Learners should be being encouraged to develop ideas themselves through using prepared base files or creating their own examples. She showed us what the youngest can learn and do with GeoGebra.



Alvaro Saenz (Spain)

Showed how he is using GeoGebra with an interactive whiteboard. He and his students use GeoGebra to prove and to solve problems.



Annemarie Schauer (Austria)

Teaching with GeoGebra means: Dual principle of geometry and algebra
GeoGebra offers a wide field of possibilities, ideal for improving, for making new experiences, for testing ideas. Very fast, maybe an aid for short term memory.

Brian Carroll (Ireland)

Carrol is working on real life problems for mathematics lessons. And showed one example: Pool Billiard. A common problem in these games is caused by the object ball being hidden from the cue ball which must then be played off one or more cushions in an attempt to strike the object ball. Consider first striking the cue ball off one cushion.
http://www.ul.ie/cemtl/Applets/PoolTable/PoolTable_1Side.html
Using the new Irish curriculum, he found 24 pilot schools and discovered that teaching with GeoGebra and focusing on real life problems brought greater emphasis on student understanding of mathematics concepts, showing that increased use of contexts and applications will enable students to relate mathematics to everyday experience. Within this approach there is an increased emphasis on ICT as part of lessons.

Brigit Bardorf (Germany)

Bardorf is working with gifted children with very high abilities.

Diane DeHon (USA)

Showed an example (examine the slopes of lines) of a student activity using GeoGebra.

Durdica Takaci (Serbia and Montenegro)

On the use of GeoGebra for examining functions

Michael O'Loughlin (Ireland)

He is a teacher who uses GeoGebra to visualize a variety of mathematics concepts and to create pictures for printouts for secondary school maths

"*I use GeoGebra as a demonstration tool in several areas of maths:*

- *Geometry: To illustrate and verify theorems.*
- *Constructions: to divide a line segment into three equal parts, to construct a triangle given either (side, side, side), (side, angle, side), (angle, side, angle), to illustrate the construction of the bisector of an angle, to demonstrate axial symmetry, central symmetry, translation*
- *Vectors: adding vectors by triangle and parallelogram methods, unit vector, perpendicular vector, equal, parallel, collinear vectors*
- *Co-ordinate geometry: y = mx + c, illustrating the effect of changing m and c constructing centres of a triangle, centroid, circumcentre, orthocentre, incentre, solving linear simultaneous equations graphically, illustrating a line concurrent with two given lines, showing a line intersecting a circle at two, one or zero points, proof of formula for the distance of a point from a line*
- *Trigonometry: unit circle, graphs of sinx, cosx, tanx, arcsinx, arctanx, demonstrating sinA in a right-angled triangle, demonstrating and verifying the sine rule*
- *Algebra: to demonstrate graphs of quadratic functions*
- *Calculus: to illustrate the limit of a function at a point of discontinuity, to demonstrate the asymptotes of rational functions and the symmetry of the graph, to illustrate the graphs of functions which the students have differentiated using the product, quotient or chain rule, showing area under a curve, area between curves*
- *Maclaurin series: to demonstrate the convergence of the series for e^x, sinx, cosx, ln(1 + x), arctanx*

In addition I also use GeoGebra to illustrate answers to examination questions in topics such as vectors, co-ordinate geometry of the line and circle, trigonometry and calculus. GeoGebra is very useful for constructing diagrams when making out notes, tests or worksheets.
I have been learning GeoGebra on a need-to-know basis so I still have some way to go to be competent in it. A few things I would like to see in GeoGebra are: to express functions in the form x = f(y) so that one can show the area between a curve and the y-axis, to have 3D capability so that one can show volumes of revolution or construct diagrams for trigonometric problems in 3D."

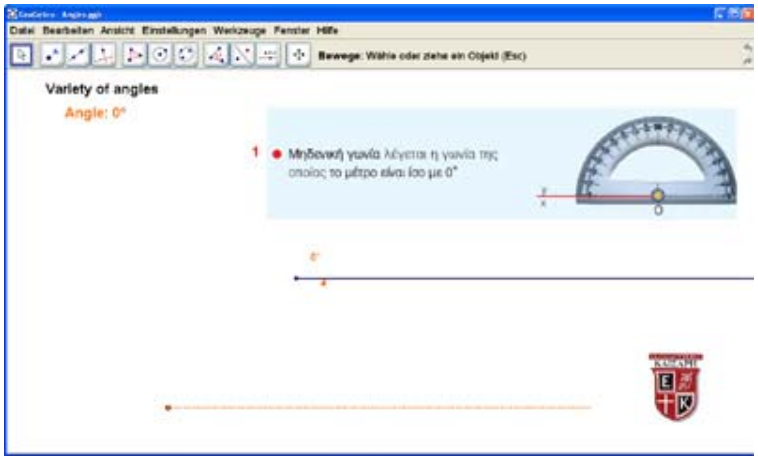
Muharren Aktumen (Turkey)

A new curriculum of primary education has been put into practice in Turkey since 2005. The new mathematics curriculum supports the use of dynamic geometric software and emphasizes the use of concrete models while teaching mathematics. While examining the new 6th-8th grades curriculum we saw two important points:

It is determined that by the use of dynamic geometry software students can develop geometric constructions or they can explore interactively the geometric shapes developed by their teacher. GeoGebra is an important teaching tool that maintains the two situations indicated above with its characteristics. We can compile its other characteristics like: it establishes a relation between algebra and geometry, is free of charge, improves continuously, has an open source code and provides mother langue support. The integration of this software can be ensured easily by these characteristics.
http://w3.gazi.edu.tr/web/aktumen/geogebra/alt%20site/applications.htm

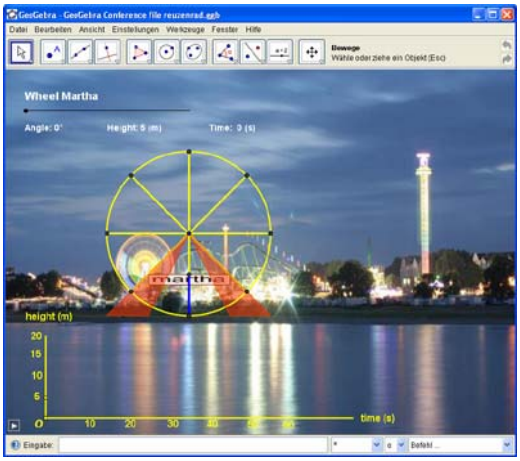
Stamatis Makris (Greece)

Makris is using GeoGebra, interactive whiteboard and a schoolbook in pdf (http://pi-schools.sch.gr/gymnasio/math_a/math/147_170.pdf). He is preparing GeoGebra-Files according to the textbook.



Sybrand Jissink (Netherlands)

Jissink is the author of a textbook and showed how they use GeoGebra for the creation of textbook materials.



Valerian N. Antone (Romania)

Using GeoGebra students can “see” abstract concept, students can make connection and discover mathematics. The ability to assess student solutions electronically may promote students’ interests

towards mathematics and advance students' cognitive abilities. In addition, performing e-contests in online environments can allow more students to access and benefit from math contests.

Wolfgang Pröpper (Germany)

With the Conics tool it is very easy to plot ellipses, hyperbolas and parabolas. Contrary to tools like Point or Line etc. the Conics tool is a very, very black box.
It is rather easy to show that for an ellipse for instance the condition $XF_1 + XF_2 = d$ (=constant) is fulfilled. But it is (nearly) impossible using only manual calculation to show that this condition leads to a bi-quadratic equation in x and y, which only depends from d and the coordinates of the focal points.
Using an appropriate computer algebra system (like TI-NspireCAS, for instance), it is very easy to do the calculation and also make the result visible. So an implementation of CAS in GeoGebra could also help to make black box Conics a white box.

3.4 Conference Day 1

General Discussion of Session 1

- How to use GeoGebra in class: as a demonstration tool, where students can interact with the software. They can guess or estimate what is happening when we move the slider or have a worksheet with tasks.
- If a student is new to using GeoGebra the question is 'How many hours it takes to learn GeoGebra?' It was suggested that it less that one hour to learn the basic and then students are able to interact with the software and learn.
- Students enjoy working with GeoGebra. They can work on mathematics for 2 hours using GeoGebra something that is fantastic.
- How difficult is for teachers to create resources? – How long does it takes them and how important is it to share resources?
- Using GeoGebra mostly geometrically in order to show an algebraic function.
- Try to draw everything in geometry in order for students to understand. So the use of GeoGebra is important since is a beautiful method to SHOW mathematics to students even in primary level.
- Use of GeoGebra in exams: use it partly, for example 20 or 30 points out of 100 is their practical task on GeoGebra. They have to use GeoGebra to answer a problem and then write a report on how they worked. Then is the written task without GeoGebra.
- In Poland they have external exams so only basic calculation. GeoGebra is an additional part for teaching to help them visualize. It is important to check what we evaluate by using GeoGebra, the students' skills to use GeoGebra or mathematics skills because we do not want to end up testing their skills and not the mathematical concepts. What if a student hasn't developed their skills in using GeoGebra does that mean that they fail?
- What is the place of GeoGebra in the curriculum in each country? It is a problem in many countries that they do not use dynamic geometry in lessons. There is a need to increase the use of GeoGebra in classrooms and in lessons. There are lessons that show the use of GeoGebra is very important in helping to understand concepts.
- GeoGebra is a new tool that enables us to discover mathematics. It is difficult to teach mathematics without providing visualizations for the students.

- Suggestions for tools: Copy paste command and Latex translator (so it is not necessary to write in latex)

Summary of Session 1

- We saw various teachers' demonstrations on using GeoGebra.
- Not everyone has access to computers in class and going to the computer lab to use would create problems in terms of availability. It would be useful if we could send home the interactive worksheets and students have homework on GeoGebra.
- Pedagogical techniques employed. A computer laboratory is needed to be used GeoGebra if students are to interact with it. It is important to keep the students interested and engaged in the task and not divert to playing games on the computers. In the classroom teachers are questioning, giving problems, using guided discovery rather than giving closed tasks.
- Issues were raised about the acquisition of computer skills as opposed to pen and paper skills. Using GeoGebra includes certain skills that are also relevant to paper and pencil methods.
- Which is the best way to use GeoGebra? It is important to share resources and teaching experiences of using GeoGebra in schools.
- A teacher has to spend a lot of time to develop GeoGebra applets. If a teacher doesn't know how to create an applet, it is very difficult to use it. So again it is important to share resources.
- Until part of assessment, using GeoGebra will not be taken seriously.

General Discussion of Session 2

- Using GeoGebra to develop and present real life problems in mathematics so that the students will be more interested and understand better the mathematical concept behind it.
- Many curriculums in several countries support the use of dynamic software. GeoGebra helps the initiation of the teaching and learning process with concrete models.
- It was suggested that when using GeoGebra with students with learning difficulties they become more engaged and put more effort in. Moreover students with hand injuries or problems with holding pen can be benefit by using GeoGebra since they can draw shapes something that they couldn't do before.
- Using GeoGebra with young students – primary and lower secondary students has benefits as it is important for them to get quick feedback on their answers, something that is not possible with paper and pencil methods.
- The use of GeoGebra is enhanced with the interactive whiteboard. Without that it would be much more difficult to use it in class.

Summary of Session 2

- Include videos to demonstrate how to use the tools (screen casts),
- Include mathtype in programming.
- Being able to copy paste and highlight points,
- Resources need to be split up into different level (high and low) and in different subjects and maybe include the lesson objectives so that others can understand the aims of each applet.
- Use GeoGebra as much as possible.
- Show sequences of lessons, i.e. last and next lessons to help teachers in their planning.

- Develop ability for students to have instant feedback when using GeoGebra tasks.
- School books need to show use of GeoGebra, perhaps with pdf documents.

3.5 Conference Day 2

General Discussion of Session 1

- Alvaro Saenz de Cabezon demonstrated different GeoGebra applications that could be used with secondary students.
- Birgit Bardorf spoke about what happens where there are gifted children and low ability students in a class and the need to differentiate in a classroom. GeoGebra allows personalize teaching for every student. There is also the concept of refund (own material for everyone) where students create their own material, they then share them and the whole class checks them to see if they are alright.
- Annemarie Schauer. We remember 90% of what we have done, so let us do it with GeoGebra. AIDAS (attraction, interest, desire, action, success) – GeoGebra facilitates this.
- Stamatis Makris demonstrated how he uses pictures and exercises from textbook in order to use the same material and students.

Session 2: Create your own GeoGebra application!

- Discuss an example of teaching a lesson using the spreadsheet in GeoGebra
- Discuss an example of teaching a lesson in algebra using GeoGebra
- Discuss an example of teaching a lesson in geometry using GeoGebra
- The group split into three and there was a sharing of experiences using the three themes.

3.6 Conclusion

- Many teachers have many ideas of applets but it is not very clear in their minds. By talking with other teachers they clear their minds and develop their skills. It was felt that more calculus material would be useful.
- The exposure to what everybody has done makes us think about how many more things are possible. We leave the conference with many more ideas on what to do.
- We have had the opportunity to meet people from other countries and realise we are small fish in a big pond and that we have to look outside our own educational system. The opportunity to hear other's opinions and ideas on using the software was great. People new to GeoGebra also felt that they were able to contribute to the session. For some this was their first presentation - and in English.
- There was a very useful exchange of ideas in the different aspects in using GeoGebra, for example how to employ constructions, using material from textbooks, using applets, using spreadsheets for learners at different levels.
- The group felt that there were many new ideas and it was a great experience but they now needed time to reflect and practice, to go home and try and replicate ideas to use in own teaching.
- It was felt that it was useful to become familiar with other countries' curriculum, the similarities and the differences and to see how other people from different countries use GeoGebra. Although we are from different countries we all talk the same language – the language of GeoGebra and this language must grow.

- It was a very rich experience talking to each other and sharing experiences and a there was a lovely spirit, with emphasis on teaching and learning. GeoGebra is a strong tool.
- GeoGebra is a strong tool. The spirit of the community is very promising. There was a reinforcing spirit and energy.

Wish List

- Share material – index on sharing material on age and topic
- To continue this development – looking forward to the progress.
- Future conferences to have time to work in small groups on areas of interest.
- Able to print documents without opening and to have name and date on the page.

4 Report of Working Group D: Creation of Instructional Materials

Working Group Chairs:

Judith Hohenwarter, judith@geogebra.org (Austria)
Andreas Lindner, andreas.lindner@ph-noe.ac.at (Austria)
Susan Papp-Varga, vzsuzsa@elte.hu (Hungary)

4.1 Abstract

Working group D "Creation of Instructional Materials" aimed to investigate the use of GeoGebra to create instructional materials for teaching and learning in all grade levels (from primary school up to university level and professional development). In total, there were 27 participants from 12 different countries of Europe, North America and Asia. In each session, a couple of participants gave short presentations about their work related to a special topic, which were followed by group discussions and a summary of the topics discussed.

Originally, this working group planned to discuss the following topics:

- Collecting information about the design and development of instructional materials with GeoGebra;
- Designing instructional materials for students that foster discovery learning, mathematical experiments and student-centred learning;
- Discussing the use of GeoGebra as an authoring tool for teachers;
- Encouraging the creation and sharing of instructional resources (e.g., lesson plans, activities, dynamic worksheets, GeoGebra files) to create a usable pool of GeoGebra-related materials for primary and secondary grades;
- Designing resources for students and teachers to facilitate the introduction of the software and to foster successful use of GeoGebra;
- Developing ideas for future projects and discussing opportunities for international collaboration;
- Creating a wish list for features, tools and commands that support the creation of great instructional materials;

4.2 Participants

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4.3 Presentations on Conference Day 1

Topic: Examples and Development of Instructional Resources

During the two, 90 minutes long sessions on the first conference day, 12 participants gave a short presentation about their work and experiences with GeoGebra. The main focus was on presenting instructional materials they developed for their teaching and to report on their methods of using GeoGebra in classrooms. In addition, some participants talked about how they created their GeoGebra constructions and interactive applets and shared some technical tips and tricks with the workshop group.

David Hobson (Ireland)

David Hobson is a teacher in a girls' secondary school in Dublin and teaches maths at lower secondary level as well as physics at upper secondary level. He is interested in the use of ICT in teaching and learning and has been using GeoGebra since last September. During his presentation,

David introduced us to his website “Green Maths”, which is a collection of interactive web pages created with GeoGebra (http://www.loretothegreen.scoilnet.ie/GreenMaths/index.html) for different mathematics topics.

Pamela Buffington (USA)

Pamela Buffington introduced us to the work of the Education Development Centre in Maine, USA, which is promoting student learning, improving teaching practices, and providing capacity-building solutions through the use of innovative educational practices and technologies. In the current projects, the EDC is using GeoGebra as an instruction and remediation tool in conjunction with formative assessment probes, to remediate student misconceptions, as well as to assist teachers in enhancing mathematical pedagogical content knowledge. Samples of their work, which include pairs of formative assessment probes and corresponding interactive GeoGebra applets, can be found online at http://maine.edc.org.

Marianne Rösch (Germany)

Marianne Rösch currently is a stay-at-home mum, who is using GeoGebra for her personal interests in mathematics and physics topics. During the last year, Marianne used GeoGebra to visualize optimization problems, vector spaces, as well as 3-dimensional and rotational objects. Thereby, she is using sliders in order to automatically animate objects and to visualize different physical phenomena. In her presentation, Marianne showed a couple of dynamic worksheets that visualize a variety of different mathematical concepts.

Margarida Oliveira (Portugal)

"*GeoGebra is a program that by its simplicity allows the development of applications of great interest to Mathematics teaching.*"
Margarida Oliveira presented two interactive applets which she created using GeoGebra: The first applet was created to investigate the derivative of a trigonometric function. The applet, which was developed in GeoGebra, allows the user to change both the frequency of the function and its amplitude in order to investigate their influence on the graphical representation. The second applet allowed users to study of cross-sections of a cube. In order to simulate a 3-dimensional representation of the solid, Margarida used rotation matrices for the three coordinate axes, which she created by simply computing the product of the 3 matrices. Using this method it is possible to create 3-dimensional drawings of a few solids and see their cross-sections if intersected by planes.

Casper Dahl Rasmussen (Denmark)

Casper Dahl Rasmussen is using random numbers in GeoGebra in order to create unique exercises for every one of his students (e.g. *a = random() + 1*, *b = 6 * random() - 3*, *c = 2 * random() - 4*, *f(x) = a * x^2 + b * x + c*). His applets enable students to work on problems like "Find the roots of *f(x)*", "Calculate the coordinates of the vertex of the given parabola", "Calculate the area between the function graph and the *x*-axis", "Find the equation for the tangent of function *f(x)* at the position *(0, f(0))*". In this way, students can practice a great number of similar problems which may help them to better understand the underlying mathematical concepts.

Georg Wengler (Austria)

Georg Wengler presented how he is using GeoGebra as a tool for demonstrations, animations, and visualizations of mathematical concepts and to investigate the pedagogy behind these concepts with his pre-service mathematics teacher-students. In his courses at the Pädagogische Hochschule in

Salzburg, his students are encouraged to develop dynamic instructional materials for their own mathematics instruction of pupils in grades 5 to 8.

Ivan de Winne (Belgium)

Ivan de Winne presented a detailed lesson plan that allows students to investigate the Pythagorean Theorem using a series of interactive GeoGebra constructions.

Wilfried Dutkowski (Germany)

In his presentation, Wilfried Dutkowsky told us about his experiences as a mathematics teacher in Germany and presented some of the GeoGebra constructions he is using during his classes.

Klaus Herzog (Germany)

Klaus Herzog also presented some examples of GeoGebra applets.

Andreas Lindner (Austria)

Andreas Lindner presented how he is inserting pictures and images into the Graphics View of GeoGebra in order to create investigations of mathematical models that are closely related to real-life. In his instructional materials, he is using images either as a background for constructions, or as interactive part of the construction. Thereby, he manipulates the images to serve these different purposes by rotating, reflecting or resizing them. This approach allows new access to experimental and discovery learning for students and often increases their motivation to work on mathematical problems.

Roger Van Nieuwenhuyze (Belgium)

Roger Van Nieuwenhuyze is a teacher at the teacher training college "Hogeschool Universiteit Brussel" in Brussels Belgium. He is the author of handbooks and exercise books on mathematics for secondary schools in Belgium ("Van Basis tot Limiet") and has written 3 ICT-books about the use of GeoGebra in secondary schools (age of the pupils: 12 until 15 years). He presented some of the more than 300 files and applets he created for his books.

Steven Dunbar (USA)

Using GeoGebra inside MathML Documents; Steven Dunbar has been experimenting with creating MathML content (using LaTeX source files, then converting to MathML/xml via TeX4ht) and then embedding "live" GeoGebra documents in the MathML files. According to Steve, the experiments have gone well and this combination proved to be especially effective in creating mathematical content for university-level education. During his presentation, Steve discussed the methods, displayed some of the results, and shared some tips on creating the mathematical content with the other participants.
"*Writing mathematical documents in this way has the benefits of providing one source document in a standard markup format which can then produce mathematical output in several formats, including *.dvi, *.pdf, *.html, *.xml and others. Any convenient editor will suffice, the learning curve is easy, and the results can be read with commonly available software.*"

4.4 Presentations on Conference Day 2

Topic: More Examples and Design of Instructional Materials
During the two, 90 minutes long sessions on the second conference day, 8 more participants gave a short presentation about their work and experiences with GeoGebra. The main focus was on

presenting instructional materials they developed for their teaching and to introduce the other participants to the school systems and classroom teaching of different countries. In addition, the design of instructional materials with GeoGebra as well as the use of GeoGebra in combination with an Interactive Whiteboard were discussed.

Temel Kösa (Turkey)

Temel Kösa presented some GeoGebra applets that simulate 3-dimensional geometric objects and provided a wish list for features of the future GeoGebra 3-D implementation.

Kyeong-Sik Choi (Korea)

Kyeong-Sik Choi provided an introduction to mathematics education using GeoGebra in Korea, where he uses the software for teaching at the Institute of Gifted Students and to supervise teams in the Gyeonggi-Buk Science High School, whose students use GeoGebra as tools for exploring mathematical concepts. During his presentation, Kyeong-Sik described his experiences with using GeoGebra in his mathematics classes as well as Korea's unique Internet environment, which requires alternative solutions for spreading the word about GeoGebra in Korea (e.g. a localised wiki and user forum called "Naver café").

Kathryn Peake (UK)

Kathryn Peake teaches at Havering Sixth Form College, a large college, with over 2000 students aged 16 to 19, of whom about 600 are studying mathematics at Advanced Level or at a lower level. In her school, GeoGebra is used mostly for teacher demonstration of mathematical facts, principles and techniques, although there is also some use of dynamic worksheets, using the college VLE. Students are also encouraged to use the application directly, in class and independently at home.
In her presentation, Kathryn talked about examples on Polar coordinates as well as parametric functions, that were created "to give a 'WOW!' factor to lessons" by allowing students to "*speedily make interesting and unexpected discoveries, so they can then ask the harder-to-answer 'Why?' and 'What if...?' type questions, leading to conjecture, proof and higher order thinking skills.*"

Dave Matthews (USA)

Dave Matthews is an experienced GeoGebra trainer who developed video tutorials, as well as a collection of GeoGebra files and interactive applets for his professional development workshops in the USA.

Simon Hempel-Jørgensen (Denmark)

"*At the moment a new curriculum is being introduced in Denmark, in which the use of ICT is a priority. At the same time there are increasing demands for documentation and evaluation of pupil learning. The new curriculum introduces competencies as goals for teaching. In this context, competencies can be perceived as a step towards citizenship. Accordingly ICT must directly aid the learning of mathematics – a not just the learning of ICT as such.*"
In his presentation, Simon Hempel-Jørgensen talked about the challenge to "*make teachers want to use GeoGebra*" in their classrooms, by introducing them "to a tool for student learning, that is easily mastered and free". Simon is creating short courses at the university college for teachers (6 – 12 hours), in which they are taught "the skills and inspiration to make GeoGebra a part of their teaching". Simon also has started a collection of resources on the official Danish educational website: http://www.emu.dk/gsk/fag/mat/fagtema/geometri/geogebra.html and some student exercises: http://www.emu.dk/elever7-10/fag/mat/geogebra/geo.html.

Example resource: see http://www.cfu-vejle.dk/matematik/evaluering/evaluering.asp.

Erdem Cekmez (Turkey)

In his presentation, Erdem Cekmez talked about solving geometric locus problems with GeoGebra and gave some suggestions for the development of the future 3-D implementation of GeoGebra.

Susan Papp-Varga (Hungary)

Susan Papp-Varga talked about her experiences and the opportunities GeoGebra offers when used with an Interactive Whiteboard. She also described the challenges she encountered and presented a list of wishes that will make it easier to use GeoGebra with an Interactive Whiteboard in the future (e.g. larger sensitive area for check boxes).

Judith Hohenwarter (Austria)

Judith Hohenwarter talked about her experiences in teacher professional development workshops in the USA where the participants were developing instructional materials with GeoGebra. She also presented some Design Guidelines for Dynamic Worksheet that she summarized together with Markus Hohenwarter based on their observations and experiences gathered during these workshops (see http://www.maa.org/joma/Volume7/Hohenwarter2/index.html).

4.5 Summary of Presentations and Discussions

Creation of Instructional Resources with GeoGebra

On the two conference days, instructional materials covering a variety of different mathematical topics, ranging from lower middle school up to university level mathematics have been presented by the working group participants. Thereby, different strategies, as well as tips and tricks concerning the actual creation of these resources with GeoGebra have been shared and discussed, like for example

- how to automatically produce a large number of practice problems for students, using the *random()* function as well as the *RandomBetween[a, b]* command (where *a* and *b* are integers) of GeoGebra, which helps to generate a new problem whenever the random numbers are updated. Such activities allow students to solve many problems of a similar type in order to help them practice certain skills or investigate the underlying mathematical concepts necessary to solve these problems;
- how to use images in GeoGebra's *Graphics View*, that allow to create real-life problems for students with the potential to foster mathematical investigations and to increase student motivation. In addition, we discussed how to modify properties of images (e.g. their size) before and after they were inserted into the GeoGebra construction, as well as how to use them either as a background image, or as an interactive part of the construction;
- how to use sliders and their automatic animation in order to visualize changes of parameters of functions dynamically, as well as movement of mathematical objects and allow students to make predictions about how they change over time;
- how to use check boxes in order to show or hide certain objects in the *Graphics View* of GeoGebra, like for example hints or solutions;
- how to simulate 3-dimensional geometric objects in GeoGebra that visualise different properties of the object by being able to rotate them, as well as to visualise cross-sections of solids.

Technical Tips and Tricks for the Creation of Instructional Resources

Some other participants shared the technical expertise necessary to create rather advanced interactive applets with GeoGebra, as well as to design rather sophisticated web pages that contain their instructional materials. Topics discussed covered

- how to create web pages containing mathematical formulas;
- how to use MathML as well as open source html editors to create web pages with embedded GeoGebra applets;
- how to use JavaScript to generate new problems, show correct solutions, or give feedback to students;
- how to include several applets in one web page, that are linked and automatically react to modifications the user makes in any one of them;
- how to embed interactive applets into presentation slides, Moodle and Wiki pages;
- how it is currently not possible to find out how a custom tool (*.ggt*-file) was originally created in order to understand how it works exactly, so it can be reused by another person than the original author;
- how to access the GeoGebra construction file of a dynamic worksheet that was uploaded to the GeoGebra UploadManager but whose URL was not provided separately for download, by changing the file name extension in the URL ("*.html*") to either "*.ggb*" or "*_worksheet.ggb*" (depending on the version of GeoGebra used to create the dynamic worksheet). Since all instructional materials uploaded to the GeoGebra UploadManager are under a *Creative Commons, Attribution, Non-Commercial, Share Alike* license, accessing, downloading, using, and modifying these construction files are allowed as long as this license is not violated (for more information see http://www.geogebra.org/en/cc_license/cc_license.htm).

Design of Instructional Resources

During the presentations and discussions, also the design of such interactive instructional resources was discussed among the working group participants. Some of the design conventions that are based on the experience of many of the participants are listed below.

- In general, interactive instructional resources, like dynamic worksheets, should be as easy and self-explanatory to work with as possible. Their purpose should be clear for the user.
- Consistency in the design of interactive applets, like for example in their layout, could be helpful for students, since students get used to these conventions and are able to focus on the new mathematical content of the resource instead of having to work out the general use of the applet (e.g. moveable objects are highlighted and larger than dependent objects).
- The amount of mathematical content per applet should be minimized to only one idea per dynamic worksheet. Instead of cluttering one applet with a lot of content, splitting up the ideas into a series of worksheets might be useful.
- The user interface options used in an interactive applet (e.g. tools displayed in the toolbar, different *Views*) should be adapted to the purpose of the applet in order to avoid distracting users from the actual mathematical content of the dynamic worksheet.
- It is essential to think about the objectives and goals of a particular applet prior to its creation, in order to select the best possible design. Especially expert GeoGebra users need to consider the purpose of the applet, which might argue for a simple design rather than a very elaborate one that shows of many "cool" features of the software but might hinder effective learning. Sometimes, less is more.

- Instructional resources should be designed in a way that maintains student motivation and does not overwhelm them with a surge of mathematical objects and tasks.
- The ultimate goal for every educator who prepares ready-to-use instructional materials, should be to help their students getting ready for the independent use of the GeoGebra application itself, in order to allow them to use the software as a general tool for mathematics rather than having to depend on the teacher to provide them with restricted environments for their mathematical experiments.

Sharing Instructional Materials on the GeoGebraWiki

In addition to creating instructional materials, we also discussed feasible ways of making these resources accessible for students as well as sharing them with other educators. Thereby, we talked about the distribution of resources via websites like the GeoGebraWiki and discussed it's current structure as well as the need for making the file upload easier, so that technically less adept users be also able to share their materials. Overall, we agreed that the GeoGebraWiki needs to be split into a family of local Wikis for different languages in the near future in order to be able to accommodate the local needs of GeoGebra users of different countries and keep the structure of the GeoGebraWiki flexible enough to be most useful for a widespread use by a large user base.

Many participants were also concerned about how difficult it became lately to search the different language sections of the GeoGebraWiki for certain instructional resources or materials for certain mathematical topics. Although the structure of each language section is up to the users themselves, it might be helpful to introduce a general structure with certain categories for instructional materials that are used across the different language sections, like for example "General Use of GeoGebra", "Resources for Teacher Use", "Resources for Student Use", "Mathematical Topic". In addition, the need for adding metadata to the resources was expressed, which could be made manageable by providing a list of standard tags that can be translated to the different languages as well as extended by the Wiki users if necessary. This metadata should also include options to add annotations, like for example explanations on how to use the instructional resources, experiences with their actual classroom use that might be helpful for other educators, as well as background information about the mathematical concepts and explanations about the actual creation of the interactive applet. Although the working group participants were aware of the difficulties these suggestions might cause, they seemed to be convinced of their usefulness and would support the efforts to implement them in the GeoGebraWiki.

Furthermore, some participants expressed their wish for a certain quality control for resources on the GeoGebraWiki by trained reviewers, although they agreed that there might not be enough manpower available to review every single resource in every language that is linked on the website. Another approach would be to allow user ratings for all resources and have an additional quality-controlled section on the GeoGebraWiki that only contains links to instructional materials that were either reviewed by expert users or that received the highest level of user ratings and therefore, have been promoted to this high quality section of the GeoGebraWiki.

Another question raised was the concern about what will happen to the quality of GeoGebra applets once publishers are starting to include them into their text books, and if they would also focus on

including interactive applets that allow for student discovery rather than restrict their mathematical experiences to demonstrations with low user activity and drill-and-practice applets.

Methods of Introducing GeoGebra to Novice Users

We also discussed ways of introducing GeoGebra to novice users, both other educators as well as students of different age groups. Most participants agreed that introductory screen recordings and video tutorials, as well as the creation of online courses and trainings for students and teachers could be beneficial if provided online for novice users. Furthermore, the question "What do users need to know to be able to effectively work with GeoGebra?" was raised and the pros and cons of letting novice users, in particular students, discover the use of new construction tools by themselves versus demonstration of their use by the teacher were discussed. As an ultimate goal, the working group agreed that students should be able to use GeoGebra independently to maximise their personal benefit of using such a versatile tool for their education.

Concerning trainings for in-service teachers, the problem of "How can we make other teachers want to use GeoGebra in their classrooms?" has been discussed. Thereby, videos or screen recordings of best practice examples seemed to be the most promising tools to help other teachers understand the potential of such software for their teaching. For the design of workshop materials, knowing about the prerequisites necessary for teaching effectively with GeoGebra could be helpful. Workshop trainers should also consider assessing the availability of technology in their participants' schools in order to be able to better adapt the training to the needs of their workshop participants (e.g. do they have access to laptop computers in their classrooms or do they have to use the school's computer lab, are the computers used connected to a reliable Internet connection, do the teachers have access to Interactive Whiteboards). Also, the design of special topic trainings, like for example "Teaching with GeoGebra in combination with an Interactive Whiteboard" or "Using GeoGebra as a Demonstration Tool" if only minimal access to a presenter computer is given, should be considered.

Classroom Use of GeoGebra

Furthermore, some participants shared their experiences of using GeoGebra with their students, also giving insight into the different methods and teaching practices, as well as school systems of their different countries of origin. Many teachers seem to still encounter difficulties related to the access to technology and struggle with the logistics of using software like GeoGebra in their classrooms on a frequent basis. Also, for many students, the availability of computers at home cannot be taken for granted and requiring the use of technology in order to complete homework, even if the necessary software itself is freely available, might raise some equity issues among children of less affluent families.

The changing role of teachers in a technology-rich mathematics lesson as well as the need for changes in the curriculum, were also discussed. The participating educators also shared experiences concerning the different ways of using GeoGebra which each other, like teacher demonstrations, student investigations using prepared instructional materials, as well as letting their students use the software application independently. With the latter approach, taking the developmental needs as well of diverse skill levels of their students into account and designing the mathematical problems and investigations accordingly, is very important, as well as appreciating their individually different ways of "understanding" and "explaining" mathematical concepts.

The group agreed that technology use for teaching requires different teaching methods in order to tap the full potential of dynamic mathematics software for mathematics education. According to the participating teachers, GeoGebra is most often used to create animations, to support explanations and demonstrations of mathematical concepts, as well as to allow for student experiments and discovery learning. Furthermore, teachers found the software useful to visualize mathematical and physics concepts, as well as to emphasize connections between these two fields of science.

Participants found the use of prepared instructional materials rather effective for everyday teaching. Especially the combination of printable and dynamic worksheets proved to be useful and effective in their teaching practice, if used in a pedagogically feasible way that fosters the better understanding of mathematics by using technology as a tool that is a means to an end and not the goal in itself. Thereby, some teachers tend to create entire lesson for their students, which include the mathematical background knowledge, combined with activities and interactive applets, and provide them online as web pages for their students. Other teachers provide a variety of different applet types for their students, starting with simple constructions and working their way up to very elaborate interactive applets. When using prepared constructions and interactive applets, it is also important to combine them with tasks and questions in order to ensure that students slow down their experimenting and use the prepared resource in the way, the author intended it to be used, in order to maximise student's benefits from using the resource. Many teachers prefer to create GeoGebra constructions from scratch during their lessons, letting their students actively participate in the creation process instead of using prepared materials (black-box principle).

As an overall goal, many educators are trying to familiarize their students sufficiently with GeoGebra in order to allow them to use the application independently. Some participants also stressed the importance of letting students, who are adept in using computers in general and discovered how to use certain GeoGebra features by themselves, teach the teacher as well as their classmates in order to keep up their motivation to explore the application. When letting students use GeoGebra independently, it is also important to think about how much scaffolding, guidance, and challenges need to be provided for a certain group of students and which specific skills they need to have in order to be able to successfully complete the given tasks. Thereby, the opportunity for collaboration among students could be an effective way of helping all students in a class to reach the objectives of the lesson and learn from each other.

Also the role of proofs for mathematics was discussed in this working group. In upper grade levels, some teachers took the approach to discuss with students how the software executes calculations in the background as well as which algorithms were used to calculate certain results. It was also mentioned, that the majority of teachers probably don't have the time to let their students think about "what is under the hood" of software like GeoGebra, and simply need to accept the software as a "black box". However, technology like GeoGebra definitely allows the introduction of more difficult mathematical concepts at a much earlier age by designing applets with open questions for students to explore, even if they cannot make a formal proof at this stage of their mathematical education.
Using dynamic mathematics software, the role and definition of proofs in mathematics is subject to change since technology allows students to tackle more difficult problems, understand advanced concepts by using visualizations, as well as assist with difficult calculations and proofs by saving time

and brain power. Finally, some participants stressed, that it is important to clarify with students that simply creating a certain construction with GeoGebra is not a proof in itself, but could give valuable insight into the underlying mathematical concepts and therefore, help to prepare the ground for actually creating a proof by hand. This also brings up the question of "When is a proof a real proof?" which needs to be thoroughly discussed with the students.

Finally, also the need to consider assessment was discussed among the participants. Questions like "What did the students actually learn when using the provided interactive applets?" or "What was the benefit of using technology in a certain situation compared to teaching the content the 'traditional' way?" were raised and discussed.

Wish List of Features for Future GeoGebra Versions

During the presentations and discussions of the first conference day, the following wish list of features for future GeoGebra versions has been created:

- Slider animation:
  - To be able to stop the animation at a certain value, and/or run through all possible values only once and then stop;
  - To set a start and end values for slider animations;
- Custom tools:
  To make it possible to find out how a custom tool was created by analysing the *.ggt*-file, possibly by saving the construction protocol of the tool with the actual tool;
- Locus: Interaction of locus lines with other mathematical objects and possibility to apply tools to them (e.g., Intersect, Tangent)
- Menus:
  - Context Menu: Add the option to change between polar and Cartesian coordinates and adapt the axes and grid accordingly;
  - Properties of the Drawing Pad: Add a grid for polar coordinates
- User Interface:
  - A drag-able toolbar
  - Create different kinds of toolbars for different math topics
- Construction Protocol:
  - Proof: Ways of capturing student activity in a construction file or applet, like for example steps of a proof.
  - Constructions protocol should include the toolbar icons
- Dynamic Worksheets:
  - A simple way of linking several dynamic worksheets by including a "Next" and "Back" button;
  - Option to include a "Print" button;
  - Making it easier to create a simple user interface for certain applets;
  - More possibilities to format the text on a dynamic worksheet (e.g. font size);
  - Provide templates for dynamic worksheets to choose from (e.g. text next to applet)
  - Adding the ability to take notes within an applet (e.g. explanations, proof) and maybe having a formula editor (e.g., Formulator MathML Weaver) available as well
- GeoGebra Wiki:
  - To allow multilingual indexing and cross-referencing of instructional resources;
  - To be able to add a write-up of pedagogical strategies and technical skills necessary to use or create the file;
  - To create a topic-oriented structure and have sets of tags for each resource;

    - To establish a library of GeoGebra tool files (*.ggt*), that provides a collection of tools for different mathematical concepts as well as grade levels (e.g. elementary school);
    - To develop criteria for a minimum quality standard for uploaded files and to find a way of (automatically?) checking if a file meets this standard. Thereby, templates for dynamic worksheets that meet these quality criteria could be provided.
    - To provide a search feature that allows users to find those resources that fit into their curriculum.
- Interactive Whiteboard:
    - Creating a presentation mode with increased sensitivity area of sliders and check boxes
    - Allow for an alternative way of right-clicking , since it is not supported by all white boards

4.6 Conclusion

In this working group, we have been able to exchange our experiences related to instructional resources created with GeoGebra and had the opportunity to discuss a variety of different topics and issues, as well as to create a wish list for future GeoGebra features. Due to the different backgrounds and countries of origin of the working group participants, it was possible to get insight into the widespread use of the software and the different challenges teachers have to face when integrating technology into their everyday teaching. Also, the need for sharing quality instructional materials and collaboration among teachers became obvious during the discussions. Overall, participants found the presentations and discussions of this working group very valuable and productive. The input and presentations of the different participants will provide a valuable basis for the future restructuring of the GeoGebraWiki as well as the improvement of the software GeoGebra itself.

5 Report of Working Group E: GeoGebra at Universities and in Teacher Education

Working Group Chairs

Freyja Hreinsdóttir, freyjah@hi.is (Iceland)
Anders Sanne, anders.sanne@ntnu.no (Norway)

5.1 Abstract

This working group focused on the use of GeoGebra at Universities and in Teacher Education. There were 17 participants from 12 different countries. Each participant gave a short presentation on his or her GeoGebra activities, interests and views. The group met for two 90 minutes sessions and a 40 minute summary each conference day. During three of these sessions the focus was in particular areas of GeoGebra use, in pre-service teacher training, in-service teacher training and University Education. This report gives a short summary of the presentations and discussion in the work group.

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5.3 Conference Day 1: GeoGebra in Teacher Education

Topic of Session 1: How to introduce student teachers to GeoGebra?
Topics of Session 2: GeoGebra and professional development; GeoGebra and e-learning

Olivia Gill (Ireland)

Olivia Gill discussed changes in the Irish second level mathematics curriculum and a new initiative entitled 'Project Maths' that aims to improve the mathematics education of second level students by promoting real-life applications in the mathematics classroom with an enhanced emphasis on IT. At the University of Limerick lab sessions & lectures on GeoGebra were therefore included in mathematics education modules. The students made applets as a part of their assessment, and some examples of these were shown. More applets can be found at www.ul.ie/cemtl/resources.htm. The students found the work challenging yet very beneficial and will aim to use GeoGebra in their final year Teaching Practise.

Aitzol Lasa, Álvaro Saénz de Cabezón and Miguel R. Wilhelmi (Spain)

Aitzol Lasa described a course given in a program of Science Education for School Teachers. He discussed the way GeoGebra was used, and gave examples of this. He also discussed reasons for using GeoGebra and issues in relation to pre-service teacher training e.g., the connection of a learning objective, a GeoGebra activity, a lesson plan, key examples, and an assessment procedure.

Mustafa Dogan and Erol Karakirik (Turkey)

Mustafa Dogan discussed a course at Selcuk University, Faculty of Education, at Primary Mathematics Department. GeoGebra software was translated to Turkish to be used in this course. Each student's work usually consisted of at least 10 different GeoGebra worksheets including both geometric and algebraic operations. Thus, more than 3000 GeoGebra worksheets samples have been constructed by around 300 trainee teachers for the last three years. The worksheets provide

many insights e.g. the students' main interests concerning dynamic geometry, struggles and misconceptions and can therefore be used for research. Selected examples of these worksheets were presented. GeoGebra worksheets were used in assessment and as a part of that the students gave their views on difficulties in using the program and suggestions for improvement.

Damjan Kobal (Slovenia)

Damjan Kobal presented his views on the use of GeoGebra. GeoGebra is a great tool for teaching and learning. But the role of a teacher remains crucial if we want to reach the majority of students. Thus, one of the main issues in promoting the creative use of GeoGebra is to make sure that the use of GeoGebra does not remain alien to the working teachers. In teacher's education GeoGebra can and must be presented as a friendly and mind provoking tool, which presents, motivates and intrigues mathematical thinking. Many mathematical concepts can be presented in a very intuitive way by the use of GeoGebra, but this might not be the best part of GeoGebra. One of the most important values of a program like GeoGebra might be in the educational added value of teacher's deep comprehension of concepts which is developed in the path of creating high quality applets. True mathematicians and devoted teachers will be impressed by the beauty and simplicity of mathematical thinking, which together with the tool of GeoGebra can convey abstract (dynamic) mathematical concepts in the form of clear visual schemes.

Discussion: How to introduce student teachers to GeoGebra?

This was the main discussion topic of the first session and touched on the following:

- How to teach GeoGebra to student teachers?
- What are the difficulties and how much time do they need to learn how to use GeoGebra?
- In what way do we want them to use GeoGebra?
- How is this affected by the way we teach them?
- What is a good way to use GeoGebra?
- What is a good reason to use GeoGebra?

Although there were large cultural differences within the group we agreed that we need to present technology in a way that makes student teachers want to use it once they start teaching. We need to teach student teachers how to use technology to *teach mathematics* in a *better* way. Teach them to use it to make mathematics more interesting. We should intertwine mathematics and technology and teach the students mathematics using technology. We should use real life examples to motivate and examples that demonstrate the added value of using GeoGebra in teaching and show real classroom use. On how detailed this instruction needs to be there were widely differing opinions within the group. Some participants believe that we should not give out specific "how-to-dos" with regard to GeoGebra whereas others think that this is exactly what a teacher needs to be able to start using GeoGebra.

How much time is needed to teach pre-service teachers to use the program itself varies greatly, it seems that first year students need many hours of teaching and often have technical difficulties using it. More mature students do not need any teaching on technical issues and can often just be told to download the program. Students who know little mathematics seem to have the greatest difficulties in learning how to use the program. So how to teach GeoGebra to student teachers depends both on their computer skills and their mathematical knowledge.

Arne Amdal (Norway)

Amdal works as a lecturer of mathematics education at the Norwegian University of Science and Technology (NTNU). He talked about how GeoGebra is implemented in the teacher training at NTNU. The students concerned all have at least a year of mathematical studies behind them. During a semester he meets the students 8 times, 4 hours each time. The students are teaching in secondary schools 7 weeks per semester. One of the lectures before they go out in practice is spent at the computer lab. The object of spending time at the computer lab is firstly that students get to learn GeoGebra and secondly to discuss how to implement GeoGebra in the class room. He tries to stimulate an inquiry based environment. The students are often asked to generalize the problems they are given. During the semester the students are given two assignments. A small one, where they are asked to report how they have used computers in their teaching, and a large one, where they write an essay where they choose their topic themselves. Some of them choose the use of ICT in mathematics teaching and learning as their topic. In the new curriculum in Norway the use of ICT is emphasized. As a consequence of this, GeoGebra and other tools are implemented in the text books.

André Heck (Netherlands)

Teachers of first-year courses in mathematics could benefit from using GeoGebra in their teaching of basic courses in calculus, geometry and algebra. However, a difficult issue is to convince them and get them started. A teacher professionalization programme might just be a good option. A question is what the contents of such a programme could be. Maybe it is worthwhile to look at positive experiences that André Heck and his colleagues have within the Master of Mathematics and Science Education at the University of Amsterdam with projects in which students develop one or two lessons about a mathematics subject using ICT, teach the lessons at a secondary school, and evaluate them. Such work might be a good option for both a professionalization programme of university teachers and for a teacher training programme. Two examples of GeoGebra-supported lessons developed by students were presented.

Freyja Hreinsdóttir (Iceland)

The School of Education at the University of Iceland recently started to use GeoGebra in courses on Geometry and Calculus for prospective mathematics teachers. Freyja Hreinsdóttir gave a brief review of GeoGebra activities in Iceland and described a new experimental projects course (6 ECTS) on many different topics including GeoGebra in teaching secondary school mathematics. Students in the course were a mix of pre-service teachers, in-service teachers and mathematics students. Due to the size of the country (pop. 300.000) there are problems in organising specialised courses for particular groups of students. During the course the students made GeoGebra worksheets, wrote papers and gave talks to the whole group explaining details on GeoGebra as well as the purpose of the worksheets and how they fit into the curriculum. The mix of students turned out to be a plus as it inspired many questions and lively discussions.

Celina Abar (Brazil)

Celina Abar presented the results achieved in continuous training of mathematics' teachers in the Post-Graduate Program Studies in Mathematics Education, with the use of a virtual learning environment (VLE) Moodle. The use of this environment allowed her to break barriers of time and distance. The participants get involved in the learning's context; they propose problems and its resolutions, formulate hypotheses, observe and review their previous designs, make decisions, in a

dialogue with the reality of their practise teaching. Activities with content on functions, geometry and algebra were proposed with the use of GeoGebra to support the teaching and learning of such contents. All the subjects proposed had as support texts and theoretical research on the use of ICT in teaching and learning of mathematical content to subsidise the development of the training. Abar concluded her presentation with the statement: "*We believe that overcoming the difficulties in the use of technology in teaching practice depends largely on the teacher and the actions required to develop his own training and autonomy.*"

Ada Sargenti, Patrizia Laiolo and Claudia Testa (Italy)

The Faculty of Sciences of the University of Turin used Moodle's features in order to create an engaging collaborative online learning community of teachers of Physics and Mathematics (DI.FI.MA.), with the purpose of formation, research, comparison, sharing of materials and information on national and international initiatives. The initiative follows the experiences of using Moodle in the initial teachers' formation on behalf of the Piedmont SIS (school of specialisation for secondary future teachers). At the moment, among the resources available on the platform DI.FI.MA., there is also a virtual class of GeoGebra, established in collaboration with the association "La Casa degli Insegnanti" (The House of the Teachers). This is a blended course for teachers who want to learn how to use this DGS, for analysing new teaching strategies for classroom activities. This course attempts to combine the elements of the traditional face-to-face meeting with the best aspects of distance education for supporting teachers in the use of GeoGebra and Moodle platform.

Anders Sanne (Norway)

Programme for Teacher Education at the Norwegian University of Science and Technology (NTNU) started to give GeoGebra workshops for teachers back in 2006. Anders Sanne shared some of his experiences from these workshops. To learn well how to teach mathematics with GeoGebra, the teachers have to work with the software over some period of time, trying out their ideas with their pupils in a class room situation. This is impossible to attain in a traditional one or two day workshop for teachers. Thus, at NTNU, they tried to organise the training as blended learning with a start-up workshop, 5-8 weeks online activities and class room practise, and a closing workshop. For the online training they used Moodle and workshop materials (http://www.geogebra.org/en/wiki/index.php/Workshop_materials) developed by Judith and Markus Hohenwarter (translated into Norwegian). This course design seems to fit well into a formal in-service training course where the teachers gain ECTS credits. But most in-service courses given in Norway are in-formal with no ECTS credits gained. In such a setting it seems nearly impossible to engage Norwegian teachers to spend enough time on the online training between the gatherings.

Mohamed Al Sayes (United Arab Emirates)

Al Sayes is a lecturer in a college for primary school mathematics and science teachers. He runs the website www.ecamaths.com, and shared some of his work and ideas with our group.

Discussion: Using GeoGebra in in-service training and e-learning

There was agreement that GeoGebra is very well suited for in-service training and online courses. Some face-to-face contact is necessary but Judith and Markus Hohenwarter's worksheets are excellent for distance learning. For in-service teachers it is important to prepare complete materials for teachers to use, not only containing information on GeoGebra but also on the pedagogy of using it. Teachers who learn to use GeoGebra during a short workshop often do not use it afterwards so it

is also important to create websites, form networks and give ongoing information to teachers who are starting to use GeoGebra in their teaching. We should visit classrooms, see what teachers are doing and give them feedback

5.4 Conference Day 2: University Mathematics

Topic of Session 1: GeoGebra in university level mathematics

Francisco Perez-Arribas (Spain)

Francisco Perez-Arribas talked about teaching of geometry at an engineering university where practical applications are important. GeoGebra is used to teach the foundations of Computer Aided Design (CAD). The use of dynamic geometry allows a better understanding of the CAD basis, how and why it works, and a revision of the student's background knowledge in projective geometry with the use of modern and interactive computer techniques. GeoGebra is very appropriate in this case because it allows both the graphical and the numerical definition. Some algorithms are described graphically and then reproduced numerically with the use of algebra, in the same GeoGebra environment. Even though GeoGebra is not used as a CAD program or as a programming environment, it is a good joint of both styles and sets a good base to start using a CAD program or programming CAD algorithms that are later used by the students in their subject program and in their future professional work. Website http://debin.etsin.upm.es/~geometria/

Tolga Kabaca and Mehmet Bulut (Turkey)

GeoGebra is a powerful tool to teach mathematics. Its dynamic feature, which allows constituting a bridge between algebra and geometry, may be used to design a discovery learning environment. In this kind of environment, we can see the student as a GeoGebra user, while we are a GeoGebra programmer. Kabaca and Bulut want to call our attention to another possible use of computers in teaching math: Students could also be seen as programmers. They illustrated this with the concept of "finding arc-length of a curve" and showed how the Students can use GeoGebra as a "programming language".

Enrique de la Torre Fernandez (Spain) and Adelina Silva Muslera (Mexico)

Fernandez and Muslera do research on the use of technologies in the mathematics classroom. They have observations and video captures of students computer screens while working with GeoGebra. Some preliminary results from their research:

- One of the potentialities of GeoGebra, the functions graphs, becomes a restriction for the students.
- When the students make derivatives, usually they do not see the graph of the derivative function, and when the derivative function is showed in the screen, it is something new for them.
- This can be denominated an obstacle in the sense that it is a lack of balance in the conceptual aspects.

Inder K. Rana (India)

The fact that GeoGebra is open source is a big plus factor for developing countries like India. Rana is interested in developing a GeoGebra supported text on Calculus, and he conducts teacher training workshops for math teachers at secondary level. Website http://www.math4all.in/

Maurice O'Reilly (Ireland)

In the spring term 2009, O'Reilly taught a one-semester module on geometry to a small group of students taking a two-subject B.A. programme at an Irish university. Students had little experience of Euclidean geometry since the middle of second level schooling. This experience involved, typically, memorising fourteen theorems isolated from the rest of their mathematical studies which would have included coordinate geometry, vectors and complex numbers, for example. In the module just taught, the emphasis was on reviewing Euclidean geometry in a more connected manner and alongside transformation, projective and non-Euclidean geometry. O'Reilly considers ideas around teaching geometry to adults with some mathematical maturity, drawing on insights gained from experience with this module. Website: http://staff.spd.dcu.ie/oreillym/geometry.htm

Alexandra Emilia Fortis (Romania)

Currently, for the support of the Geometry classes she is using MathCAD and Maxima. The first one is a commercial product that proved to be limited with respect to some particular problems, while the second one, an open-source product, is not user friendly, and with major limitations regarding the graphical representation of most aspects in the curricula. Considering these aspects, it became imperative to find some free software that could graphically support the curricula for the Geometry course. Despite the fact that 3D is not yet available, Fortis sees GeoGebra as one important software candidate for her teaching. The educational aspects in teaching elementary geometry in secondary schools, emphasised by research papers, offer good reasons for her choice.

Discussion: GeoGebra in University level mathematics

For University mathematics it is generally easy to use GeoGebra, the students usually have a strong mathematical background as well as some background in computer programming. GeoGebra is used as a tool to visualise, to "find the algebra of a picture", "to make students think" and to change their perception about mathematics. GeoGebra can also be used to document students work and gain some insight into their misconceptions and mistakes.

5.5 Group Discussions

The participants split into two smaller groups, teacher training and university mathematics. The discussion continued along the lines of the previous sessions and is summarised below.

Teacher training

There was some discussion on how to motivate teachers to use GeoGebra. In some countries teachers are forced to use dynamic geometry software (e.g. GeoGebra) by curriculum changes and some participants believe that this is the only way whereas most others think that it is much more important to motivate teachers to use GeoGebra. To achieve this we should teach GeoGebra in a way that enhances and explores concepts. We should create materials where GeoGebra can be used, help the teachers identify these situations and help teachers understand the potentiality of dynamic software like GeoGebra. Teachers need time to prepare new material and should be given an opportunity to do so.

GeoGebra in university mathematics

This discussion focused on GeoGebra as a wonderful tool for exploring and visualising mathematics. For asking questions, collaborating and engaging students in a mathematical conversation.

What is needed?

We need to establish guidelines and didactic principles for teaching to teach with GeoGebra. We need to find a way of sharing courses designed by educators in different countries, possibly an online "Journal of practical teaching with GeoGebra". We also need to do pilot studies on the impact of GeoGebra in teaching and learning of mathematics.

Wish list (from discussions and abstracts)

- Tools to construct a command library
- Language for making scripts (with detailed help)
- Better plug-ins for using GeoGebra with e-learning tools like Moodle.
- Possibility of increase in font size for labelling axis
- Choice of function display
- Possibility of incremental display

5.6 Conclusion

It was very valuable for the participants in the work group to exchange their ideas and experience on GeoGebra. There were big cultural differences within the group and this inspired some very lively discussions. This tells us that it is too optimistic to think that there should be only one way to introduce and use GeoGebra in mathematics teaching. Local considerations must be taken, but the group agreed that the focus should be on the mathematics itself using GeoGebra as a wonderful teaching tool or media.

6 Report of Working Group F: GeoGebra Institutes and Research

Working Group Chairs:

Zsolt Lavicza, zsolt@geogebra.org (UK)
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Katarzyna Winkowska-Nowak, k.winkowska.nowak@gmail.com (Poland)

6.1 Abstract

This working group aimed to brainstorm ideas for developing international collaborative research projects, to promote the development of new research ideas and priorities of projects, and to find out how to find and assist funding opportunities for both research and pragmatic purposes. The list of topics to be discussed in this working group:

- Developing and prioritising research ideas/topics;
- Supporting and sharing local and international research projects;
- Sharing information about international funding opportunities;
- Investigating postgraduate student funding options;
- Assisting the establishment of local GeoGebra Institutes;
- Assisting the collaboration between GeoGebra Institutes;
- Encouraging publications and dissemination;
- Exploring opportunities for professional development in local and international communities;

- Designing a functional and effective IGI website and Wikis

6.2 Participants

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6.3 Presentations

Péter Körtesi, GeoGebra Institute of Miskolc (Hungary)

Abstract

Our Hungarian GeoGebra Didactical Research Group will function in the framework of the Hungarian Mathematics Learning Centre established through the European Virtual Laboratory of Mathematics Leonardo project, and will be hosted by the Department of Analysis of the University of Miskolc. We plan to develop a student project data- base, available to all partners through the European Virtual Laboratory of Mathematics (EVLM) project, and even to a larger cooperation. The wise use of the available Internet based educational technology, computer based teaching materials and computer algebra software, without reducing the students' mental contribution is important to promote the good learning skills. Individual and group projects are meant to catalyse the usual didactical methods, and increase their efficiency. In the EVLM project we have created a network including the 9 partners, and we offer a portal each university with teaching materials, and software description. The portal will last longer, and we plan to develop it (http://www.uni-

miskolc.hu/evml/). One of the most intensive directions for developing is the dissemination of the use of GeoGebra. This is the site where the files we produce appear (http://www.uni-miskolc.hu/evml/geogebra/).We will continue the international cooperation of educators in exchanging of experience in mathematical education to promote the recent methods in tutorials and lectures, due to CEEPUS (Central European Exchange Programme for University Studies) and Leonardo projects, and partners working in grammar schools, and vocational schools in the area of the University of Miskolc. Increasing the participation of teachers and students in meetings organized by the partners we will attract student communities in the use of GeoGebra and their teachers in research.

The European Computer Algebra Driving Licence (ECADL) is a future project, based on a series of summer universities with the same title. The idea was made up in international cooperation in the Active Methods in Teaching and Learning Mathematics CEEPUS Network, coordinated by Péter Körtesi, University of Miskolc, and involving 18 partner universities from 13 countries. We do want to teach students the basic, intermediate and professional level of using CAS. We plan to include the presentation of GeoGebra as part of curriculum in the basic level course. The ECADL activities end up with a certificate named European Computer Algebra Driving Licence - which will be accepted as partial study form. We plan to elaborate the intermediate level and advanced level of the ECADL, to be extended to a set of joint courses, involving the courses with appropriate content available at the partners. We plan to continue to organize the Intensive Course/ Summer University in the topic of the ECADL - Right use of computer algebra software in learning Mathematics, and we will include in it the GeoGebra software in more extent. As concerning our plans, we plan to develop materials in teaching and learning mathematics for the university, to do didactical research on the methodology to apply in teaching, and collaborative learning the software. We do plan to offer teacher and student training for the use of the software. We teach computer science students as well, and we plan to contribute in developing the software as well.

Recommendations

- Develop a European license for technology use in mathematics teaching
- Develop competitions with GeoGebra
- Involve more PhD students
- Define a national structure for GeoGebra Institutes
- Develop a formal Charter for local GeoGebra Institutes

Katarzyna Winkowska-Nowak, GeoGebra Institute of Warsaw (Poland)

Abstract

One of the most important sign of our times is constant change. This is especially true in a field of ICT and in the field of education. Teachers have to become learners for life if they want to follow the changes and challenges of modern society.

GeoGebra is a perfect example of a phenomenon which help create communities of active, ever leafing teachers. First it is a perfect tool for exploration in mathematics and sciences. It brings enthusiasm at all levels: in university faculty, students, teachers and pupils. The ideas behind the GeoGebra: Forums, Wikis, communities, shearing the resources and training help to organize around the enthusiasm.

I will talk in my short presentation of possibilities which GeoGebra gives both to researcher, teacher and to a person who organized teachers association with aim of bringing ICT to Polish schools.

Recommendations

- Try to organise local meetings with GeoGebra
- Look for bi-national financial support
- Try to establish prizes for GeoGebra use for both teachers and students
- Consider the most sustainable structure for local GIs

Akihito Wachi (Japan)

Abstract

Wachi described the difficulties of GeoGebra use in Japan. There is only a small community of GeoGebra users in Japan and it causes difficulties for current users. Also, there is no publication about GeoGebra use and it is not integrated into textbooks in Japan. Wachi posed questions to the audience:

- How to develop user groups in such circumstances?
- How to advertise and popularise GeoGebra in Japan?

Recommendations

- Examine countries where GeoGebra is integrated into textbooks and try to find ways to adopt such approaches to local needs
- Write basic GeoGebra texts that could be easily translated to local languages
- Write short articles to teacher bulletins/journals explaining GeoGebra use

Djurdjica Takači and Arpad Takači, Novi Sad (Serbia)

Abstract

Explained the possibility to organise GeoGebra conferences in Serbia and GeoGebra should make presence at different conferences. CADGME-2012 will be held in Novi Sad and it could be a good place to host the next conference.

Recommendations

- Develop a strategy so that GeoGebra can make presence at conferences
- Encourage people to organise pre-, post- GeoGebra conferences at other meetings or have special sessions within conferences.

Yilmaz Aksoy and Ibrahim Bayazit, GeoGebra Institute of Ankara (Turkey)

Abstract

They outlined the brief history of our GeoGebra institute of Turkey: Our institute has been established at the beginning of the 2009. Our all members have a PhD degree in Math Education and all of us have already studied on using technology to teach math. We have used Maple dominantly to teach math and in our research studies. GeoGebra is new software for our country as in world. The first presentation was done in 2006 by the Turkish academicians, who are also translators of GeoGebra into Turkish, Mustafa Dogan and Erol Karakirik. We thank them to introduce us to GeoGebra.

Although Maple is a very strong symbolic tool, we had lived some difficulties during our studies;

- Our elementary students' ability of using English is not sufficient to use Maple efficiently as most of our teachers.
- We need to organize a serious training session of using Maple, because Maple does not work dynamically between geometry and algebra. So the user must learn most of the codes to start using.
- Maple is very expensive because of its commercial characteristic. This is a very important obstacle to make it widely usable in teaching.

GeoGebra is very good alternative using technology widely in our math classes. This is the reason why we decided to study on GeoGebra. I want to summarize our several studies on GeoGebra from the beginning of 2009;

- First, we started to study on converting our previous studies into GeoGebra environment. By this way, we aimed to develop our GeoGebra knowledge and ability.
- We used GeoGebra in teacher education in our university departments. Students of GeoGebra courses learned how to use GeoGebra. Then, they developed dynamic worksheets and web pages for teaching mathematics at secondary school levels. They linked real life situations to mathematical concepts in their worksheets. According to their responses they found GeoGebra helpful tool for mathematics education. For answering questions of Turkish GeoGebra users in forum, Markus helped us for opening a section in GeoGebra User Forum. After that, we used this forum for sharing and discussing ideas.
- We used GeoGebra in our math education courses. After teaching pre-service teachers how to use tools of GeoGebra, we taught them how to develop dynamic materials for teaching mathematics in the classes. They used the developed materials at 6th -8th classes to see the effects of them on the students' learning mathematics. By this way they experienced the use of dynamic materials in the classes.
- First formal organization was in April as a workshop in The First International Congress of Educational Research Association in Canakkale. Almost all math educator and people, related to math education, participated to our workshop. Almost all participants have used GeoGebra in our workshop. Especially, teacher participants ask us to organize a training session in their schools.

One of our near plans for GeoGebra was organizing GeoGebra workshops in some cities of Turkey for the math teachers in various levels. We need financial support to carry out this project. We may use European grants for this purpose. An international relationship can be constructed in an EU project. We are all ready to establish this kind of project as GeoGebra Institute of Ankara, Turkey.

Recommendations

- Organise teacher training at local institutions
- Have a list of summary of GeoGebra projects to be able to seek collaborators (website)
- Seek project applications together and joint efforts in writing proposals (website)

Jan Guncaga and Janka Majherova (Slovakia)

Abstract

In their presentation they described some project possibilities for research and application of GeoGebra in education. In order to do this, they use open information sources from different projects' programs from the Internet. Moreover, they presented their own experiences with the implementation of projects, which aim at education of teachers.

Recommendations

- They have lots of experiences in preparing and participating in large EU projects, so the community could draw on their expertise
- Develop a list of potential grant applications (website)
- Possibly hire professional grant writers

Carlos Gimenez, GeoGebra Institute of Catalonia (Spain)

Abstract

Since early 2008 I've been involved in the inception and creation of the Associació Catalana de GeoGebra, the local IGI Institute in Catalonia (Spain), so I'm here to share our short experience with the members of this discussion group, and also to get your feedback in this field.
According to Markus's idea, the main goals of our organization are focused in spreading the use of GeoGebra in our community, carrying out workshops, seminars, courses and other activities that may lead to a viral growth of the use of computer aided technologies in our teaching activity.
We are also studying different ways of promoting our association, starting with the creation of a Moodle based environment (http://acGeoGebra.cat) and following up with the publication of a periodical bulletin in the near future.
On the other hand, we must face the main problem related to small associations, which is searching for funding opportunities to enable us to develop our projects.
Finally, I think that this first International GeoGebra conference may offer local institutes the possibility of establishing a certain kind of collaborative (net)work among them, with the aim of generating positive synergies.

Recommendations

- Develop guidelines about how teachers can be involved in the work of local GIs
- Teacher training is key for GeoGebra use
- Consider funding applications to and with non-profit associations
- Develop and maintain a list of GeoGebra conferences, and other conference presentations.

Douglas McDougall, GeoGebra Institute of Canada (Canada)

Abstract

McDougall explained the work of several colleagues in Canada to develop a GeoGebra Institute. Also, he explained the possibility of developing international competitions with GeoGebra.

Recommendations

- One or several institutes in a country? How can we define a good structure?
- Must adapt the GI structure to the growing number of institutes
- Think about international student competitions

Sigbjørn Hals, GeoGebra Institute of Norway (Norway)

Abstract

Hals explained research on teachers' using technology in mathematics classrooms. Also, gave insight into how GeoGebra was integrated into Norwegian textbooks and how the Norwegian GeoGebra Institute came to existence.

Recommendations

- Research must be an important parts of local GIs
- Must understand why and why not teachers use technology in their classrooms and how can we assist teachers in technology use
- Work with textbook companies

Andreas Philippou (Cyprus)

Abstract

The University of Cyprus is responsible for the pre-service education of teachers of secondary education. In this framework, we developed a program for preparing math teachers to use integrate computers into their teaching in the mathematics classrooms.

A large portion of this program focused on teaching secondary mathematics using GeoGebra. In the conference we will present a sample of activities used by pre-service teachers to introduce mathematical ideas to students. Most of these activities refer to the concept of limits, derivative, integrals etc.

Recommendations

- Research is needed on pre-service teachers
- GeoGebra is a tool for mathematics or it is changing mathematics?

Markus Hähkiöniemi, Finland

Abstract

Hähkiöniemi described a teaching learning sequence for definite integral, in high school, age 17 with GeoGebra in Finland.

Recommendations

- Higher level mathematics is possible with GeoGebra
- Need research and development on this area

Maria Fahlgren and Mats Brunström (Sweden)

Abstract

Fahlgren and Brunström explained the importance of mathematical competencies in Sweden and the focus on adaptive reasoning.

Recommendations

- It is important to do research on reasoning and GeoGebra
- What are the advantages and limits using GeoGebra in reasoning

6.4 Overall Recommendations of the Group

Structure of local institutes

- Guidelines for establishing of GI
- Define the hierarchy and legal aspects and the dimension of GI
- Create an advisory board to help to solve issues connected with GI

Development

- Books about GeoGebra
- Books with GeoGebra
- Student competitions
- Organizing of general and specialized GeoGebra conferences on global and local levels + proceedings
- Journal GeoGebra, Newsletter, Bulletin

Training

- Evaluation of training for pre-service and in-service teachers
- Evaluate the consequence of training
- In summary, we need the research on training

Research

- Website/database

    - Build up a list of projects (database/website)
      Abstract of these projects
      Establish connections and collaboration
    - List of grants: Calls for support local and international grants
- To do research to clarify the role of GeoGebra among other mathematical software and consider cultural/organizational aspects of using technology
- Embed the GeoGebra research in the corpus of technology related educational research
- Present international research proposal based on GeoGebra
- Invoke a call special for research on GeoGebra
- Professional grant writer and research support

7 Concluding Remarks

The First International GeoGebra Conference was an inspiring event both for participants and organizers. It has brought together people from a large diversity of countries and different educational institutions who shared their experiences and ideas around the use of GeoGebra in classrooms all over the world. Many participants, who had been working together via e-mail and online platforms for years, finally had the opportunity to meet face to face. This conference was characterized by a strong sense of community and has sparked many ideas for new developments of the software GeoGebra, for research projects concerning its use in classrooms, for new local user groups and GeoGebra Institutes, as well as for future conferences in various continents. Thus, we think that this conference was able to reach its main goal: To be the starting point of future GeoGebra projects, events, and local communities.

We want to thank all participants for joining us at this conference and hope to continue our close collaboration in the future. We would also like to thank Prof. Bruno Buchberger and his team of RISC at the Johannes Kepler University Linz for their help in preparing and hosting this conference in the beautiful setting of the castle of Hagenberg.