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I2GEO 2010 – Conference Report

July 2-3, 2010

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[1] OJ L 79, 24.3.2005, p. 1.

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1 Summary – Committing the Intergeo Project to the Mathematics Education Community

I2GEO 2010, the first conference on Interoperable Interactive Geometry – established by the Intergeo Project – took place in Hluboká nad Vltavou (Czech Republic, July 2-3), immediately following CADGME 2010, the Conference on Computer Algebra and Dynamic Geometry in Mathematics Education.

A declared goal of the Intergeo Project was to enable the mathematics education community – teachers, researchers and learners – to take over the project and to self-sustain it. This conference and the associated proceedings are one building block of this goal.

The conference brought together over 60 members of the mathematics education community and experts in themes of Interoperable Interactive Geometry from all over Europe (France, Germany, Spain, Netherlands, Czech Republic, Luxembourg, Slovenia, Slovakia, Estonia, Ukraine) and beyond (Canada, Brazil, United States).

The conference has been arranged around three important themes of Interoperable Interactive Geometry: Structural Aspects, Technology, and Quality Assessment, highlighted through planary lectures related to each topic by key-members of the Intergeo Project. As a fourth topic we also invited contributions to the Intergeo platform i2geo.net.

Altogether, 19 high quality contributions have been presented at the conference covering a broad range of topics around Interoperable Interactive Geometry in particular related to the use of the Intergeo platform for teaching and learning mathematics and research highlighting the theoretical frameworks behind ontology based structuring and the quality assessment system. The contributions have clearly shown the benefits of the project in a broader sense as research activities around underlying structures (ontology based linking), real life usage as classroom experience and testing (quality insurance of content), and technological aspects as interoperability and the development of content rich applications using the broad facilities of interactive geometry systems to enhance teaching and learning mathematics.

This report summarizes the key activities of the conference (keynotes, presentations) as well as its key outcomes. Implications for future efforts related to the Intergeo platform, its use and sustaining a living community of practice are also presented in the report.

1.1 Committees

The I2GEO 2010 conference was organized and supported by the Intergeo Consortium and its associate partners. The following persons and institutions were involved in the organizing und program committees.

1.1.1 Organizing Committee

Ulrich Kortenkamp, PH Karlsruhe / CERMAT, Germany
Pavel Pech, University of South Bohemia, Czech Republic
Christian Dohrmann, PH Schwäbisch Gmünd / CERMAT, Germany
Roman Hašek, University of South Bohemia, Czech Republic

1.1.2 Program Committee

Colette Laborde, IMAG Grenoble, France (Chair)
Ulrich Kortenkamp, PH Karlsruhe / CERMAT, Germany (Chair)
Miguel Abanades, Universidad Complutense, Spain
Peter Baptist, University of Bayreuth, Germany
Caroline Bardini, University of Montpellier 2, France
Francisco Botana, Universidad de Vigo, Spain
Arjeh Cohen, TU Eindhoven, Netherlands
Ramon Eixarch, Maths for More, Barcelona, Spain
Jesus Escribano, Universidad Complutense, Spain
Roman Hašek, University of South Bohemia, Czech Republic
Maxim Hendriks, TU Eindhoven, Netherlands
Jean-Marie Laborde, Cabrilog S.A.S., France
Yves Kreis, Université du Luxembourg, Luxembourg
Paul Libbrecht, DFKI Sarbrücken, Germany
Daniel Marques, Maths for More, Barcelona, Spain
Christian Mercat, University of Montpellier 2, France
Pavel Pech, University of South Bohemia, Czech Republic
Tomas Recio, Universidad de Cantabria, Spain
Volker Ulm, Universität Augsburg, Germany
Alfred Wassermann, University of Bayreuth, Germany

2 Conference Program

2.1 Plenary lectures

2.1.1 Structural Aspects

Colette Laborde (IMAG Grenoble, France) and Paul Libbrecht (DFKI Sarbrücken, Germany) provided an overview of structuring issues and underlying theories related to the theoretical frameworks of the Intergeo platform focussing on the following key aspects:

- Ontologies for Mathematics Education
- Formalization of Curricula
- Cross-Cultural Aspects of Mathematics Education
- Classification by Topics vs. Classification by Competencies
- Searching and Organizing Mathematical Content
- Metadata for Mathematical Resources and Activities
- Knowledge Management in Mathematics Education

2.1.2 Technology

Yves Kreis (Université du Luxembourg, Luxembourg) and Ulrich Kortenkamp (PH Karlsruhe / CERMAT, Germany) were focussing on technological aspects related to

- Formal Descriptions of Constructions, Exercises and other Digital Content in Mathematics
- Data Exchange in Mathematics and Mathematics Education
- Comparison of Interactive Geometry Tools
- Mathematics Education and Social Networks/Web 2.0
- Integration of Digital Content in the Classroom
- Innovative Uses of ICT in Teaching Mathematics.

2.1.3 Quality Assessment

Christian Mercat (University of Montpellier 2, France) discussed issues concerning the quality assessment of contents and its theoretical foundation by highlighting the following:

- Quality Criteria for Interactive Mathematics Content
- Standards for Quality Assessment of Educational Content
- Best Practices and Case Studies on Using Interactive Geometry in the Classroom
- Identification of Critical Features of Electronic Content that Create Added Value
- Teacher Education and Life-Long Learning
- Educational Research based on the Quality Framework of Intergeo

2.2 Additional plenary lectures

An additional plenary lecture was given by Wei-Chi Yang, Radford University/United States about "Improving Teachers' Level of Geometric Development Using Dynamic Content„.

In his talk, Yang reported that many mathematics teachers in the United States lack conceptual understanding of geometry topics they teach. As students they are typically exposed to geometry content through procedures and as in-service teachers they tend to continue with this pattern of teaching procedurally. He suggested the use of dynamic course content as one way of improving teachers' conceptual understanding of geometry. High school teachers who have limited opportunity to develop their conceptual understanding of geometry tend to conduct their classrooms using activities focused on developing student's procedural knowledge of geometry.

Yang pointed out that in a regular mathematics curriculum in the US, geometry and algebra content are not well integrated. Normally there is little or no integration of algebra and geometry and each content area taught in a separate course at different grade levels. He underlined that researchers showed the importance of integrating and linking algebra and geometry content. However, for Yang it is very difficult to conduct such integration given the traditional course sequencing in the United States public school curriculum. Thus Yang suggested that dynamic content can provide more opportunities for integration of algebra and geometry topics.

In his talk Yang introduced examples that students encounter in Calculus courses, and how dynamic geometry can be integrated with computer algebra system to make challenging content more accessible to students. He underlines that teachers' conceptual understanding of these mathematical constructs can also be deepen through the use of technological tools in teachers' education and mathematics instruction.

Another plenary lecture was given by Tomas Recio, Universidad de Cantabria/Spain, on „Usage Increase of DGS through Intergeo". He presented outcomes and conclusions based on an Intergeo report that discusses the situation of DGS usage in Europe during the period 2007 to 2009. Furthermore, the report deals with the question on how to evaluate the impact of the Intergeo project towards the use of DGS. From a methodological point of view he discussed the problem of defining appropriate quantitative and qualitative indicators to examine the DGS usage in a broader sense and on a European level using indicators like

- Ratio of DGS papers in popular teachers' journals
- Activities on DGS at teachers' conferences and relevant math teachers meetings
- Occurrence of DGS for official curriculum of mathematics.

Tomas Recio concluded that the outcome of a project such as Intergeo, directly concerned with providing math educators communities with resources, ready for classroom use, and favouring the gathering of DGS practitioners, would do much more for DGS usage than curricular changes (at least if they go in the positive direction, or at least not forbidding the use of DGS). Some more time is still needed before the Intergeo effect can be perceived. Therefore, he underlines, that the main recommendation of this report should necessarily go in the direction of supporting the continuation, by whatever means, of the Intergeo goals and the maintenance of the Intergeo platform.

2.3 Presentations

Strategies for the use of Technological Resources in a Discipline of a Distance Learning Mathematics Teaching Degree Program

Celina Abar, Post Graduate Program Studies in Mathematics Education Pontifical Catholic University São, Brazil

Summary: Celina Abar presented some strategies that teams of research professors and advisors used in developing the content and activities of the Distance-Learning Mathematics Teaching Degree program at the Pontifical Catholic University of São Paulo, in a virtual learning environment, in this case Moodle. As coordinator in the activities that enabled the process of making the course viable and in constructing the proposals for teaching and learning the different disciplines, the issues that emerged and triggered debates between the faculty members could be identified. Among these issues, her presentation was based on the following underlying question: which strategies were used by teams of teachers in preparing the material for their respective disciplines, to promote the students' learning and to facilitate the use of mathematical language in a virtual environment?

The Use of Interactive Visualizations to foster the Understanding of Concepts of Calculus - Design Principles and Empirical Results

Andrea Hoffkamp, Berlin Institute of Technology, Germany

Summary: Andrea Hoffkamp presented her work, that is basically meant as a contribution to a qualitative structural-oriented approach to school calculus. In this context several interactive learning activities based on Java applications were developed. By interactively visualizing functional dependencies simultanously in different representations the students are enabled to explore various aspects of functional dependencies. The activities emphasize both the dynamic aspect as well as the object view of a functional dependency by using a double-stage vizualisation.

The activities were used in a qualitative study with 10th grade students (age: 15 to 16) in different secondary school classes in Berlin, Germany. Based on the analysis of video observations some results of the study were presented. Moreover, the presentation provided a broad overview of the theoretical foundation related to the concept of calculus and its implications for teaching and learning functional thinking using dynamic representations which were implemented in a certain set of learning applications and activities.

Rationale for the Intergeo quality assessment process

Sophie Soury-Lavergne[1], Ana Paula Jahn[2] and **Jana Trgalova[1]: [1]** Lyon National Institute for Pedagogical Research (INRP), France; **[2]** UNIBAN São Paulo Brasil

Summary: The lecturers discussed the quality assessment process implemented on the i2geo platform and its aims to support teachers' integration of dynamic geometry (DG) in the classroom practices. The platform does not impose constraints on characteristics of contributed resources but rather provides tools enabling users to review and comment on resources, which affords an easier access to relevant resources as well as their continuous improvement. They explained the elaboration of a quality review tool that relies on a questionnaire addressing all possible aspects of a DG resource. The design of the questionnaire draws on general criteria for pedagogical resource evaluation and theoretical considerations on the use of ICT, and more specifically DG in classrooms: intertwining of student's conceptual and technical work framed by the instrumental approach, math education theoretical frameworks, mainly the theory of didactical situations and specific knowledge about potentialities of DG for mathematical teaching and learning. For example, DG added-value dimension of a resource relies on research results regarding possible ways of taking advantage of DG in teaching activities, like soft and robust constructions or different functions of the drag mode. The aim of questions related to this dimension is twofold: describing more precisely how a resource takes advantage of DG and making authors and users reflect on possible ways of using it. The lecturers summarized, that the questionnaire helps users better know the reviewed resource (its strengths and limitations), which favours its appropriation for classroom implementation. Thus, quality reviews are a way to support integration of DG into teachers' practices.

Worksheet Creator 2: Blended geometry for the class room

Michael Gerhäuser: Chair of Mathematics and Mathematics Education, University of Bayreuth, Germany

Summary: Gerhäuser presented a web application called Worksheet Creator 2 to support the teacher and ease the process of creating dynamic worksheets. He pointed out, that there are a lot of tools available to create dynamic mathematical content at the computer, e.g. GeoGebra, Cinderella, GEONExT, and many more. But to use this dynamic content in the classroom, it takes more than just handing out a GeoGebra or GEONExT construction file to the students. A predestined way for the preparation of dynamic mathematical content for the use in the class room is to use html web pages in which the content is embedded together with explanations and exercising instructions.

Re-use? Is this Re-Use?

Paul Libbrecht: Competence Center for E-Learning DFKI gGmbH, Germany

Summary: In his presentatoin, Paul Libbrecht discussed the general notions of re-use: at least as it has been understood by many computer-scientists, as was probably used by the Intergeo project description, and what it can mean in a more realistic setting.

He presented definitions of the technical re-use: the one that expects a real data operation of "copy and deploy".

He pointed out, that this kind of operation is a far too restricted view: when an educator is gathering resources, he gathers them because they are interesting. For some of them, he can easily "copy and deploy" but, for many, there's a little itch that prevents the copy and deploy to be done... "Not bad! Redoing it in my favorite geometry system will be easy!"

Libbrecht suggested to investigate the re-use methods and proposed that users should be allow to explicitly mark the links of yesbeing a copy of, a relationship that applies to the copy operation as well as to all other re-use methods (copy-and-paste, imitation, transclusion...).

Interactive geometry inside MathDox

Hans Cuypers, Jan Willem Knopper and Maxim Hendriks: Department of Mathematics and Computer Science, Eindhoven, Netherlands

Summary: In this presentation the lecturers described how they envision using interactive geometry inside MathDox pages. In particular, by some examples they discussed how users and mathematical services (offered by various mathematical software packages) can interact with the geometric objects available. This not only includes manipulation of the geometric objects by users but also as a result of computations by computer algebra systems. Furthermore they discussed how manipulation of geometric objects can be used as input for queries to computational services to produce new views on a document.

The lecturers approach is based on the OpenMath encoding of geometric objects and the InterGeo file format. The communication between Dynamic Geometry Software (DGS) and a MathDox page has been realized by the means of an OpenMath phrasebook implemented in JavaScript.

3D Dynamic Geometry Tools – Helpers or an Obstacle?

Sarka Gergelitsova: MFF UK, Prague, Czech Republic

Summary: Sarka Gergelitsova discussed, that 3D dynamic models can be a great help in teacher's effort to support students' spatial abilities, their understanding concepts of solid geometry and core of 3D problems. However, handling such a tool may be a difficulty by itself and an undesirable obstacle for students. Tools need to be easy to use and models for students need to be well- prepared. Certain aspects have been discussed regadring the use of these tools: Illustration and demonstration of spatial problems that are difficult or time-consuming to describe via planar views or solid models, explanation of students' mistakes and clarification of the core of the problem itself instead of planar static manifestation of the correct answer via picture or verbal description, power to attract and maintain students' attention and to provide the correct answer to the problem or task automatically without teacher's effort, visualization of the answer to the problem and power to check the correctness of the individual steps in constructing 3D objects, support of spatial imagination related to motion and power to facilitate and/or automate teacher's creation of didactic printed materials and tests including correct answers to them without necessity to solve each of the variants of the test individually.

Automated Generation of Equations for Linkage Loci in a Game Physics System

Miguel A. Abanades[1], Francisco Botana[2] and **Jesus Escribano[3]**: [1]CES Felipe II Universidad Complutense de Madrid, Spain; [2] Departamento de Matemática Aplicada I Universidad de Vigo, Spain; [3] Departamento de Sistemas Informáticos y Computación Universidad Complutense de Madrid, Spain

Summary: A web-based tool designed to compute the equations of loci associated to linkages constructed using the game physics application Phun was presented. Complementing the graphing abilities of Phun, the equations are remotely computed using symbolic algebraic techniques from the field of Automated Deduction.

Besides adding exact mathematical knowledge to Phun, the algebraic completeness of the equations is shown to provide complete information about the different possible loci generated by a given mechanism in different configurations.

Special attention is given to four bar linkages motivated by the celebrated result by Kempe stating that any algebraic curve can be realized as the locus associated to a linkage composed basically of a combination of four bar linkages.

The lecturer showed that the reciprocal relation between the degree of a linkage locus and the number of links does not exist.

Adding Intelligent Assessment – A Java Framework for Integrating DGS into Interactive Learning Activities

Andreas Fest: University of Education Schwäbisch Gmünd, Germany

Summary: Andreas Fest presented a Java based framework for the development of interactive learning environments based on laboratories containing dynamic geometry applets. As a result, DGS applets of different types can be integrated into the same laboratory and interact with each other.

The presented framework can be used to enrich interactive DGS constructions and exercises with automated and semi-automated assessment algorithms and allows recordings of learning processes using a capture & replay software. Two exemplary learning environments based on the framework were shown and contributed to the Intergeo platform as candidates for the I2GEO 2010 content award. At least, his learning laboratory MoveIt was elected for this award.

Theoretical Fundaments for an Intelligent Tutorial System Towards the Learning of Geometry at a High School Level

Josep Maria Fortuny[1], Michel Gagnon[2], Nicolas Leduc[2], Johanne Gauthier[3], Corina Rosu[3], Michèle Tessier-Baillargeon[3], Eloi Puertas[4], and **Philippe R. Richard[5]:** [1]Departament de Didàctica de la Matemàtica i de les Ciències Experimentals Universitat Autònoma de Barcelona, Spain; [2]Département de génie informatique et génie logiciel École Polytechnique de Montréal, Canada; [3]Département de didactique Université de Montréal, Canada; [4]Departament

de Matemàtica Aplicada i Anàlisi Universitat de Barcelona, Spain; [5]Université de Montréal and Universitat Autònoma de Barcelona

Summary: The presentation aimed at laying down the multidisciplinary fundaments of the geogebraTUTOR system (GGBT), a research and technological realisation project developed in didactics of mathematics (mathematics education) jointly with informatics computer science. In its design, GGBT presents as an intelligent tutorial system, which supports the student in the solving of complex problems by assuring the management of discursive messages as well as the management of problems. The lecturers pointed out that by situating the learning model upstream and the diagnostic model downstream, GGBT proposes to act on the development of mathematical competencies by offering a control of the acquiring of knowledge in the interaction between the student and the milieu, which allows for the adaptation of the instructional model (learning opportunities) according to the instrumented actions of the student. The notions of inferential and construction graph, which reveals themselves as a structured bridge (interface) between the very contextualised world of didactical contracts and the formal computer science models, structures GGBT in a way to allow the tutorial action to adjust itself to the competential habits conveyed by a certain classroom of students and to be enriched by the research results in mathematical education.

Working on Resources Quality Assessment in I2GEO

Frédérique Bourgeat[1], Anne Calpe[1], Marina Digeon[1], Esmaël Esfahani[1], Isabelle Leyraud[1], Sophie Soure-Lavergne[2], René Thomas[1], Olivier Touraille[1], and Jana Trgalova[2]: [1]Institute for Research on Mathematics Education (IREM), Lyon, France; [2]National Institute for Pedagogical Research (INRP), Lyon, France

Summary: The lecturers group's mission is working on quality assessment of resources available on i2geo platform while testing the platform itself to suggest improvements. Resources were analysed using a questionnaire reviewing their pedagogical, didactical and technical aspects. The reviews were done after an analysis of the resources, before any test in class, and sometimes after a test with pupils. The work is comparable to the "guide du routard" (backpacker's guide): it aims at bringing to light activities the group identified as pedagogically sound and interesting in the multitude of those proposed. To keep track of everyone's work and share it with the group, a "logbook" in which the progress of the research is recorded has been used: results obtained by the search engine, choices of resources to review, their subsequent use (or not) with our students, their possible modifications... The lecturers pointed out that using the platform has changed their teaching practices: the platform has become a tool (like a textbook) for the design of teaching activities. Instead of creating activities from scratch, the lecturers suggested to first have a look if the platform proposes resources corresponding to certain expectations. The resources involved in the working process were not used directly: while appropriating them, they have been modified or taken for some inspiration according to certain needs and aims.

i2geo.net: An analysis of resources in Spanish

José Luis Valcarce: Departamento de Matemáticas IES Pontepedriña Santiago de Compostela, Spain

Summary: The purpose of his presentation was to analyze and provide statistics on a collection of resources of the Intergeo platform that are written in Spanish, estimating the percentage of those that come with documentation to facilitate their use in classroom tasks. That is: How many (Spanish) resources are better than just a well-made construction? José Luis Valcarce pointed out that after almost three years since the beginning of the project Intergeo, the most visible result and the one that will be the key for evaluating Intergeo's impact in the future is the platform in which the resources are collected. Concerning the impact of Intergeo's repository, the aspects related to the presentation of resources will be important and also the facility of search, the speed of response in order to find what is being searched for, the pertinence of the answers the platform offers with respect to the different queries, etc. But perhaps more important, from the presenters point of view, is the quality of each of the resources, not only regarding the technical accuracy of the provided geometric construction, but also considering the accompanying textual or visual documentation.

Experience of the user of interactive geometry and the project Intergeo

Jitka Nováková: SPŠ Tábor, Komenského, Tábor, Czech Republik

Summary: The presentation was focused on the use of interactive geometry as a support in educational process. The interactive tools were used during lessons in mathematics and descriptive geometry. The presentation summarized experience of the author collected during last four years at a secondary technical school. Examples on various topics (functions, limits, derivations, conics), developed by the author, were presented. Jitka Nováková summarized, that the exchange of prepared demonstrations among teachers using the Intergeo platform makes the process of developing and using interactive tools very effective.

Proofs of the inscribed angle theorem.

Pavel Leischner: University of South Bohemia, Faculty of Education, České Budějovice, Czech Republic

Summary: The inscribed angle theorem says that central angle is double of an inscribed angle when the angles have the same arc of base. It is traditionally proved by the same way as Euclid in his Elements introduced, although a simpler and more modern ways are possible. The presentation showed two of them by Cabri tools representation. Files can be used in interpreting the curriculum or for self-discovery work of pupils.

The first proof uses properties of axis of chords and its corollary is a proposition which says that composition of reflections over two intersecting lines is rotation.

In the second proof is firstly derived theorem of intersecting chords which says that double angle formed inside by two non parallel chords in a circle is equal to sum of intercepted arcs. The proposition is easy to show by symmetry of arcs between parallel chords. The inscribed angle theorem is a corollary of the intersecting chords proposition.

Dynamic mathematics and computer-assisted testing: GeoGebra inside TAO

Yves Kreis[1], Carole Dording[1], Vincent Porro[2], and Raynald Jadoul[2]: [1]Research Unit Educational Measurement and Applied Cognitive Science University of Luxembourg Faculty of Humanities, Arts and Educational Science B.P. 2 L-7201 Walferdange Luxembourg; [2]Département Centre d'Innovation par les Technologies de l'Information Centre de Recherche Public Henri Tudor 29 avenue John F. Kennedy L-1855 Luxembourg-Kirchberg

Summary: Yves Kreis presented the integration of the dynamic mathematics system GeoGebra into the computer-assisted testing framework TAO. The presentation was focussed on the explanations of the tools involved as well as their communication. Furthermore, a small-scale test was introduced, explaining the building of such a test, describing its realization as well as the constraints met and reporting on the collected data as well as its possible usage.

Improving Undergraduate Students' Attitudes towards Geometric Proof through a Daily-Life Story using Dynamic Geometry Software

Hussein Abdelfatah: University of Education Karlsruhe, Germany

Summary: This work is a part of a larger study aimed at investigating the effectiveness of a suggested approach, which presents geometric problems through a daily-life story using dynamic geometry software for both school pupils and undergraduate students. Hussein Abdelfatah's approach aimed in particular to enable undergraduate students to feel the importance of geometry in daily life, to share in the process of formulating geometric statements and conjectures, to experience the geometric proof more than validating the correctness of geometric statements, and to start with a real-life situation going through seven steps to geometric proof. The content of the suggested approach was organized so that every activity is a prerequisite for entering the next one, either in the structure of geometric concepts or in the geometric-story context. Twelve undergraduate students from the Faculty of Education in Suez Canal University, Egypt participated in the study experiments and responded to three Likert-type questionnaires, which were prepared by the researcher with the purpose of assessing students' attitudes towards geometry and geometric proof, towards using computers in mathematics learning, and towards the suggested approach. The lecturer discussed results showing that there was no significant difference in general between pre- and post- administering of attitudes towards geometry and geometric proof. Contrarily, the analysis of single responses to questionnaire items showed significant changes in students' beliefs about geometry, geometric proof and towards using the suggested approach.

Reducing graphical user interfaces in DGS

Florian Schimpf[1] and Christian Spannagel[2]: [1]University of Education Ludwigsburg, Germany; [2]University of Education Heidelberg Germany

Summary: Graphical user interfaces (GUIs) of dynamic or interactive geometry software (DGS) allow users to interact with the DGS by using a computer mouse. Clicking on a GUI icon performs an action like choosing a construction tool or manipulating an object. Florian Schimpf pointed out, that for novices it can be difficult to recognize and recall the icons needed for a task. Learning mathematics and learning the use of a dynamic geometry system could lead to cognitive overload. Several dynamic geometry software systems try to solve this problem by offering different GUIs: Expert users can choose between a wide range of icons while for novice users only the most basic icons are presented. In an experiment carried out with full and reduced interfaces of the dynamic geometry software Cinderella the eye movements and gaze points of the users were recorded by using eye tracking. It has been measured how long users need to find given icons in different types of interfaces. Findings of this experiment were described and ideas for further studies were discussed.

2.4 Workshops

Jana Trgalova and Sophie Soury-Lavergne gave a workshop directed to the Quality Assessment System of the Intergeo platform. The participants were introduced to work with the quality questionnaire on the platform. Several reviews have been performed during this session followed by discussions on the general purpose and use of the review system.

3 Outstanding Contributions

3.1 Best Paper Award

For the Best Paper Award the contribution by Andrea Hoffkamp, “The Use of Interactive Visualizations to foster the Understanding of Concepts of Calculus - Design Principles and Empirical Results“ was selected by the program committee. The article provides important results about the influence of Interactive Geometry content as provided by the Intergeo project to every-day teaching. The Program Committee highlighted in particular the very strong theoretical basis of the paper that goes far beyond the usual techno-centric approaches that are presented at many conferences. At the same time, the results that are gained using that theoretical framework are relevant for the classroom and can provide deeper insights in the proper use of interactive geometry.

3.2 Best Content Award

The Best Content Award was awarded to a contribution by Andreas Fest from the University of Education Schwäbisch Gmünd (now Ludwigsburg), who contributed a learning laboratory about line reflections. The laboratory convinces by its innovative use of geometry software to

provide „hints and feedback on demand“. The contribution was created within a German research project called „SAiL-M – Semi-automatic Assessment and includes latest results about cognitive, affective and motivational aspects of technology-based mathematics education. The Program Committee honoured the detailed and extensive work of Andreas Fest that creates a best practise example for Intergeo.

4 Proceedings

4.1 Online Proceedings

The online proceedings of the conference are available at http://cermat.org/i2geo2010 for download. All articles have been reviewed and were edited for coherent layout and presentation. For further details we refer to the website.

4.2 ZDM Issue

On the basis of the contributions for the conference the editors of the ZDM (The International Journal on Mathematics Education, managing editor Gabriele Kaiser) issue 2011-4 on Intergeo, Colette Laborde and Ulrich Kortenkamp, invited authors to contribute by proposing extended versions of their conference articles for submission. The description of the issue is contained in the appendix of this report. In addition, several authors from outside the project and who did not visit the conference were asked to provide an outside view of the project. As the peer review process for the ZDM issue is still in progress, we are not allowed to disclose the submissions yet; however, all information will be available on the ZDM website at http://www.springer.com/education+%26+language/mathematics+education/journal/11858.

5 Conference Questionnaire

A short questionnaire was used to investigate the (1) participants' overall impressions regarding the conference, (2) their experience using the platform, and (3) the overall acceptance of the Intergeo project and its beneficial contribution to foster math education.

Alltogether, 29 questionnaires have been used for the following evaluation.

5.1 About my person

The first part of the questionaire asked for personal information regarding the participants' (professional) background and expertise. Some statistics are given below.

5.1.1 Which country are you from?

Germany	Spain	France	Netherlands	Canada	Luxembourg
4	1	5	1	1	1

Slovenia	Slovakia	Ukraine	Estonia	Czech Republic
2	2	2	2	8

5.1.2 What is your profession?

Professor for Math Education	University/Highschool Teacher	Software Developer	Researcher	Student
4	18	1	4	2

5.1.3 If you are a teacher, what school level you teach at and which discipline?

Highschool / University	Secondary School	Grammar School
15	1	1
Mathematics / Computer Science		**Didactics of Mathemtics**
15		2

5.1.4 How confident are you with Dynamic Geometry?

Less Confident (Novice)	Confident Enough	Very Confident (Expert)
3	12	11

5.1.5 Are you Intergeo partner (Consortium), associate to it or extern to the project?

Consortium	Associate	Extern
9	5	11

To summarize these numbers, nearly all participants – those who filled the questionnaire – are educators at university/highschool level giving lectures in mathematics, computer science, and didactics of mathematics in particular in teacher education.

5.2 About the platform

5.2.1 Are you registered on the i2geo.net platform?

Yes	No
23	4

5.2.2 Among the following tools, which one have you used already, with satisfaction or not, or do you plan to use?

	used with satisfaction	used with frustration	plan to use in the future	don't know this tool
Search for a resource by a search tool	**18**	6	4	0
Search for a resource by browsing resources	9	**11**	5	2
Download a resource	**18**	4	4	1
Use an i2geo resource in a class?	4	2	**12**	6
Curriculum browse	**8**	6	7	5
Contribute a resource	**11**	5	9	2
Report a bug	**10**	0	6	8
Read a comment or a review of a resource	**16**	1	7	2
Comment on a resource	**11**	3	9	3
Fill a quality questionnaire	**9**	5	8	5
Create or participate in a group	6	3	**9**	7
Use multilingualism	**8**	5	3	7
Put a resource in a favourite	5	1	**13**	6
Create a collection of resources	5	2	**11**	5

5.2.3 Are you member of a community of users of the platform i2geo.net?

Yes	No
10	13

5.2.4 What is your overall impression about the platform ?

Negative	Rather negative	Rather positive	Positive
1	1	10	14

5.2.5 What aspects of the platform do you find the most useful?

Especially searching facilities of the platform by using plain text queries, ontology-based search, and overview listings of resources have been highlighted as very useful.

Moreover, aspects as multilingualism, the use of independent applets, and direct access and openess are of importance.

The possibility to gather resources, to share & communicate lead to the users' experience to explore new ideas on how to use resources in classroom. The implemented quality assessment framework (quality questionnaire) was mentioned to be a novel and very helpful feature for educators.

5.3 About the project

5.3.1 Do you think that the geometrical part of the curricula of your country (or state) are covered by the Intergeo topics and competencies?

Yes	No	„Dont know“
15	8	3

5.3.2 As far as you know, what other countries curricula are covered by Intergeo?

France, Spain, Germany, Italy, and United Kingdom

5.3.3 Have you taken part into a local user meeting?

Yes	No
14	13

5.3.4 What is your overall impression about the whole project?

Negative	Rather negative	Rather positive	Positive
0	2	2	25

5.3.5 How did you learn about the project?

- Personal communication with colleagues and members of the Intergeo project (16)
- Internet (I2G website) and Email (5)
- University and conferences (4)
- Other projects (4)

5.4 About the conference

5.4.1 Have your expectations been fulfilled?

Yes	No
25	0

5.4.2 What is your overall impression about the conference?

Negative	Rather negative	Rather positive	Positive
0	1	6	21

5.4.3 For what reason did you decide to attend the conference?

- I'm a member of the Intergeo Project (Consortium Member, Associate Partner)
- To share results and for fun
- To learn about the usage of the platform
- Curiosity and Interest in the project ant its outcomes
- To meet experts in the field of Interactive Geometry

5.4.4 What are you expecting from the project in future?

- Higher acceptance, a growing community, and wide adoption in teachers' professional development
- More resources, lots of evaluations, sustainability, and continuation of the platform i2geo.net
- An extending file format as well as defining a powerful API
- To increase the usage of the platform and DGS in general
- To live, and not to collapse!
- Well organized content, easy conversation
- To keep the platform running, organize Local User Meetings, and complete the implementation of curricula
- To help teachers to use successfully DGS in their classroom
- Important help in teaching geometry modules plus better dealing with whole lessons

5.4.5 What effect does the Intergeo project have on your professional practice (as a teacher, researcher, software engineer…)?

- To bridge the gap between research and users' needs
- To discover multicultural wealth
- To think more about educational aspects
- Ontology is useful to my research. I include using of i2geo.net to courses of pre-service and in-service teachers
- To gather new ideas and contacts
- It changed my way to search resources (easier) and to create activities
- I now understand the importance of using ontologies for structuring purposes
- At this time and in future I would use the resources
- I already use it in preparing teachers courses

5.4.6 About the project: Further comments

- A feeling, that we definitely achieved something really useful
- There is an urgent need for follow up projects where majority of resources will have quality reviewed, full metadata tagged, and competencies (Curricular) linked
- The platform is too complex, teachers (in Germany) won't use it, because of lots of alternatives in Germany

5.4.7 What have you learnt?

- Different views on how DGS may be used in classroom
- State of the project and its theoretical ideas (Ontology)
- I got more familiar with I2geo.net
- An overview about the project and very nice concrete examples of using I2G
- New technical developments
- There are wonderful things in geometry which have been started
- A lot of efforts have already been done to generalize the usage DGS
- Some valuable details about resources and the platform (in common)
- How to evaluate resources and more general, how to use the platform I2Geo.net
- The diversity of teachers' experience & proficiency
- Views of teachers from other countries about the I2Geo project and the platform
- The place of the quality work inside the project
- I2GEO is more complex than I expected
- We have to stress didactics not technology and platform

5.4.8 What will you remember best?

- Mathdox
- Fun group and the warm and supportive atmosphere
- Quality aspects and the methodology
- Tales about testing
- The interchanges with colleagues and experts about some topics
- That I2G is thriving & just beginning
- The connection of DGS with the curricular aspects of mathematics education
- Fantastic features of DGS (but mostly not useful for education in school (in Germany) concerning Gymnasium/ Realschule…
- Cakes and pauses, social events, Ulli's explanations of English goal to 2:2

5.4.9 About the conference: further comments

- Need to better frame the teachers' contributions' values
- Good organization!

- When and where is the next I2GEO?
- As for me, one of the most interesting reseach-theme is connected with improving the quality of resources
- Very interesting but I had the impression that very few talks were related to I2geo (except for plenary talks).
- Could be more people there

5.4.10 Other comments (final question)

- Try to emphasize resources for learners' work (not for teachers administration)
- I feel the need to "educate" reviewers how some chosen sources are marked by stars (especially in the part of didactics and contribution of dynamics). I recommend to add a checkpoint for authors of sources to check when they think the source is innovative and then to review these sources by a special reviewer – expert in understanding what is DGS and what is teaching mathematics about.

5.5 Conclusions from the Questionnaires

The participants of the conference represented a good sample of the users the Intergeo Project is targeting, with a high percentage of highschool and university teachers in mathematics. Thus, it is reasonable to consider results from the questionnaires to the Intergeo user group as a whole.

The platform tools provided by the consortium are mostly accepted and used with satisfaction. Still, although the users are confident with using the platform, they only plan to use resources found on i2geo.net in the future. A key problem seems to be the browsing features provided so far. We used this as an incentive to improve the browsing features of the platform during the weeks after the conference, including better previews, vignettes and a carrousel of recent resources. Despite the mentioned shortcomings, the overall impression of the users about the platform is rather positive or positive.

People from countries with curriculum encodings done within the project are convinced that the geometric part of their curricula is covered by the Intergeo topics and competencies. This indicates that the Geoskills ontology is complete and usable.

Half of the questionnaire participants have taken part in local user meetings, but all (or almost all) are impressed positively about the whole project and see their expectations of the conference fulfilled. In conclusion, both those who knew the project in detail before and those who did not are satisfied.

The free form questions reveal a lot of insight into the users' opinions about the project and give important directions for the future. From the statements it is visible that the users are convinced that the project as such needs more time for development, but they see that we created a solid foundation that is capable of fulfilling these expectations. In particular, statements like "I now understand the importance of using ontologies for structuring purposes" – "I2GEO is more complex than I expected" – "it changed my way to search resources (easier) and to create activities" and "At this time and in future I would use the resources" demonstrate this perception. But there is also criticism with regard to the usability of the platform (concerning a german quote), pointing to local efforts that provide better alternatives (without explicitly saying which ones). The European aspect of Intergeo does not seem to be understood by some, whereas other acknowledge it. The aspect of quality assurance was mentioned in particular,

which underlines our original concept that this is one of the three fundamental pillars for a widespread adoption of interactive geometry content.

6 Overall Conclusions of the Conference

The conference gathered mostly people from the "core" Intergeo countries. Unfortunately, this proves that the concept of country representatives did not work for the Intergeo project. We recommend to have a dedicated partner from every European country in similar projects for the future, otherwise a complete coverage of Europe does not seem to be possible.

Nevertheless, the sample population coming from 11 countries with diverse background from schools and universities was able to highlight the strengths and the weaknesses of Intergeo and in particular of the provided platform. We are happy to see that finally the platform appears to be robust enough to be used by thousands of people, and we used the last months of the funding period of Intergeo to fix all usability concerns that were mentioned.[2]

It was planned that the conference should help integrate the project into the academic community of mathematics education and research in mathematics education, in particular by

- Identifying issues and features of the content and the platform
- Gathering key people from all over Europe and even overseas for stimulation of further work
- Spreading the adoption of the platform as a useful tool
- Disseminating the ideas behind the key infrastructure element, the ontology, and the quality assessment
- Producing a high-quality documentation by means of a journal collection of key papers.

All these goals have been or will be fulfilled. The general response of the community is indeed positive, and we will try to organize a follow-up conference in 2012 to harvest what we planted today.

As a last statement we would like to cite from one participant's questionnaire, who says that the Intergeo project does have the effect on his professional practice "*to discover multicultural wealth"* – we are proud that we could achieve this effect!

[2] As of the time of writing we had two after-conference releases of the platform server software that fixed most of the outstanding issues.

7 Appendix

7.1 ZDM Proposal

7.1.1 Proposal for an Issue of ZDM - The International Journal on Mathematics Education

Title: Intergeo – Interoperable Interactive Geometry for Europe

(Alternative: Educational Research on Sharing of Interactive Geometry Based Content)

Editors: Ulrich Kortenkamp, PH Karlsruhe, and Colette Laborde, IMAG Grenoble

7.1.2 Description of the planned issue

The Intergeo Project is a EU co-financed project that aims to make digital content for mathematics teaching in Europe more accessible, usable and exploitable. The project is built on three main pillars: Enhancing the access to interactive-geometry-based mathematical content, enabling the exchange of content by taking down technical and legal hurdles, and assessing the educational value of content by quality testing.

Each of these pillars needs expertise from mathematics education, mathematics, and computer science. Access to existing vast amount of activities, learning paths, exercises, examples collections, etc. can only be easy if the content is properly indexed and tagged. For that, the project created an ontology of mathematical topics and skills (the GeoSkills ontology) that can be used for the classification and organization of interactive material for mathematics teaching and learning. Also, search tools and algorithms have been implemented based on this ontology, that are now available on a centralized platform at http://i2geo.net. Furthermore, curricula of several countries have been encoded, such that the Intergeo platform can be used for cross-curriculum search.

The exchange of content is only possible if teachers and others can use the material they find with their current hardware and software setup. Intergeo provides the community with a data exchange format that is being adapted by all major commercial and open-source software producers. At the same time, all resources on i2geo.net come with reuse-friendly licenses, like the Creative Commons license. Therefore, users can adapt or translate the resources they want to use in their classes to their own needs.

Finally, not all content is equally suited for each classroom situation. Among others, it depends on the experience of the teachers (and students) with ICT enhanced teaching, the declared goals of the curriculum and the technical prerequisites. Also, even if an activity is feasible for teaching, its educational value might still be debatable. Those who want to use computers in teaching depend on the experience of others, and we provide everybody with an easy-to-use but still detailed way to provide feedback about each resource. The quality assessment framework developed in the project is used for evaluating resources, and it is also a good starting point for research in ICT-supported teaching of mathematics and teacher education.

The project started in October 2007 and its funding will end in 2010. However, a declared goal was to enable the mathematics education community – teachers, researchers and learners – to take over the project and to self-sustain it. The planned issue is meant as a documentation and communication tool that will be the most important place of information about the projects' results, its continuation, and further aspects that are important to the community.

In June 2010 an Intergeo conference will take place in Budweis, Czech Republic, in conjunction with the 3rd CADGME (Computer Algebra and Dynamic Geometry Systems in Mathematics Education) conference. This conference is meant to both present the project and its results and to invite external contributions that ensure the user-orientation and thus the sustainability of Intergeo after the end of its funding period. Selected high-quality papers of the conference shall be included in the ZDM Intergeo issue.

In order to include the complete international discussion we plan to invite articles also from non-European researchers in ICT-based mathematics education. This bears the opportunity to view the project in an unbiased way and at the same time to raise the overall quality and relevance of the special issue.

7.1.3 Proposed Structure of the Issue

Due to the three-fold approach of the Project described above, we want to match this structure in the proposed issue. It shall consist of three sections: STRUCTURAL ASPECTS, TECHNOLOGY, and QUALITY ASSESSMENT. Each section will contain an introductory paper written by consortium members of Intergeo, one or two invited papers by an expert in the field, and up to two selected papers from the conference. The invited papers should aim to give an outside view of the project, including aspects that have not been covered so far, and also provide a perspective on the further development of the tools and methods that resulted from the project.

The section on STRUCTURAL ASPECTS will focus on

- Ontologies for Mathematics Education
- Formalization of Curricula
- Cross-Cultural Aspects of Mathematics Education
- Classification by Topics vs. Classification by Competencies
- Searching and Organizing Mathematical Content
- Metadata for Mathematical Resources and Activitites
- Knowledge Management in Mathematics Education

The section on TECHNOLOGY will cover

- Formal Descriptions of Constructions, Exercises and other Digital Content in Mathematics
- Data exchange in Mathematics and Mathematics Education
- Comparison of Interactive Geometry Tools
- Mathematics Education and Social Networks/Web 2.0
- Integration of Digital Content in the Classroom
- Innovative Uses of ICT in Teaching Mathematics

Finally, the QUALITY ASSESSMENT section will report on

- Quality Criteria for Interactive Mathematics Content
- Standards for Quality Assessment of Educational Content
- Best Practices and Case Studies on Using Interactive Geometry in the Classroom
- Identification of Critical Features of Electronic Content that Create Added Value
- Teacher Education and Life-Long Learning
- Educational Research based on the Quality Framework of Intergeo

7.1.4 Prospective authors and referees

The Intergeo consortium includes several experts in mathematics education, mathematics, and technology integration who can serve as authors for the introductory papers. In particular, the consortium includes:

- Caroline Bardini, Christian Mercat and others from the University of Montpellier 2
- Paul Libbrecht and others from DFKI Saarbrücken
- Colette Laborde, Jean-Marie Laborde and others from Cabrilog / Grenoble
- Peter Baptist, Alfred Wassermann and others from the University of Bayreuth
- Yves Kreis and others from the University of Luxembourg
- Tomas Recio, Francisco Botana, Jesus Escribano and others from U Cantabria / U Vigo
- Arjeh Cohen, Maxim Hendricks and others from the TU Eindhoven
- Daniel Marques and Ramon Eixarch from Maths for More, Barcelona
- Pavel Pech and Roman Hašek and others from the University of South Bohemia, and
- Ulrich Kortenkamp and others from the University of Education Karlsruhe

All consortium members can also serve as referees. The consortium is complemented by the "associate partners" of the project (full list available at http://i2geo.net/xwiki/bin/view/Main/Partner), including Markus Hohenwarter, Cyrille Desmoulins, the Sesamath association, Luc Trouche and the IUFM / INRP, Sophie Soury-Lavergne, Jana Trgalova, Jürgen Roth, Heinz Schumann, René Grothmann, Andreas Göbel, Andreas Meier, Roland Mechling, José Francisco Rodrigues, Nicolas van Labeke, Thomas Lingefjard, and Volker Ulm, just to name a few.

7.1.5 Timeline

As soon as the editors of ZDM accept this proposal, we will send out invitations to submit short abstracts for the invited papers. From these abstracts we will select the contributing authors in accordance with the ZDM editorial board.

As we intend to include selected papers from the Intergeo conference that takes place in June 2010, we expect to have the first versions of those papers in September 2010, roughly the same time when we expect the invited contributions.

Planned dates:

- Submission of Abstracts for Invited Papers until February 2010
- Selection of Invited Papers: March 2010, Notification of authors until April 2010

- Submission of selected Conference Papers and Invited Contributions until Oct. 2010
- Refereeing until end of 2010
- Final versions of Papers due March 2011.