EDITORIAL

[1]Daniel JARVIS
[2]Rushan ZIATDINOV

[1]Schulich School of Education, Nipissing University, Canada
PhD (Education Studies), Full Professor
E-mail: danj@nipissingu.ca
URL: http://faculty.nipissingu.ca/danj/index.htm
[2]Department of Computer & Instructional Technologies, Fatih University, Turkey
PhD (Mathematical Modeling), Assistant Professor
E-mail: ziatdinov@fatih.edu.tr, rushanziatdinov@gmail.com
URL: http://www.ziatdinov-lab.com/

The past decade has witnessed a period of explosive development in information technologies (IT), and the related issue of the changing nature of the teacher's role within modern educational systems has become central. Today's teachers are unable to ignore the educational potential of state-of-the-art information technologies, or the hardware and software advances, which are shifting the process of education towards the next level on all fronts. Based on existing and ongoing research into teaching and learning with technology, teachers are able to considerably increase the potential for higher educational impact of lessons, and for increased student engagement and motivation.

Following the introduction of computer science courses, there were several attempts to bring computers into the tutoring or self-study process in various disciplines. To achieve this goal, in the early stages, students were asked to use simple, in-house computer training programs, and the entire process was managed by the IT teacher. Beyond this, enthusiastic subject-based teachers would sometimes take part, using certain software programs with which they were familiar to reinforce the learning in their respective courses. But generally speaking, most attempts to fully implement computers or technology across the curriculum (i.e., system-wide, or departmental implementation) have failed. The obstacles for wider implementation have included the following: the imperfection of the software products; the organizational difficulties related to computer lab access; and the unpreparedness of teachers in facilitating technology-based lessons.

Psychologically, the process of implementing information technologies into education was made significantly less daunting by the increasing user-friendliness and overall appearance of the courseware packages and programs. Further, information technologies made it increasingly easier to access information (e.g., World Wide Web) to be used in learning opportunities, to personalize the learning, and to differentiate instruction according to student needs and strengths. Furthermore, information technologies allowed for new kinds of student interaction (internal and external to the educational institution), and new ways of encouraging active student involvement. However, due to the organizational and methodical difficulties described above, the ambitious goals regarding technology in education have by in large still not been fully realized in schools.

Today, we do however observe a significant growth in teachers' interest in the application of information technologies in education, especially in the domain of mathematics. Although there have been a number of dynamic geometry programs widely used in education throughout the past few decades (e.g., Autograph, Cabri, The Geometer's Sketchpad), one relatively new software package, GeoGebra, has seen a tremendous increase in international popularity and usage.

GeoGebra (geogebra.org) is a freely-available, open-source, dynamic mathematics software package which began as a masters' thesis project created by Austrian professor Markus Hohenwarter in 2002. After 10 years, some 35 developers and a small army of volunteer contributors and translators have made it one of the most useful and popular educational programs in the world. In 2012, GeoGebraTube was released with version 4.0 of the software as a simplified platform for applet sharing among international users. In 2012, GeoGebraWeb, an Html 5 version of the program which runs in a web browser, was released to the public. This version of the software can be used on desktop/laptop computers, tablets, or even smartphones.

Currently, developers are working on a tablet version of GeoGebra for iPad, Android, and Microsoft Windows 8. GeoGebra has been translated into more than 44 languages, used in 190 countries, and downloaded by approximately 500,000 users per month, and so it is clearly making an impact on mathematics education. The real strength of the software development lies in the strength and energy of its extended and enthusiastic international community (Hohenwarter, Jarvis, & Lavicza, 2009).

In this special issue of the *European Journal of Contemporary Education*, "**GeoGebra in the Digital Era**," we will be presenting five articles relating to the implementation of, and research surrounding, the mathematical software known as GeoGebra.

In the first article, *Teaching Materials "Surface Area of Geometric Figures," Created Using the Software Package GeoGebra,* author Slaviša Radović maintains that in order to increase student engagement and motivation, teachers must invite the use of multimedia and change their teaching and assessment practices accordingly. Radović provides the reader with an example of the power of GeoGebra in allowing students to model and explore concepts relating to **surface area**, with a particular focus on increasing interactivity between students and teachers in the learning process.

In the second article, *The First Derivative of an Exponential Function with the "White Box/Black Box" Didactical Principle and Observations with GeoGebra,* authors Natalija Budinski and Stephanie Subramaniam demonstrate how GeoGebra can be used to experiment, visualize, and connect various concepts such as **function, first derivative, slope, and tangent line**. According to Budinski and Subramaniam, GeoGebra enriches the educational process and opens up new questions and possibilities for students, as instructors embrace new didactical approaches.

In the third article, *Modeling and Visualization Process of the Curve of Pen Point by GeoGebra*, authors Muharrem Aktümen, Tuğba Horzum, and Tuba Ceylan provide a specific example of how GeoGebra can be used to model a mathematics topic, in this case the use of **parametric equations**, using both two- and three-dimensional visualization. The authors contend that determining mathematical concepts and relationships based on real-life models using these types of technology-based tasks, as well as jointly considering the algebraic and geometric representations during the process, improves the student learning and deepens mathematical understanding.

In the article, *GeoGebra Software Use within a Content and Language Integrated Learning Environment,* Helena Binterová and Marek Šulista present the results of a research study focusing on the analysis, comparison, and description of students' attitudes towards the **teaching of mathematics lessons presented in a foreign language (English)** using the Content and Language Integrated Learning (CLIL) method in three elementary schools. The authors highlight the difference between the attitudes of the CLIL method learners and those of their student counterparts who experienced similar mathematics lessons, but in their mother tongue (Czech). The research also focused on the question of whether or not, or to what degree, the implementation of the foreign language (English) along with the use of an interactive tool, such as GeoGebra software in mathematics lessons, was perceived as being meaningful and as significantly improving the effectiveness of student learning.

In the final article entitled, *Creating a YouTube-Like Collaborative Environment in Mathematics: Integrating Animated GeoGebra Constructions and Student-Generated Screencast Videos,* researchers Jill Lazarus and Geoffrey Roulet discuss the integration of student-generated GeoGebra applets and Jing screencast videos to create a YouTube-like medium for **online sharing** in mathematics. They underscore the value of combining dynamic mathematics software and screencast videos for facilitating communication and representations in a digital context, and they specifically highlight the power of GeoGebra software for student expression and creativity.

As we have seen, the first three articles describe the effectiveness of GeoGebra, and some related technology-rich pedagogical approaches, at the elementary, secondary, and tertiary levels, respectively. The final two articles report on research studies in which GeoGebra was used to enhance mathematics learning in the English language within Czech schools using the CLIL method; and, to encourage creativity and communication among students as they shared GeoGebra constructions and screencast videos within an online social media forum.

We hope you will agree that this special issue provides an interesting and informative series of perspectives on both teaching and research in relation to the software known as GeoGebra, as it continues to be adopted and further developed in the 21st century digital era.

References

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Daniel Jarvis is professor of mathematics and graduate education in the Schulich School of Education at Nipissing University, North Bay, Ontario, Canada. His background is in the areas of mathematics and visual arts, and he enjoys highlighting connections between these two disciplines. His research interests include technology (specifically that used in mathematics instruction), integrated curricula, teacher professional learning, and educational leadership.

Rushan Ziatdinov is an assistant professor in the Department of Computer & Instructional Technologies at Fatih University, Istanbul, Turkey. In the beginning of his scientific career he was holding the positions of assistant professor in the Department of Geometry & Mathematical Modeling at Tatar State University of Humanities and Education and in the Department of Special Mathematics at Tupolev Kazan National Research Technical University (Kazan University of Aviation), Kazan, Russia. Then he moved to Seoul National University, South Korea where he was a Postdoc in Computer-Aided Design and Information Technology Lab. His current research interests include geometric modeling, computer aided geometric design, educational animation, computer graphics in mathematics education, use of computer models in natural science education, instructional technologies in mathematics education, computer modeling, realistic modeling, computer-aided aesthetic design and educational ergonomics.