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# Maths teachers' adventure of ICT integration: From an open online course towards an online teacher community

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*The purpose of this paper is to introduce an ongoing Erasmus+ project “Maths Teachers’ Adventure of ICT Integration (MTAI)” and its outputs. The main aim of the project is to provide professional development for mathematics teachers to integrate Information and Communication Technologies (ICT) into their lessons. To achieve this, three intellectual outputs have been designed; an open online course (OOC), open educational resources (OER), and an online teacher community (OTC). In the scope of the OOC teachers should gain insights about ICT integration into mathematics classrooms. Through development and dissemination of OER we aim to help overcome the scarcity of resources. Through support of peer teachers and researchers at participating organizations we hope to establish an OTC including the teachers participating in the OOC. This paper focuses on the design of the three outputs.*

*Keywords: Erasmus+ project, online learning, open educational resources, online community, professional development*

## Introduction

Numerous research studies (Li, & Ma, 2010; Cheung, & Slavin, 2013) have shown that technology integration can play an effective role in tackling the challenges of teaching mathematics. In their study Hew and Brush (2007) have determined several barriers of technology integration for teachers: resources, institutional constraints, subject culture, attitudes and beliefs, knowledge and skills, and assessment. They also describe strategies to overcome these barriers such as: having a shared vision and technology integration plan; overcoming the scarcity of resources; changing attitudes and beliefs; reconsidering assessments; and conducting professional development. Bingimlas (2009) and Kopcha (2012) have also pointed out that professional development activities for teachers play an important role concerning technology integration in education and, in relation to this, several studies indicate the potential of active professional communities (Arkün, & Aşkar, 2013; Duncan-Howell, 2010; Vrasidas, & Glass, 2004).

## MTAI

The project “Maths Teachers’ Adventure of ICT Integration”<sup>1</sup> (MTAI, [www.mtaii.com](http://www.mtaii.com)) aims to help overcome the barriers of knowledge and skills in relation to ICT integration (Hew and Brush, 2007) into mathematics teaching by creating a professional development environment for teachers that

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includes several of the abovementioned strategies. To achieve this, three intellectual outputs have been designed, focusing on a different strategy each, and combined with each other, forming a professional development environment for mathematics teachers from different countries.

Addressing the need for direct professional development opportunities, an open online course (OOC) is designed as the first output of the project. The goal is to help teachers gain some insight into the potential benefits of using technology for education, particularly for learning and teaching mathematics. As part of the OOC teachers are guided towards developing interactive instructional materials and integrating them into their own classroom teaching. The second output addresses the scarcity of high quality, yet ready-to-use educational materials through the development and dissemination of open educational resources (OER). The project's third output will provide the infrastructure and expertise to establish and foster an online teacher community (OTC) that is expected to support the participating teachers beyond the duration of the project. Social, instructional, and technical support will be provided to teachers through the OTC by peers (other teachers) and researchers from the participating organizations.

In addition, the project partners will provide a series of face-to-face workshops, with different content targeting the specific needs of mathematics teachers in each of the participating countries. These events will also serve to promote and disseminate the project's outputs.

### **Output 1: Open online course**

The MTAII OOC is underpinned by three modules that address different aspects of ICT integration for teaching mathematics: (a) Module 1 – ICT use for learning and teaching, (b) Module 2 – Design and development of instructional materials with GeoGebra, (c) Module 3 – Implementation, and evaluation of ICT integration.

After a general introduction of ICT integration and its potential benefits for teaching and learning mathematics (Module 1), participating teachers will be guided through the process of analyzing, designing and developing their own instructional materials based on the interactive mathematics software GeoGebra (Module 2), before they are encouraged to implement their designed lesson in their classrooms and evaluate their experiences supported by experts and peers (Module 3).

As Hew and Brush (2007) have highlighted the necessity for teachers to be able to have easy access to technology, the GeoGebra Math Apps ([www.geogebra.org](http://www.geogebra.org)) have been selected for the project. This set of educational mathematics software applications has been developed for teaching and learning mathematics and are freely available all over the world. In addition to the apps being available in a multitude of different languages, the accompanying GeoGebra Materials platform offers additional support and features related to the creation and dissemination of interactive educational materials. The sharing of such materials with students is achieved by the use of GeoGebra Groups, a simplified Learning Management System (LMS) for mathematics educators and their students.

The Technology Integration Planning (TIP) model (Roblyer and Doering, 2014) was selected as the theoretical framework for the OOC. Organized in three phases, the TIP Model provides a practical approach to lesson planning by guiding teachers towards methods and strategies of using ICT for their teaching in an effective way. It also helps them to identify and address the potential challenges involved in this process. Thus, Module 1 of the OOC is based on Phase 1 of the TIP model, the analysis of learning and teaching needs, whilst Module 2 focuses on Phase 2, planning for integration.

Finally, Module 3 will conclude the course by implementing Phase 3, post-instruction analysis and revision, of the TIP model.

### **Module 1: ICT use for Learning and Teaching**

The main goal of Module 1 is to illustrate the purpose and benefits of using ICT for the teaching and learning process, by introducing a variety of suitable technology applications, as well as sharing best practice examples with the participating teachers, in order to demonstrate effective strategies of technology integration. In addition to providing their expertise in ICT integration, the project partner HU (Hacettepe University, Department of Computer Education and Instructional Technology, Ankara, Turkey) will also guide the participants of the OOC through phase 1 of the TIP Model (Roblyer and Doering, 2014). In the second step, teachers are led towards assessing their own technological pedagogical content knowledge necessary for teaching a self-selected topic in their own classroom, based on the Technological Pedagogical Content Knowledge (TPACK) framework suggested by Koehler and Mishra (2009).

TPACK is a model to emphasize the types of knowledge needed by a teacher for effective instructional practice in a technology based learning environment. This framework suggests that ICT integration for teaching specific content like mathematics, requires understanding of the three components Technology (T), Pedagogy (P) and Content (C), as well as of the relationships between them, resulting in seven different knowledge (K) areas: CK, PK, TK, PCK, TCK, TPK, and TPACK. According to Koehler and Mishra (2009) teachers should have technological pedagogical content knowledge in order to be able to effectively integrate ICT into teaching.

In order to support the TPACK framework, each of the project partners contributes according to their area of expertise, with HU providing TPK, JKU (Johannes Kepler University, Department of Mathematics Education, Linz, Austria) contributing PCK and AIGB (GeoGebra Institute Association of Botoşani, Romania) adding TCK. By creating an interdisciplinary OOC, the participants of the OOC should be able to form TPC Knowledge, which represents the intersection of all three knowledge areas. Roblyer and Doering (2014) suggest teachers assess the knowledge they already have and either use this knowledge or identify what they need to learn and broaden their technology-based teaching methods.

### **Module 2 – Design and Development of Instructional Materials with GeoGebra**

Following a general introduction of ICT integration into mathematics teaching and assessment of their TPC Knowledge in Module 1 of the OOC, Module 2 provides an opportunity for the participants to plan their own technology-supported lesson, deepen their technology content knowledge by learning about the basic use of the GeoGebra Math Apps, as well as create their own instructional materials and integrate them into their lesson plans. Both AIGB and JKU will combine their expertise and experience concerning the introduction of teachers to mathematics software, its use for teaching and learning, as well as the development of interactive instructional materials, while developing Module 2.

The main aims of Module 2 of the OOC are: to raise participants' awareness of pedagogical aspects of integrating ICT into their teaching (Bingimlas, 2009) by providing best practice examples for different methods of successful ICT integration into mathematics teaching; and to guide them towards planning and developing their own technology-supported lesson tailored to their own classroom

teaching. The participating teachers are first encouraged to select a mathematical topic relevant for their teaching. They are then guided through the planning process of a technology-integrated lesson by implementing the following steps: (a) deciding the objectives of the lesson and selecting effective assessment strategies to evaluate the success of the lesson; (b) analyzing and preparing their technological teaching environment and inquiring about potential technical support available during the lesson; (c) selecting appropriate instructional strategies and planning how to implement and adapt them to their students' needs; and finally (d) designing and creating appropriate instructional materials and activities that will help their students reach the objectives of the lesson.

Awareness of the different technology-related skills of the course participants, as well as of their potential previous knowledge of using the GeoGebra Math Apps, Module 2 of the OOC will also provide the opportunity to broaden the participants' technology content knowledge by learning about the basic use and features of certain GeoGebra Math Apps, as well as introducing online tools to create instructional materials on the GeoGebra Materials platform.

By providing a series of different tutorial components to introduce the GeoGebra Math Apps, participants will have the option to select the app most relevant to the mathematical topic of their lesson (e.g. geometry, function graphing, manipulation of equations). As suggested by Preiner (2008), the content and structure of the tutorial components are carefully selected, taking into account the potentially different technical abilities and diverse backgrounds of the OOC participants, as well as the difficulty level of mathematical content and the potential complexity of the introduced features of the software. Thus, the content of each tutorial component will be partitioned into a series of interactive worksheets containing one task each, that can be solved quite easily and enable participants to progress steadily through the chosen content. Being aware of the different technological abilities of the course participants, basic tasks will be optional, but will guide the participants towards gaining the skills necessary to also solve more complex, mandatory tasks of the respective tutorial component.

In order to allow for an individual learning pace and the option of selecting content relevant for each of the course participants, each tutorial component will provide automatic and immediate feedback to the user's work on the provided interactive tasks. However, expert course moderators will be available throughout Module 2, providing feedback or assisting with potential technology-related problems participants might encounter.

Furthermore, the participating teachers will learn how to create their own interactive instructional materials by using the online editors for interactive worksheets and online books provided on the GeoGebra Materials platform. Thus, they will explore the option of creating new interactive worksheets relevant for their lesson 'from scratch', as well as experience the possibility of searching the platform for suitable ready-to-use interactive online worksheets of other authors and collecting them in a so called GeoGebra Book. In this process, the participants will be able to decide themselves whether to share their developed materials with their peers or keep them private, only sharing them with the course moderators for feedback purposes. During the entire planning and lesson preparation process, course moderators and experienced GeoGebra material authors from JKU and AIGB will be available to support the participating teachers on a pedagogical and mathematical content level, as well as providing technical support, an aspect that Bingimlas (2009) identified as being a potential barrier for effective ICT integration if lacking. In addition, the course team will offer constructive

feedback about the newly developed materials and lesson plans, increasing the likeliness of a successful and effective implementation of the lesson in the teachers' classrooms.

### **Module 3 – Implementation, and Evaluation of the ICT Integration**

By the end of Module 2, the course participants are expected to have finished the planning stage of their technology-supported lesson, which should be ready to be implemented in their classrooms at the beginning of Module 3. Subsequently, Phase 3 of the TIP Model (Roblyer and Doering, 2014) will be applied in order to guide teachers through analyzing and reflecting about their lesson, as well as to help them to revise and improve their initial lesson plan. During this process, participants will be encouraged to share their lesson plans, as well as reflection about the implementation with their peers, allowing for further revisions and improvements of their instructional materials, based on the expertise of the experts and their peers.

After completion of the OOC, i.e. by the end of Module 3, each of the course participants is expected to have designed and carried out an effective technology-supported lesson, which can be shared among and reused by peer teachers, contributing to an online pool of ready-to-use interactive instructional materials that foster ICT integration into mathematics teaching.

### **Implementation of the OOC**

As the project is a transnational cooperation of the three countries Austria, Romania, and Turkey, the participating teachers are expected to be from diverse backgrounds with different native languages. Consequently, a nurturing and meaningful online environment for the participants is needed. The following guidelines for increased participation in online communities suggested by Çoban and Arkün-Kocadere (2016) have been taken into account for the implementation of the developed OOC: limiting the number of participants and forming communities from small groups; giving the opportunity to interact in their mother tongue; focusing on participants' direct needs; giving feedback; gamifying the online environment; limiting the workload of the participants; expressing the aim of community and expectations from participants explicitly.

Being aware of the local needs of teachers to support communication, feedback and development of educational materials in their native languages, as well as to encourage participation in the accompanying online discussions (Çoban, & Arkün-Kocadere, 2016), the OOC will take place in four language branches - English, German, Romanian and Turkish - as opposed to offering one course requiring all participants to use English for communication. Each of the four language branches will be supported and moderated by the project partners, as well as additional experts fluent in the respective languages. Also, limiting the number of course participants per language will allow for smaller discussion groups as well as individual feedback by moderators and peers, who will be able to directly address the needs of each of the participating teachers, keeping in mind the different educational backgrounds and teaching methods in the respective countries. Each of the four language branches of the OOC will use a different GeoGebra Group as the platform for communication and sharing of materials, providing valuable insights into the needs of different language groups, which will allow us to repeat the OOC in the future and make it available to the educational community in even more languages.

Some gamification elements will be integrated into the OOC to encourage teachers' continued involvement and active participation, as well as to attempt to minimize the drop-out rate during the

course. Gamification can be defined as using game elements in a non-game context. Literature shows that gamification has the potential to solve engagement, motivation, and especially participation problems in online courses (Çağlar & Arkün Kocadere, 2015). In their applied study, Borrás-Gene, Martínez-Núñez, Fidalgo-Blanco (2016) found that participation in online courses can be increased by developing online communities and gamification methodologies, in addition to providing support for students' learning and participation, by increasing their motivation. Being aware of the potential benefits of gamification elements for online courses, like rewards, badges, leaderboards, progress bars, and levels, the project team is currently planning a potentially gamified environment for the different Modules of the OOC, including the subdivision of each Module into levels, allowing participants to keep track of their progress in each level, as well as awarding the successful completion of each level. Furthermore, the course participants might be able to compete among each other, taking into account their current level of progress, their activity level of participating in the course, as well as their readiness to support their peers throughout the duration of the course. Finally, successful completion of each of the tutorial components in Module 2 might result in awarding a badge on the respective participant's GeoGebra Profile page, while MTAII certificates will be awarded for a successful completion of the entire OOC.

As a professional development opportunity for in-service mathematics teachers, the time-frame and duration of the OOC were planned carefully and took account of the limited time available to teachers during the school year in general, as well as the potentially different schedules of the school year in the countries of the participating teachers. Thus, the OOC will be implemented over 6 weeks with an expected workload of about 3 hours per week for the participants (M 1 - one week; M 2 - three weeks; M 3 - two weeks). Since the implementation of the developed lesson plans involves students, the participating teachers will be informed about the general expectations of the course and the required classroom teaching at the beginning of the OOC to allow for sufficient time for organizational issues related to technology-supported teaching methods.

### **Output 2: Open Educational Resources (OER)**

After the OOC, the materials developed by the participating teachers will be reviewed by the GeoGebra experts at JKU and AIGB and selected materials will then be transformed into OER, to help overcome the aforementioned scarcity of resources for ICT integration (Bingimlas, 2009; Hew, & Brush, 2007). The project partners will develop best practice examples and make lesson plan suggestions for different teaching methods that can be added to the interactive GeoGebra materials developed as part of the OOC. By translating these materials into multiple languages involved in this transnational project and publishing them on the GeoGebra Materials platform, a large community of teachers will have access to these high-quality instructional materials. In this way, teachers (and especially those who are new) to the concept of ICT integration in their everyday teaching, can benefit from the outputs of the project by getting access to a variety of ready-to-use interactive instructional materials, as well as to the experiences and expertise of teachers, who are expert ICT users for teaching and learning mathematics.

### **Output 3: Online Teacher Community (OTC)**

The third output aims to establish an online teacher community to complement the OOC and ensure sustainability of the project outcomes. Literature shows the success of online teacher communities

for professional development in general, as well as for supporting the ICT integration into teaching and learning process in particular (Arkün, & Aşkar, 2013).

The OTC will be designed and conducted with the support of the 3 project partners (JKU, HU, AIGB) who developed the OOC and will use GeoGebra Groups as the underlying platform. Again, four different OTC branches will be provided, allowing participants to communicate in their native languages, while the moderators of the OTC groups will also communicate in English across these language groups. In addition, high quality interactive instructional materials developed in either of the languages might be translated and adapted to the teaching methods of the other language OTC branches, making them available to a larger community of teachers across the different countries.

Throughout the lifespan of the project, the OTC will provide a platform for teachers to discuss their experiences with technology-supported teaching and learning, exchange their lesson plans and educational materials, and share their reflections and improvement suggestions. The participating teachers will receive support from peer teachers as well as from the experts in the partner organizations through the teacher community. The OTC is expected to have a long life cycle as it will be supported by the project partners as well as GeoGebra experts, with the goal of becoming self-sustaining community groups by the end of the project, being complementary to other efforts of ICT integration and sharing of high-quality interactive instructional materials. Furthermore, as opposed to the teacher communities on some other subjects, the project's OTC will be a math teacher community focused on ICT integration into teaching and learning, developing ready-to-use high-quality instructional materials in different languages tailored to the diverse needs of mathematics teachers and students in different countries.

## **Conclusion**

The main aim of the project described in this paper, is to combine the diverse expertise of the project partners for the design and development of a professional development environment for mathematics teachers consisting of an open online course, open educational resources and an open teacher community, and focusing on overcoming a selection of different barriers of ICT integration into teaching and learning of mathematics.

The online course is designed to support the participating teachers throughout the entire process of planning and developing materials, while also supporting them during the implementation of their technology-integrated lessons and subsequent revision of their materials. Through the development of high-quality and ready-to-use resources in different languages, many mathematics teachers will be able to benefit from the project's efforts by joining an online community of mathematics teachers willing to integrate ICT into their everyday teaching. By building a community that combines the expertise of researchers and actual classroom teachers from different countries and languages, the project aims to develop a network providing continuous support for teachers at all stages of ICT integration into the teaching and learning process, that we hope will become self-sustaining and outlast the duration of the actual project.

While the content of this paper focuses on the design and implementation of the described project, further studies will describe the accompanying research design and analyze its outcomes.

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