

## Topic Study Group 49

### Distance Learning, E-learning and Blended Learning of Mathematics

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**ABSTRACT** Topic Study Group 49 built on current and emerging research in distance learning, e-learning and blended learning. Specifically, we pushed the boundaries of what is known through a deeper examination and discussion of recent research and development in teaching and learning through these modalities, with a focus on primary, secondary, and higher education.

*Keywords:* Distance learning; E-learning; Blended learning.

#### 1. Aims of TSG-49

Our TSG-49 aimed to build on current research and highlight emerging research into how distance learning, e-learning and blended learning were enacted in the context of mathematics education. Participants were invited to contribute papers for the following sub-themes:

1. The emerging work on the usage of such mobile technologies, as cell phones and tablets, for distance learning or blended instruction.
2. Incorporation of social media in online (or blended) technologically mediated courses.
3. Flipped classroom.
4. Developing the role of the faculty/moderator/tutor in online mathematics education.
5. Exploration of the emergence and sustainability of communities of practice in online environments of collaboration and co-construction of resources.
6. Utilization (Web 2.0, Web 3.0 etc.) and designing tasks, resources or environment in e-learning, blended learning, and distance education modalities.
7. Enabling mathematical collaboration in online mathematics education and orchestrating productive mathematical conversations in an online or in a blended setting.
8. Using distance learning, e-learning and/or blended learning in mathematics

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pre-service teachers' training, professional development of in-service teachers, and/or to promote the collaboration between teacher education researchers.

9. Assessment and evaluating of the effectiveness of distance education, e-learning and blended learning.
10. Research methodologies and paradigms for studying online and blended mathematics education.

### ***1.1. Submissions***

We received 23 submissions from authors of eight countries (Australia, Austria, Brazil, Germany, Mexico, Nepal, Russia, USA). Submissions comprised six long presentations, 10 short oral presentations and 7 poster presentations. During the conference, 16 papers were scheduled, and 10 were presented across 4 sessions.

### ***1.2. Sessions***

The four sessions included both short and long oral communications. Each session was facilitated by one of our TSG's co-chairs and were well attended by members of our TSG. Discussion prompts were utilized to promote discourse focused on the implications of the study for online learning in the current COVID-19 context and for mathematics education in general. The final session included identification of emerging research themes and identification of opportunities for future research.

## **2. TSG-49 Themes**

The 10 papers presented during the congress were grouped into 3 themes:

- Flipped classroom and hybrid environments
- Mobile devices, task design and other resources
- E-learning and online professional development: Courses, reflections, and interactions

The papers for each theme are listed in Tab. 1 (on the next page).

### ***2.1. Flipped classroom and hybrid environments***

The first two papers focused on flipped classroom and hybrid environments. While the flipped classroom approach may seem easily adaptable to cater for online learning as a result of the COVID-19 pandemic, restrictions meant that there was no opportunity to implement the in-class phase of flipped learning. Rothe's study<sup>[1]</sup> investigated the importance of the in-class time in a flipped classroom, with results suggesting that students experienced difficulties in achieving higher-order learning goals in the changed scenario. Hoyos et al.<sup>[2]</sup> presented a paper which described the framework, methodology, analysis, and results of an exploratory study around the implementation of a hybrid learning environment designed to address the teaching and learning of

Tab. 1. The list of papers for each theme

<b>Paper and author(s)</b>
<b><i>Flipped classroom and hybrid environments</i></b>
[1] Fostering higher order thinking in the flipped classroom — an analysis of students' proof schemes. <b>Jennifer Rothe</b> (Germany).
[2] Hybrid environments of learning: teacher efficiency and potential for student learning by collaboration. <b>Veronica Hoyos, Estela Navarro, Victor Raggi, and Sergio López</b> (Mexico).
<b><i>Mobile devices, task design and other resources</i></b>
[3] Designing tasks to improve plane transformation using DGE with touchscreen. <b>Alexandre Assis and Marcelo A. Bairral</b> (Brazil).
[4] Using free software to implement verification problems with parameters. <b>Ilya Alexandrovich Posov and Dmitry Irikovich Mantserov</b> (Russia).
[5] Workshop activity in online courses of mathematics education: insights for learning and assessment. <b>Niroj Dahal</b> (Nepal).
<b><i>E-learning and online professional development: courses, reflections, and interactions</i></b>
[6] A reflective practice on an online mathematics class. <b>Haoyi Wang</b> (USA).
[7] Case study on the change process of a mathematics teacher in an online professional development course. <b>Stefanie Schallert and Robert Weinhandl</b> (Austria).
[8] Participants' patterns of interaction within and across social networks in a massive open online course for educators. <b>Heather Barker, Gemma F. Mojica, Karen Hollebrands, and James Smiling</b> (USA).
[9] The role of the lecturer in facilitating productive mathematical conversations in online mathematics pre-service teacher education. <b>Tracey Muir</b> (Australia).
[10] Transforming numeracy professional development for pre- and in-service mathematics teachers and families through e-learning. <b>Leicha A. Bragg, Chris Walsh, and Tracey Muir</b> (Australia).

functions. The hybrid environment led to improvements in teacher practice, and refinement or validation of students' conceptions.

## **2.2. Mobile devices, task design and other resources**

The next three papers focused on mobile devices, task design and other resources. Assis's and Bairral's research<sup>[3]</sup> illustrated designed tasks on GeoGebra with touchscreen and reflected about the design of them to improve plane transformation in High School with students without previous instruction in this content. Posov and Mantserov's paper<sup>[4]</sup>, based on computer-aided assessments, rewrote a condition on a function with a logical expression on its parameters, and then proposed ways to implement it using GeoGebra and Sage. And, Noroj's study<sup>[5]</sup> identified best ways to engage students in the process of learning and peer assessment by using workshop as a learning and assessment tool for MPhil in Mathematics Education for the course Graph and Network.

## **2.3. E-learning and online professional development: courses, reflections, and interactions**

The other five papers focused on e-learning and online professional development (courses, reflections, and interactions). Wang's paper<sup>[6]</sup> reported on a reflective

practice that examines both qualitative and quantitative datasets in understanding the implemented multimedia distance learning environment at an entry-level math classroom at a large state university in the Midwest and its resulting consequences on the math learning and assessment performance of the students. Schallert and Weinhandl's paper<sup>[7]</sup> presented a case study approach to examine the different elements of a change process of a secondary teacher within an online course for mathematics teacher training. Barker et al.<sup>[8]</sup>, based on social network and sentiment analyses, examined the discussion forum posts of 159 educators from 46 countries who participated in a Teaching Mathematics with Technology MOOCs for Educators. Muir's study<sup>[9]</sup> provides an example of an online forum, which highlights how pre-service teachers can be engaged in productive online mathematical discussions, particularly when facilitated by the instructor's and other learners' presence. Bragg et al.<sup>[10]</sup> presented a multipronged approach to transform the provision of numeracy professional development for educators and families through the design of three open-access resources.

### **3. Areas for Future Research**

In our final presentation session, the participants discussed potential future research topics and publication possibilities. Participants in TSG-49 topics' discussion concurred that further research into the nature, purpose, and significance of online, blended, and e-learning in mathematics education was needed, especially in the context of the deep socio-cultural changes brought about globally by the COVID-19 pandemic.

Finally, methodologies to gather data and to analyze online interaction (among students or teachers) using asynchronous or synchronous tools continue to be a field of interest, as well as investigating more on what ways the affordances and limitations of online tools and apps are influencing the task design and/or math's teaching and learning.