INTRODUCTION TO THE PROCEEDINGS OF ICTMT 15

Raimundo Elicer[1], Uffe Thomas Jankvist[1], Alison Clark-Wilson[2], Hans-Georg Weigand[3] and Marianne Thomsen[1,4]

[1]*Aarhus University, Danish School of Education; raimundo@edu.au.dk, utj@edu.au.dk*

[2]*University College London; a.clark-wilson@ucl.ac.uk*

[3]*Julius-Maximilians-Universität of Würzburg; weigand@mathematik.uni-wuerzburg.de*

[4]*University College Copenhagen; mart@kp.dk*

FACTS AND FIGURES

The Fifteenth International Conference on Technology in Mathematics Teaching (ICTMT 15) took place on September 13–16, 2022, in the Danish School of Education, Aarhus University, located on campus Emdrup, in the Northwestern district of Copenhagen, Denmark. There were a total of 66 participants from 15 different countries.

The scientific programme consisted of plenary lectures, paper sessions, a poster session and hands-on workshops. The four plenary lectures related to each of the four themes of the conference. Thirty-one papers were presented and discussed throughout the week. The poster session included eight contributions. Furthermore, participants had the chance to join one or two of the 11 workshop activities.

The conference also included a rich social programme in the city of Copenhagen. On Monday, 13 September, the poster session was accompanied by a wine reception sponsored by Maplesoft. On Tuesday, 14 September afternoon, participants went for a walk-and-talk near campus, leading to a visit to Grundtvig's Church. The conference excursion was a bus and ferry tour combo throughout the streets and canals of Copenhagen on Wednesday, 15 September. The trip's last stop was Christianshavn, within walking distance of the conference dinner venue, namely the restaurant Spiseloppen, located in the free town Christiania.

CONNECTIONS AND CONNECTIVITY

ICTMT 15 certainly focused on the impacts that the coronavirus pandemic has had on global mathematics education. However, it looked at the impacts of digital technology from a much wider perspective. In particular, the conference aimed to highlight how technology facilitates the multiple "Connections and Connectivity" between us all to achieve the goals of purposeful mathematics education in the early 21st century.

By "Connections" we mean the interrelationships between researchers, teachers, students, parents, policymakers, and industry (big and small). "Connectivity" includes oral, aural, textual and gestural communications as mediated by the internet, learning environments and classroom activities. Together, "Connections and Connectivity" describes the relationships between people, between different ideas and strategies to teach, and between people and environments. It offers a frame through which to interpret assessment in mathematics education as a more formative process from the point of view of both teachers and students.

Within the overarching frame of "Connections and Connectivity", the conference concerned four themes that give structure to these proceedings and which we describe in the following paragraphs.

Designing technology

The first theme addressed the design of technology for mathematical learning and its assessment—a focus on theoretical or actual 'designs' with contributions from researchers, industry and teachers.

Chronis Kynigos gave his plenary lecture situating concrete digital tool designs within strong theoretical underpinnings of post-normal science. He challenges the role of mathematics and mathematics education in a world surrounded by wicked problems. As a response, his talk focuses on "Choices with consequences" (ChoiCo), a digital tool where students have the chance to grapple with mathematical aspects inside socio-scientific games.

Some contributions to this theme reported students' experiences as part of the design of digital learning environments for engaging with mathematical ideas. Some examples are: the case of an algebraic modelling web tool for relational thinking (Oldenburg), a computer-based learning environment for mathematical modelling (Frenken), metaphor-based animations for algebra (Bos & Renkema) outdoors and home versions of an applet for math trails (Jablonski et al.; Larmann et al.), an applet for preformal proving (Platz), and error-inducing interactive videos (Schirmer et al.). Some had a particular focus on feedback, by making sense of it in a multimodal algebra learning system (Reid et al.) and producing it semi-automatically for handwritten tasks (Moons & Vandervieren).

Others focused on designs of mathematical tasks making use of digital tools. These included tasks using GeoGebra's algebra view (Gregersen), silent video tasks (Kristinsdóttir et al.), tasks for integrating programming and computational thinking (Elicer & Tamborg), and creative tasks with digital-media (Diamantidis & Kynigos).

Making sense of 'classroom' practice

The second theme aimed at making sense of 'classroom' practices with and through technology—a focus on the work of teachers and lecturers, where the classroom might be geographically located or mobile. Again, contributions could be both theoretical and practical.

In her plenary lecture, Anna Baccaglini-Frank set the scene in the distance-teaching context in Italy resulting from the Covid-19 pandemic. She re-examined Ruthven's (2012) claim that technologies "are not strongly framed in didactic terms (…); nevertheless, in practice, they are often appropriated to a reproductive didactic" (p. 629). In that sense, she challenged the theme by advocating for a shift from teaching mathematics *with* technology to teaching mathematics *through* technology.

In this theme, most contributions focused on the role of digital technologies for different purposes of students' development, including the mathematical thinking competency (Thomsen & Jankvist; Pedersen), the notion of STEAM (Ferrara et al.) and Allgemeinbildung (Johansen).

Some authors looked at how technologies can prompt issues of classroom practice, such the effect of digital textbooks in the gender gap (Brnic & Greefrath), graphing calculators in connecting geometry and functions (Subtil et al.) and computer algebra systems in conjecturing and proving theorems (Szücs).

Another group of contributions focused on mathematics teachers' interactions with new technologies. Two studies took a professional development perspective concerning the inclusion of computational thinking (Nøhr et al.) and pre-service teachers' experiences at an online school (Tunç-Pekkan et al.). Another two studies zoomed into the orchestrating role of teachers mediated by a videogame (Vilchez & Lemmo) and a distance learning context (Faggiano & Mennuni).

Fostering mathematical collaborations

The third theme was concerned with the fostering of mathematical collaborations with and through technology—a focus on the communications aspect of technology, including assessment strategies.

Shai Olsher positioned his plenary talk as a concrete application of topic-specific learning analytics to foster collaborations between students *through* technology. By focusing on geometrical example-eliciting tasks, his research group defined automatic assessment-based recommendations for grouping students with different pedagogical purposes. His study displays content-informed group categories and implications for teaching.

Some contributions focused on connectivity issues, such as a platform for online teacher education (Tunç-Pekkan et al.), modularised mathematics courses for engineering (Kiliç et al.) and heuristic worked example videos in a collaborative setting (Wirth & Greefrath). Other contributions were centred on particular mathematical communicative aspects mediated by digital tools, including handwriting in tablet-computers with smartpens (Schüler-Meyer), and digital geometry environments (Bach & Bikner-Ahsbahs).

Innovating with technologies

The fourth theme dove into innovating with technologies for mathematical learning—a focus on highly innovative approaches in the early stages of development for constructive critique by the community.

As a sharp example of such innovations was given by Dan Meyer in his plenary presentation entitled "Pixels are pedagogy". Joining us virtually from California, he introduced the platform Desmos as a way of questioning two common beliefs; namely, that mathematics is a purely objective discipline and that technology is a morally neutral actor. The speaker described the pedagogical decisions that underpinned the design of the platform by enabling the audience to experience it first-hand.

Some contributions to this theme focused on digital learning environments for mathematical modelling (Frenken & Greefrath), linear functions (Barana) and deductive geometry (Ballin & Kouropatov). Others discussed how state-of-the-art technologies and constructs intertwine with mathematics teaching and learning, here among mobile devices (Ludwig et al.), virtual and mixed reality (Dilling & Sommer), data science (Podworny & Fleischer), machine learning (Fleischer & Podworny), computer-aided assessment (Fahlgren et al.; Klingbeil et al.), and programming and computational thinking (Tamborg et al.).

THE ICTMT SERIES

This biennial conference began in Birmingham, UK, in 1993, under the influential enterprise of Bert Waits from Ohio State University. The previous instance was held in Essen, Germany, in 2019. ICTMT 16 is set out to be organised and take place at the National and Kapodistrian University of Athens, Greece.

REFERENCES

Ruthven, K. (2012). The didactical tetrahedron as a heuristic for analysing the incorporation of digital technologies into classroom practice in support of investigative approaches to teaching mathematics. *ZDM Mathematics Education*, *44*(5), 627–640. https://doi.org/10.1007/s11858-011-0376-8