

BRAZIL

DELTA '17

BOOK OF
ABSTRACTS

11th Southern Hemisphere Conference
on the Teaching and Learning of
Undergraduate Mathematics and Statistics

26 Nov/01 Dec 2017 | Gramado, Brazil

PROMOTERS



FINANCIAL SUPPORT



GENERAL INFORMATION

The Venue

The venue for the conference is the Event Center of FAURGS, in Gramado.

Address

R. São Pedro 663 – Centro – Gramado/RS
CEP 95670-000

Registration Desk

For general enquiries and assistance, please visit the Registration Desk, situated on the entrance hall.

Disclaimer

Whilst we have endeavored to ensure all information is accurate, the organizers reserve the right to change any aspect of the program without prior notice.

Name Badges

Please ensure that you wear your conference name badge at all times during the conference sessions and social functions.

Internet Access

There is free Wi-Fi access at the Event Center. The wireless network is **BrazilDelta** and the password is **brazildelta17**

Social Program

Welcome Reception

Sunday 26 November, in the Boulevard Cafeteria, 20:00. Dress code is "casual".

Conference Excursions

Wednesday 29 November is free for sightseeing. More information can be found at <http://bit.ly/2x9LsHE>. Please note that there is no tour included in the registration fee.

Conference Dinner

The conference dinner will be a traditional south Brazilian barbecue on Thursday 30 November. The venue is Churrascaria Garfo e Bombacha. Dress code is "casual".

WELCOME

Welcome to Brazil Delta, the Eleventh Southern Hemisphere Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics. This is the first time Brazil hosts the Delta conference, and we are pleased to welcome you to Gramado, a "German" town in Southern Brazil. Brazil Delta has delegates and guests from ten countries!

We hope that this event can foster diverse debates on current issues of mathematics education within the higher education sector, and also that useful new networking and collaborations can be developed. In order to achieve these we will have provoking keynote and invited speakers, and a magnificent venue to "Think Diversity", our theme conference. The publications for this conference include the special Public Access supplement 'Brazil Delta 2017 Conference Special Issue' of the International Journal of Mathematical Education in Science and Technology, the Proceedings, the Communications and the Programme. The iJMEST issue and the Proceedings were double blind peer reviewed by at least two reviewers per paper.

We have worked hard to be able to host this conference in Brazil. Given the current political situation and the cuts in funding that Science and Education have suffered in recent years, it is only with much persistence and dedication that it was possible to organize this conference in Brazil.

We wish you an enjoyable and memorable stay in Gramado!

In pursuit of excellence in teaching and learning,

Maria Madalena Dullius, *on behalf of the organizing committee*

Local organizing committee

Maria Madalena Dullius (UNIVATES) – chair

Italo Gabriel Neide (UNIVATES)

Marli Teresinha Quartieri (UNIVATES)

Marcelo de Carvalho Borba (UNESP)

Amanda Gabriele Rauber (UNIVATES)

Suzana Helena Stratti Bonzanini (UNIVATES)

Scientific Committee

Marcelo de Carvalho Borba (UNESP) – Chair

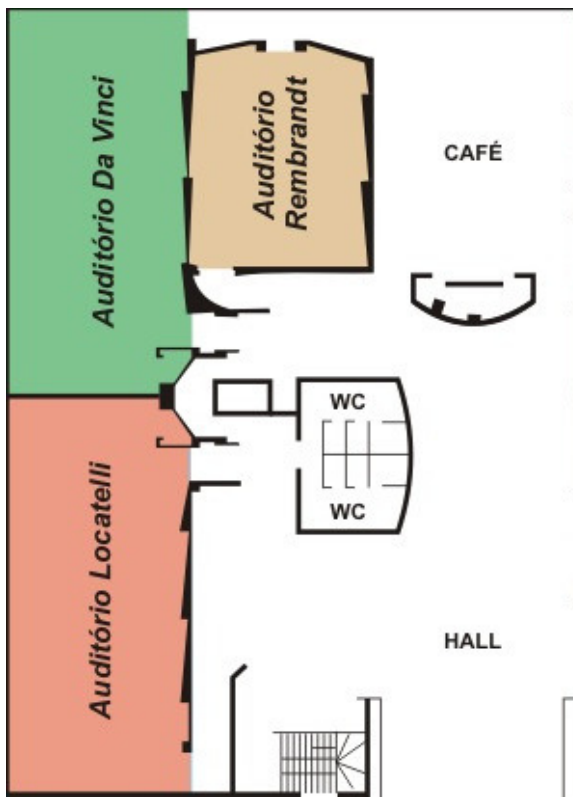
Italo Gabriel Neide (UNIVATES)

Greg Oates (UTAS)

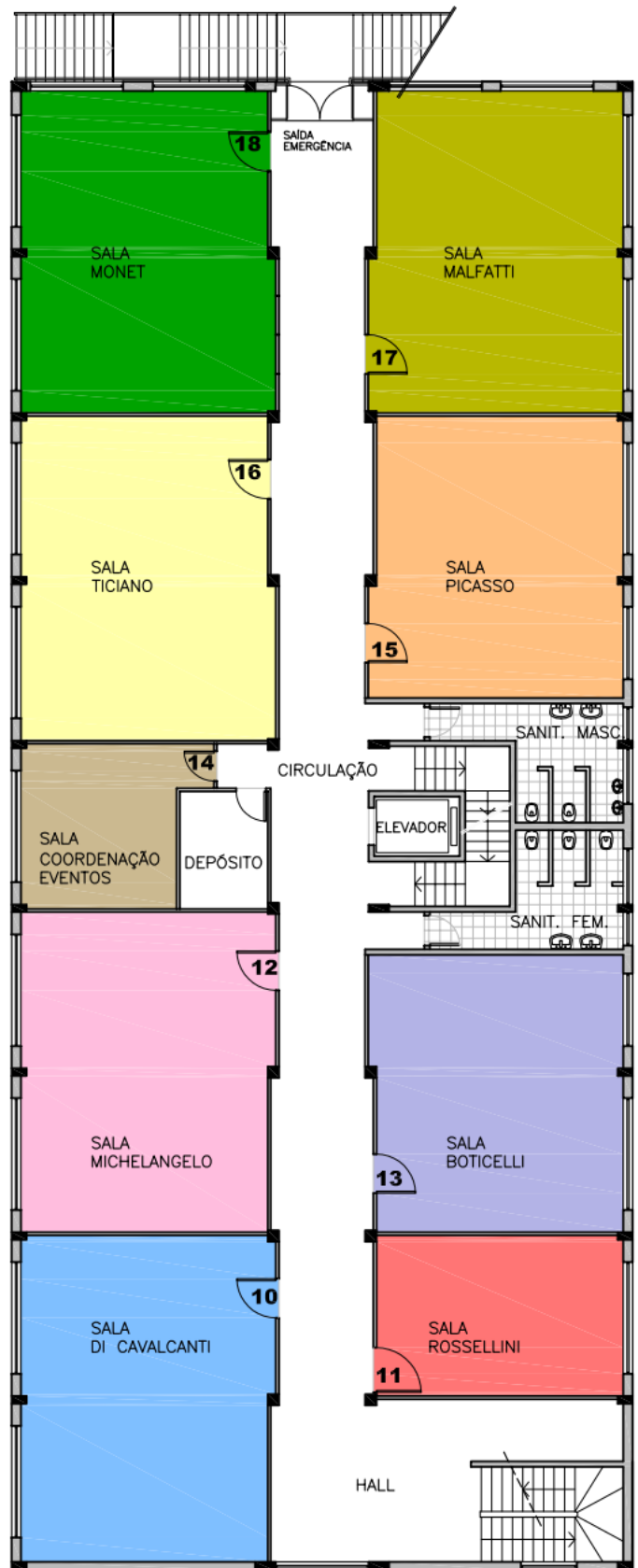
Victor Martinez Luaces (UDELAR)

João Frederico Meyer (UNICAMP)

VENUE MAP



First Floor



Second Floor

PROGRAM

SUNDAY – 26 NOVEMBER

TIMETABLE	ACTIVITY	PLACE
18:00	Participants registration	Entrance Hall
20:00	Cultural Presentation – Welcome Cerimony	Boulevard Cafeteria

MONDAY – 27 NOVEMBER

TIMETABLE	ACTIVITY	PLACE
08:30	Participants registration	Entrance Hall
09:30	Opening Session	Auditorium Rembrandt
10:00	Coffee Break	Hall Foyer
10:30	Plenary Session – Modelling in education! Modelling and statistics in Research <i>João Frederico Meyer – UNICAMP</i> <i>Marcelo de Carvalho Borba - UNESP</i>	Auditorium Rembrandt
12:00	Lunch	Serra Grill Restaurant
14:00	Multiple Stream Session 1	Meeting rooms
15:30	Coffee Break	Hall Foyer
16:00	Multiple Stream Session 2	Meeting rooms
17:30	Invitation to: International Journal of Research in Undergraduate Mathematics – Springer. <i>Chris Rasmussen</i>	
17:45	Happy hour	

TUESDAY – 28 NOVEMBER

TIMETABLE	ACTIVITY	PLACE
09:00	Plenary Session- Recent Developments in Post-Calculus Mathematics Education Research <i>Chris Rasmussen – San Diego State University</i>	Auditorium Rembrandt
10:30	Coffee Break	Hall Foyer
11:00	Posters	Hall Foyer
12:00	Lunch	Serra Grill Restaurant
14:00	Multiple Stream Session 3	Meeting rooms
15:30	Coffee Break	Hall Foyer
16:00	Multiple Stream Session 4	Meeting rooms
17:00	Screening sponsored by the "Judy Paterson Memorial Fund" Movie: Navajo Math Circles film	Auditorium Rembrandt
18:00	Refreshments sponsored by the "Judy Paterson Memorial Fund"	

WEDNESDAY – 29 NOVEMBER

Free day for sightseeing

THURSDAY – 30 NOVEMBER

TIMETABLE	ACTIVITY	PLACE
08:30	Multiple Stream Session 5	Meeting rooms
10:00	Coffee Break	Hall Foyer
10:30	Multiple Stream Session 6	Meeting rooms
12:00	Lunch	Serra Gril Restaurant
14:00	<p>Plenary session - Technology in Mathematics Education: Back to the Future?</p> <p><i>Greg Oates - School of Education, University of Tasmania, Australia</i></p> <p><i>The Judy Paterson Speaker</i></p>	Auditorium Rembrandt
15:30	Coffee Break	Hall Foyer
16:00	<p>Plenary Session – Facing the challenges of mathematical modelling for pre-service teacher education</p> <p><i>Mónica E. Villarreal - University of Córdoba – National Scientific and Technical Research Council</i></p>	Auditorium Rembrandt

FRIDAY – 01 DECEMBER

TIMETABLE	ACTIVITY	PLACE
09:00	<p>Plenary Session - Social Media Mathematics</p> <p><i>Ansie Harding – University of Pretoria</i></p>	Auditorium Rembrandt
10:30	Delta '19 presentation	Auditorium Rembrandt
11:00	Closure session	Auditorium Rembrandt
11:30	Coffee Break	Hall Foyer

Abbreviations:

[FP] – Full paper

[A] – Abstract

[iJMEST] – Paper published in the International Journal of Mathematical Education in Science and Technology

MULTIPLE STREAM SESSION 1 - MONDAY			
TIMETABLE	ROOM MALFATTI: Teaching and learning practices	ROOM TICIANO: Teaching and learning practices	ROOM MONET: Innovations
14:00	The investigative teaching practice motivating the student's autonomous learning process [FP] <i>Aline Silva de Bona</i> <i>Marcus Vinicius de Azevedo Basso</i>	Conceptions of function in a first Calculus course: an APOS theory based study [FP] <i>Luisa Rodriguez Doering</i> <i>Vanessa de Azeredo Abreu</i> <i>Elisabete Zardo Búrigo</i>	SOWISO, a new integrated learning environment for undergraduate mathematics [A] <i>Marc Habbema</i>
14:30	Inquiry as an Entry Point to Equity in the Classroom [iJMEST] <i>Gail Tang</i> <i>Houssein El Turkey</i> <i>Emily Cilli-Turner</i> <i>Milos Savic</i> <i>Gulden Karakok</i> <i>David Plaxco</i>	Promoting Metacognition as a Habit of Mind in Undergraduate Classroom Communities [A] <i>Emilie Hancock</i>	A novel approach to mathematics examination design and Marking [FO] <i>David Easdown</i> <i>Ruth Corran</i> <i>Brad Roberts</i>
15:00	Nurturing mathematical creativity and curiosity in Foundation Mathematics students [A] <i>Rachel Passmore</i>	Just take a breath: bringing mindfulness into large classrooms [A] <i>Claire Blackman</i>	The need for new attitudes in the teaching – and the learning – of a relevant Linear Algebra in undergraduate levels [FP] <i>Clarice Favareto Salvador</i>

MULTIPLE STREAM SESSION 2 - MONDAY

TIMETABLE	ROOM MALFATTI: Technology	ROOM TICIANO: Technology	ROOM MONET: Technology
16:00	<p>Knowledge amplifiers and cognitive reorganizers, two realities present in the use of technological tools in the mathematical classes in the city of rio Gallegos [FP]</p> <p><i>Dora Silvia Maglione</i> <i>Fabiana Saldivia</i></p>	<p>The exploitation of videos in teacher training [A]</p> <p><i>Márcia Jussara Hepp Rehfeldt</i> <i>Ieda Maria Gingo</i> <i>Marli Teresinha Quartieri</i></p>	<p>Contributions of the Mathematical Modeling to the development of Statistical Literacy of students from a graduate technology course [A]</p> <p><i>Andréa Pavan Perin</i> <i>Maria Lúcia Lorenzetti Wodewotzki</i></p>
16:30	<p>Students' dialogues in the study of Definite Integral based on the analysis of a physical model with technology [FP]</p> <p><i>Débora da Silva Soares</i> <i>Guilherme Vier</i></p>	<p>Smart Physics: Teaching physics with smart-carts and smart-phones [A]</p> <p><i>Jeff Nijssse</i></p>	<p>Student Experience informs a supportive-environment framework for inline assessment in Moodle [A]</p> <p><i>Pragashni Padayachee</i> <i>Shirley Wagner-Welsh</i> <i>Hermien Johannes</i></p>
17:00	<p>The Effect of Using Simulations on Students' Learning of Inferential Statistics in an Elementary Statistics Class in the Mathematical Sciences Department of the University of Wisconsin-Milwaukee [FP]</p> <p><i>Kevin McLeod</i> <i>Alexa Schut</i></p>	<p>The impact of mathematics software remediation in mathematics for engineering students at a university in the Eastern Cape Province of South Africa [A]</p> <p><i>Lynette Bester</i> <i>T. Mandindi</i></p>	<p>I Festival of Digital Videos and Mathematics Education [A]</p> <p><i>Hannah Dora de Garcia e Lacerda</i> <i>Marcelo de Carvalho Borba</i></p>

MULTIPLE STREAM SESSION 3 - TUESDAY

TIMETABLE	ROOM MALFATTI: Technology	ROOM TICIANO: Math educators	ROOM MONET: Technology
14:00	The geogebra software as atool in the teaching of trigonometrical functions [A] <i>Romildo Pereira da Cruz</i> <i>Marli Teresinha Quartieri</i> <i>Italo Gabriel Neide</i> <i>Maria Madalena Dullius</i> <i>Amanda Gabriele Rauber</i>	Perspectives in Teaching Statistics in a Pedagogy Course in DE [A] <i>Auriluci de Carvalho Figueiredo</i> <i>Michel da Costa</i>	Multiple representations in the study of analytic geometry: production of videos in the distance learning mathematics [A] <i>Liliane Xavier Neves</i> <i>Marcelo de Carvalho Borba</i>
14:30	How the Internet act on the mathematical modeling online [A] <i>Jeannette Galleguillos</i> <i>Marcelo de Carvalho Borba</i>	Designing a short course for graduate teaching assistants (GTAs) in mathematics: principles and practice [FP] <i>Cosette Crisan</i> <i>Melissa Rodd</i>	A Web Application to Support the Continuing Learning of Elementary Mathematics [A] <i>Héctor Fernando Gómez</i> <i>Ramón Ronzón</i>
15:00	Using virtual and physical learning spaces to develop a successful mathematical learning community, both for on-site and distance provision [A] <i>Belinda Huntley</i> <i>Dr Jeff Waldock</i> <i>Andrew Middleton</i>	Humans-with-media: the case of teachers'-in-formation-with-paper-folding collective [A] <i>Zaida Margot Santa Ramirez</i> <i>Carlos Mario Jaramillo López</i>	#FeesMustFall: Changing the landscape of e-Assessment [A] <i>Hermien Johannes</i> <i>Simon Goldstone</i> <i>Shaun Meyer KoshalaTerblanche</i> <i>Simon Goldstone</i>

MULTIPLE STREAM SESSION 4 - TUESDAY

TIMETABLE	ROOM MALFATTI: Miscelaneous	ROOM TICIANO: Teaching and learning practices
16:00	<p>A cross-border STEM class on the theme of Energy to enhance the statistics education at the level of 6th grade of basic school curriculum of mathematics [A]</p> <p><i>Yuriko Yamamoto Baldin</i></p> <p><i>Masami Isoda</i></p> <p><i>Raimundo Olfos</i></p> <p><i>Soledad Estrella</i></p>	<p>Student Enrichment in Mathematics: A Case Study with First Year University Students [iJMEST]</p> <p><i>Harry Wiggins</i></p> <p><i>Ansie Harding</i></p> <p><i>Johann Engelbrecht</i></p>
16:30	<p>Math Circles for all Ages: From Navajo Math to the Research University [FP]</p> <p><i>Matthias Kowski</i></p>	<p>Creating a Confident Competent Questioning Culture [A]</p> <p><i>Anne D'Arcy-Warmington</i></p> <p><i>Heather Lonsdale</i></p>

MULTIPLE STREAM SESSION 5 - THURSDAY

TIMETABLE	ROOM MALFATTI: Teaching and learning practices	ROOM TICIANO: Teaching and learning practices
08:30	An Inquiry-Oriented Approach to a Guided Reinvention of Eigen theory [A] <i>Megan Wawro</i> <i>Michelle Zandieh</i> <i>David Plaxco</i>	Investigating Students' Perceptions of Graduate Learning Outcomes in Mathematics [JMEST] <i>Deborah King</i> <i>Cristina Varsavsky</i> <i>Shaun Belward</i> <i>Kelly Matthews</i>
09:00	Mathematical failure(s) of bridging students and the impact(s) on their progress and affect [A] <i>Phil Kane</i>	Helping students overcome failure by developing 'growth mindsets' [A] <i>Anita Campbell</i>
09:30	Challenging assumptions of notational transparency: the case of vectors in engineering mathematics [JMEST] <i>Tracy S. Craig</i>	Understanding of Limits and Differentiation as Threshold Concepts in a First-Year Mathematics Course [FP] <i>Greg Oates</i> <i>Robyn Reaburn</i> <i>Michael Brideson</i> <i>Kumudini Dharmasada</i>

MULTIPLE STREAM SESSION 6 - THURSDAY

TIMETABLE	ROOM MALFATTI: Modelling	ROOM TICIANO: Miscelaneous	ROOM MONET: Miscelaneous
10:30	Analysis of undergraduates' works on an inverse modelling problem within the frame of mathematical working spaces [FP] <i>Victor Martinez-Luaces</i>	Evaluating the effectiveness of clickers to optimize performance in a Statistics 100 course [A] <i>Fransonet Reyneke</i> <i>Lizelle Fletcher</i> <i>Ansie Harding</i>	A tale of two journeys [A] <i>Barbara Miller-Reilly</i> <i>Charles O'Brien</i>
11:00	Approximations of e and pi: an exploration [iJMEST] <i>Philip Brown</i>	Attendance: The mismatch between academics and students. Who is right? [A] <i>R. Nazim Khan</i>	Accommodation in the formal world of mathematical thinking [iJMEST] <i>Sepdeh Stewart</i>
11:30	Predicting Second Year Mathematics Success using Statistical Models [A] <i>Lizelle Fletcher</i>	Engaging Distance Students [A] <i>Cami Sawyer</i>	First Year Engineering Mathematics: What's the Optimal Blend? [FP] <i>Diana Quinn</i> <i>Bronwyn Hajek</i> <i>Jorge Aarão</i>

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PLENARY SESSIONS

Modelling in education! Modelling and statistics in Research

João Frederico Meyer – UNICAMP

Marcelo de Carvalho Borba - UNESP

Research on Modelling and mathematics education began more than two decades ago. In 2017 we had our tenth Conference on this subject (X CNMEM), which takes place biannually. In our interactive round table, Marcelo Borba will describe part of this history and some of the main discussions on such conferences. In particular, it will discuss how Modelling interacts with other trends in Mathematics Education such as Ethnomathematics and the use of Digital Technology. But historically, Modelling in Brazil is also a result of the work of some applied mathematicians, who dedicated part of their time to Mathematics Education. These professional mathematicians kept on being mathematicians but maintained their interest (and participation!) in Maths Education. In order to celebrate such interaction, the second part of our interactive round table will have João Meyer (known as "Joni") illustrating mathematical as well as statistical tools and their uses that have been recently developed in Applied Mathematics that involved Statistics as well as many other areas using examples. The purpose of this is to argue for mathematical syllabuses that include the mathematical treatment of real-life problems, remembering that not all of our undergraduate students will be theoretical mathematicians. He intends to justify this use, as well as his personal experience, the present challenges to society and science for which mathematical knowledge is essential, with some examples and viable solutions, using new mathematical concepts, technology-based approximations, and a criticism of any result both from a mathematical point of view as well as from a social viewpoint. Finally, in this talk, we will try to campaign for new mathematical subject themes more suited for our world in lieu of mathematics from previous centuries - really previous! And an operational emphasis on the use of mathematics coupled with a critical use of reasoning, abstraction and obtaining results.



Marcelo C. Borba is a Professor of the Graduate Program in Mathematics Education and of the Mathematics Department of UNESP (State University of São Paulo) in Brazil, where he chairs the research group GPIMEM. Marcelo researches the use of digital technology in mathematics education, online distance education, modeling as a pedagogical approach and qualitative research methodology. He is a member of the editorial board for *Educational Studies in Mathematics* and an Associate Editor of *ZDM*. Marcelo has delivered invited presentations internationally in 14 countries all over the world. He is the current vice-chair in the Teaching Committee of the main funding agency in Brazil. He has also been a member of the program committee for several international conferences. Marcelo has published several books, book chapters and refereed papers in Portuguese and in English. He is the editor of a collection of books in Brazil which have been published over the last twelve years and include 26 books to date.



João Frederico C. A. Meyer (a.k.a. "Joni") has been teaching at Campinas State University (UNICAMP) since 1971. He majored in Mathematics and has worked in Applied Mathematics ever since completing his graduate studies, working mainly in Mathematical Ecology and Numerical Analysis at UNICAMP. Besides papers, chapters in books and two complete books, he has tutored over 50 Master's dissertations and Doctorate thesis in 3 different countries and several universities. He has been on the directing board of the Brazilian Society for Computer and Applied Mathematics as well as on its Scientific Committee. He was a co-founder of this society as well as the Brazilian Society for Mathematics Education in which he coordinated the Math Modelling Work Group. He is on the editorial board of several scientific journals and is an ad-hoc reviewer for other journals. He has a great interest in Mathematical Education with which he has been involved ever since the seventies (of the last century...).

Recent Developments in Post-Calculus Mathematics Education Research

Chris Rasmussen – San Diego State University

In this talk Chris Rasmussen will present a review of recent developments in post-calculus mathematics education research. In the past 10 years the field has witnessed considerable growth, with more and more research moving away from identifying student difficulties to studies of learning and teaching processes and productive ways that instruction moves forward student thinking. He argues that much of this work can be seen as falling in what Stokes refers to as “Pasteur’s quadrant,” which refers to basic research that seeks to extend the frontiers of understanding but is also inspired by considerations of use. He also highlights the emerging body of work that is examining lecture-oriented instruction, inquiry-oriented instruction, and professional development for undergraduate instructors. He concludes with a look ahead at the intersection of undergraduate mathematics education research and other discipline based educational research (e.g., Chemistry, Physics, Biology, Engineering), with an eye toward what we can learn from other disciplines and ways in which we need to better coordinate with them.



Chris Rasmussen, Ph D., is Professor of mathematics education and Associate Chair in the department of mathematics and statistics at San Diego State University. He received his B.A., M.A. and Ph.D. from the University of Maryland in Mechanical Engineering, Mathematics, and Mathematics Education, respectively. After receiving his undergraduate degree he served as a Peace Corps Volunteer in Sierra Leone, West Africa. He is currently co-Editor-in-Chief of the *International Journal of Research in Undergraduate Mathematics Education*. His research investigates inquiry-oriented approaches to

the learning and teaching of undergraduate mathematics, focusing on how mathematical ideas are developed through student exploration and teacher-student classroom discourse. He has also been at the forefront of a national study of successful calculus programs, which has identified a number of programmatic features that are common among the programs identified as being more successful than peer institutions. Currently, he is co-PI on two national studies of the Precalculus to Calculus 2 sequence with the goal of better understanding current departmental practices related to these courses and the process of departmental and institutional change and ways that professional organizations can support and help sustain such change.

Technology in Mathematics Education: Back to the Future?

Greg Oates - School of Education, University of Tasmania, Australia

In this presentation, Greg Oates will conduct a brief stocktake of the current use of technology in mathematics education, and engage in some crystal-ball gazing as to how it might be used in the future. First, he will briefly discuss the history of the use of digital technologies in mathematics education, focusing primarily on the period of growth from the mid-1990's. He will next consider some of the theoretical perspectives that have emerged over that period, and using the framework for integrated technology developed and the model of Pedagogical Technology Knowledge (PTK) developed by Thomas and Hong, he will attempt to describe the 'current state of play' for the effective integration of technology in the teaching and learning of mathematics in undergraduate mathematics. Finally, using this position and framework as a starting point, he will postulate what might be some significant challenges ahead for teachers and institutions in the continuing search for effective meaning-making in mathematics with technology.

Dr. Greg Oates holds a Master's degree in logic and a Ph.D. in mathematics education from



the University of Auckland and a Diploma in Secondary Mathematics Teaching from the Auckland College of Education, New Zealand. He began his career teaching secondary mathematics, latterly as Head of Department, before returning to Auckland University where he taught undergraduate mathematics and post-graduate mathematics education until 2016 when he moved to the University of Tasmania, Launceston Australia. He currently teaches mathematics education for pre-service teachers in primary and secondary school at UTAS.

His research interests include the integration of technology into mathematics curricula, collaborative learning in mathematics, and professional development for teachers at all levels (primary to undergraduate), with a specific focus on pedagogical content knowledge (PCK). He has attended every Delta since 1999, been a member of the Delta International Steering Committee (ISC) since 2005, was the Chair of the 2011 Delta Conference in Rotorua, New Zealand, and Guest Editor for the iJMEST Proceedings in 2007, 2009 and 2017.

Facing the challenges of mathematical modelling for pre-service teacher education

Mónica E. Villarreal - University of Córdoba – National Scientific and Technical Research Council

In this talk Mónica Villarreal will refer to the importance of mathematical modelling activities for pre-service teachers. As in many countries in the world, in her local context (Argentina), new national standards for initial mathematics teacher education at the university level, as well as official curricular documents for secondary school recommend the introduction of applications and modelling for mathematics teaching. Meanwhile the realities of universities and secondary schools show that such activities are rare in both educational contexts in Argentina. At universities, teacher education programs are structured as a sum of mathematics courses, general pedagogy courses, mathematics education courses and a set of teaching practices in secondary school classrooms. In such programs, the highest hourly load is allocated to mathematics courses. The teaching approach in these courses is mainly based on the sequence theory-examples-exercises. Problem solving focuses primarily on pure mathematics, while applications of mathematics to other areas of knowledge or the development of modelling activities, that link the mathematical domain with the real world, are scarcely present. In this scenario, it is hard for future teachers to develop knowledge and abilities to design, implement and account for mathematical modelling activities at school. Many researchers have long indicated that if we want future teachers to be able to design modelling activities for their classes, it is necessary for them to have modelling experiences during their initial teacher education, passing through a complete cycle of mathematical modelling. In view of this situation, and the difficulties to change the teaching approaches in mathematics courses, we have tried to find alternative paths in order to give room to modelling experiences among the pre-service mathematics teachers attending the mathematics teacher education program in our university. To this end, we decided to create a *modelling scenario* as part of a mathematics education regular annual course for pre-service mathematics teachers. Since 2010, the pre-service teachers attending this course discuss about what mathematical model and modelling are, they analyse modelling projects developed at the secondary school level, and finally, they are invited to form small groups and develop their own modelling projects. To this end, the pre-service teachers select a theme of the real world of their interest, formulate problems related to it, select variables, raise hypothesis, create a model, validate it, or modify it in case it does not

satisfy the required conditions. Attending the purposes of this particular conference, and based on data gathered for seven years, she will present an overview of pre-service teachers' modelling projects, focusing the attention on the kind of mathematical knowledge they used or they needed to learn in order to give account of the problems they have posed. She will also briefly refer to the kind of themes they selected and to the important role of technology in some of the modelling projects.



Mónica Villarreal is Associate Professor in the Faculty of Mathematics, Astronomy, Physics, and Computation at the University of Córdoba, Argentina. She is a researcher of the National Scientific and Technical Research Council (CONICET). Her interests in teacher education, mathematical modeling, and use of digital technologies in educational contexts, have inspired her research during the last years. Since 2016, she is the Argentinean representative on the International Commission on Mathematical Instruction (ICMI).

Social Media Mathematics

Ansie Harding – University of Pretoria

The internet and social media in particular has brought a new awareness of mathematics amongst the general public. It has alerted people to interesting problems and also to seemingly unsolvable problems that has them thinking and discussing. The talk will firstly take a look at this phenomenon. But there is a more serious side to it as underpinnings of social media is that of sound mathematics. The talk will then also look at the mathematics involved and how it should direct our teaching.



Prof **Ansie Harding** is a Professor at the Department of Mathematics and Applied Mathematics in the Faculty of Natural and Agricultural Sciences. Her research focuses on the challenges of teaching and learning mathematics at a tertiary level. Her research contributes to understanding and alleviating the current education crisis in the field of science in South Africa, especially in addressing the under-preparedness of school leavers for the transition to university mathematics. Her overall passion is in the creative side of mathematics, an interest that has led to numerous popular talks both locally and internationally.

MULTIPLE STREAM SESSION 1

Room Malfatti: Teaching and learning practices

The investigative teaching practice motivating the student's autonomous learning process

Aline Silva de Bona | *Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Sul, Osório, Brazil*

Marcus Vinicius de Azevedo Basso | Departamento de Matemática Pura e Aplicada, Universidade Federal do Rio grande do Sul, Porto Alegre, Brazil

This article discusses classroom practices based on research and dialogue aimed at raising students' awareness of their individual learning processes. The goal is to present and share theoretical ideas and examples of teaching actions that improve the learning of concepts of mathematics. The case study was carried out in the subject Didactics for mathematics in Elementary School of the undergraduate program in mathematics of the IFRS - Osório Campus, from August to September of 2016 with a class of 22 students. The data are made up of the students' accounts, recorded and transcribed, on classroom practices, focusing on three actions. The study is theoretically based on learning as defined by Piaget, on dialogue and autonomy as conceived by Paulo Freire and on the concept of mathematical investigations in the classroom of João Pedro da Ponte. The results highlight the students' engagement with the activities in the classes, which allow for a learning of concepts beyond what was previously planned by the teacher, including the realization that classroom research enables students to develop their individuality in the classroom: their doing, thinking and learning.

The full paper of this presentation will be published in the Conference Proceedings.

Inquiry as an Entry Point to Equity in the Classroom

Gail Tang | *Department of Mathematics/Physics/Computer Science, University of La Verne, La Verne, CA, United States of America*

Houssein El Turkey | *Department of Mathematics and Physics, University of New Haven, New Haven, CT, United States of America*

Emily Cilli-Turner | *Division of Science and Mathematics, University of Washington, Tacoma, WA, United States of America*

Milos Savic | *Department of Mathematics, University of Oklahoma, Norman, OK, United States of America*

Gulden Karakok | *School of Mathematical Sciences, University of Northern Colorado, Greeley, CO, United States of America*

David Plaxco | *Department of Mathematics, University of Oklahoma, Norman, OK, United States of America*

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Although many policy documents include equity as part of mathematics education standards and principles, researchers continue to explore means by which equity might be supported in classrooms and at the institutional level. Teaching practices that include opportunities for students to engage in active learning have been proposed to address equity. In this paper, through aligning some characteristics of inquiry put forth by Cook, Murphy and Fukawa-Connelly with Gutiérrez's dimensions of equity, we theoretically explore the ways in which active learning teaching practices that focus on inquiry could support equity in the classroom.

Nurturing mathematical creativity and curiosity in Foundation Mathematics students

Rachel Passmore | *University of Auckland, Auckland, New Zealand*

Creativity in Mathematics is often associated with problem solving; a solution might be labelled creative if it is particularly elegant. Such creativity is an aspect I aim to encourage in my students, but my quest goes wider than that. Similarly the type of mathematical curiosity I strive to promote with my students is not just curiosity about an answer but rather about posing mathematical questions that pique their interest.

Inspiration for introducing more creativity in mathematics came from traditional Maori and Pacifica weaving designs. Similar designs are used to teach non-linear

graphs and equations. Student engagement with this task was very high and the results were outstanding. Learning derived from this activity includes not only transformations of non-linear graphs and equations, but also familiarity with domains and ranges of functions.

At the last DELTA conference I shared some of my students' video creations. One question in my video assessment asks students to construct a context for a set of three simultaneous equations with a particular solution. I will share some of the creative contexts that students have devised.

Encouraging mathematical curiosity in my students was challenging and initially rather disappointing. Students were extremely reluctant to pose mathematical questions and appeared to have little mathematical curiosity. I discovered this was largely due to a lack of understanding about what a mathematical question was. Practice with Fermi questions has assisted with student formulation of questions. I will describe activities where students are asked to pose mathematical questions in response to short video clips.

Room Ticiano: Teaching and learning practices

Conceptions of function in a first Calculus course: an APOS theory based study

Luisa Rodriguez Doering

Vanessa de Azeredo Abreu

Elisabete Zardo Búrigo

*Departamento de Matemática Pura e Aplicada, Universidade Federal do Rio Grande do Sul,
Porto Alegre, Brazil*

This work presents a study about the conceptions of function of students in an initial Calculus course and the ways in which these conceptions favour or hinder the resolution of problems and the accomplishment of tasks in the discipline. The analysis takes as reference the categories of APOS Theory, proposed by Ed Dubinsky and others. A group of thirteen students participated in a follow-up project during the second semester of 2013, when they were taking an initial Calculus course for the second time. During this follow-up, records were collected about students' problem solving. The analysis of these data (resolutions) allowed us to identify the presence of evidence of the action conception and process

conception of function. The action conception of function was apparent mainly in the performance of tasks that can be solved through algebraic manipulations or analysis of partial aspects of the graph of the function. On the other hand, it was also possible to identify that the action conception is an obstacle to the performance of non-routinely tasks that require an overall analysis of the function or coordination of algebraic and graphical records.

The full paper of this presentation will be published in the Conference Proceedings.

Promoting Metacognition as a Habit of Mind in Undergraduate Classroom Communities

Emilie Hancock | *University of Northern Colorado, Greeley, USA*

Research in mathematical problem solving has long identified metacognition as an essential component of the problem-solving process, and a 21st Century skill. As students learn new mathematical concepts and problem-solving strategies, they should learn how to manage and regulate application of this new knowledge. Thus, providing students authentic problem-solving experiences necessitates the promotion of metacognitive thinking and shifting, at least to some degree, the responsibility of monitoring and control from teacher to student. As the activity within a classroom community of practice creates a micro culture of negotiated activities and interactions among students and the teacher, over time normative behavior emerges. For metacognitive thinking to develop, it must be an explicit part of the classroom culture and have opportunities to become established as normative activity. In this talk, I discuss a qualitative research study exploring the use of portfolio problem-solving sessions and write-ups to mediate metacognitive thinking during problem solving in a first-year, inquiry-oriented undergraduate math course in the United States. Regularly throughout the 15-week semester, students worked together on non-routine problems, and submitted written documentation of their judgment and decision-making processes during their entire problem-solving process, from initial thoughts to final solution attempt. Classroom audio- and video-data, written artifacts, and interviews conducted with students and the primary instructor were collected. Microanalysis was conducted to identify semester-long changes in normative metacognitive activity during portfolio problem-solving episodes. Macro analysis utilizing Activity Theory as an analytic framework situated these results, highlighting contradictions as catalysts for change. Results and teaching implications are presented.

Just take a breath: bringing mindfulness into large classrooms

Claire Blackman | *Dept of Maths and Applied Maths, University of Cape Town, Cape Town, South Africa*

As a lecturer at a South African university that has an increasingly diverse student body, I have spent a lot of time thinking about how to create a safe, nurturing space for my large, often extremely stressed, first-year mathematics class. I decided that one of the most useful things I could do is to give my students the tools to focus and quieten their minds and emotions, and so I decided to include two minutes of mindful breathing meditation at the start of each class. The response from my 200 students was overwhelmingly positive, and I noticed that these students were more relaxed and focused than other classes. I have since started including mindful breathing at the start of all my classes and workshops.

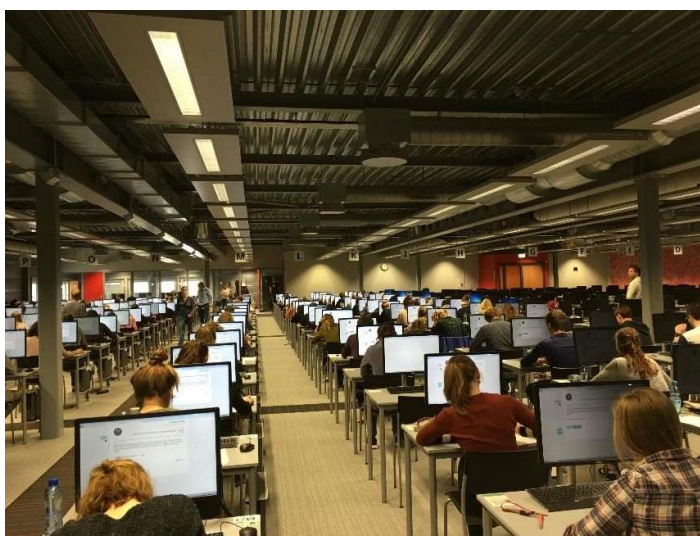
In this talk, I'll discuss how I introduced mindfulness to my students, how I run the meditation, and what my students and I experienced. I'll also give some background about the scientific research into the effect of mindful practice on the brain.

Room Monet: Innovations

SOWISO, a new integrated learning environment for undergraduate mathematics

Marc Habbema | *SOWISO - E-learning for Math & Science, Netherlands*

In the current learning age, content cannot be seen separate from technology anymore. The SOWISO e-learning platform, designed for teaching undergraduate mathematics/statistics, combines the best of both



Students taking a mathematics exam with SOWISO

worlds. The software originated at Eindhoven University of Technology (the Netherlands).

Students can input open answers like calculations and equations (any domain/complexity) and receive targeted feedback: the software not only sees that a mistake is made, also what that mistake is, guiding them towards the final answer (using CAS, R, SAGE).

Teachers use the software in a wide variety of settings:

- Creating their own content with the authoring environment (accepting LaTeX, amongst others, as input)
- Using turn-key undergraduate courses on subjects like (pre-)calculus, linear algebra
- Getting rid of the book entirely and only using SOWISO, or only using it for (formative) tests
- Providing (upcoming) students with diagnostic tests, followed by an adaptive SOWISO course

These applications already show that the tools allow for many (blended) learning settings supporting teachers by taking care of correcting homework and tests. "With the help of this software I can focus more on the creative part of teaching again" one teacher said.

SOWISO is young but has been quickly adopted by many universities worldwide (in many cases replacing MapleTA or other tools). In the southern hemisphere the first users are Tshwane University of Technology (SA) and Edith Cowan University (AU).

All universities report successful cases : increasing results/participation/ satisfaction by students, decreasing work-load for teachers, saving money by reducing the number of TA's in large foundation courses.

A novel approach to mathematics examination design and Marking

David Easdown | *School of Mathematics and Statistics, University of Sydney, Sydney, Australia*

Ruth Corran | *Department of Mathematics, American University of Paris, Paris, France*

Brad Roberts | *School of Mathematics and Statistics, University of Sydney, Sydney, Australia*

We introduce, motivate and describe a new approach to the design and marking of mathematics examinations. The method is suitable for successfully mapping student performance to a range of grade thresholds in the context of holistic or criterion-based assessment. It uses just one examination to assess and distinguish the performance and achievement of students coming from a bimodal or

multimodal distribution with regard to backgrounds, preparedness and aspirations. The method combines and reflects the two phases in the SOLO taxonomy that distinguish deep from superficial learning. This also highlights different learning behaviors and outcomes as students move through and beyond liminal space, in the theory of threshold concepts. The design has been implemented in the School of Mathematics and Statistics at the University of Sydney, particularly with regard to assessment of mathematics units of study taken by large numbers of first year students.

The full paper of this presentation will be published in the Conference Proceedings.

The need for new attitudes in the teaching – and the learning! – of a relevant Linear Algebra in undergraduate levels

Clarice Favaretto Salvador | Instituto de Ciências Exatas e Tecnológicas, UNIP; Campinas, SP, Brasil

In this work I briefly present the difficulties students must overcome when studying and trying to learn Linear Algebra as cited in the literature as well as in my professional work. In addition, I present the possibility of using Mathematical Modelling of some real-life problem-situations to introduce basic Linear Algebra, before student's contact with abstract and theoretical definitions. I also emphasize the need for these theoretical and abstract concepts, but I use the examples to motivate their teaching and studying, after introducing some basic Linear Algebra concepts using the hopefully relevant examples provided here. I conclude by presenting possibilities of a radical change in the way Linear Algebra is considered; in syllabuses, programmes, classes and textbooks.

The full paper of this presentation will be published in the Conference Proceedings.

MULTIPLE STREAM SESSION 2

Room Malfatti: Technology

Knowledge amplifiers and cognitive reorganizers, two realities present in the use of technological tools in the mathematical classes in the city of rio Gallegos

Dora Silvia Maglione

Fabiana Saldivia

Universidad Nacional de la Patagonia Austral, Unidad Académica Río Gallegos, Argentina

A study carried out on teachers of mathematics in the intermediate level in the city of Rio Gallegos, indicated that mathematical software may be used by a significant proportion of teachers. But, how do teachers make use of these technological tools? Armella (2002) considers that technological tools play two roles in the teaching and learning processes of mathematics: as amplifiers of mathematical knowledge (i.e., perform calculations faster), or as cognitive reorganizers or psychological instruments (i.e. to do new tasks and reorganize previous tasks in new ways). These are in fact two phases of the same process which depend on the degree of appropriation that the teacher has obtained from the tool, and this will have an impact on teaching practice.

In a first step, it is natural that the information and communications technology (ICT) are gradually presented as a reinforcing tool, until the teacher becomes more familiar with the role of technologies in the teaching and learning process. These tools can be used to amplify the scope of application.

In the mathematics classes of Río Gallegos that we observed, specific mathematical software is mostly used at initial stage; however, we have also seen some cases where this has evolved into a higher stage.

In this paper we present some classroom experiences that contrast with these two ways of making use of technological tools.

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The full paper of this presentation will be published in the Conference Proceedings.

Students' dialogues in the study of Definite Integral based on the analysis of a physical model with technology

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Guilherme Vier

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The aim of this paper is to analyse the dialogues developed by students when reflecting on the concept of the definite integral, based on the analysis of a mathematical model for the phenomenon of free-fall. The context of the research is an extension course offered to Mathematics Majors students from the University of Rio Grande do Sul State, Brazil, which proposed the study of Differential and Integral Calculus concepts based on the analysis of the aforementioned mathematical model. The research is qualitative and is based on the studies of Alrø and Skovsmose [1] about communication in Mathematics classrooms. Two patterns of communication were identified: inquiry co-operation; and what we called conduction, performed by one of the students. In addition, we observed the participation with and reorganization by the software of three dialogical acts: getting in contact, challenging and evaluating.

Reference:

Alrø H, Skovsmose O. *Diálogo e Aprendizagem em Educação Matemática*. [Dialogue and Learning in Mathematics Education] 2nd ed. Minas Gerais: Autêntica Editora; 2006. Portuguese.

The full paper of this presentation will be published in the Conference Proceedings.

The Effect of Using Simulations on Students' Learning of Inferential Statistics in an Elementary Statistics Class in the Mathematical Sciences Department of the University of Wisconsin-Milwaukee

Kevin McLeod

Alexa Schut

University of Wisconsin-Milwaukee, Milwaukee, USA

We report on a study which looked at the effect of introducing simulations into one introductory statistics class at the University of Wisconsin-Milwaukee during the Fall 2016 semester. We find statistically significant improvement ($p < 0.01$) in student understanding of confidence intervals. This finding supports the results of a recent study undertaken at Iowa State University.

The full paper of this presentation will be published in the Conference Proceedings.

Room Ticiano: Technology

The exploitation of videos in teacher training

Márcia Jussara Hepp Rehfeldt

Ieda Maria Gingo

Marli Teresinha Quartieri

University of Vale do Taquari – UNIVATES, Lajeado, Brazil

This work is the result of an action developed in the research entitled "Methodological Strategies for Innovation and Curricular Reorganization in the Field of Mathematics Education in Primary Education". The purpose of this study is to illustrate the implications of using a video about Mathematical Modeling in continuing teacher education. For the elaboration of the video, a script of actions was developed. Initially, several Mathematical Modeling practices developed by the members of the research were recorded. Then the editing of the images of the modeling practices and the creation of slides in an online platform occurred. Finally, the narration, the final edition and the finalization of the resource were carried out. The video, which lasted 8 minutes, contemplated definitions about mathematical modeling and illustrated the steps to be followed, according to some authors. Armed with the video, the research team carried out several training courses, among which: undergraduate students and teachers who already work in six local schools. After the training, a questionnaire was made available to verify the impact that the resource caused on the participants of the meetings. The answers were entered into the online TagCrowd software to account for the frequency of certain words. The most cited words were: clear, contributed, contribute, which specifically referred to videos. From the analysis of results, it is possible to affirm that the video of Mathematical Modeling contributed, in a clear way, to the understanding of the main characteristics of this tendency.

Smart Physics: Teaching physics with smart-carts and smart-phones

Jeff Nijse | *Auckland University of Technology, Auckland, New Zealand*

Students in introductory physics classes are often excited by the real world applications of the material yet struggle with abstract interpretation. This becomes challenging when coupled with foundation-level students that have not had a lot of exposure to techniques such as graphing and data analysis. Communication

through graphs is a key concept to understand the relationship between position, velocity, and acceleration. This is consistently an area where students struggle.

In this presentation two fundamental concepts in introductory physics will be analyzed with the use of cheap technology—a common smartphone (\$30 USD), and more expensive technology— a PASCO wireless smart cart (\$180 USD).

First, a classic physics lab involves tracking the motion of an object and describing its behavior using a graph. This can be accomplished in a number of ways; traditionally with a teacher demonstration, followed by explanation and theory. Secondly, simple harmonic motion is another classic physics demonstration. This usually involves an elaborate set up with motion detectors connected to a computer.

Through the addition of simple and affordable technology, motion tracking experiments can quickly and easily be incorporated into the lecture and or lab that enable real-time results and feedback for the students. Using only what comes pre-packaged in a smartphone can easily model motion and *put an experiment in every student's hands!*

The impact of mathematics software remediation in mathematics for engineering students at a university in the Eastern Cape Province of South Africa

Lynette Bester

Mandindi, T.

Walter Sisulu University, South Africa

This study was initiated by the poor state of mathematics in South Africa. The 2015 Trends in International Mathematics and Science Study reported that South Africa rated 38 of the 39 countries assessed. In the Eastern Cape Province of South Africa, which consists mainly of rural areas and where most of the engineering students at a university in this area come from, the percentage of Grade 12 learners who achieved 40% and above in mathematics dropped from 26,3% in 2013 to 21,8% in 2015. The unacceptable state of prospective students' mathematics knowledge and the fact that mathematics is a fundamental subject for engineering students, emphasized the need for remediation.

Civil and electrical engineering students in the extended diploma programme participated in this study. A mixed research design was used to investigate the impact of a computer based mathematics intervention to fill the gaps in participants' mathematics background. Examination results indicated that this

intervention had a positive effect on the pass rate in mathematics of civil engineering participants. Interviews and an online survey at the end of the remediation revealed that 96% of the students were in favor of this intervention. With limited staff, time and resources, this study indicated that appropriate mathematics software can successfully be used as an intervention to fill the gaps in the mathematics knowledge of students entering courses that require a mathematics background. Follow up work should be done to confirm these findings.

Room Monet: Technology

Contributions of the Mathematical Modeling to the development of Statistical Literacy of students from a graduate technology course

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Maria Lúcia Lorenzetti Wodewotzki

Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro, Brazil

The current work presents ongoing doctoral research, implemented in the higher education environment with the focus of enabling the Applied Statistics discipline. The research took place in an environment based on Mathematical Modeling, in which the student actively participated in the teaching-learning process, exploring subjects of his interest. This project aimed at discussing the contributions that emerge from Statistics teaching to the development of Statistical Literacy in its three dimensions: interpretation, critical questioning and production, whenever Mathematical Modeling projects are carried out in higher education technology courses. The data were collected both from the recording of an audio containing the oral presentation made to the class as well as the written version of the final work. The results indicated that the students passed by the three dimensions, because they were able to read information, numbers, symbols, tables and charts, critically evaluating them, besides communicating arguments and making decisions. Regarding the contributions of the Mathematical Modeling methodological orientation to the development of this competence, it can be affirmed that it was fundamental, because statistical literacy occurs when meaning is found in the statistical data in several contexts and, for this reason, it is part of the way the reader places his thoughts and analysis, and considers the data a way

to know and decipher the context of the research. Mathematical Modeling, starting from an initial situation in order to get to a desired final situation, requires a close look at all the information provided.

Student Experience informs a supportive-environment framework for online assessment in Moodle

Pragashni Padayachee | *Centre for Educational Assessment for Access and Placement, Centre for Higher Education Development, University of Cape Town, Cape Town, South Africa*

Hermien Johannes | *Centre for Teaching, Learning and Media, Nelson Mandela University, Porth Elizabeth, South Africa*

Shirley Wagner-Welsh | *Department of Mathematics, Nelson Mandela University, Porth Elizabeth, South Africa*

With the increased intake of students at many higher education institutions, the teaching, learning and assessment of large groups is one of the biggest challenges facing educators. Appropriate online assessment may address some of the challenges. In this paper, the experiences of 392 mathematics students, undertaking their assessments via Moodle at a University in the Eastern Cape of South Africa, are described. Student experiences informed the design of a supportive-environmental framework for online assessment.

The theoretical lens for this research study is framed by mastery learning, student experience and online assessment. The research reported on in this paper highlights one aspect: the third phase of the action-research cycle, namely, to observe the implementation of online assessment.

I Festival of Digital Videos and Mathematics Education

Hannah Dora de Garcia e Lacerda

Marcelo de Carvalho Borba

Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro, Brazil

The Research Group on Informatics, other Media and Mathematics Education (GPIMEM), that has been advancing research involving technologies which can be used as educational resources, promoted the First Festival of Digital Videos and Mathematics Education. The Festival is part of The Digital Videos project in the Distance Mathematics Degree (E-licm@t-Tube) that aims to understand the possibilities of the production and use, in a collaborative way, of videos in the training of teachers of distance learning Mathematics, also extending to face-to-

face courses and to schools of Basic Education. For the Festival, students and Pre-service Mathematics Teacher and Basic Education submitted a total of 120 videos produced by them, in which mathematical content was part of the script. The videos were analyzed by a jury composed of artists, mathematicians and mathematical educators, by three evaluation criteria: the nature of the Mathematical Idea, Creativity and Artistic-Technological Quality. For this oral presentation, our focus will be an initial analysis of the videos awarded in the Higher Education category, regarding the criteria The Nature of the Mathematical Idea. The submitted videos are hosted on the festival's website, making it a repository of didactic material containing videos with mathematical content. At the moment, we have one scientific research, two master's degree and six doctor's degree students developing their qualitative research associated to the E-licm@t-Tube. We hope, from the Festival, to contribute to the communication of mathematical ideas and the establishment of a culture of digital mathematical video production.

MULTIPLE STREAM SESSION 3

Room Malfatti: Technology

The geogebra software as a tool in the teaching of trigonometrical functions

Romildo Pereira da Cruz

Marli Teresinha Quartieri

Italo Gabriel Neide

Maria Madalena Dullius

Amanda Gabriele Rauber

Universidade do Vale do Taquari – UNIVATES, Lajeado, Brazil

This work presents the use of GeoGebra as a pedagogical tool for the teaching of trigonometric functions tool in a class of 34 students, participants of the discipline "Introduction to the Exact Sciences". The application occurred during the course "Teaching Internship in the Undergraduate Level", which is a part of the Master's Degree in Teaching, at a Higher Education Institution located in Rio Grande do Sul, Brazil. The goal was to analyze and interpret the behavior of students and the learning situations emerging from the use of such software. The research was

outlined in the qualitative perspective and systematic observations and the application of questionnaires were used for data collection. The analysis of such questionnaires was based on Content Analysis. During the investigation and the monitoring of the activities developed, it was noticed that the students sharpened their senses and showed evidence of improvement in the use of content, especially in the recognition of functions from the natural, algebraic and graphical registers, as well as better comprehension of the treatment procedures for each case. With this, we can infer that, in the investigated classroom, the participation in activities that involved the use of software increased the learning potential of students. It was observed that the interaction between students, and the interaction of students with the professor, supported by the meaning of the activities, was fundamental for the success of the practice. The results suggest a positive perspective on the learning of students with the use of software, provided that it takes into account good planning and well-defined objectives, in order to incorporate them into educational practices.

How the Internet act on the mathematical modeling online

Jeannette Galleguillos | *Universidad de Valparaíso, Chile*

Marcelo de Carvalho Borba | *Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro, Brazil*

Facebook is a highly favorable social network for people to participate in a discursive social activity. We used the social network in an online extension course for interactions of teachers in mathematical modeling. We see modeling as a process of posing and solving problem, from studying an interest topic. In this work, we observed a group of mathematics teachers in the construction and development of a problem by mean of the social network. We focus on observing how digital technologies act in online mathematical modeling. We use Activity Theory to analyze the discussions of participants in a closed group. In the resolution process tensions emerged in the participants with a crucial role of the Internet in the online mathematical modeling.

Using virtual and physical learning spaces to develop a successful mathematical learning community, both for on-site and distance provision

Belinda Huntley | *University of South Africa – UNISA, Pretoria, South Africa*

Jeff Waldock | *Sheffield Hallam University, Sheffield, UK*

Andrew Middleton | *Sheffield Hallam University, Sheffield, UK*

Student engagement, satisfaction and academic success is built upon a sense of belonging – of being part of a professional community that provides comprehensive support. This can be achieved through a culture of expectation and behavior, suitable support structures and effective use of physical and virtual learning space.

Carefully designed physical and virtual learning spaces, together with a managed peer-support network, help create a partnership learning community within which this process can flourish. Our hypothesis is that learning spaces are not only conceptual and provided, but co-constructed, especially in our digital and hybrid contexts where the learner has more influence over the space and places they co-construct and inhabit.

In this presentation, we will describe our experiences of developing and making effective use of virtual and physical spaces to develop successful mathematical learning communities both at Sheffield Hallam University in the UK - where activities are principally face-to-face, and at the University of South Africa (UNISA) – where they are mainly virtual. Innovation in the design and use of discipline-specific physical space can have an important role in helping learners achieve this through a sense of 'becoming and belonging' (Willcock, 1999). We will explore the 'equivalence of place' and the changing role of academic staff in fostering professional learner identities both through traditional on-site delivery, and through the distant, blended or hybrid approach.

Room Ticiano: Math Educators

Perspectives in Teaching Statistics in a Pedagogy Course in DE

Auriluci de Carvalho Figueiredo

Michel da Costa

Universidade Metropolitana de Santos – UNIMES, Santos, Brazil

Distance Education (DE) plays a fundamental role nowadays, and consequently also in the formation of teachers. Our research group composed of teachers who have been working for some time with this training in face-to-face mode faced a great challenge: how to deal with subjects in Teacher Training courses in DE? So, the present article represents a larger research project on the subject, and we choose here to treat some possibilities of teaching and learning of Statistics in a Pedagogy course in a University of the State of São Paulo in DE. Our concern among others was to combine statistical knowledge, articles in the area of Statistical Education and teaching practices. The study was carried out from the analysis of records in evaluative and non-evaluative activities in the virtual environment that happened in forums and tasks, among others. We were aware that the teaching of Statistics in a Pedagogy course goes far beyond the concepts that involve a discipline, but also with a look of future teachers of this area of knowledge. Research shows that teacher trainers often do not take into account the creation of subjects which integrate disciplines with specific content and the ones with pedagogical content, and point out that the responsibility for this transposition would be under the responsibility of teachers in the pedagogical area. Among other conclusions, we present testimonials of reflection on the part of the students about content covered in Basic Education and possibilities to approach content from various perspectives coming from research in the area of Statistical Education.

Designing a short course for graduate teaching assistants (GTAs) in mathematics: principles and practice

Cosette Crisan

Melissa Rodd

UCL Institute of Education, University College London, London, UK

Graduate Teaching Assistants (GTAs) are postgraduate research students who contribute to the teaching of undergraduates while they pursue their own doctoral research. This paper reports on a mathematics-specific 10 learning hour introduction to teaching for postgraduate mathematics research student GTAs. The principles that guided the design of the course are discussed and results from our practitioner research are presented. We found that 'training' could not be delivered in such a short course yet, paradoxically perhaps, education could be achieved, given the qualities of our GTA participants.

The full paper of this presentation will be published in the Conference Proceedings.

Humans-with-media: the case of teachers'-in-formation-with-paper-folding collective

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Carlos Mario Jaramillo López | *Universidad de Antioquia, Medellín, Colombia*

Paper folding can be a medium which allows the production of geometric knowledge in the classroom, when it is used by a thinking collective of human beings (teachers in formation). In this sense, the purpose of the research considered was to answer the question: how to produce some school geometric knowledge in a teachers-in-formation-with-paper-folding collective? Taking into account that the production of knowledge can be generated by a thinking collective of humans-with-media, so the considered theoretical framework was the theoretical construct of *humans-with-media* of Borba and Villarreal (2005). On the other hand, the methodology made characteristics of the research paradigm explicit through the application of an experimental design, from the ideas of Molina, Castro, Molina and Castro (2011) and Doerr and Wood (2006). The analysis of each one of the episodes was done through a methodological triangulation process. Subsequently, a global retrospective analysis was done to establish the categories and to discuss them. The above mentioned analysis allowed us to

describe the production of geometric knowledge which emerged from the collective of teachers-in-formation-with-paper-folding. Likewise, a characterization of this group was achieved, as a contribution to the in-question theoretical construct. With respect to the paper folding, it was possible to conclude that the collective of teachers-in-formation-with-paper-folding became a formation space, because as participants, they had the opportunity to: understand concepts and procedures of school geometry and to generate academic and professional learning, to analyze teaching situations, and to reflect on their future roles as teachers, among others.

Room Monet: Technology

Multiple representations in the study of analytic geometry: production of videos in the distance learning mathematics

Liliane Xavier Neves | *Universidade Estadual de Santa Cruz*

Marcelo de Carvalho Borba | *Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro, Brazil*

This proposal deals with ongoing research that seeks to analyze the ways that students of Distance Learning Mathematics articulate multiple representations when they produce videos on Analytic Geometry. We will present digital videos as multimodal resources (Walsh, 2011; Jewitt, et al, 2016) that allow the expression of ideas related to contents of Analytic Geometry based on audiovisual thinking for the exploration of the senses in order to provoke changes in mental processes (Ferrés, 1996). The contributions of the manipulations of different representations to the process of giving meaning to mathematical concepts were described by Lesh (1981) who identified such manipulations as part of the development of mathematical learning. In this research we seek to analyze the role of audiovisual resources in the process of articulating different representations, considering the conceptual structure characteristic of Analytic Geometry, which opens possibilities for the treatment of concepts from algebraic and geometric representations, as well as the potential of video in the exploration of senses and in the conditioning of way knowledge is constructed (Borba, Villarreal, 2005). The locus of research is a Distance Learning Mathematics course, a space where learning becomes empowered by the internet and is one of the recent trends in research in

mathematics education (Borba et al., 2016). We will present an initial analysis of the videos produced by the participants in the research through reflections supported on the topics in question, namely, multiple representations, the construct human beings-with-digital videos and multimodality.

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A Web Application to Support the Continuing Learning of Elementary Mathematics

Héctor Fernando Gómez

Ramón Ronzón

Universidad del Caribe, Mexico

According to the Programme for International Student Assessments (PISA) the performance of Mexican students in mathematics is far below the average of the OECD countries. As a consequence, Mexican students suffer from severe difficulties in their transition to engineering programmes at different universities. One of these difficulties is a large failure rate in first-year mathematics courses which, in the end, is a principal cause of attrition. In order to support incoming students to engineering programmes, we built a new web application based on the use of expert systems. Expert systems are artificial intelligence techniques used to solve problems replicating the skills of a human expert. In our web platform, expert systems are used to solve, and to describe the solution, of exercises in different algebra and geometry topics. Additionally, we integrated a module in which students can solve exercises step by step. Every step is reviewed by an expert system allowing an immediate feedback for the student. The web application has been used in an introductory mathematics course for engineering students at the Universidad del Caribe in Cancún, Mexico. We study the impact of these tools by implementing a regression analysis, specifically by modelling through a Bayesian network. In the presentation we describe the results obtained.

#FeesMustFall: Changing the landscape of e-Assessment

Hermien Johannes

Simon Goldstone

Shaun Meyer

Koshala Terblanche

Nelson Mandela University, Porth Elizabeth, South Africa

In 2016, student protests at most South African Universities reached a boiling point, resulting in the closure of campuses and up to a six week loss of time from the academic calendar. While student protests have been ongoing in South Africa since the mid-90s, a national student movement in 2015, under the tag #FeesMustFall, came to prominence protesting against rising Higher Education fees which lead to a disruption across a number of Institutions of learning in September 2016. These events had a ripple effect on the uptake of Blended and Online Learning at South African Universities. The creative application of online tuition and alternative forms of assessment assisted staff and students to advance completion of the academic year.

The closure of campuses placed Infrastructure and Information demands on the ICT services unit. Engineers and administrators had to develop solutions for implementation at a secured off campus venue which would form the hub for faculty, students and support personnel – extending the traditional campus teaching, learning and assessment spaces like never before.

The reduction of available teaching time tested Institutional readiness and drove the demand for accelerated technology adoption. Faculty required extensive training and support from the Academic Developers within the Centre for Teaching, Learning and Media.

The increased utilization of the Learning Management System with respect to access, performance and the changing requirements for online assessment, tested all aspects of the system's various capabilities. Valuable lessons were learned regarding the setting up of remote assessment laboratories and the accompanying guidelines and procedures for the correct deployment of online assessment activities. These informed practice to conduct successful assessments – be it continuous, formative or summative. The real world context inspired new thinking about design for authentic and connective assessment.

An important driver for e-Assessment is being able to control the environment, which was difficult to do. Therefore, an innovative connective assessment design

model was developed and applied to address some of these difficulties in a variety of contexts using various technologies within a networked environment. This model is underpinned by theories of Connectivism and Mastery Learning. Important design principles for connective assessment will be discussed, supported by examples from applications in different disciplines and reflections on various faculty experiences.

MULTIPLE STREAM SESSION 4

Room Malfatti: Miscellaneous

A cross-border STEM class on the theme of Energy to enhance the statistics education at the level of 6th grade of basic school curriculum of mathematics

Yuriko Yamamoto Baldin | *Universidade Federal de São Carlos, Brazil*

Masami Isoda | *University of Tsukuba, Japan*

Raimundo Olfos | *Pontificia Universidad Católica de Valparaíso, Chile*

Soledad Estrella | *Pontificia Universidad Católica de Valparaíso, Chile*

The challenge of implementing STEM Education with themes of global importance such as Energy at the level of basic education has been worked within the APEC Lesson Study Project, as one fundamental initiative of the International APEC HRD–UNESCO Project since 2015. Among the “Sustainable Developments Goals” of this Project, those of “quality education”, “affordable and clean energy”, “responsible consumption and production” and “partnership for the goals” motivate collaborative actions of schools and educators towards efficient lessons with real data (APEC database) in classrooms. The structure of Lesson Study has based the research work of innovative lessons on energy efficiency and cross border education since 2016, by the countries collaborating within the APEC project. This presentation aims to bring the results of a recent cross- border STEM class for 6th grade using real data, between Chile and Brasil, planned and executed under Lesson Study principles, potentialized by the communication technology that permitted real time interactions between the classrooms. The lesson has enhanced the contents of the basic mathematics curriculum, enriched with the evidence of statistical thinking of students and the power of a cross cultural environment for the learning.

Math Circles for all Ages: From Navajo Math to the Research University

Matthias Kawski | *School of Mathematical & Statistical Sciences, Arizona State University, USA*

This article reports activities and efforts to bring math circles to much broader ranges of communities. By age these range from elementary grades to college-ready students, and to teachers at all levels. We report on extreme geographic differences, from very small schools in small hamlets in the most remote corners of Indian reservations to advanced high school age students whose hunger for higher mathematics cannot be served by their high-schools, even in rich suburban districts.

After a quick survey of the characteristics of math circles and our experiences over seven years with research oriented math circles in metropolitan areas, our report focuses on efforts over the last four years to connect students in the most remote corners of Indian Reservations with research mathematicians.

The second part of the report elaborates one specific, typical example of a math circle session that has been successfully tested over a very broad age-range, including a teachers circle.

The full paper of this presentation will be published in the Conference Proceedings.

Room Ticiano: Teaching and learning practices

Student Enrichment in Mathematics: A Case Study with First Year University Students

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Ansie Harding | *Department of Mathematics and Applied Mathematics, University of Pretoria, Pretoria, South Africa;*

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This paper presents an enrichment case study to showcase a possible avenue for attending to the needs of academically strong mathematics students. We report on a group of university students who were presented with the opportunity of

exploring a specific first year mathematics topic deeper, using an inquiry-based learning approach as part of an enrichment programme. Following the intervention, students completed a questionnaire and a few were interviewed to establish their experiences of the enrichment programme. We discuss the successes and pitfalls of the intervention and report on the impact it had on the participants.

Creating a Confident Competent Questioning Culture

Anne D'Arcy-Warmington

Heather Lonsdale

Department of Mathematics and Statistics, Curtin University, Perth, Australia

A key part of problem-solving lies in formulating effective questions. This is often discussed under the guise of reciprocal teaching and think-aloud strategies. In teaching the art of asking a good question can be a key factor for both students and staff. Many students (and staff!) don't feel adequately equipped or confident enough to ask questions, and this can hinder the development of personal and academic skills. As a result, it is important to incorporate many facets of the art of questioning in a classroom setting. In this talk we will discuss a variety of techniques to encourage a culture of questioning in the classroom. A key element of this involves fostering a welcoming community where students feel comfortable expressing their ideas. We felt we should finish this abstract with a question; what do you think?

MULTIPLE STREAM SESSION 5

Room Malfatti: Teaching and learning practices

An Inquiry-Oriented Approach to a Guided Reinvention of Eigen theory

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Michelle Zandieh | Department of Applied Sciences and Mathematics, College of Technology and Innovation, Arizona State University, Mesa, AZ, USA

David Plaxco | Mathematics Department, Clayton State University, Morrow, GA, USA

The Inquiry-Oriented Linear Algebra (IOLA) curricular materials are designed to be used for a first course in linear algebra at the university level. Many of the tasks in the IOLA materials are created to facilitate students engaging in task settings in such a way that their mathematical activity can serve as a foundation from which more formal mathematics can be developed. The materials include rationales for design of the tasks, suggestions for promoting student and instructor inquiry, and examples of typical student work. In the submission, we illustrate the IOLA materials by summarizing aspects of student work on a task sequence that supports students' reinvention of diagonalization and eigentheory.

The full paper of this presentation will be published in the Conference Proceedings.

Mathematical failure(s) of bridging students and the impact(s) on their progress and affect

Phil Kane | University of Auckland, New Zealand

Failure is an unfortunate option for a solid minority of bridging mathematics students, and too many appear to not have an "at-homeness" (Cockcroft, 1982) with number. Addressing these learners' needs requires not only deliberate acts of teaching but also consideration of the systems in place. Prior to 2015 students who completed and failed the Maths91F course were all progressed to the Maths92F course in the next semester with the rest of the cohort. However, in spite of their achieving and passing in other subjects, these failing students almost without exception failed Maths92F also, so a whole year on these students were still unable to enter university. Then in 2015, a repeat Maths91F course was offered in semester two to those who had narrowly failed earlier. After examining results

before and after 2015, the 2015-2017 results of the candidates between the two semesters, and by keeping an occasional diary, an informal picture emerges about the students who succeeded the second time around. Unsurprisingly, these students attended religiously, they submitted everything on time, they were driven to improve in a subject that had thwarted them to now, they asked questions when unsure (and sometimes when curious), and they likely had D or D+ grades from semester one. It was also evident that the 'chapter chase' in semester one had to be partly renovated into opportunities for them to interact with threshold concepts such as place value and decimal systems, and multiplicative and proportional reasoning, that seem to have been missed or forgotten in their compulsory education.

Challenging assumptions of notational transparency: the case of vectors in engineering mathematics

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The notation for vector analysis has a contentious nineteenth century history, with many different notations describing the same or similar concepts competing for use. While the twentieth century has seen a great deal of unification in vector analysis notation, variation still remains. In this paper, the two primary notations used for expressing the components of a vector are discussed in historical and current context. Popular mathematical texts use the two notations as if they are transparent and interchangeable. In this research project, engineering students' proficiency at vector analysis was assessed and the data were analyzed using the Rasch measurement method. Results indicate that the students found items expressed in unit vector notation more difficult than those expressed in parenthesis notation. The expert experience of notation as transparent and unproblematically symbolic of underlying processes independent of notation is shown to contrast with the student experience where the less familiar notation is experienced as harder to work with.

Room Ticiano: Teaching and learning practices

Investigating Students' Perceptions of Graduate Learning Outcomes in Mathematics

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Cristina Varsavsky | *Faculty of Science, Monash University, Clayton, Australia*

Shaun Belward | *College of Science and Engineering, James Cook University, Townsville, Australia*

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The purpose of this study is to explore the perceptions mathematics students have of the knowledge and skills they develop throughout their programme of study. It addresses current concerns about the employability of mathematics graduates by contributing much needed insight into how degree programmes are developing broader learning outcomes for students majoring in mathematics. Specifically, the study asked students who were close to completing a mathematics major (n=144) to indicate the extent to which opportunities to develop mathematical knowledge along with more transferable skills (communication to experts and non-experts, writing, working in teams and thinking ethically) were included and assessed in their major. Their perceptions were compared to the importance they assign to each of these outcomes, their own assessment of improvement during the programme and their confidence in applying these outcomes. Overall, the findings reveal a pattern of high levels of students' agreement that these outcomes are important, but evidence a startling gap when compared to students' perceptions of the extent to which many of these – communication, writing, teamwork and ethical thinking – are actually included and assessed in the curriculum, and their confidence in using such learning.

Helping students overcome failure by developing 'growth mindsets'

Anita Campbell | *University of Cape Town, Cape Town, South Africa*

Students who have experienced failure in university mathematics may be unsuccessful in changing their academic behaviour due to limiting self-beliefs. A key self-belief that affects mathematics achievement is the belief that academic ability is fixed (known in social psychology as having a 'fixed mindset') rather than capable of growing (having a 'growth mindset'). Students with growth mindsets tend to ask questions, persist when challenged, and value learning more than looking smart. Students with fixed mindsets are more likely to view behaviour such as asking questions and working persistently as indicators of lower ability. The link between self-beliefs and behaviour, and the fact that beliefs are usually deeply held and difficult to change, may explain why students can describe what behaviour would improve their academic achievement and yet not succeed in making sustained changes to their behaviour.

Interventions to develop growth mindsets have mostly targeted school students rather than university students. In this presentation I discuss an intervention to develop growth mindsets in engineering mathematics students at a university in South Africa through a voluntary peer tutoring project on the social media platform WhatsApp. The project design and issues regarding data collection and data analysis on the qualitative data analysis software Nvivo will be discussed.

Understanding of Limits and Differentiation as Threshold Concepts in a First-Year Mathematics Course

Greg Oates | School of Education, University of Tasmania, Launceston, Australia;

Robyn Reaburn | School of Education, University of Tasmania, Launceston, Australia;

Michael Brideson | School of Physical Sciences, University of Tasmania, Hobart, Australia

Kumudini Dharmasada | School of Physical Sciences, University of Tasmania, Hobart, Australia

Threshold concepts remain relatively unexplored in mathematics, despite suggestions that the *troublesome nature* of such concepts pose a critical barrier to student understanding of mathematics. Many studies have identified student difficulties with limits, and their findings point to a strong likelihood that limits do indeed constitute a threshold concept in mathematics. This paper describes the initial results in a study that sought to investigate students' understanding of limits and differentiation from the perspective of *Threshold Concepts*. While the findings to date do not provide conclusive evidence for limits as a threshold concept, they

do reinforce the troublesome nature of the limit concept, and suggest some important implications for the teaching of limits consistent with previous studies.

The full paper of this presentation will be published in the Conference Proceedings.

MULTIPLE STREAM SESSION 6

Room Malfatti: Modelling

Analysis of undergraduates' works on an inverse modelling problem within the frame of mathematical working spaces

Victor Martinez-Luaces | FJR-Fing, UdelaR, Montevideo, Uruguay

This paper describes mainly two previous experiences, in Buenos Aires, Argentina, and Colima, Mexico. In both cases, an inverse modelling problem was proposed to undergraduates from different university careers. The students worked on it in different contexts; however, their productions had similarities and also differences, basically due to their mathematical background as well as other circumstances that are studied in detail here. With the aim of analysing the development of their mathematical work, we consider the framework given by the "Mathematical Working Space" (MWS) developed by French scholars which has been widely used by francophone and Latin American researchers.

The study presents a brief introduction of the MWS framework, and then it expounds the selected problem and the several reformulations. After that, in the following two sections the cases of Buenos Aires and Colima are presented. The outcomes of these teaching and learning experiences are studied within the MWS framework and taking into account the obtained results, various final conclusions are drawn.

The full paper of this presentation will be published in the Conference Proceedings.

Approximations of e and pi: an exploration

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Fractional approximations of e and π are discovered by searching for repetitions or partial repetitions of digit strings in their expansions in different number bases. The discovery of such fractional approximations is suggested for students and teachers as an entry point into mathematics research.

Predicting Second Year Mathematics Success using Statistical Models

Lizelle Fletcher | *Department of Statistics, University of Pretoria, South Africa*

In the pursuit of student success, the Natural and Agricultural Science (NAS) Faculty at the University of Pretoria in South Africa is paying particular attention to undergraduate courses with a low pass rate. Mathematics students is one specific group of second year students that are of concern. The NAS Faculty identified a need for a model to inform decisions on admission requirements and possible rerouting of students, based on existing student data.

Several sets of student data were merged to construct models for predicting success of second year students. It was found that performance in the first year of study, mathematics performance in the students' matric year, as well the sex and mother tongue vs. preferred language of instruction significantly contributed to explaining second year performance in mathematics. (South Africa has eleven official languages, reflecting its ethnic diversity, however this is recognised as a potential obstacle in the teaching of subjects with a technical language.)

CHAID analysis, a data segmentation technique, was used to create tree-based classification models to explicate the relationship between second year mathematics performance and the various predictors. In addition, multinomial logistic regression models were constructed to further explore the influence of the first year modules, and where applicable, the prerequisite second year modules, on the outcome of second year mathematics modules. So-called "Safe" and "At-risk" students were identified using the information obtained from the statistical modelling to assist in advising students about their subject choices.

Room Ticiano: Miscellaneous

Evaluating the effectiveness of clickers to optimize performance in a Statistics 100 course

Fransonet Reyneke

Lizelle Fletcher

Ansie Harding

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This paper focuses on the role of audience response systems, i.e. clickers in a large first level statistics course. Various intervention strategies were introduced over a period of several years with a view to improve students' learning and success rates. Departing from the traditional teaching model an online homework system was implemented, followed by the flipped classroom. Clickers were subsequently implemented to enable active and cooperative learning inside the lecture hall. This facilitates peer engagement and discussions amongst students who become more involved and enjoy using clickers. A clicker allows every student to submit an answer without fear of embarrassment by peers when answering incorrectly. Without clickers the same students tend to always answer the questions in class. Effective, anonymous feedback is another important advantage of clickers, not only for students but also for lecturers. Misconceptions of difficult concepts can immediately be dealt with and provide students with interaction opportunities. Class attendance can also be monitored and the influence of class attendance on performance be tested. More important is the versatility of clickers concerning assessment. There will always be human capacity constraints and therefore clickers should be used to its full potential in class. It should not only be used for formative, but also for summative assessment and both assessment processes are discussed and evaluated.

Attendance: The mismatch between academics and students. Who is right?

R. Nazim Khan | *University of Western Australia, Perth, Australia*

Most academics consider class attendance as key performance. Various strategies have been implemented in order to entice students to attend classes and engage more fully with the course, with limited if any success. This is a study on evaluating student performance based on attendance.

Engaging Distance Students

Cami Sawyer | *Massey University, New Zealand*

Teaching an introductory university mathematics course for students studying by distance is challenging. Over the past 4 years I have been transforming a course covering the basics of algebra, matrices, and calculus, from being delivered primarily by paper to using technology. The course has had issues with engagement and preparedness because there are a large number of adult learners and students with full-time jobs. I am continually experimenting with combinations of incentives and disincentives to change student behaviour. I have incorporated online quizzes in the assessment and developed specialised videos for each topic. The videos are the change the students remark on the most. I will discuss what makes my videos different from Khan academy or other videos online, how I incorporate my teaching philosophy around student engagement into a directed teaching medium such as video, and other changes I am looking at exploring.

Room Monet: Miscellaneous

A tale of two journeys

Barbara Miller-Reilly | *University of Auckland, Auckland, New Zealand*

Charles O'Brien | *Business consultant, Auckland, New Zealand*

Two decades ago we met: Charles, a young business man needing assistance with a debilitating fear of mathematics; Barbara, an experienced teacher of maths-avoidant adults, in the early stages of research for her doctorate. Both of us were embarking on big challenges. An initial six-month course enabled Charles to progress from viewing mathematics as "the most disgusting, unappealing building" to one "with form, balance and symmetry" and, on the other hand, the metaphors gathered from Charles became an illuminating part of Barbara's PhD thesis. Recently Charles asked Barbara to teach him again, trying to meet the mathematical prerequisites for entry to a post-graduate business degree. This talk considers our reflections of our respective journeys over two decades.

Charles' experience is that overcoming mathematics anxiety during adulthood is a transition of major magnitude. The stages in Charles' story are his perception of a need, his commitment to address the problem by taking specific actions to become

more comfortable with mathematics, his recognition of a turning point having been reached, which has resulted in a change in his mathematical perspectives and concern for others with similar needs. Barbara felt a great personal achievement completing her doctorate, as it was the culmination of much of her previous experiences both in life and in her profession. It also resulted in further professional recognition, as well as personal and professional growth. We come from different sub-groups in society: an academically-able maths-avoidant adult; and a mature woman undertaking doctoral studies. Unexpectedly we each provided a crucial component of the other's journey.

Accommodation in the formal world of mathematical thinking

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In this study, we examined a mathematician and one of his students' teaching journals and thought processes concurrently as the class was moving towards the proof of the Fundamental Theorem of Galois Theory. We employed Tall's framework of three worlds of mathematical thinking as well as Piaget's notion of accommodation to theoretically study the narratives. This paper reveals the pedagogical challenges of proving an elegant theory as the events unfolded. Although the mathematician was conscious of the students' abilities as he carefully made the path accessible, the disparity between the mind of the mathematician and the student became apparent.

First Year Engineering Mathematics: What's the Optimal Blend?

Diana Quinn | *Teaching Innovation Unit, University of South Australia, Australia*

Bronwyn Hajek | *School of Information, Technology and Mathematical Sciences, University of South Australia, Australia*

Jorge Aarão | *School of Information, Technology and Mathematical Sciences, University of South Australia, Australia*

There are many choices for learning mathematics for engineering students with courses available in face-to-face, blended and fully online modalities. Students are demanding more flexibility in their programs, however the temptation to misuse this flexibility to avoid mathematical studies until it is too late can be an

unfortunate side effect. Using the 3P model of student learning as a guide, we explore what happens when you try to find the optimal blend – the best of the available online and face-to-face teaching and learning to create a motivating student-centered learning experience that is flexible, effective and engaging for first year engineers. Developments trialled included online quizzes for changing attitudes and teaching foundational concepts, online lecture options, the adoption of Board Tutorials supported by a problem-solving approach for more complex engineering modelling problems and online interactive problems. The optimal blend will depend on the course and its students. Implementing blended learning by combining the best of online learning tools and F2F learning activities can make for excellent courses provided that the focus remains on student learning rather than course delivery.

The full paper of this presentation will be published in the Conference Proceedings.

POSTERS

Statistical literacy and projects

Cassio Cristiano Giordano | Pontifícia Universidade Católica de São Paulo

Statistical literacy is critical for academic education, for professional life, and, above all, for the exercise of empowerment in our society, given the ease of access to data streaming from diverse media. Reading and interpreting these data, as well as expressing ideas informed by them, have become essential for every individual. However, despite the principles conveyed in Brazilian national and state curriculum guidelines, the teaching and learning of statistics have not received their deserved space in São Paulo schools in the majority of textbooks marketed for use in high schools. Project-based teaching and learning of statistics constitute opportunities to promote statistical literacy. Moreover, this approach has the potential to change, in a notable manner, the relationship among teacher, student, and knowledge, promoting greater autonomy for students to develop their own research. To analyze the development of literacy and changes in the didactic contract under a project-based approach, a case study was conducted. The subjects were 43 students aged 17-20 years from the high school, who were distributed into nine groups of four or five members. During two months they participated in the entire process of developing a statistical investigation, from selecting themes and

formulating research questions to the dissemination of results. The results revealed that this approach encourages the development of statistical literacy, creating conditions for a breach of the didactic contract – an important step in the development of students' autonomy, preparing them for future challenges in their lives, the university, the labor market and any other situation.

Selected calculus topics: a dynamic approach using Geogebra

André Nagamine | *Universidade Estadual do Sudoeste da Bahia, Brazil*

Camila Macedo Lima Nagamine | *Universidade Estadual do Sudoeste da Bahia, Brazil*

Rosane Leite Funato | *Universidade Estadual de Santa Cruz*

The process of teaching Differential and Integral Calculus (DIC) in Brazilian universities has been an object of study over several years. However, even in more recent research one aspect is common: the great difficulty presented by most students in understanding the subjects of these courses (Calculus I, Calculus II, etc.). A consequence of this fact is the high failure rate in DIC, which is also mentioned by several authors in the literature. Therefore, the objective of this work is to propose the use of the GeoGebra software, by the teacher, in certain topics of the DIC considered essential for the good understanding of this subject as a whole. The methodology consists in identifying which would be these essential points and then construct in GeoGebra a representation of that content that can facilitate the understanding of the points by the students. This methodology can be used in any of the courses of the DIC. We will use, as theoretical foundation, the theory of the Instrumental Approach, because within this theory GeoGebra would be what is considered as an instrument. In addition, we also rely on the Semiotic Representation Registry, because in the development of a certain topic of the DIC, GeoGebra allow us to obtain different records of representations of the objects studied.

Building graphics of two-variable functions using sliceforms

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Rosane Leite Funato | *Universidade Estadual de Santa Cruz, Brazil*

Liliane Xavier Neves | *Universidade Estadual de Santa Cruz, Brazil*

Joedson deJesus Santana | *Universidade Estadual de Santa Cruz, Brazil*

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In the study of the construction of graphs of functions of two variables we can visualize interesting mathematical objects. However, it is not always an easy task to represent them graphically, that is, a set of points in three-dimensional space whose coordinates obey a given law. In this sense, we present a proposal to assist in the construction of function graphs of two variables using the technique known as Sliceforms, starting from the interaction between the analytical and geometric representations of the function boundary maps of two previously selected variables, to explore the interactions between the Algebraic and graphical representations of these functions. Sliceforms is a technique that unites art and mathematics, allowing the construction of models that are made by intersecting sets of parallel regions parallel to each other, which together can generate interesting spatial surfaces. The structure of these models can be folded flat, as well as provide the spatial visualization of two sets of orthogonal patches with each other. Geogebra and Maple software were used to construct the sketches of the contours, contour map, function graphs and other mathematical objects we used for the construction of Sliceforms. For the development of learning with the help of the software in question and the concrete Sliceform model, approached as instruments, it is based on the Instrumental Approach.

Analysis of resolutions provided by engineering course students for the problems proposed, a meaningful view

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José Cláudio Del Pino | *Universidade do Vale do Taquari – UNIVATES, Brazil.*

Instigated by the fact that Higher Education students express conceptual and procedural difficulties regarding the interpretation, analysis and solving of problems, and such skill being deemed necessary for the Calculus I subject, it was decided to investigate how students taking that subject solved problems. Taking as theoretical foundation Ausubel's Theory of Meaningful Learning as proposed by David P. Ausubel and followed up, interpreted and complemented by Joseph

D. Novak (Ausubel et al., 1980) and D. Bob Gowin (1981 apud MOREIRA, 2006), in which the main idea is to consider what learners already know and, by stating that, Ausubel intends to focus on the individual's cognitive framework, that is, the ideas and contents they have regarding a given topic, it was intended to map out students' previous ideas with the objective of teaching them accordingly by identifying the basic organizational concepts and utilizing resources that would facilitate learning in a meaningful fashion. Meaningful learning is a process through which a new piece of information interacts with the existing, specific knowledge framework (subsumer concept) resulting in a new piece of information that acquires a new meaning, including for the pre-existing subsumers. After categorizing the obtained solutions, it was perceived that most students did not use mathematical knowledge taught at school for the proposed problem solving, but did use resolutions that contained their own logical reasoning in such a way that equations appeared with low frequency.

Production of videos with Mathematical content: a look through social semiotics

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Marcelo de Carvalho Borba | *Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro, Brazil*

This article presents data from a research on the production of videos with mathematical content developed in the city of Blumenau, state of Santa Catarina (Brazil). Middle school students (aged 13-14) from three municipal schools produced videos, where they expressed their mathematical ideas about some topic of the curriculum. On the whole, 19 videos were produced during the research. This article analyzes one of these videos, using the social semiotics theory, which takes into account not only the final video produced, but also the production process. When this process - involving humans-with-media - is taken into account, it is possible to understand the choice of producers for certain modes and designs used in the video.

Virtual mathematics and teacher training: use of information and communication technologies in public spaces

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Wenden Charles de Souza Rodrigues

Salete Maria Chalub Bandeira

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The purpose of this article is to present the actions of the virtual mathematical project that aims at the interaction of students involved with mathematics teaching and Information and Communication Technologies (ICT), using GeoGebra on smartphones or computers. The project was funded by the Acre Research Support Foundation (FAPAC) and counts on the partnership of the High Schools of the municipalities of Rio Branco and Tarauacá; College of Application of the Federal University of Acre (UFAC); Center for Educational Innovation (CRIE / SEE-AC) through the Institute of Mathematics, Sciences and Philosophy of Acre and UFAC. Teachers of these institutions acted as instructors of the Project Courses. Our methodological proposal is to train teachers that can “multiply” and disseminate the teaching of mathematics through the use of ICT both in the capital and in the small villages of Acre, one of the states located in the Amazon jungle. Courses were offered for five groups of twenty UFAC students, mostly scholarship holders of the Institutional Program of Teaching Initiation Scholarship (PIBID) to act as multipliers. In this paper we present the experience of a State School involved with the project and with five “Pibidians” students, to offer workshops for two hundred and fifty students of the first year of High School. Faculty from UFAC acted as advisors. Our work is based on that of Borba, Silva and Gadaniadis (2015) which addresses the phases of digital technologies in Mathematics Education; Borba and Penteado (2005) with a focus on Informatics and Mathematics Education; Araújo e Nóbrega on learning mathematics with GeoGebra and others. As a partial result, the project in the training phase with the multipliers has been favorable to create a dynamic paradigm for teaching mathematics with current technologies.

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A tale of two diagnostic tests

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It is not uncommon to use what are called diagnostic, placement, readiness or competency tests once students arrive at university to gauge their basic skills in mathematics or literacy. This paper begins by discussing diagnostic mathematics tests, including the many reasons for which these are run and what actions might then be taken.

Two such tests with repercussions for students are discussed. These two tests are for different student cohorts and are run for different reasons. Their purposes and the actions taken as a result of the tests are considered. The tests have a positive impact on student learning.

