

Research in Mathematics Education (RME)

A group of academics and research students from the School of Education and Lifelong Learning sharing interest, experience and expertise in mathematics education



RME Funders



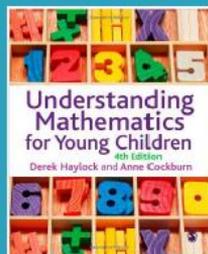
Pedagogical perspectives of university mathematicians

Collaborative research with university mathematicians reflecting on samples of student work to analyse student understanding and their own teaching practices



Securing the understanding of key mathematical ideas

A highly influential, research-informed approach through real-life examples, classroom data illustrations, classroom activities recommendations and – crucially – pauses for reflection and teachers' own practising of mathematics



Is mathematics T.I.R.E.D.?
Studying quiet disaffection in the secondary mathematics classroom
14yr olds experience mathematics as **Tedious, Isolating, Rote-learning, Elitist and Depersonalised**



M.U.M.A.P. Mapping University Mathematics Assessment Practices
Identifying *patterns of assessment* across universities in England and Wales; case studies of *innovative assessment practice*
dominance of closed book examination; some tailoring of assessment to different branches of mathematics; students' preference for closed book examination.

ACADEMIC VISITORS AND COLLABORATORS FROM ACROSS THE WORLD

8 doctoral completions since 2008 ★ mathematics undergraduates' adaptation of abstract mathematical discourse ★ business students' conceptual understanding of statistics ★ the role of peer interaction in adolescents' self-regulated learning ★ conceptual change in primary children's understanding of fractions ★ effectiveness of group-work in primary lessons ★ autoethnography of mathematics teaching ★ catering for individual differences in mathematical learning ★ primary children's views of mathematics through drawing



2003



2013

Keynote at conference in celebration of Professor Juha Oikkonen

Elena Nardi

Friday, 25 October 2019

e.nardi@uea.ac.uk

@mathtask

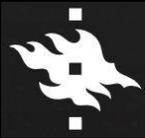
Thank you

for the invitation, your hospitality and your presence today!

Research in Mathematics Education (RME) Group at UEA

www.uea.ac.uk/education/research/areas/mathematics-education





I draw on my experiences as a mathematics education researcher collaborating with research mathematicians in order to tell, and celebrate,
a story of paths crossing at four points:
in research, teaching, professional development and public engagement.

I discuss these four tiers of examples to propose a re-imagining of this story, not merely as a story of paths crossing – but as **a story of paths ‘meeting’ at a vanishing point**, a point where the boundaries between the two communities fade into insignificance, recede and may even be replaced by a strong sense of **joint and multi-faceted enterprise**.

I conclude with indicating how this joint enterprise may look like in the near future and for action that may bring about **positive and lasting change**.

Elena Nardi, e.nardi@uea.ac.uk, @mathtask

Research in Mathematics Education (RME) Group at UEA

www.uea.ac.uk/education/research/areas/mathematics-education



Today's talk is based on:

2014. Mathematics in Undergraduate Study Programmes: Challenges for Research and for the Dialogue between Mathematics and Didactics of Mathematics. Oberwolfach, Germany.

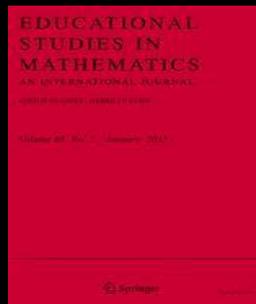


2015. The many and varied crossing paths of Mathematics and Mathematics Education *Mathematics Today (Special Issue: Windows on Advanced Mathematics)*, August, [212-215](#). Edited by Celia Hoyles and Richard Noss.

2015. Where form and substance meet: Using the narrative approach of *re-storying* to generate research findings and community rapprochement in (university) mathematics education. *Educational Studies in Mathematics* [92\(3\), 361–377](#).

2016. Exploring and overwriting mathematical stereotypes in the media, arts and popular culture: The *visibility spectrum*, *khdm-Report*, [5, 73-81](#)

2017. From *Advanced Mathematical Thinking* to *University Mathematics Education*: A story of emancipation and enrichment. In T. Dooley & G. Gueudet (Eds.), *Proceedings of the 10th Conference of European Research in Mathematics Education (CERME)* ([pp. 9-31](#)). Dublin City University: Ireland.



...but it is most closely an updated variation of two talks, n
2015 and 2018



INAUGURAL LECTURES

AUTUMN 2015



Tuesday 27 October, 6.30pm
**MATHEMATICS AND MATHEMATICS
EDUCATION: A STORY OF PATHS
JUST CROSSING OR OF MEETING
AT A VANISHING POINT?**

Prof Elena Nardi
School of Education and
Lifelong Learning Sciences

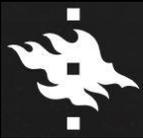
JSC lecture theatre

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E events@uea.ac.uk
W uea.ac.uk/events



British Federation of Women Graduates



Synergy between mathematicians and mathematics educators: A story of many, and potent, facets / Conference in celebration of Professor Juha Oikkonen / Fri 25 Oct 2019 / University of Helsinki

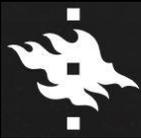


***Mathematics and Mathematics Education:
A story of disciplinary paths crossing
or of meeting at a vanishing point?***



Research in Mathematics Education (RME) Group at UEA
www.uea.ac.uk/education/research/areas/mathematics-education





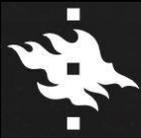
Today:

I draw on my experiences of collaborating with colleagues from mathematics in order to tell **a story of paths crossing**, of mathematicians and mathematics educators intersecting at various points in **research, teaching, professional development and public engagement activities**.

In this story I position myself as a **(non-research) mathematician who chose to become a researcher in mathematics education** and has been involved in these collaborations for 25 years.

The story has three parts.

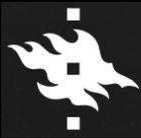




- First (Part I) I trace the **relationship between mathematicians and mathematics educators** (particularly in research) and I offer a potted account of issues that have been helping this relationship grow, grow at a not-always satisfactory pace or occasionally stall.
- Then (Part II) I offer **examples of initiatives deepening this relationship**, from research, teaching and professional development.
- Then (Part III) I offer examples of **initiatives where the two communities have been working together towards the strengthening of another, very crucial, relationship: that of the public with mathematics.**

A closing thought which (may!) explain today's title answer the ...'so what?' and 'what's next?' questions...

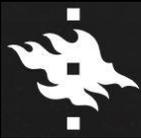




To start with:

Why does the relationship between mathematics and mathematics education matter in the first place?





Synergy between mathematicians and mathematics educators: A story of many, and potent, facets / Conference in celebration of Professor Juha Oikkonen / Fri 25 Oct 2019 / University of Helsinki



Changing student demographic

Increasing sensitivity to student needs

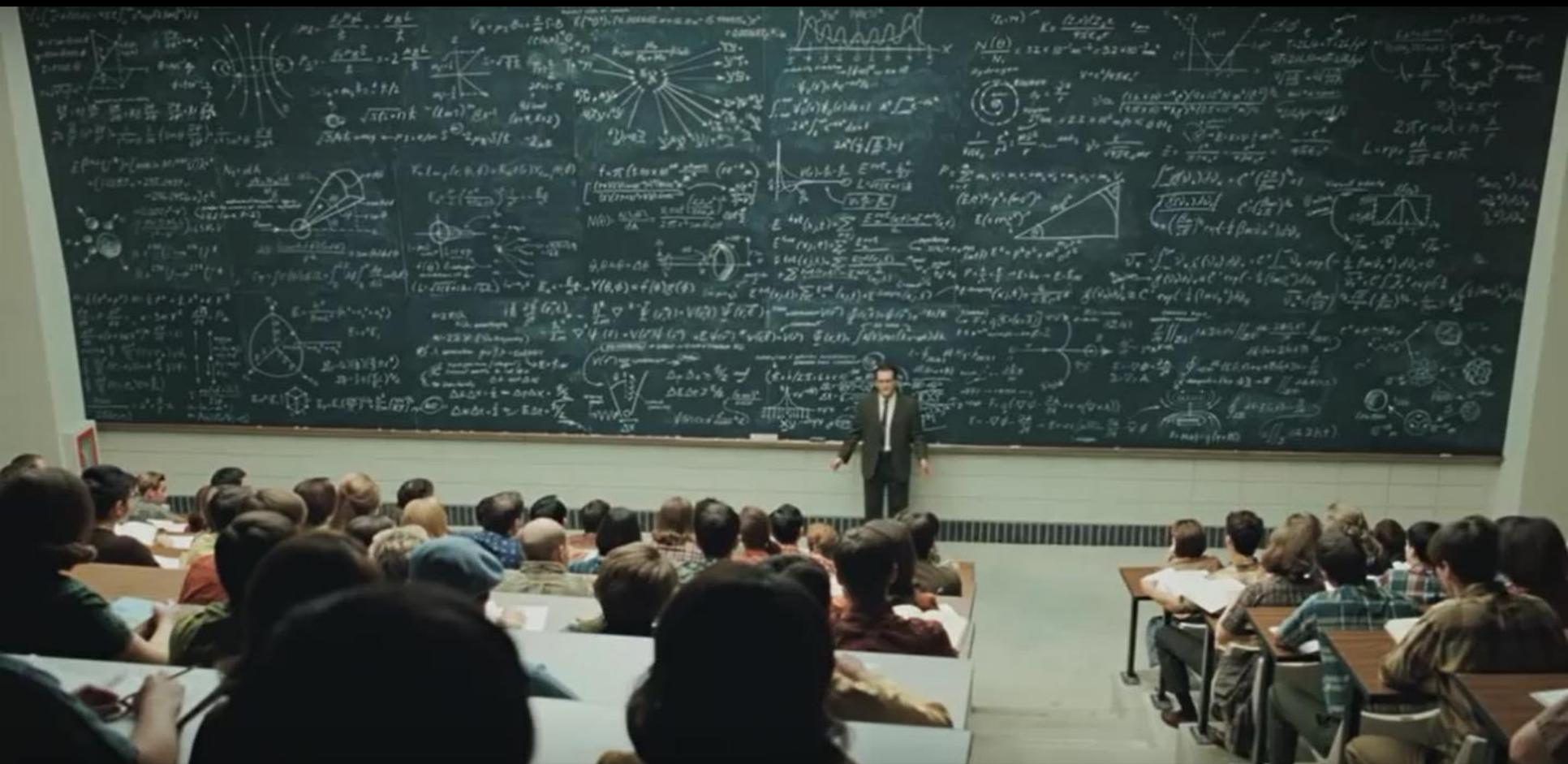
Shifts in university pedagogies

Employability

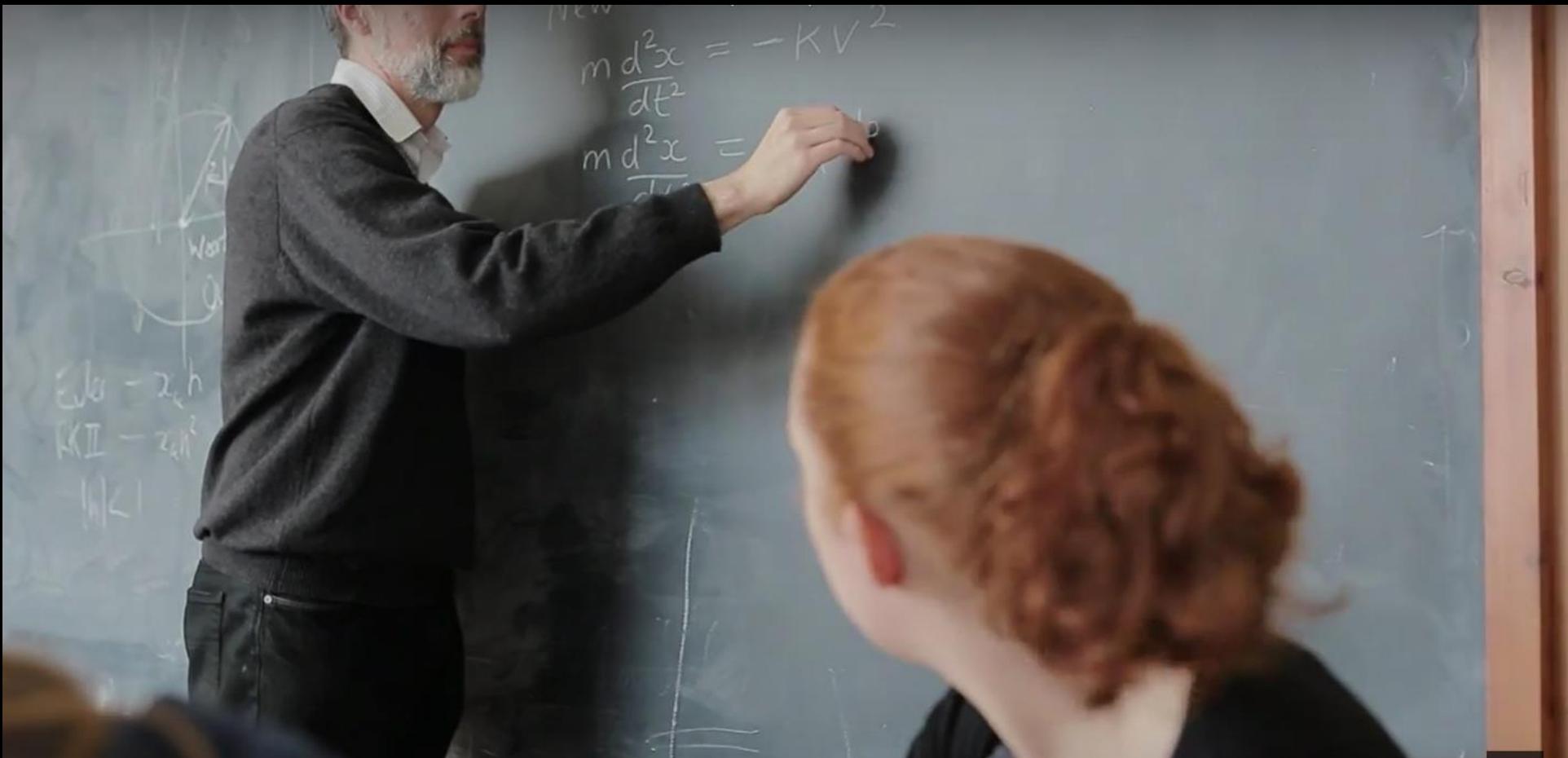


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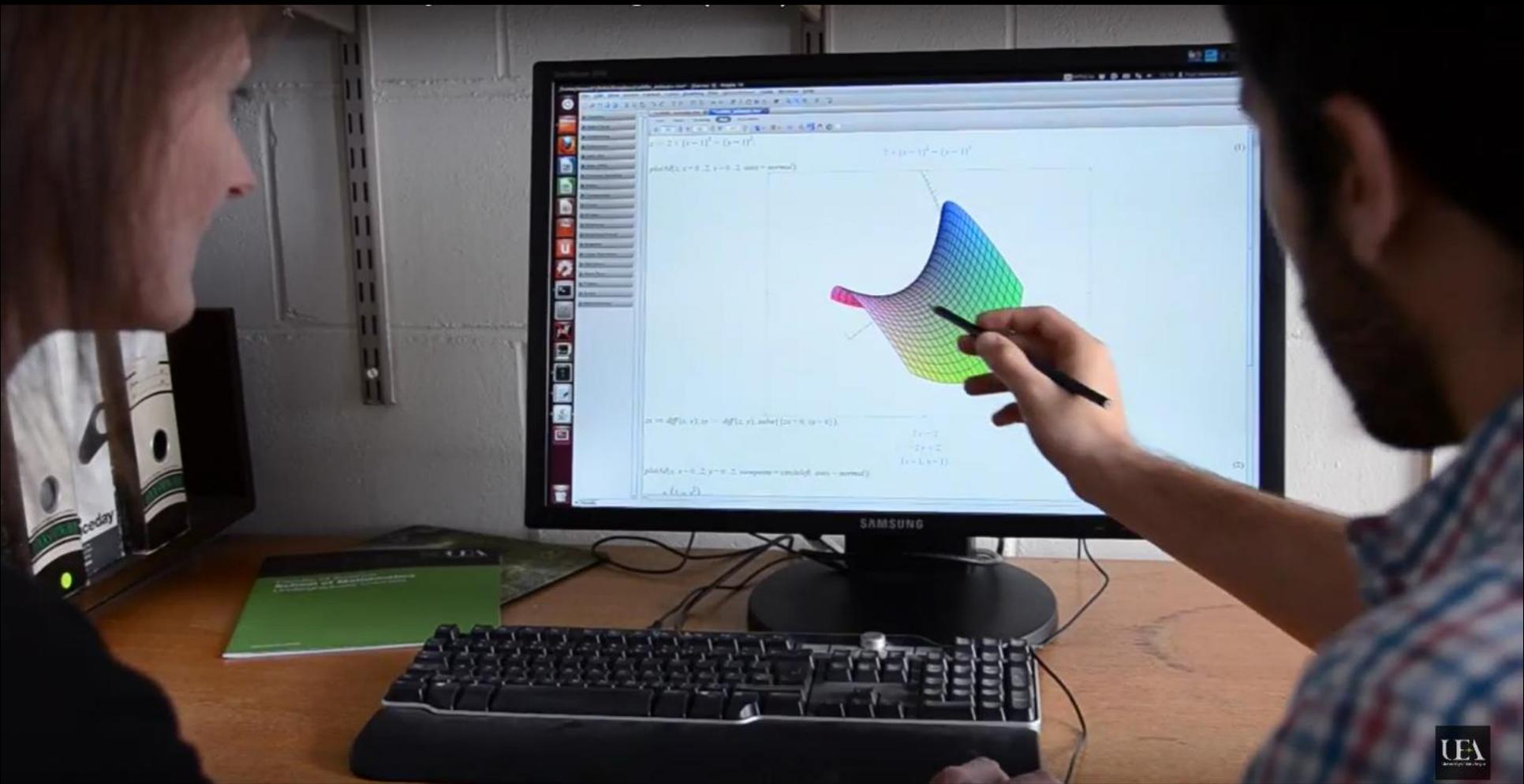




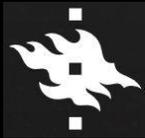
Still taken from A Serious Man (2009): <https://www.youtube.com/watch?v=7iggyFPls4w>



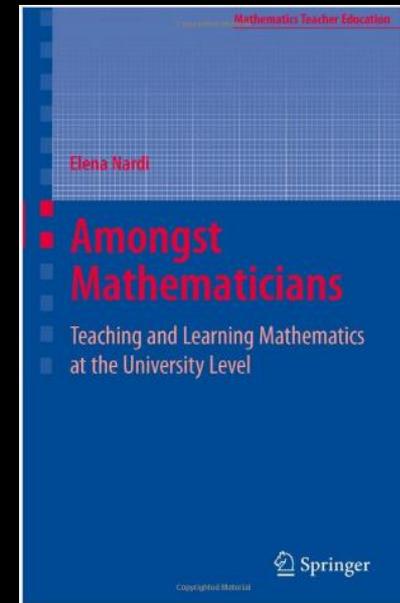
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Still taken from UEA promotional video: <https://www.youtube.com/watch?v=qRzVX8c1be4>

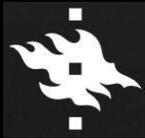


- A common observation: the **fragility of the relationship between M and RME**
- (denial, oblivion, suspicion...)
- Relationship between M and RME: perceived **benefits, obstacles and desires**
- Reporting such conversations is not new.
- Example: 1998. Anna Sfard's discussion with Shimshon A. Amitsur.
- Range of authors from a variety of contexts: Michèle Artigue, Gerry Goldin



**Ch8. Fragile, yet crucial:
The relationship between
mathematicians and
researchers in
mathematics education**





p.257-292: Chapter 8. Fragile, yet crucial: The relationship between mathematicians and researchers in mathematics education

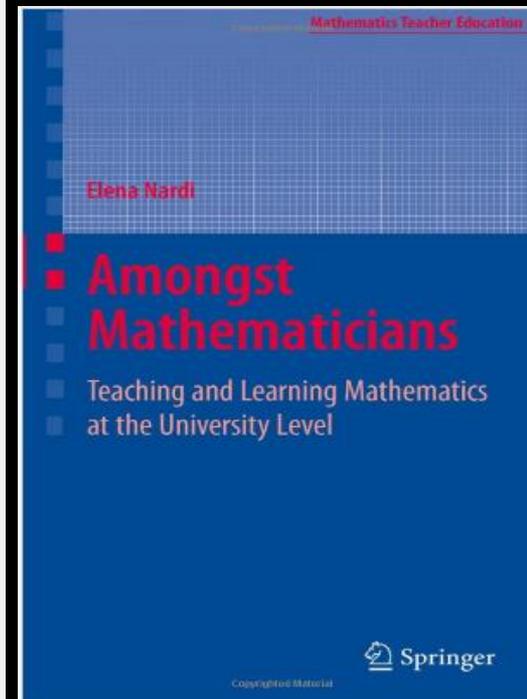
M cites the **benefits** for pedagogical practice ensuing from

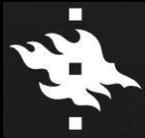
- using the findings of educational research
- engaging with educational research

M also reflects on, and often **critiques**, the practices of RME

- how RME *is* done
- how it *could* be done
- how RME theory is being built
- how RME is written up
- how RME is being disseminated.

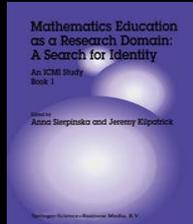
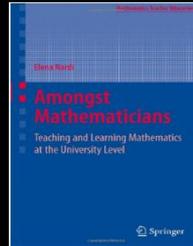
Finally M and RME acknowledge the **stereotypical perceptions** of mathematics, mathematicians and educational research that **tantalise their relationship**.





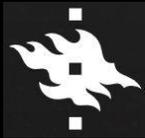
Fragile, yet crucial: The relationship between mathematicians and researchers in mathematics education

- RME needs to stay as **close to M** as possible.
- M suspicion generated by the **explosion of theories in RME** that methodologically and epistemologically M may not understand.
- M's didactician = **sub-mathematician syndrome**
- M may seek **help from RME**, but RME cannot always offer that help (Brousseau's criteria for RME output such as relevance, immediacy, freedom from jargon)
- RME may **expose weaknesses of teaching** and complicity in the malfunctioning and ineffectiveness of an educational system. It can therefore be unpleasant, even disturbing, and thus be ignored or disregarded by M. M may also disregard the complexity of learning issues and RME's sometimes **convoluted recommendations** may annoy M.
- RME needs to engage more systematically with disseminating its outputs to **less specialist, but committed** like M, audiences.
- **RME as a field is both basic and applied.**



Artigue (1998). Research in mathematics education through the eyes of mathematicians.





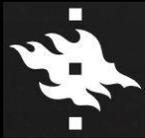
Examples from:

Research (R)

Teaching (T)

Professional development (PD)

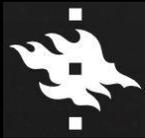




Research dating from 1990s to to-date to trace the evolution of collaborative research between M and RME

- i. from studies of university **mathematics students' learning** of particular mathematical topics (e.g. 1996 doctoral thesis)
- ii. to a progressively shifting focus on **university mathematics teachers' perspectives/practices** in mathematics and mathematics teaching (e.g. UMTP, *Amongst Mathematicians*).
- iii. to more recent **more specialised studies of a smaller 'grain size'** that may grow into **change research**
- iv. (in parallel) systematic engagement with *University Mathematics Education (UME) theory*





Synergy between mathematicians and mathematics educators: A story of many, and potent, facets / Conference in celebration of Professor Juha Oikkonen / Fri 25 Oct 2019 / University of Helsinki **Part II Deepening the relationship between M and RME /R**



(doctoral thesis, 1996)

www.uea.ac.uk/~m011

***The Novice Mathematician's Encounter With Mathematical Abstraction:
Tensions in Concept-Image Construction and Formalisation***



Excerpts from the Abstract

...20 first-year mathematics undergraduates were observed in their weekly tutorials in four Oxford Colleges during their first two terms (200h) on Foundational Analysis, Calculus, (Topology), Linear Algebra and Group Theory. The students were also interviewed twice.

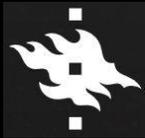
...The novices' encounter with mathematical abstraction was described as a **personal meaning-construction process** and as an **enculturation process**: the new culture is Advanced Mathematics introduced by an expert, the tutor.

...Concept image construction was described as a **construction of meaningful metaphors** and an exploration of the ***raison d' être* of the new concepts and the new reasoning** and was characterised by the **tension between the Informal/Intuitive/Verbal and the Formal/Abstract/Symbolic.**



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A flavour of findings from the doctoral thesis...

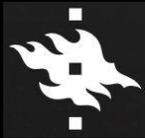
MATHEMATICS UNDERGRADUATES' RESPONSES TO SEMANTIC ABBREVIATIONS, 'GEOMETRIC' IMAGES AND MULTI-LEVEL ABSTRACTIONS IN GROUP THEORY



1. The **static and operational duality** within the concept of **order of an element** as well as the **semantic abbreviation** contained in $|g|$.
2. The often problematic use of **'times'** and **'powers of'** in association with **the group operation**.
3. The ambivalent use of **'geometric' images** as part of meaning bestowing processes with regard to the notion of **coset** and **quotient group**.
4. The problematic conceptualisation of the **multi-level abstractions** embedded in the concept of **isomorphism**.

(Nardi, 2000)





Progressively shifting focus on university mathematics teachers' pedagogical and epistemological perspectives

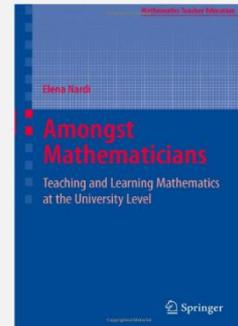
UMTP (University Mathematics Teaching Project)

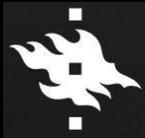
Spectrum of Pedagogical Awareness

with Barbara Jaworski and Stephen Hegedus



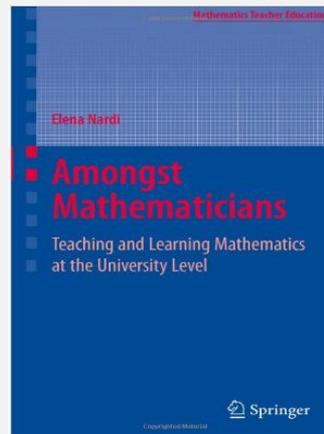
Amongst Mathematicians
Teaching and learning mathematics at University Level
With Paola Iannone

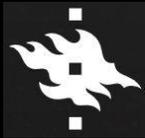




5 key research characteristics

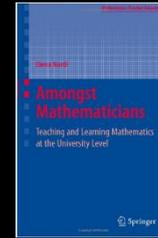
collaborative
mathematically focussed
context-specific
non-prescriptive
non-deficit





Flavour of findings [ch.4]

M's pedagogical and epistemological perspectives
on students' **mediating mathematical meaning**
through words, symbols and diagrams



0. To appear and to be:

Conquering the 'genre' speech of university mathematics

1. Strings of Symbols and Gibberish – Symbolisation and Efficiency

- (i) Desperate juggling of axioms and random mathematics
- (ii) To-ing and fro-ing between mathematics and language

2. Premature Compression:

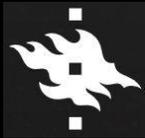
- (i) Why is $\det(aI_n) = a^n$ true?
- (ii) Why is $xox = xox^{-1} \Rightarrow x = x^{-1}$ true?

3. Visualisation and the role of diagrams

4. Undervalued or Absent Verbalisation

and the Integration of Words, Symbols and Diagrams





Signs of maturity?

Recent studies of a **smaller** “grain size” ...

Thoma, A. & Nardi, E. (2018). Transition from school to university mathematics: Manifestations of unresolved commognitive conflict in first year students’ examination scripts. *International Journal for Research in Undergraduate Mathematics Education* [4\(1\), 161–180](#).

...but also attempts to trace **discursive shifts** over a longer period of time...

Viirman, O. & Nardi, E. (2019). Negotiating different disciplinary discourses: Biology students’ ritualized and exploratory participation in Mathematical Modelling activities. *Educational Studies in Mathematics* 101(2), [233-252](#).

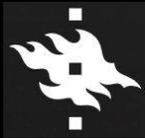
...and thus register and embed more **rigorous, longitudinal change?**

Moustapha-Corrêa, B., Caetano da Silva Bernardes, A., Giraldo, V., Biza, I. & Nardi, E. (due Dec 31). [working title: Facilitating shifts of mathematics teachers’ pedagogical and epistemological discourses through history-focussed MathTASK activities]. *Journal of Mathematial Behavior*.

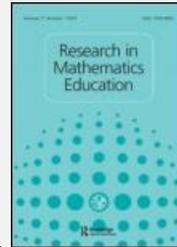
Could these types of study be the **rising stars of change research**
in university mathematics education?

[work to be reported in ICME14 in 2020, and in preparation with Chris Rasmussen and Dan Reinholz]





Systematic engagement with theory
A Special Issue
Institutional, sociocultural and discursive approaches to research in university mathematics education
Research in Mathematics Education 16(2), July 2014
Selected approaches
Anthropological Theory of the Didactic
Theory of Didactic Situations
Instrumental and Documentational Approaches
Communities of Practice and Enquiry



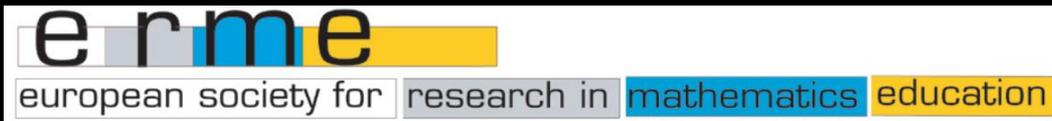
Theory of Commognition

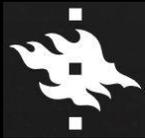
Guest-edited by:

Elena Nardi, Irene Biza, Alejandro González-Martin, Ghislaine Gueudet, Carl Winsløw



How may these approaches offer **complementary, overlapping and in some cases diverging or even incommensurable** lenses on UME research questions?





Examples from **teaching**

to trace the evolution of collaboration between M and RME towards:

- a more inclusive approach to **mathematics education modules in mathematics programmes**

The learning and teaching of mathematics (led by Irene Biza)

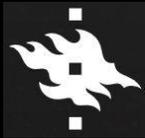
Children, teachers and mathematics: Changing public perceptions of mathematics

- engaging mathematics education researchers with **teaching mathematics modules and support for student learning**

[UEA: Problem Solving, Mechanics & Modelling, with Iannone and Biza]

[UEA Student Support Services, with Thoma and Papadaki]

[elsewhere: e.g. Loughborough's MEC, Agder's MatRIC]



Examples from **professional development**

to trace the evolution

from generally **unpopular, non-discipline specific training**

of new lecturers in mathematics

to more appealing, **mathematics-specific training** formats

RME involved in the training of new M and offer opportunities

- to familiarize with mathematics education research findings
- to reflect on practice

Proof 'guide'

UEA Centre for Staff Educational Development

MA Higher Education Practice Module:

Evaluative Conversation

How to Prove It:
A brief guide
for teaching Proof
to Year 1 mathematics undergraduates

Elena Nardi and Paola Iannone

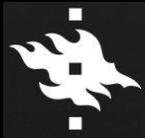
0 .	d_{11}	d_{12}	d_{13}	d_{14}	...
0 .	d_{21}	d_{22}	d_{23}	d_{24}	...
0 .	d_{31}	d_{32}	d_{33}	d_{34}	...
0 .	d_{41}	d_{42}	d_{43}	d_{44}	...
⋮	⋮	⋮	⋮	⋮	⋮

$$x_n = 0.d_{n1}d_{n2}d_{n3}d_{n4} \dots$$



University of East Anglia

MA in Higher Education Practice
HANDBOOK 2014-15



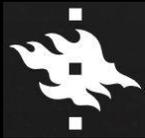
Examples from:

Research (R)

Teaching (T)

Professional development (PD)

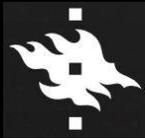




Examples of initiatives

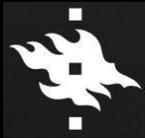
where the two communities have been working together towards the strengthening of another, very crucial and often very fragile, **relationship:** that of the **public with mathematics**

- **research and development** activity
 - teaching mathematics to non-mathematics students and raising the profile of mathematics education research
 - teaching mathematics in school (teacher preparation)
- **teaching *about*** mathematics to non-mathematics students
- **engagement** activity: raising public appreciation of mathematics

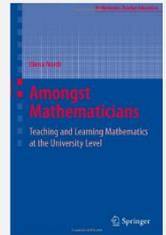


Research and development work into
teaching mathematics to non-mathematics students and raising the profile of RME

- Ongoing collaboration between the **RME Group and several UEA Schools / Student Support Services**
- Ongoing collaboration with the Centre for Research and Innovation in Mathematics Teaching, **MatRIC**, Norway.
- Recent collaborations with Mathematics Departments in Athens (Greece), Seville (Spain), Tunis (Tunisia), Dortmund (Germany), Rio de Janeiro (Brazil), Auckland (New Zealand) etc.



Research and development work into teaching of school mathematics
Using situation-specific tasks to trigger teacher reflection



- Fostering **advanced mathematical thinking** in the mathematics classroom
- Balancing act between **classroom management** and mathematical learning
- Exploring the potentialities of **digital resources** in the mathematics classroom
- Challenging Ableist Perspectives on the Teaching of Mathematics **CAPTeanM**



Transforming **A**spirations *into* **S**trategies **i**n **C**ontext
involving, so far, hundreds of mathematics teachers, led by Irene Biza



teaching **about** mathematics to non-mathematics students BA Education

Children, teachers and mathematics: Changing public perceptions of mathematics

Year 3, Autumn Semester



We explore a range of issues that relate to young children's learning of one of the most **important, yet notoriously feared and misunderstood**, subject: **mathematics!**

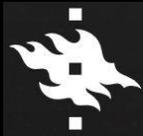
[...]We aim to share some of the **excitement** experienced by those who love mathematics – enthusiastic teachers, university mathematicians and other professionals – but we also examine some of the key **challenges** that young children face when they engage with mathematical learning in primary school.

We investigate where the social and psychological '**stigma**' of mathematics comes from – the fear that prevents many from building a good relationship with mathematics.

We juxtapose this 'stigma' with results of neuroscience that show that mathematical thinking is quite natural; in fact that **mathematical ability is innate to all human beings!**

We also juxtapose these research findings with examples from **popular culture** (TV, films, pop music) and the arts that seem to **perpetuate** largely '**math-o-phobic**' images.

We consider how **education**, particularly in the crucial years of primary school, **can work against the tide of such images** and introduce children to the creativity and excitement of mathematics!



Synergy between mathematicians and mathematics educators: A story of many, and potent, facets / Conference in celebration of Professor Juha Oikkonen / Fri 25 Oct 2019 / University of Helsinki *Part III: Deepening the relationship of the public with mathematics*



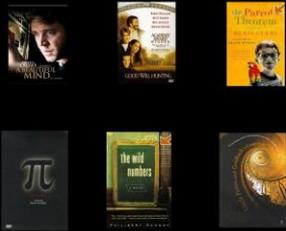
**A GOOD MOMENT IN TIME TO STOP
'SHYING AWAY FROM THE NATURE OF OUR SUBJECT'?
TOWARDS AN OVERWRITING OF MATHEMATICAL STEREOTYPES IN POPULAR CULTURE***
(or: from invisibility to exotic presence, political correctness and normalisation/acceptance)

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'I liked singing, athletics, English. I hated Arithmetic. I never had my mind on it. You know, I was always dreaming off the window.'
Marilyn Monroe on her feelings towards school subjects at about 14
Marilyn on Marilyn, BBC documentary

The relationship between mathematics and students is often tantalised by perceptions of tedium, difficulty, lack of creativity, elitism and unsociability. *Outside* schooling one influence on young people's attitudes (and choice of field of study) originates in representations of mathematics and mathematicians in popular culture.

The abundance of certain images of mathematics painstakingly reinforced by popular culture (e.g. 'madness/strangeness', 'intelligence as devious artifice', 'ivory-towerism') establishes that this representation is still far from desirable.



EVIDENCE: TimeOut Film Guide (2005).
Number of films indexed under
SCIENTISTS: 15. INVENTORS: 22
MAD SCIENTISTS (a separate entry!): 72

CLAIM: The timing for considering questions such as 'if we were to work towards overwriting stereotypical images, how receptive would lay consciousness be to a more accurate, and appealing, representation of mathematics?' might be rather good... given recent **signs** (e.g. from press, film, TV, theatre, literature and popular music) which seem to suggest a shift towards a more intelligent and subtle representation...



BAND: Coldplay
ALBUM: X & Y
SONG TITLES:
The Scientist, Proof, Twisted Logic etc

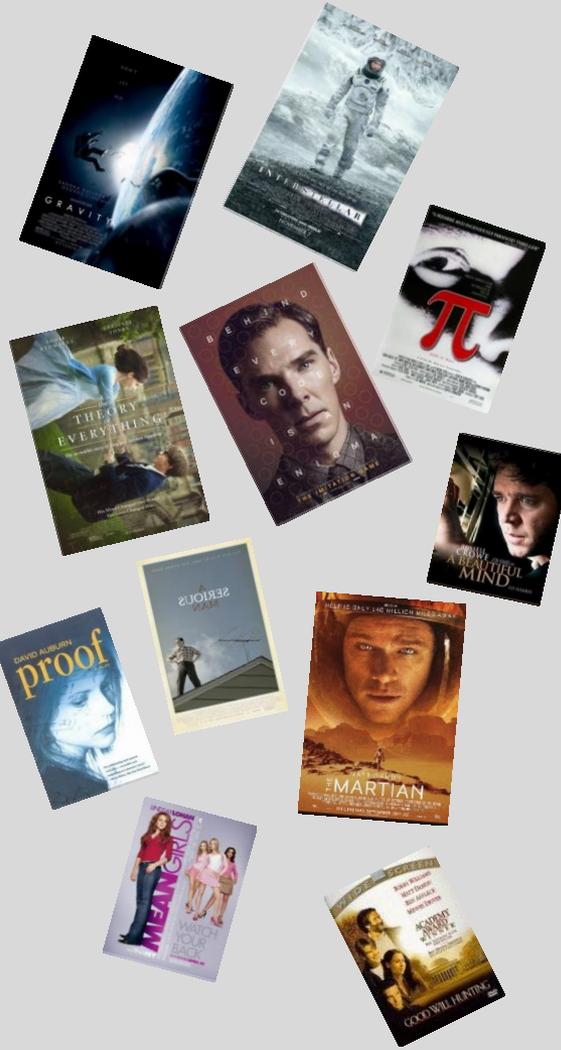
LYRICS: 'tidal waves', 'speed of sound', 'figures and numbers', 'proof', 'logic', 'deciphering the codes' etc.

...signs which our community needs to make the most of. Systematically, relentlessly and with gusto!

'We all use math everyday. To forecast weather, to tell time. We also use math to analyse crime, reveal patters, predict behaviour. Using numbers we can solve the biggest mysteries we know'.
Numb3rs, TV drama (voiceover to the opening credits)

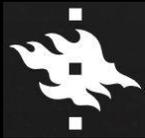
WE ALL USE MATH EVERY DAY

*Based on a Public Lecture for the Norfolk branch of UK's *Mathematical Association* (2 February 2006)



Research in Mathematics Education (RME) Group at UEA
www.uea.ac.uk/education/research/areas/mathematics-education





Examples of **public engagement** that aim to draw non-mathematicians into the world of mathematics considering the possibility of **serious studies**.

MAUD

Maths at Uni Day
since 2006

MAUD10: July 2015
EDU, MTH, Further Maths

Mushrooming into a suite of Outreach events to young people across the region.
Next... 18-26 October 2019, Norwich

Playing games with the Giants

Mathematics is a **game** played according to certain simple rules with meaningless marks on paper.

Hilbert

Pascal

Plato

Erdős

Euler

Mathematics may not be ready for such problems

Friday 25th October in the FORUM 10:00-16:00
Part of the Norwich Science Festival

UEA University of East Anglia
STUDENT SERVICES

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the **forum**

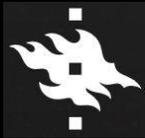
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norwichsciencefestival.co.uk NorwichSciFest Norwich Science Festival

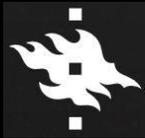




So:

Can this story of mathematicians and mathematics educators intersecting at various points in research, teaching, professional development and public engagement activities be re-imagined, not merely as a story of paths crossing, but as a story of paths meeting at a vanishing point – a point where the boundaries between the two communities fade into insignificance and even recede?...

***There is too much in common
and too much at stake for both not to....***



And, surely, since Professor Oikkonen started his distinguished career, the synergy between the two communities has seen brighter and brighter days...

So: a long way to have come and still a long way to go...



Research in Mathematics Education (RME)

A group of academics and research students from the School of Education and Lifelong Learning sharing interest, experience and expertise in mathematics education

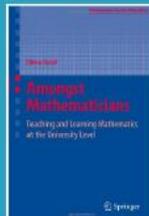


RME Funders



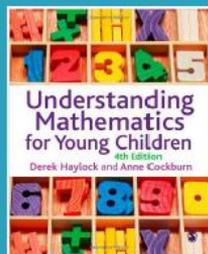
Pedagogical perspectives of university mathematicians

Collaborative research with university mathematicians reflecting on samples of student work to analyse student understanding and their own teaching practices



Securing the understanding of key mathematical ideas

A highly influential, research-informed approach through real-life examples, classroom data illustrations, classroom activities recommendations and – crucially – pauses for reflection and teachers' own practising of mathematics



Is mathematics T.I.R.E.D.?

Studying quiet disaffection in the secondary mathematics classroom
14yr olds experience mathematics as Tedious, Isolating, Rote-learning, Elitist and Depersonalised

M.U.M.A.P. Mapping University Mathematics Assessment Practices
Identifying patterns of assessment across universities in England and Wales; case studies of innovative assessment practice
dominance of closed book examination; some tailoring of assessment to different branches of mathematics; students' preference for closed book examination.

ACADEMIC VISITORS AND COLLABORATORS FROM ACROSS THE WORLD

8 doctoral completions since 2008
★ mathematics undergraduates' adaptation of abstract mathematical discourse
★ business students' conceptual understanding of statistics
★ the role of peer interaction in adolescents' self-regulated learning
★ conceptual change in primary children's understanding of fractions
★ effectiveness of group-work in primary lessons
★ autoethnography of mathematics teaching
★ catering for individual differences in mathematical learning
★ primary children's views of mathematics through drawing



2003



2013

Keynote at conference in celebration of Professor Juha Oikkonen

Elena Nardi

Friday, 25 October 2019

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@mathtask

Thank you for your attention: Q&A time!

Research in Mathematics Education (RME) Group at UEA
www.uea.ac.uk/education/research/areas/mathematics-education

