AN INTERNATIONAL SURVEY STUDY EXPLORING TEACHERS' PERCEPTIONS ON USING MATHEMATICAL STORYTELLING: THE CASE OF ENGLAND

Dr. Natthapoj Vincent Trakulphadetkrai

B.A. (Hons), M.Sc. (Oxford), M.Sc. (London, UCL), Ph.D. (Cambridge), QTS, SFHEA

Associate Professor of Mathematics Education, University of Reading
ESRC Policy Fellow, Education Endowment Foundation (EEF)
Founder, MathsThroughStories.org

n.trakulphadetkrai@reading.ac.uk
www.Natthapoj.org   @NatthapojVinceT   /   www.MathsThroughStories.org   @MathsStories

What are

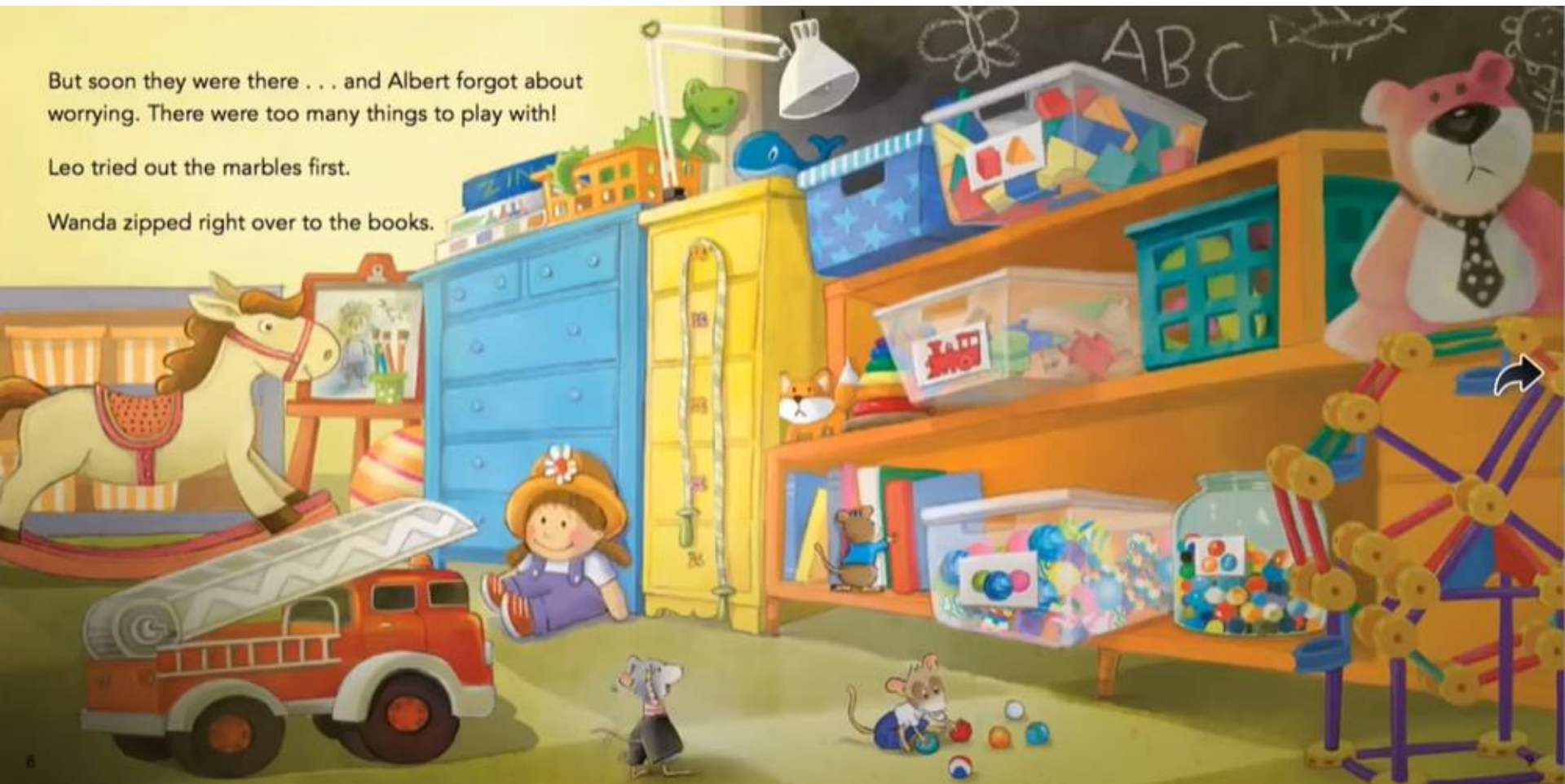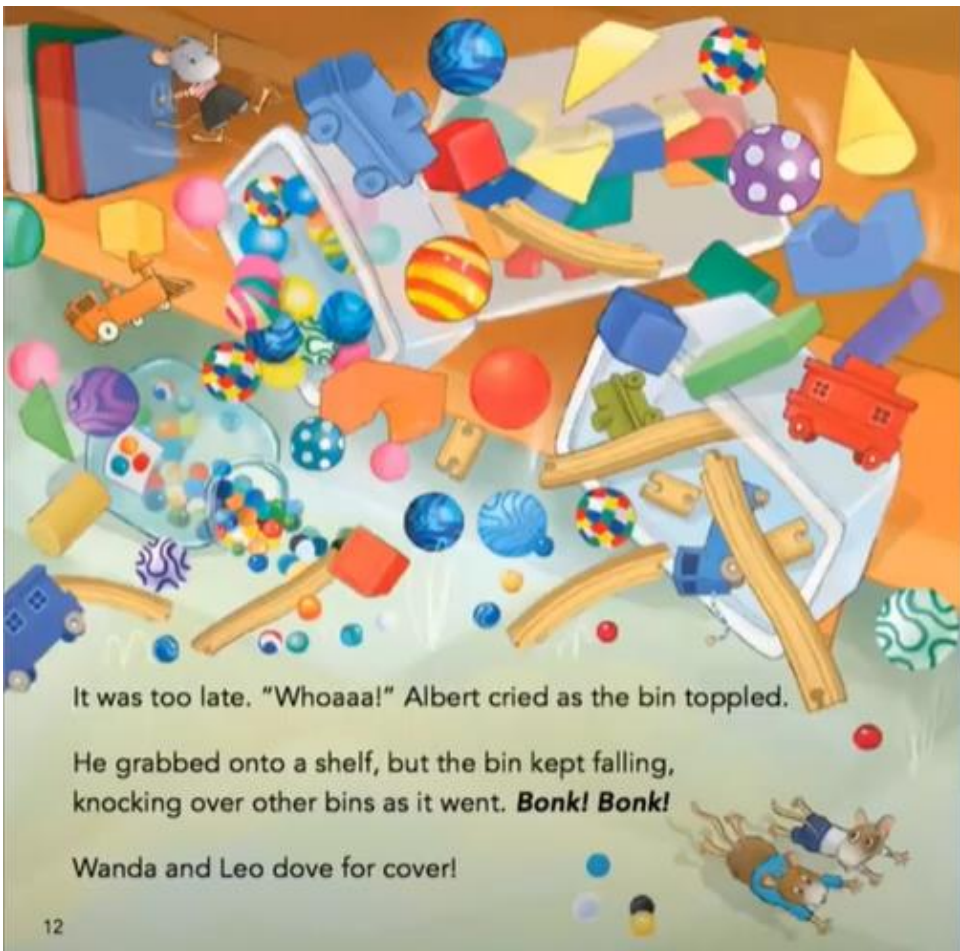# '**Mathematical** Storytelling'?

A MOUSY MESS
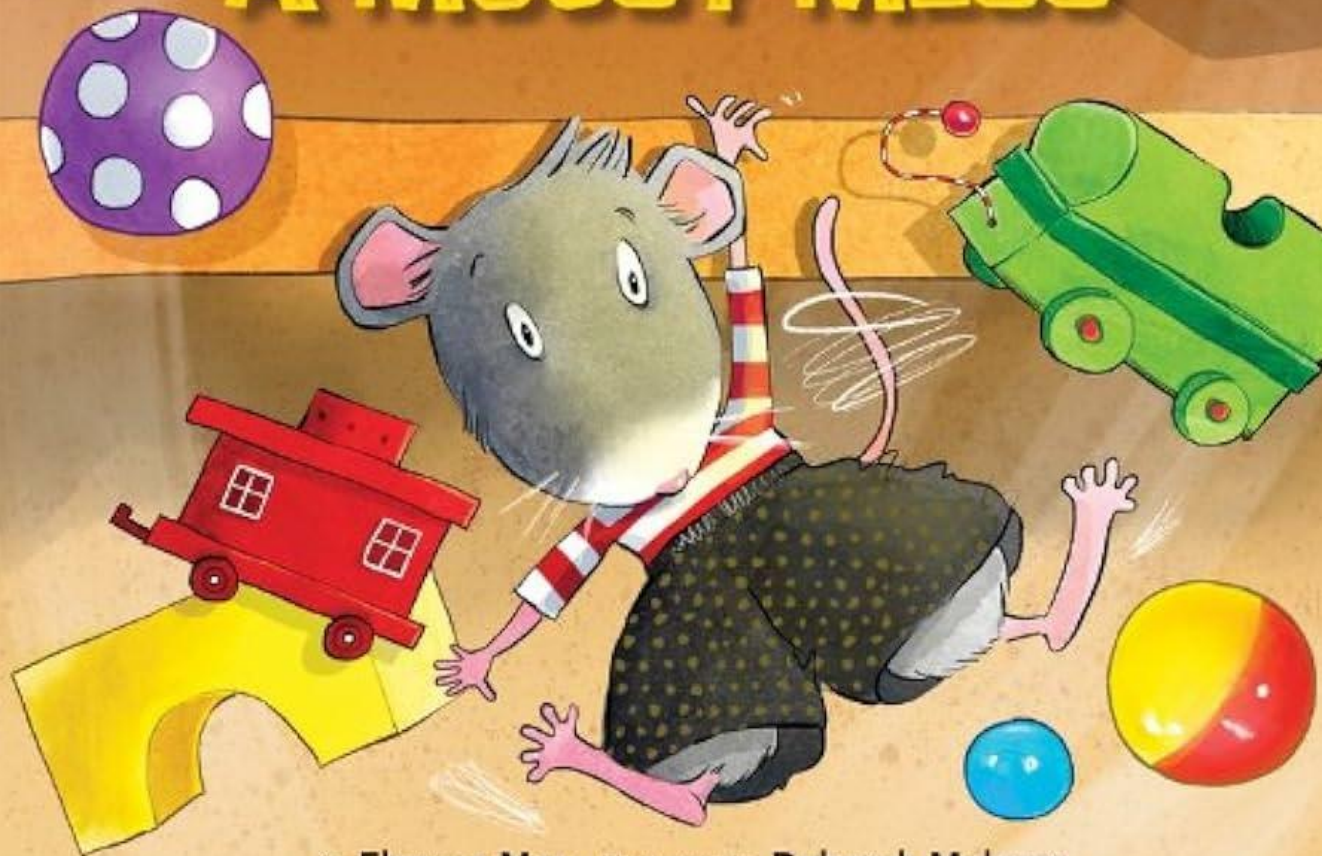
by **Eleanor May** • Illustrated by **Deborah Melmon**

But soon they were there . . . and Albert forgot about worrying. There were too many things to play with!

Leo tried out the marbles first.

Wanda zipped right over to the books.

It was too late. "Whoaaa!" Albert cried as the bin toppled.

He grabbed onto a shelf, but the bin kept falling, knocking over other bins as it went. **Bonk! Bonk!**

Wanda and Leo dove for cover!

Together, the three mice stared at the mess.
"Uh-oh," Leo said.

"Oh, no!" Albert panicked. They had to get everything put away, or the People would know they'd been there!

But how?

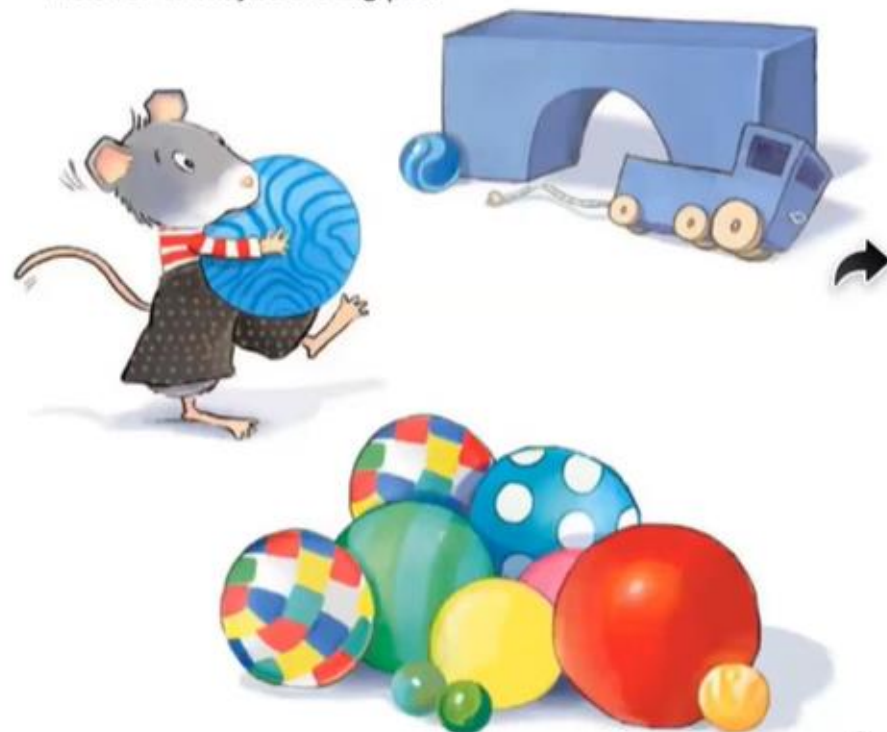Albert and Leo zipped around, making piles.
"Small things!"

"Big things!"

"Red things!"

Albert picked up a blue ball and headed for the blue pile.
Then he stopped. Should it go in the round, roll-y pile
instead? Or maybe the big pile?

"You can sort in lots of different ways," said Wanda, "and you did! You sorted some things by color . . .
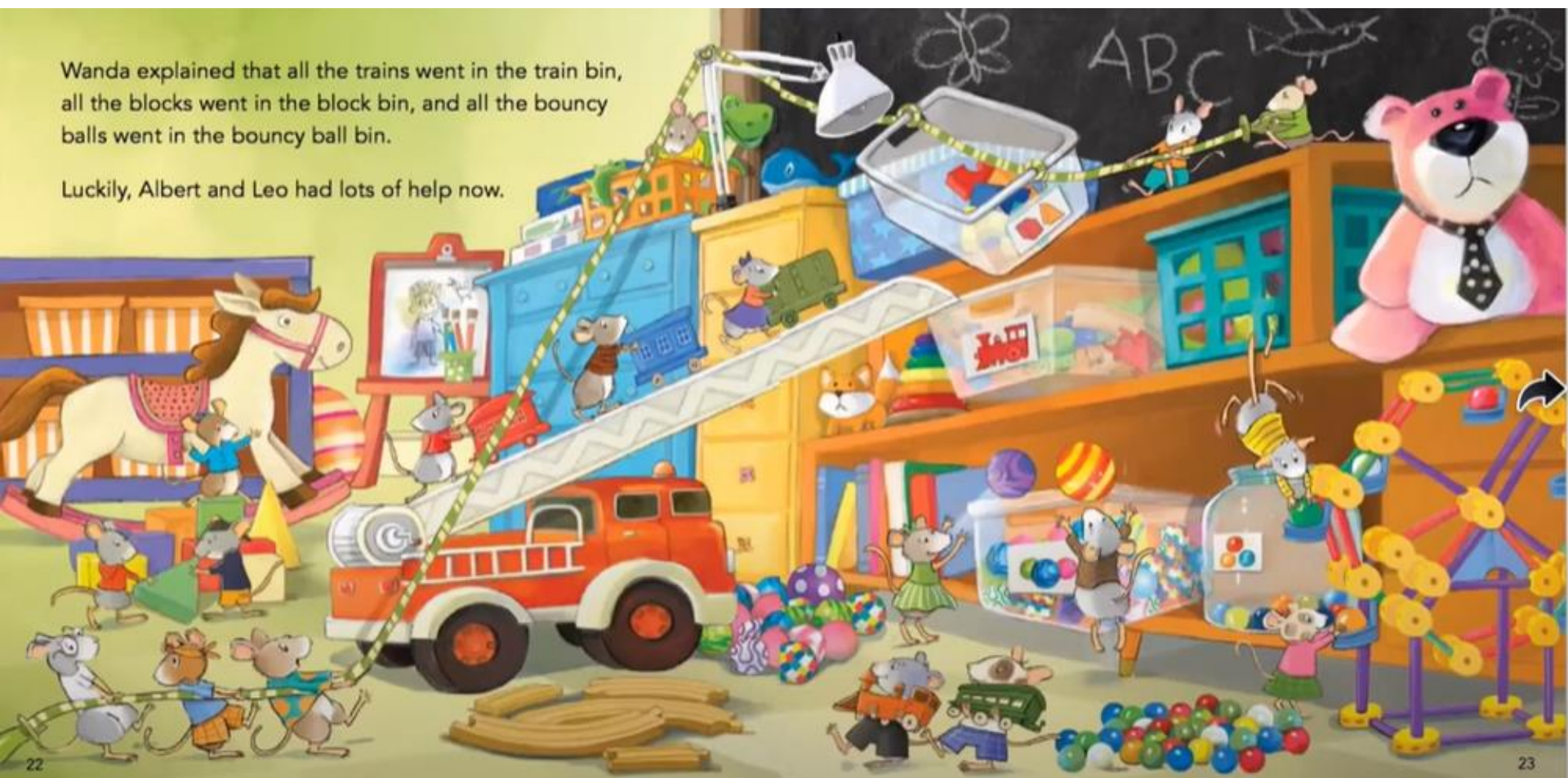
some by shape . . .

and some by size."

"But we need to sort everything by the kind of toy it is," Wanda said. "These are both marbles. So they go in the marble jar."

Wanda explained that all the trains went in the train bin, all the blocks went in the block bin, and all the bouncy balls went in the bouncy ball bin.

Luckily, Albert and Leo had lots of help now.
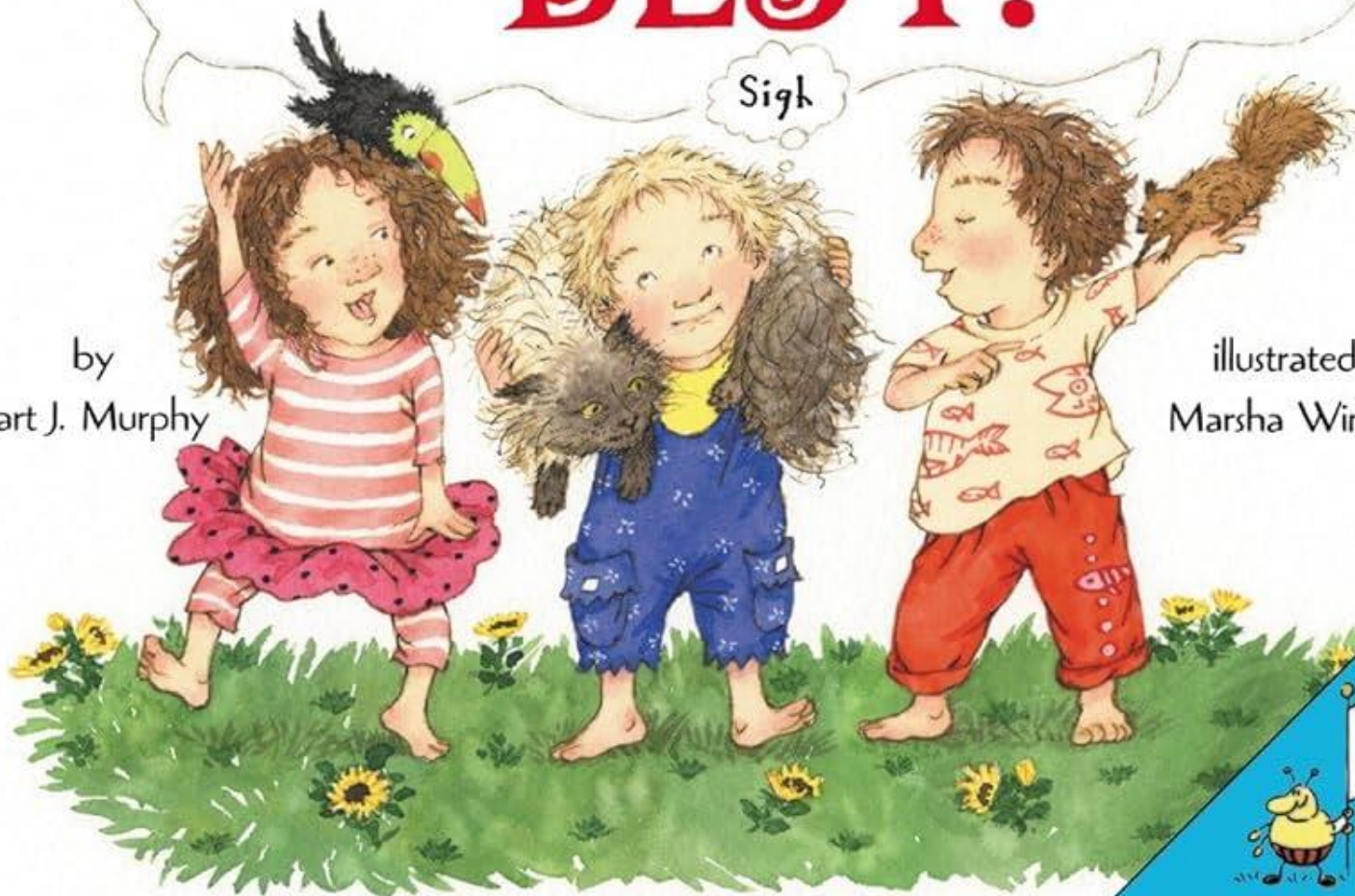
Jill helped Jeff tape sheets of paper
up one side of his window.
"It's 3 sheets high," Jeff
announced.

Then he made as many rows as he could across the window.
"I can make 4 rows," he said. "That's 12 sheets of paper in all."

See? Mine's way bigger.

Jenny taped sheet after sheet of newspaper along one of her wall.

"My room is 6 sheets wide," she announced.

Then Jill helped her tape sheets along the next wall.

"That's 5 sheets," said Jenny. "So if I covered the whole floor with newspaper, that would be 30 sheets in all."

AN ADVENTURE IN STATISTICS
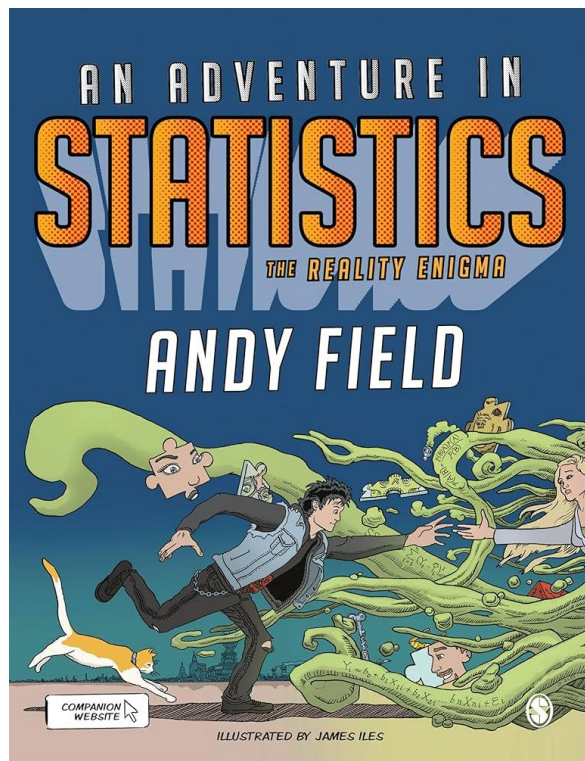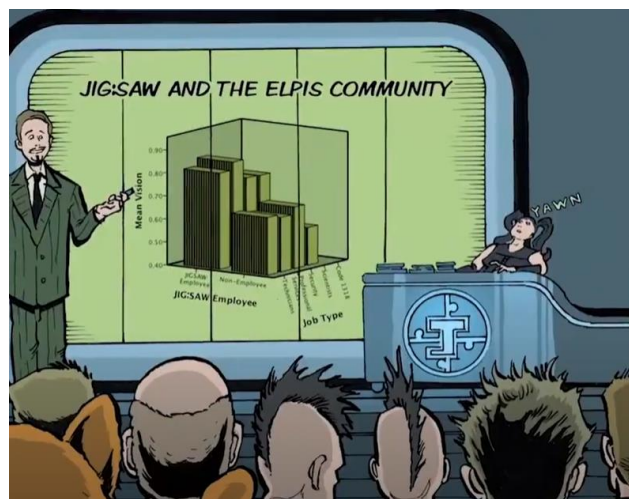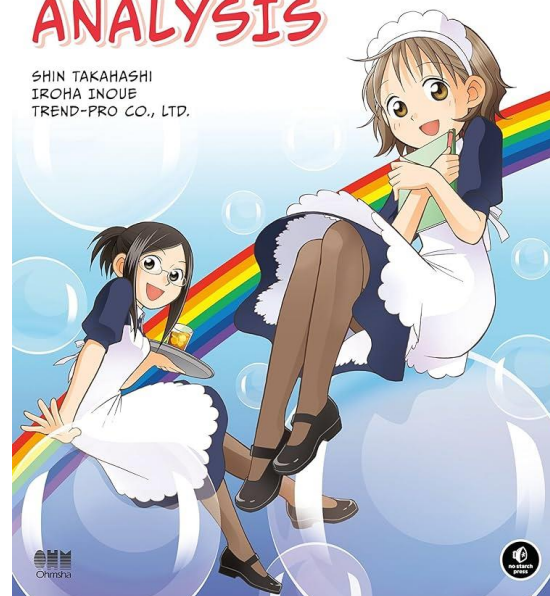
THE REALITY ENIGMA

ANDY FIELD

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INVERSE FUNCTIONS

$y = 2x + 1$

FIRST, I'LL EXPLAIN *INVERSE FUNCTIONS* USING THE LINEAR FUNCTION $y = 2x + 1$ AS AN EXAMPLE.

WHEN x IS ZERO, WHAT IS THE VALUE OF y?

$y = 2x + 1$
$= 2 \times 0 + 1$
$= 0 + 1$
$= 1$

IT'S 1.

HOW ABOUT WHEN x IS 3?

$y = 2x + 1$
$= 2 \times 3 + 1$
$= 6 + 1$
$= 7$

IT'S 7.

THE VALUE OF y *DEPENDS* ON THE VALUE OF x.

SO WE CALL y THE *OUTCOME*, OR DEPENDENT VARIABLE, AND x THE *PREDICTOR*, OR INDEPENDENT VARIABLE.

YOU COULD SAY THAT x IS THE BOSS OF y.

YES.

I'M THIRSTY! YOUR DRINK, SIR.

WHAT? ...HUH?

BOSS

SERVANT

14 CHAPTER 1 A REFRESHING GLASS OF MATH

IN OTHER WORDS, IF THEY WERE PEOPLE...

x WOULD BE THE BOSS, AND y WOULD BE HIS SERVANT.

SHINE MY SHOES!

YES, SIR.

OUR UNIFORMS KIND OF LOOK KIND OF LOOK OPPOSITE, DON'T THEY?

HA HA, YOU'RE RIGHT.

ANYWAY,

GLEAM

IN INVERSE FUNCTIONS...

...THE BOSS AND THE SERVANT SWITCH PLACES.

I'M QUEEN FOR A DAY!

FILL 'ER UP!

YES, MA'AM!

SO THE SERVANT IS NOW THE BOSS?

YUP. THE SERVANT TAKES THE BOSS'S SEAT.

INVERSE FUNCTIONS 15

THE MANGA GUIDE™ TO

COMICS INSIDE!

REGRESSION ANALYSIS

SHIN TAKAHASHI
IROHA INOUE
TREND-PRO CO., LTD.

Ohmsha

no starch press

JIG:SAW AND THE ELPIS COMMUNITY

Mean Vision

JIG:SAW Employee   Non-Employee

JIG:SAW Employee

Job Type

YAWN

HEY, AREN'T YOU ZACH SLADE?

HEY ZOMBIE W
HOW ARE YOU

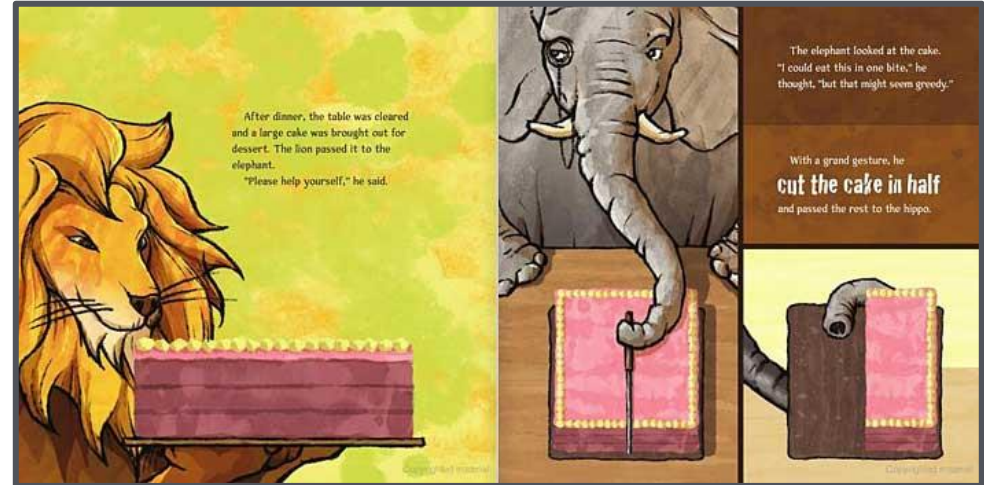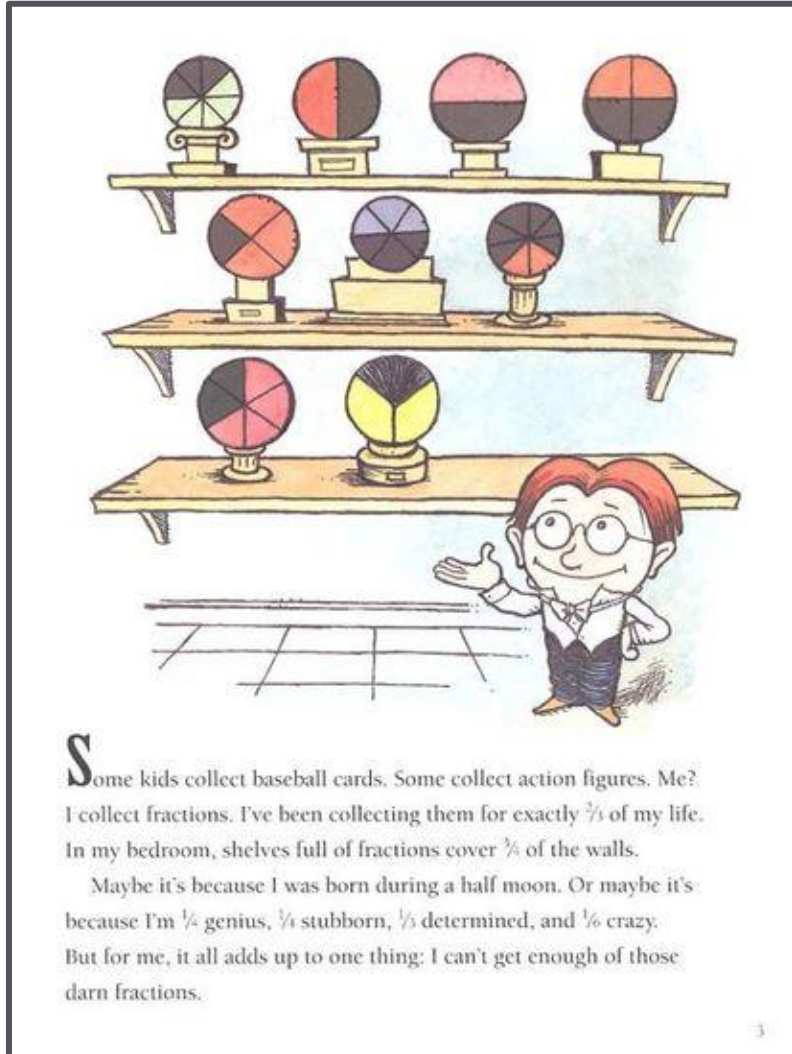# What are 'mathematical storytelling'?

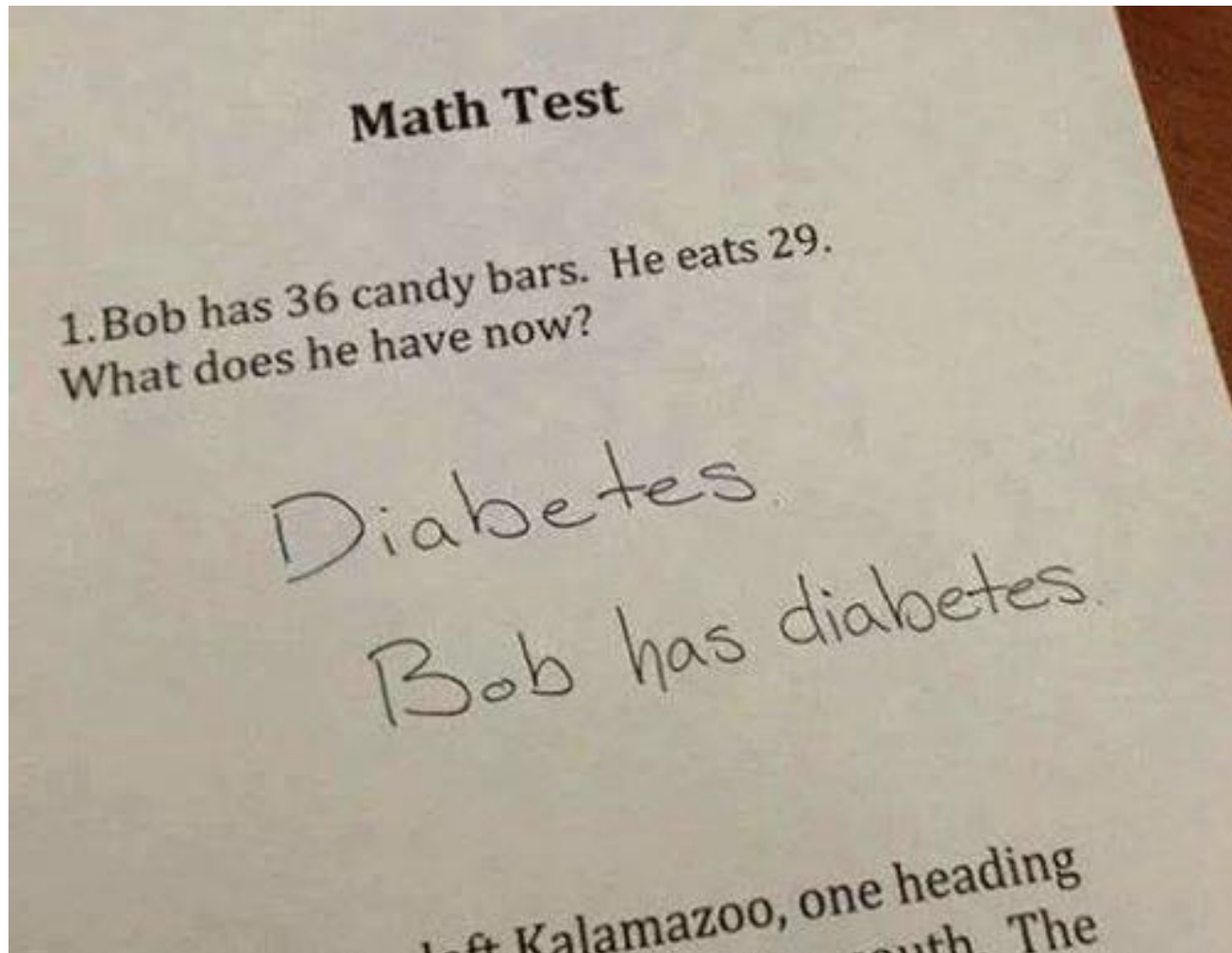The use of narratives that illustrate how mathematical knowledge and skills can be meaningfully used by characters in the stories to help them solve a problem.

This approach can be used with mathematics learning of **all** ages.

To help visualise abstract mathematical topics

See: Elia et al. (2010)

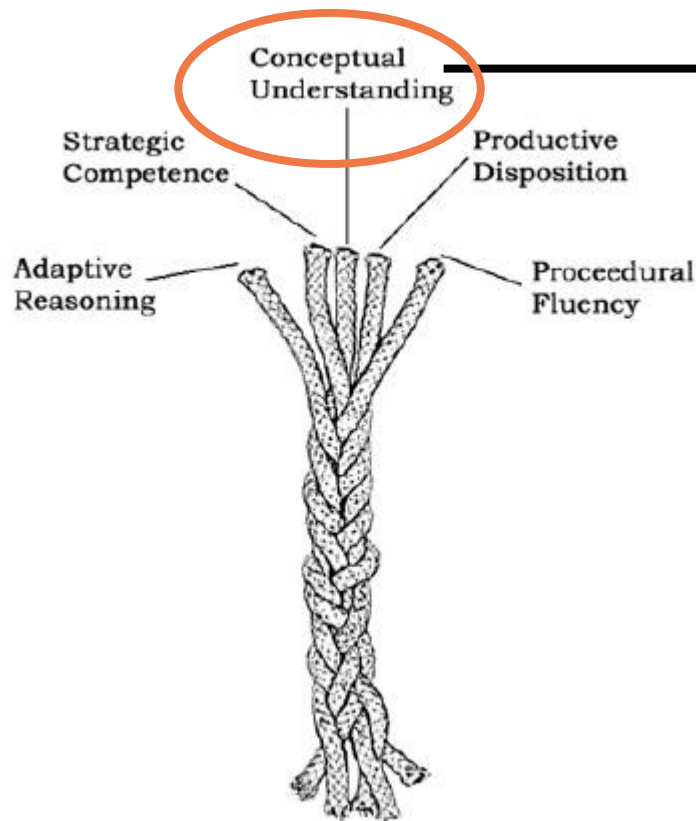# To give a meaningful context for mathematics learning

See: Gunbas (2015)

To foster children's conceptual understanding of mathematical concepts

Kilpatrick et al.'s (2001)

Mathematical Proficiency

One's ability to **"represent mathematical situations in different ways"** and the degree of students' conceptual understanding can thus be measured by examining "the richness and extent of the connections [between representations] they have made" (p. 119).

1.1) Number Sentence

4 X 7 = _____

Show how you work out the answer in the boxes below:

Informal jotting:

7 + 7 + 7 + 7 = 28

Formal written method:

7
X 4
28

1.2) Image

Can you represent the number sentence above *visually?*
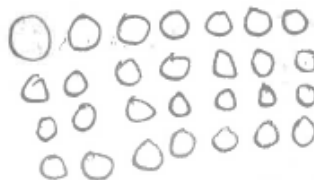
1.3) Word Problem

Using the number sentence above, can you create your own word problem?

A girl apes to the park, She finds theese coins
10p, 5p, 5p. She goes to the ice cream van she
wants one, one ice cream costs 20p, does she
have ~~have~~ 20p?

yes

Research Gap

While research over the past three decades have documented pedagogical benefits of teaching mathematics using storytelling, research into teachers' perceptions regarding the use of such approach is virtually non-existent.

Thompson (1984, p. 106) notes that "any attempt to improve the quality of [...] teaching must begin with an understanding of the conceptions held by the teachers".

(Pajares, 1992, p. 307): "the beliefs teachers hold influence their perceptions and judgements, which, in turn, affect their behaviour in the classroom".

The Current Study

What do in-service teachers and pre-service teachers in **England** perceive to be key barriers to, and enablers for, the use of storytelling in mathematics teaching and learning?

(Part of an international survey study)

Article 1 (Taylor & Francis Online)

Taylor & Francis Online

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Articles

Pre-service and in-service teachers' perceptions on the integration of children's literature in mathematics teaching and learning in Ireland

Mark Prendergast ✉ , Lorraine Harbison, Sue Miller & Natthapoj Vincent Trakulphadetkrai

 Full Article   Figures & data   References   Citations   Metrics   Reprints & Permissions   Get access

Abstract

The beneficial role that children's literature plays in facilitating the meaningful integration and advancement of literacy and numeracy in the primary mathematics classroom has been well validated by research findings internationally. In Ireland, supporting the development of literacy and numeracy is a key educational priority. Consequently, a myriad of policy initiatives such as the *Literacy and Numeracy for Learning and Life* strategy

Related

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Maltese of child learning...

Article 2 (Educational Studies in Mathematics)

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Taiwanese primary school teachers' perceived enablers for and barriers to the integration of children's literature in mathematics teaching and learning

Der Ching Yang[1] · Iwan Andi Jonri Sianturi[2] · Chia Huang Chen[3] · Yi-Wen Su[4] · Natthapoj Vincent Trakulphadetkrai[5]

Abstract

This study is part of the international survey studies on teachers' beliefs concerning the integration of children's literature in mathematics teaching and learning, and this paper reports the findings of the thematic analysis of open-ended survey responses elicited from 287 primary school teachers and teacher trainees in Taiwan. Using the seminal social psychology theory, the Theory of Planned Behaviour (Ajzen in *Organizational Behavior and Human Decision Processes, 50*, 179–211, 1991) to frame the findings, this study highlights 11 perceived barriers and 11 perceived enablers that are thought to influence the teachers' intention to integrate children's literature in their mathematics teaching. More specifically, we identified time constraint, lack of pedagogical knowledge and confidence, and resource constraint as being the most-cited perceived barriers, while pedagogical benefits, desire to improve teaching, and enabling social norms were identified as the top perceived enablers. Ultimately, this article offers several recommendations to address some of these key perceived barriers.

Article 3 (Springer Link)

Springer Link

Australian primary school teachers' perceived barriers to and enablers for the integration of children's literature in mathematics teaching and learning

Sharyn Livy, Tracey Muir, Natthapoj Vincent Trakulphadetkrai ✉ & Kevin Larkin

Abstract

This qualitative survey study set out to investigate in-service and pre-service primary school teachers' perceived barriers to and enablers for the integration of children's literature in mathematics teaching and learning in an Australian educational context. While research over the past three decades have documented pedagogical benefits of teaching mathematics using children's literature, research into teachers' perceptions regarding the use of such resources is virtually non-existent. The study thus filled this research gap by drawing responses from open-ended survey questions of 94 in-service and 82 pre-service teachers in Australia. A thematic analysis revealed 13 perceived barriers classified under five themes with Lack of Pedagogical Knowledge and Confidence, and Time Constraint, representing 75% of all perceived barriers. Moreover, 14 perceived enablers were identified and classified under five themes with Pedagogical Benefits and Love of Stories representing around 70% of all perceived enablers. Findings also showed that most of the teachers in the study (around 75%) never or infrequently used children's literature in their mathematics classrooms. The study highlights the role of professional learning and teacher training in ensuring that both in- and pre-service teachers have the necessary pedagogical knowledge, experience and confidence in using children's literature to enrich their mathematics teaching.

Article 4 (Taylor & Francis Online / Cogent Education)

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TEACHER EDUCATION & DEVELOPMENT | RESEARCH ARTICLE

Maltese teachers' beliefs concerning the integration of children's literature in mathematics teaching and learning

Marie Therese Farrugia & Natthapoj Vincent Trakulphadetkrai ✉ | Emrullah Erdem (Reviewing editor)

 Full Article   Figures & data   References   Citations   Metrics   Licensing   Reprints & Permissions   PDF

In this article

- Abstract
- 1. Introduction
- 2. Integrating children's literature with mathematics
- 3. Theoretical framework
- 4. The current study and its contribution to the field
- 5. Research methods

Abstract

This exploratory mixed-methods study set out to explore Maltese primary school teachers' perceived barriers to, and enablers for, the integration of children's literature in mathematics teaching. Data were collected by means of an online questionnaire and semi-structured interviews, and analysed thematically using Ajzen's Theory of Planned Behaviour. The responses given by the participants showed that integration of mathematics and stories was not a common practice. The perceived barriers were categorised as *Resource Constraint, Time Constraint, Lack of Pedagogical Knowledge and Confidence, Doubts about Outcome Expectancy,* and *Inhibiting Social Norms* while the three perceived enablers identified were *Pedagogical Benefits, Love of Stories,* and *Enabling Social Norms*. Given that the majority of the participating teachers acknowledged the potential benefits of the approach and expressed a wish for training, one key recommendation of the study is for teaching mathematics through stories to be explicitly included in pre-service and in-service professional development programmes.

Keywords: mathematics education, children's literature, teachers' beliefs, the theory of planned behaviour

Related articles

Pre-service and in-service teachers' perceptions on the integration of children's literature in mathematics teaching and learning in Ireland
Mark Prendergast, Irish Educational Studies, 2018

Codeswitching as a tool in teaching Italian in Malta
Hertan Gauci et al., International Journal of Bilingual Education and Bilingualism, 2013

The effects of case-based learning on early childhood pre-service teachers' beliefs about the pedagogical uses of ICT
Chansila Angeli *, Learning, Media and Technology, 2006

Teachers' sense of efficacy in their work with pupils with learning, emotional and behavioural difficulties
Maja Kuronja, Emotional and Behavioural Difficulties, 2018

Peer-learning between pre-service teachers: embracing Lesson Study...

With thanks to ...

Australia team

Dr. Sharyn Livy (Monash University)

Prof. Tracey Muir (University of Tasmania)

Dr. Kevin Larkin (Griffith University)

Taiwan team

Prof. Der Ching Yang (National Chiayi University)

Iwan Andi Jonri Sianturi (National Chiayi University)

Dr. Chia Huang Chen (National Taichung University of Education)

Dr. Yi-Wen Su (University of Taipei)

Ireland team

Dr. Mark Prendergast (Trinity College Dublin, University of Dublin)

Dr. Lorraine Harbison & Sue Miller (Dublin City University)

Malta team

Dr. Marie Therese Farrugia (University of Malta)

Indonesia team*

Iwan Andi Jonri Sianturi (Indiana University (Bloomington, USA)

Ajzen's (1991)
Theory of Planned Behaviour (TPB)

Attitude toward the behaviour is a personal evaluation of the behaviour in question and this can be favourable or unfavourable

Subjective norm is when a person's beliefs are influenced by perceived social pressures to perform or not to perform a behaviour

Perceived behavioural control is when a person's beliefs are influenced by factors, such as time, money, assistance from other people that either assist or hinder behaviour
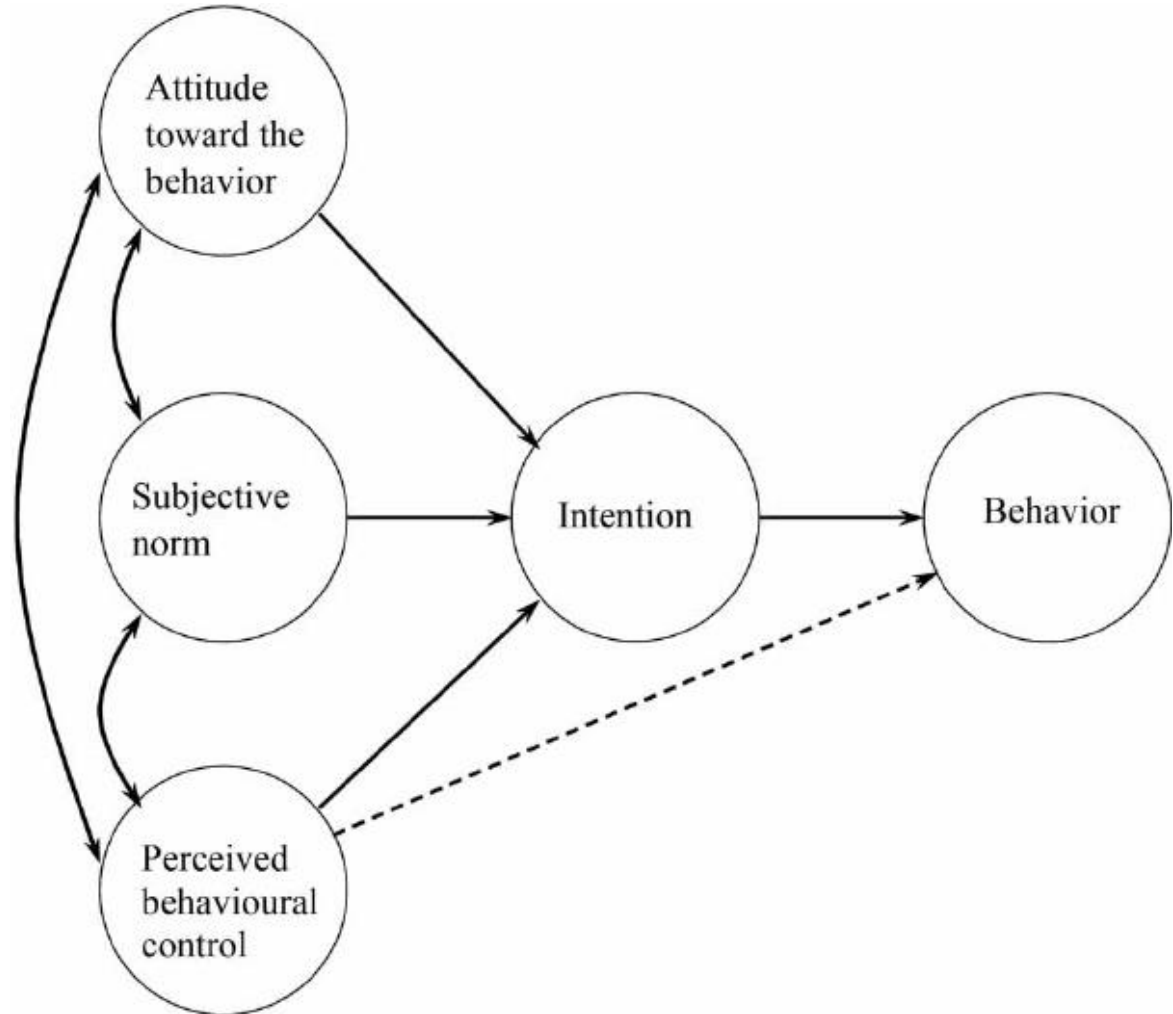
Research Design #1

Design: Cross-sectional survey design

Instrument: Survey developed specifically for the study with open-ended survey questions (printed and on-line)

Sample:

- In-service teachers (ISTs) -127 ISTs (across England)
- Pre-service teachers (PSTs) - 1,003 PSTs (across 22 universities in England)

Sampling:

- Convenience sampling (via social media posts and at training workshops in March – July 2022)

Research Design #2

Data analysis:
- Stage 1 - Thematic deductive and inductive analysis
- Stage 2 - Thematic deductive analysis using Ajzen's (1991) TPB framework

Stage 1 - Coding
- Beliefs mentioned repeatedly by the same teacher were counted only once.
- Teachers were able to state more than one perceived enabler/barrier.

Coding reliability
- *Step 1:* The researcher and his Research Assistant (RA) independently coded the responses of the first fifty teachers (Teachers 1-50) on both the Enablers and Barriers datasets (as part of the RA's training).
- *Step 2:* The RA then coded the rest of the datasets (i.e., responses of Teachers 51-Teachers 1130).
- *Step 3:* The researcher subsequently moderated half of each dataset that the RA has coded (i.e., Teachers 1 – 565) and discussed any discrepancies until agreement was reached
- *Step 4:* The RA went back to update/adjust his coding of the responses of Teachers 566-1130.

Characteristics of
Survey Participants

TOTAL	1130	%		IN-SERVICE TEACHERS	127	%		PRE-SERVICE TEACHERS	1003	%
Sex				**Sex**				**Sex**		
Male	170	15.0		Male	31	24.4		Male	139	13.9
Female	937	82.9		Female	92	72.4		Female	845	84.2
Prefer not to say	23	2.0		Prefer not to say	4	3.1		Prefer not to say	19	1.9
Teaching Experience				**Teaching Experience**				**Teaching Experience**		
Less than 5 years	n/a	n/a		Less than 5 years	47	37.0		Less than 5 years	n/a	n/a
6-10	n/a	n/a		6-10	34	26.8		6-10	n/a	n/a
11-15	n/a	n/a		11-15	29	22.8		11-15	n/a	n/a
16-20	n/a	n/a		16-20	8	6.3		16-20	n/a	n/a
Over 20 years	n/a	n/a		Over 20 years	7	5.5		Over 20 years	n/a	n/a
Prefer not to say	n/a	n/a		Prefer not to say	2	1.6		Prefer not to say	n/a	n/a
Class taught				**Class taught**				**Class taught**		
3-4	n/a	n/a		3-4	3	2.4		3-4	n/a	n/a
4-5	n/a	n/a		4-5	21	16.5		4-5	n/a	n/a
5-6	n/a	n/a		5-6	15	11.8		5-6	n/a	n/a
6-7	n/a	n/a		6-7	11	8.7		6-7	n/a	n/a
7-8	n/a	n/a		7-8	14	11.0		7-8	n/a	n/a
8-9	n/a	n/a		8-9	14	11.0		8-9	n/a	n/a
9-10	n/a	n/a		9-10	16	12.6		9-10	n/a	n/a
10-11	n/a	n/a		10-11	19	15.0		10-11	n/a	n/a
A wide range of class levels	n/a	n/a		A wide range of class levels	11	8.7		A wide range of class levels	n/a	n/a
Not indicated	n/a	n/a		Not indicated	3	2.4		Not indicated	n/a	n/a
Regions				**Regions**				**Regions**		
East Midlands	54	4.8		East Midlands	28	22.0		East Midlands	26	2.6
East of England	45	4.0		East of England	0	0.0		East of England	45	4.5
London	215	19.0		London	4	3.1		London	211	21.0
North West	248	21.9		North West	4	3.1		North West	244	24.3
South East	432	38.2		South East	52	40.9		South East	380	37.9
South West	41	3.6		South West	3	2.4		South West	38	3.8
West Midlands	73	6.5		West Midlands	34	26.8		West Midlands	39	3.9
Yorkshire and the Humber	22	1.9		Yorkshire and the Humber	2	1.6		Yorkshire and the Humber	20	2.0
Training				**Training**				**Training**		
Yes	73	6.5		Yes	27	21.3		Yes	46	4.6
No	1031	91.2		No	75	59.1		No	956	95.3
Cannot remember	26	2.3		Cannot remember	25	19.7		Cannot remember	1	0.1
Frequency				**Frequency**				**Frequency**		
Never	905	80.1		Never	56	44.1		Never	849	84.6
Infrequently (1-10)	203	18.0		Infrequently (1-10)	54	42.5		Infrequently (1-10)	149	14.9
Frequently (>10)	22	1.9		Frequently (>10)	17	13.4		Frequently (>10)	5	0.5

TRAINING

Table 1

Comparison of the proportion of teachers received the training across the six* countries (N=1859)

Themes	Average (N=1859) ISTs = 536 (28.8%) PSTs = 1,323 (71.2%)	England (N=1130) ISTs = 127 (11.2%) PSTs = 1,003 (88.8%)	Taiwan (N=287) ISTs = 190 (66.2%) PSTs = 97 (33.8%)	Australia (N=176) ISTs = 94 (53.4%) PSTs = 82 (46.6%)	Ireland (N=154) ISTs = 51 (33.1%) PSTs = 103 (66.9%)	Malta (N=34) ISTs = 23 (67.6%) PSTs = 11 (32.4%)	Indonesia (N=78) ISTs = 51 (65.4%) PSTs = 27 (34.6%)
Yes	**31.6%**	6.5%	15%	41%	n/a	35.3%	60.3%
No	**60.3%**	**91.2%**	80.1%	50.6%	n/a	50%	29.5%
Cannot remember—too long ago	**8.1%**	2.3%	4.9%	8.5%	n/a	14.7%	10.3%

FREQUENCY

Table 2
Comparison of the frequency of teachers using storytelling in their mathematics teaching across the six countries (N=1859)*

Themes	Average (N=1859) ISTs = 536 (28.8%) PSTs = 1,323 (71.2%)	England (N=1130) ISTs = 127 (11.2%) PSTs = 1,003 (88.8%)	Taiwan (N=287) ISTs = 190 (66.2%) PSTs = 97 (33.8%)	Australia (N=176) ISTs = 94 (53.4%) PSTs = 82 (46.6%)	Ireland (N=154) ISTs = 51 (33.1%) PSTs = 103 (66.9%)	Malta (N=34) ISTs = 23 (67.6%) PSTs = 11 (32.4%)	Indonesia (N=78) ISTs = 51 (65.4%) PSTs = 27 (34.6%)
Never	**56.8%**	**80.1%**	72.1%	38.1%	51.3%	44.1%	55.1%
Infrequently (1-10 lessons)	**29.3%**	18.0%	25.8%	37%	40.3%	35.3%	19.2%
Frequently (> 10 lessons)	**11.3%**	1.9%	2.1%	18.2%	8.4%	11.8%	25.6%
Not indicated	**2.6%**	0%	0%	6.8%	0%	8.8%	0%

Findings – Enablers

'What would enable you to integrate storytelling as part of your mathematics teaching?'

19 categories broadly grouped under six themes

Table 3

Survey Responses Concerning Perceived Enablers for the Integration of Storytelling in Mathematics Teaching

Theme 1: Availability of Resources (33.6%)				
Categories	**Examples of statement**	**Total** *(N = 966/1130)*	**In-service teachers (ISTs)** *(N = 112/127)*	**Pre-service teachers (PSTs)** *(N = 854/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
1. Encouraged and inspired by the availability of relevant story picture books for mathematics teaching (and a database of such books)	"If I had an knowledge of what picture books are available."	249 (19.4)	26 (17.4)	223 (19.6)
2. Encouraged and inspired by the availability of story-based Maths lesson ideas	"A guide on how to teach using literature- example lessons."	182 (14.2)	24 (16.1)	158 (13.9)

Theme 2: Perceived Pedagogical Benefits (26.9%)				
Categories	Examples of statement	Total (N = 966/1130) f* (%)	In-service teachers (ISTs) (N = 112/127) f* (%)	Pre-service teachers (PSTs) (N = 854/1003) f* (%)
3. Encouraged and inspired by teacher's own perception that the approach makes the teaching more engaging and fun	"I like to try and make my mathematics lessons as exciting and engaging as possible and I find that incorporating picture books is a great way of achieving this."	188 (14.6)	12 (8.1)	176 (15.5)
4. Encouraged and inspired by teacher's own perception that the approach helps children to apply and make meaningful connections between their mathematics learning and their everyday life	"A belief in the power of children's literature to provide a meaningful and engaging context for mathematical problem solving."	58 (4.5)	11 (7.4)	47 (4.1)
5. Encouraged and inspired by teacher's own perception that the approach makes mathematics learning more accessible to students	"It would have helped me as a child when I found maths too abstract and needed scaffolding support to make the bridge."	35 (2.7)	4 (2.7)	31 (2.7)
6. Encouraged and inspired by teacher's own perception that the approach supports children's language development	"It allows students to think mathematically and enhance their literacy skills at the same time."	3 (0.2)	0 (0.0)	3 (0.3)
7. Encouraged and inspired by teacher's own perception that the approach helps children to visualise mathematical concepts	"To support students to visually connect with concept."	22 (1.7)	0 (0.0)	22 (1.9)
8. Encouraged and inspired by teacher's own perception that the approach can help to develop children's mathematical understanding and word problem-solving skill	"It can enhance the level of mathematics understanding."	34 (2.6)	5 (3.4)	29 (2.6)
9. Encouraged and inspired by teacher's own perception that the approach can help make mathematics learning more memorable	"To give children another way to remember maths facts."	5 (0.4)	1 (0.7)	4 (0.4)

Theme 3: Knowledge of the Approach (22.4%)				
Categories	**Examples of statement**	**Total** (N = 966/1130)	**In-service teachers (ISTs)** (N = 112/127)	**Pre-service teachers (PSTs)** (N = 854/1003)
		f* (%)	*f** (%)	*f** (%)
10. Encouraged and inspired by teacher training programme and/or other forms of professional development training	"I went to a Professional Learning [...] that gave some great examples of what literature we could use in our maths lessons."	215 (16.7)	18 (12.1)	197 (17.4)
11. Encouraged and inspired by teacher's own awareness of story picture books that are appropriate for mathematics teaching	"Knew of the text and how it linked to the concept."	43 (3.3)	10 (6.7)	33 (2.9)
12. Encouraged and inspired by teacher's own awareness/knowledge of the approach	"Knowing how to use books in maths"	30 (2.3)	0 (0.0)	30 (2.6)

Theme 4: Desire to Improve Teaching (10.6%)				
Categories	**Examples of statement**	**Total** *(N = 966/1130)*	**In-service teachers (ISTs)** *(N = 112/127)*	**Pre-service teachers (PSTs)** *(N = 854/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
13. Encouraged and inspired by teacher's own belief in the value of cross-curricular teaching	"I thought it was important to encourage literacy in the maths and integrate the subjects."	60 (4.7)	12 (8.1)	48 (4.2)
14. Encouraged and inspired by teacher's own desire to try new methods of teaching mathematics	"Trying to find new ways to teach concepts."	19 (1.5)	1 (0.7)	18 (1.6)
15. Encouraged and inspired by teacher's own belief that the approach is an effective way to teach mathematics	"Been doing it for a long time and know it's effective."	57 (4.4)	13 (8.7)	44 (3.9)

Theme 5: Enabling Social Norms (5%)				
Categories	**Examples of statement**	**Total** *(N = 966/1130)*	**In-service teachers (ISTs)** *(N = 112/127)*	**Pre-service teachers (PSTs)** *(N = 854/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
16. Encouraged and inspired by school's ethos and key stakeholders (e.g., school leaders, mentors, colleagues and parents)	"Mentor teachers encourage to do so as students tend to me more captivated by stories."	64 (5.0)	9 (6.0)	55 (4.8)

Theme 6: Love of Stories (1.6%)				
Categories	**Examples of statement**	**Total** *(N = 966/1130)*	**In-service teachers (ISTs)** *(N = 112/127)*	**Pre-service teachers (PSTs)** *(N = 854/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
17. Encouraged and inspired by teacher's love of stories	"I love picture story books so it's natural for me to use them."	5 (0.4)	0 (0.0)	5 (0.4)
18. Encouraged and inspired by children's love of stories	"Students, in my experience, love stories being read to them and therefore really get involved in the learning."	11 (0.9)	1 (0.7)	10 (0.9)
19. Encouraged and inspired by the approach's ability to foster children's love of stories and reading	"It encourages and interest in books and reading"	4 (0.3)	2 (1.3)	2 (0.2)
	Total	**1284 (100)**	**149 (100)**	**1135 (100)**

* *f* is here taken to refer to the number of teachers who mentioned a particular belief. Beliefs repeated by the same teacher were counted only once. Participants were able to state more than one perceived enabler, explaining why the total number of *f* (N=1284) exceeded the total number of teachers who responded to this survey question (N=966).

Enablers as framed by Ajzen's (1991) Theory of Planned Behaviour (TPB)
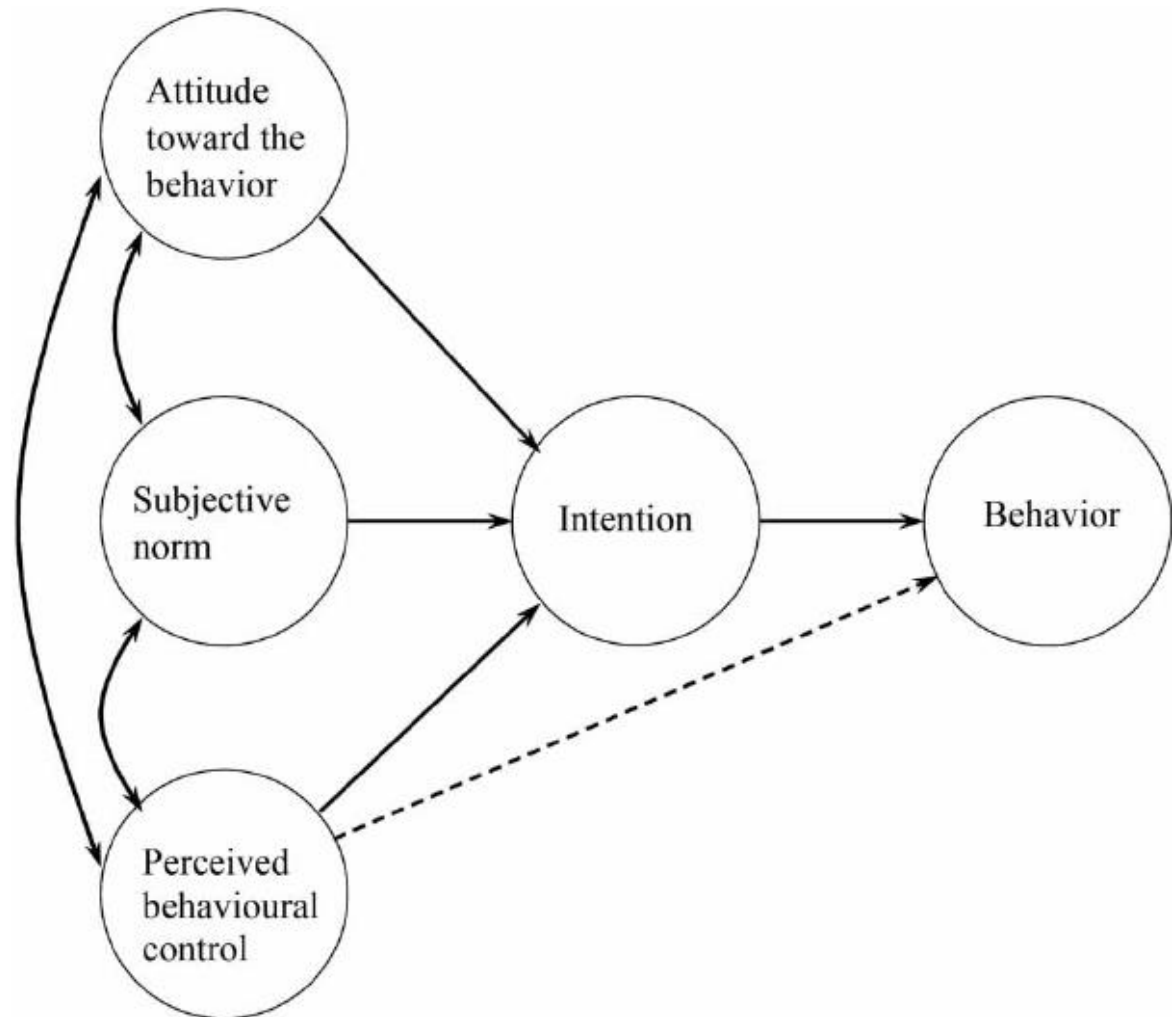
Attitude toward the behaviour is a personal evaluation of the behaviour in question and this can be favourable or unfavourable
Perceived Pedagogical Benefits, Desired to Improve Teaching, Love of Stories

Subjective norm is when a person's beliefs are influenced by perceived social pressures to perform or not to perform a behaviour
Enabling Social Norms

Perceived behavioural control is when a person's beliefs are influenced by factors, such as time, money, assistance from other people that either assist or hinder behaviour
Availability of Resources, Knowledge of the Approach

ENABLERS

Table 4

Comparison of the Enablers themes across the six* countries (N=1859)

Themes	Average (N=1859) ISTs = 536 (28.8%) PSTs = 1,323 (71.2%)	England (N=1130) ISTs = 127 (11.2%) PSTs = 1,003 (88.8%)	Taiwan (N=287) ISTs = 190 (66.2%) PSTs = 97 (33.8%)	Australia (N=176) ISTs = 94 (53.4%) PSTs = 82 (46.6%)	Ireland (N=154) ISTs = 51 (33.1%) PSTs = 103 (66.9%)	Malta (N=34) ISTs = 23 (67.6%) PSTs = 11 (32.4%)	Indonesia (N=78) ISTs = 51 (65.4%) PSTs = 27 (34.6%)
Theme 1: Availability of Resources	7.6%	33.6%	1.8%	3.2%	2.1%	0%	5.1%
Theme 2: Perceived Pedagogical Benefits	49.5%	26.9%	53.4%	57.4%	47.9%	62.6%	48.4%
Theme 3: Knowledge of the Approach	6.9%	22.4%	1.8%	9.6%	0%	0%	7.8%
Theme 4: Desire to Improve Teaching	16.3%	10.6%	30.6%	10.9%	21.3%	9.4%	15.2%
Theme 5: Enabling Social Norms	11.7%	5%	9.8%	7.1%	25.6%	6.3%	16.6%
Theme 6: Love of Stories	8.0%	1.6%	2.5%	11.7%	3.2%	21.9%	6.9%

Findings – Barriers

'What would prevent you from integrating storytelling as part of your mathematics teaching?'

17 categories broadly grouped under five themes

Table 5

Survey Responses Concerning Perceived Barriers for the Integration of Storytelling in Mathematics Teaching

Theme 1: Lack of Pedagogical Knowledge and Confidence (52.3%)				
Categories	**Examples of statement**	**Total** *(N = 1102/1130)*	**In-service teachers (ISTs)** *(N = 126/127)*	**Pre-service teachers (PSTs)** *(N = 976/1003)*
		f* (%)	*f** (%)	*f** (%)
1. Limited or lack of awareness of suitable story picture books for specific mathematical concepts or age groups	"Not knowing good examples of texts to use for the different topics - not having a built-up database."	385 (23.0)	46 (22.1)	339 (23.2)
2. Limited or lack of awareness / knowledge / experience / training in the approach	"I do not have the specific understanding of how to effectively and seamlessly integrate children's literature into my maths teaching."	421 (25.2)	29 (13.9)	392 (26.8)
3. Perceived difficulty and/or fear in implementing the approach	"Generally fearful of taking a risk with something like mathematics, that must be taught so explicitly."	56 (3.4)	4 (1.9)	52 (3.6)
4. Lack of experience and confidence in teaching either maths or/and English in general	"Feeling that I lack confidence in teaching maths somewhat anyway."	12 (0.7)	0 (0.0)	12 (0.8)

Theme 2: Doubts about Outcome Expectancy (25.3%)				
Categories	**Examples of statement**	**Total** *(N = 1102/1130)*	**In-service teachers (ISTs)** *(N = 126/127)*	**Pre-service teachers (PSTs)** *(N = 976/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
5. Perceived unsuitability of the approach for children of certain age groups	"I am unsure if this strategy would be as appropriate for upper primary as it is for lower primary. I need to know more about this strategy."	64 (3.8)	7 (3.4)	57 (3.9)
6. Perceived limitation of the approach in catering for different literacy ability levels and learning needs	"Some young children struggle significantly with […] reading."	40 (2.4)	8 (3.8)	32 (2.2)
7. Perceived incompatibility between storytelling and mathematics teaching	"Teaching can be a bit 'siloed'. At times when teaching using a book I felt a bit torn when students would pick up something they were interested in [...] but I had prepared a lesson on estimating and counting plastic toys in a big jar."	69 (4.1)	12 (5.8)	57 (3.9)
8. Perceived incompatibility between the approach and the school's adopted mathematics teaching scheme, textbook, assessment approach, and ethos	"Different direction of school teaching."	184 (11.0)	13 (6.3)	171 (11.7)
9. Doubt about the effectiveness of the approach	"Is it supporting the learning?"	26 (1.6)	2 (1.0)	24 (1.6)
10. Potential reduction/loss of mathematical focus when using the approach which may cause children some confusion and distraction	"The fear that children will drift away from the mathematical element of the story and concentrate on another aspect."	40 (2.4)	0 (0.0)	40 (2.7)

Theme 3: Time Constraint (11.3%)				
Categories	Examples of statement	Total (N = 1102/1130)	In-service teachers (ISTs) (N = 126/127)	Pre-service teachers (PSTs) (N = 976/1003)
		f* (%)	*f** (%)	*f** (%)
11. Limited or lack of time (unspecified)	"Did not have the time to search for literature that matched the topics."	75 (4.5)	11 (5.3)	64 (4.4)
12. Limited or lack of time to search for suitable mathematical story picture books	"Time looking for good storybooks with a mathematical connection."	18 (1.1)	9 (4.3)	9 (0.6)
13. Curriculum pressure	"So much content to cover - often little time to reinforce concepts in an overarching manner; often little time to give contextual problem-solving opportunities for reinforcing mathematical concepts."	41 (2.5)	12 (5.8)	29 (2.0)
14. Limited or lack of time to plan for lessons using this approach	"The time it takes to meaningfully plan lessons or units around the key ideas/messages in a text can be a limitation."	30 (1.8)	13 (6.3)	17 (1.2)
15. Limited or lack of time to read a story during the lesson	"If time was running short in a lesson the stories would be cut out."	25 (1.5)	7 (3.4)	18 (1.2)

Theme 4: Resource Constraint (9%)				
Categories	**Examples of statement**	**Total** *(N = 1102/1130)*	**In-service teachers (ISTs)** *(N = 126/127)*	**Pre-service teachers (PSTs)** *(N = 976/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
16. Limited or lack of suitable story picture books for mathematics teaching at school	"I struggle to find books in my school that were available for the topics I was teaching e.g. two-digit addition and time."	151 (9.0)	30 (14.4)	121 (8.3)

Theme 5: Inhibiting Social Norms (2%)				
Categories	**Examples of statement**	**Total** *(N = 1102/1130)*	**In-service teachers (ISTs)** *(N = 126/127)*	**Pre-service teachers (PSTs)** *(N = 976/1003)*
		f* **(%)**	*f** **(%)**	*f** **(%)**
17. Perceived unwillingness of key stakeholders (e.g. school leaders, mentors, parents) for this approach to be trialled	"In my own classroom, I would feel very comfortable incorporating children's literature in my Maths teaching. I find being out on teaching placement though is very limiting if the teacher [mentor] isn't willing and open to change and trial in the classroom. Totally inflexible teacher not willing to allow me to try anything outside her teaching repertoire."	34 (2.0)	5 (2.4)	29 (2.0)
	Total	**1671** **(100)**	**208** **(100)**	**1463** **(100)**

* *f* is here taken to refer to the number of teachers who mentioned a particular belief. Beliefs repeated by the same teacher were counted only once. Participants were able to state more than one perceived barrier, explaining why the total number of *f* (N=1671) exceeded the total number of teachers who responded to this survey question (N=1102).

Barriers as framed by Ajzen's (1991) Theory of Planned Behaviour (TPB)

Attitude toward the behaviour is a personal evaluation of the behaviour in question and this can be favourable or unfavourable
Doubts about Outcome Expectancy

Subjective norm is when a person's beliefs are influenced by perceived social pressures to perform or not to perform a behaviour
Inhibiting Social Norms

Perceived behavioural control is when a person's beliefs are influenced by factors, such as time, money, assistance from other people that either assist or hinder behaviour
Lack of Pedagogical Knowledge and Confidence, Time Constraint, Resource Constraint

BARRIERS

Table 6
Comparison of the Barriers themes across the six* countries (N=1859)

Themes	Average (N=1859) ISTs = 536 (28.8%) PSTs = 1,323 (71.2%)	England (N=1130) ISTs = 127 (11.2%) PSTs = 1,003 (88.8%)	Taiwan (N=287) ISTs = 190 (66.2%) PSTs = 97 (33.8%)	Australia (N=176) ISTs = 94 (53.4%) PSTs = 82 (46.6%)	Ireland (N=154) ISTs = 51 (33.1%) PSTs = 103 (66.9%)	Malta (N=34) ISTs = 23 (67.6%) PSTs = 11 (32.4%)	Indonesia (N=78) ISTs = 51 (65.4%) PSTs = 27 (34.6%)
Theme 1: Lack of Pedagogical Knowledge and Confidence	**35.0%**	**52.3%**	22.8%	48.5%	23.4%	21.7%	41.5%
Theme 2: Doubts about Outcome Expectancy	**13.3%**	**25.3%**	9.5%	4%	14.4%	12.9%	13.5%
Theme 3: Time Constraint	**30.9%**	11.3%	53.1%	26.5%	23.4%	45.7%	25.4%
Theme 4: Resource Constraint	**16.6%**	9%	13.2%	15%	37.8%	15.2%	9.3%
Theme 5: Inhibiting Social Norms	**4.2%**	2%	1.3%	6%	1.2%	4.3%	10.4%

Conclusion

The emerging 'belief structure' as found in our study's datasets across the 5(+1) countries is stable and consistent.

Ajzen's (1991) TPB provides a useful framework to help meaningfully frame our findings.

The study's findings highlight the role of professional learning and teacher training in ensuring that both in- and pre-service teachers have the necessary pedagogical knowledge, experience and confidence in using mathematical storytelling to enrich their mathematics teaching.

Limitation

In the context of this England paper, in-service teachers were outnumbered by pre-service teachers. Thus, the overall findings are quite skewed towards pre-service teachers.

Further Research Directions

Not age specific (2023-2025)
Exploring gender representations in mathematical story picture books

Early Years (2023-2027)
In collaboration with Campaign for Learning, we successfully secured approx. £200,000 (from the Charity of Sir Richard Whittington) to conduct a 4-year project to train parents of pre-school children in disadvantaged areas in London to engage in family mathematical storytelling and to explore its impact on children's use of mathematical language at home.

Primary
- *2019-2021:* As part of my University of Reading's Research Fellowship project, I explore extent to which mathematical storytelling by children can help foster their conceptual understanding of mathematical concepts.
- *2022-2024:* Funded by the British Academy / the Leverhulme Trust, this on-going project explores the extent to which mathematical storytelling by children can help foster their mathematical talk at school.

Secondary (n/a)
In collaboration with Cambridge and DCU colleague, we are successfully shortlisted for the final stage of the Leverhulme grant application (approx. £180,000) to explore the impact of the approach on secondary school students (both increasing learning attainment and reducing maths anxiety).

Impact-Generating Activities

Dissemination of Findings – Social Media

Dissemination of Findings – Blog Posts

Wrote blog posts and articles for non-academic audiences on national platforms (e.g., the National Centre for Excellence in the Teaching of Mathematics [NCETM] website, TES, etc.)

Dissemination of Findings – Workshops

Training over 4,100 in- and pre-service teachers in the UK and internationally (e.g., at the University of Cambridge, King's College London, Dublin City University, the City University of New York, Norwegian University of Science)

Dissemination of Findings – Curriculum Developers

In 2019, I was invited to meet with representatives of Ireland's National Council for Curriculum and Assessment (NCCA) in Dublin including Dr. Jacqueline Fallon (Director of Curriculum and Assessment, NCCA) and other NCCA representatives in charge of developing Ireland's new primary mathematics curriculum to be rolled out in 2022.

(Dr. Fallon had previously read one of my research articles reporting key perceived barriers to and enablers for the integration of story picture books in mathematics teaching as reported by Irish primary teachers.)

Dissemination of Findings – Policy Makers

Presented my research at Westminster to representatives of the Department for Education, the All-Party Parliamentary Group for Education, the Education Select Committee, the Parliamentary Office of Science and Technology, and the House of Common Library.

The event was kindly hosted by Matt Rodda, MP for Reading East.

MathsThroughStories.org

- A non-profit research-based initiative

- Provides a wide range of free on-line resources for teachers and parents

- Since its launch in 2017, the website has now been viewed over 1,580,000 times by around 430,000 teachers and parents from more than 220 countries.

MATHSTHROUGHSTORIES.ORG

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Transforming the way mathematics is taught and learned globally - one mathematical story at

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Currently, there are over

500

stories on our database of recommendations

that can be used to teach

44

mathematical concepts for learners from aged 3 to 18

NUMBERS
(Counting and Place Value)

NUMBER RECOGNITION

ONE-TO-ONE CORRESPONDENCE

COUNTING FORWARDS TO AND BACKWARDS FROM 10/20

COUNTING FORWARDS TO AND BACKWARDS FROM 100

SKIP COUNTING

LARGE NUMBERS

Book Reviews

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by simply clicking on any of
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and would like your mathematical story reviewed by us,

click here for more details.
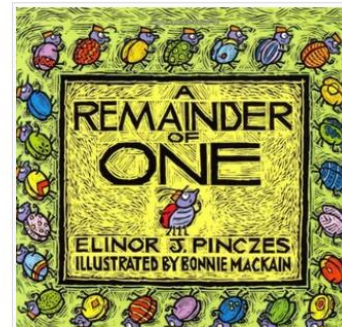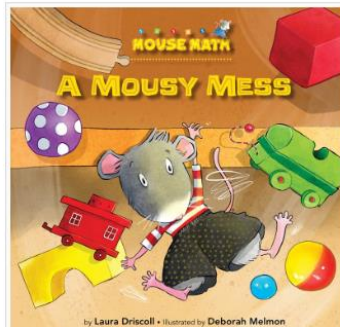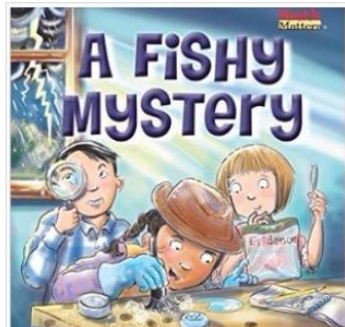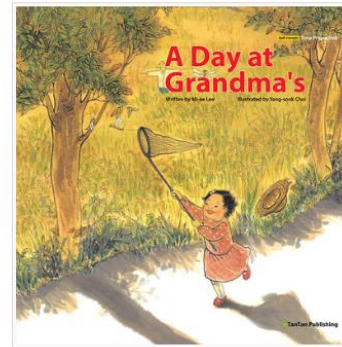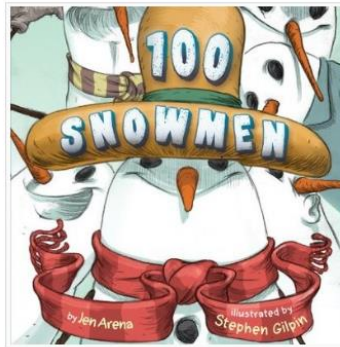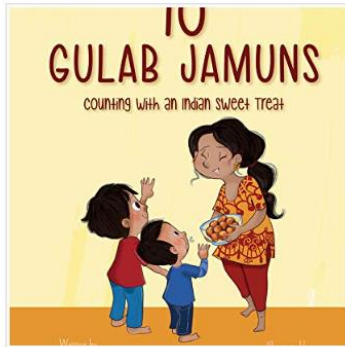
Lesson Plan Ideas Shared by Teachers
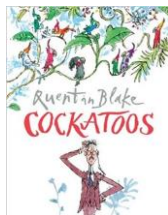
Cockatoos (EYFS)
http://www.mathsthroughstories.org/uploads/5/7/2/5/5725305
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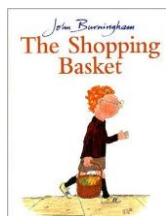
The Shopping Basket (KS1)
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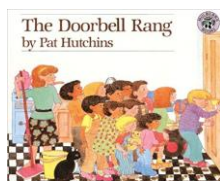
The Doorbell Rang (Lower KS2)
https://www.mathsthroughstories.org/uploads/5/7/2/5/572530
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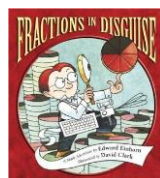
Fractions in Disguise (Upper KS2)
http://www.mathsthroughstories.org/uploads/5/7/2/5/5725305
5/lesson_plan_-_bonnie_mcclure_-_fractions_in_disguise.pdf

Sir Cumference and the Dragon of Pi (Upper KS2)
https://www.mathsthroughstories.org/uploads/5/7/2/5/572530
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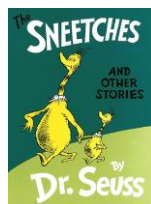
The Sneetches (KS3)
https://www.mathsthroughstories.org/uploads/5/7/2/5/572530
55/lesson_plan_-_oliver_pinel_-_the_sneetches_1.pdf

Case Study Videos

MathsThroughStories.org – Teach measurement using 'Holes' by Louis Sachar

https://www.youtube.com/watch?v=7awyV0LzReg&t

Examples of (Emerging) Impact

St Columba's Catholic Primary School
(Birmingham, UK)
@StColumbasB45

Maths Resources
Home » Parents » Maths Resources

Please click on the links below to acc
We hope you find this useful.
Useful Websites for ideas/resources:

www.primarymathschallenge.org.uk –
www.primarymathschallenge.org.uk/f
www.mathsthroughstories.org

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

St Gregory's Catholic Primary School
(Liverpool, UK)
@StGregorysL27

MATHS THROUGH STORIES

There are lots of books that have mathematical themes. Have a look at this website to see how you can teach your child all about Maths - through story books!!

http://www.mathsthroughstories.org/

Send your photographs into school through Class Dojo, of you and your child sharing Maths through stories at home!

CLICK HERE TO ACCESS THE SCHOOL'S MATHEMATICS CURRICULUM WEBPAGE

St Michael with St John Church of England Primary School
(Lancashire, UK)

Maths Stories

Stories can be a great way to support children's understanding of tricky mathematical concepts and provides them with visual prompts to help them recall their learning and apply it in different ways. The link below suggests books which can be used to support each area of the Maths curriculum, alongside the age ranges that they are best suited for.

https://www.mathsthroughstories.org/recommendations.html

CLICK HERE TO ACCESS THE SCHOOL'S MATHEMATICS CURRICULUM WEBPAGE

Sandford Hill Primary School
(Staffordshire, UK)
@sandford_hill

◆ Stories can be great opportunities for maths learning. One great free resource for maths stories is www.mathsthroughstories.org/recommendations.html but you can use other books too!

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

South Bank Primary School
(Middlesbrough, UK)

Stories can be great opportunities for maths learning. Check out https://www.mathsthroughstories.org/recommendations.html or you can use books you have at home!

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

St Anne's Infants' School
(Bristol, UK)

• Stories can be great opportunities for maths learning. One great free resource for maths stories is https://www.mathsthroughstories.org/recommendations.html but you can use other books too!
• Use manipulatives like bricks or toys of different sizes or amounts. Measuring items, scales, construction materials, puzzles, sorting and pattern materials are also great sources for discussion!

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

Brompton Westbrook Primary School
(Kent, UK)
@BWPrimary

Mathematical Stories

CLICK HERE TO ACCESS THE SCHOOL'S MATHEMATICS CURRICULUM WEBPAGE

Lanesend Primary School
(Isle of Wight, UK)
@lanesendprimary

https://www.mathsthroughstories.org/recom
Maths for specific topics, covering the whole
stories too.

CLICK HERE TO ACCE

Leeming Primary School
(North Yorkshire, UK)
@RAF_Leeming

There are also a couple of websites below containin
so please ask Mrs. Wiltshire if you want to find out m
http://www.topmarks.co.uk/maths-games/hit-the-bu
http://www.mathsthroughstories.org

CLICK HERE TO ACCESS THE SCHOOL'

Townley Primary School
(Cambridgeshire, UK)

Maths

We are working very hard to develop maths across our school. One of the most important ways we think we can really improve the outcomes for our children in maths is by working in partnership with you, our parents and carers. When we held our workshop for parents those that came felt it would be really beneficial to have more information about maths and helping your child at home. Each class now has a maths monkey so you can talk about maths even more! Mrs Williams is currently putting together a pack for you to have at home, in the meantime here are a few things to help.

www.mathsthroughstories.org (maths stories to share with children)

CLICK HERE TO ACCESS THE SCHOOL'S MATHEMATICS CURRICULUM WEBPAGE

Onchan School
(Isle of Man, UK)

Reading Stories

When reading a story with your child, look for opportunities to practise and talk about Maths.

https://www.mathsthroughstories.org/recommendations.html

The website above gives you a list of books for different topics in Maths.

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

Our Lady Catholic Primary School
(Hertfordshire, UK)
@OurLadySchWGC

Learning Resources to support children with Home Learning:

• Maths - www.nrich.maths.org
• Maths - www.mathsthroughstories.org

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

Stories can be great opportunities for maths learning. Check out mathsthroughstories or you can use books you have at home!

Use manipulatives like bricks or toys of different sizes or amounts to support learning. Measuring, building, puzzles, sorting and patterns can be great!

When you see your child practising maths in everyday tasks, praise them!

CLICK HERE TO ACCESS THE ABOVE WEBPAGE

Westfields Junior School
(Hampshire, UK)
@westfields_jun
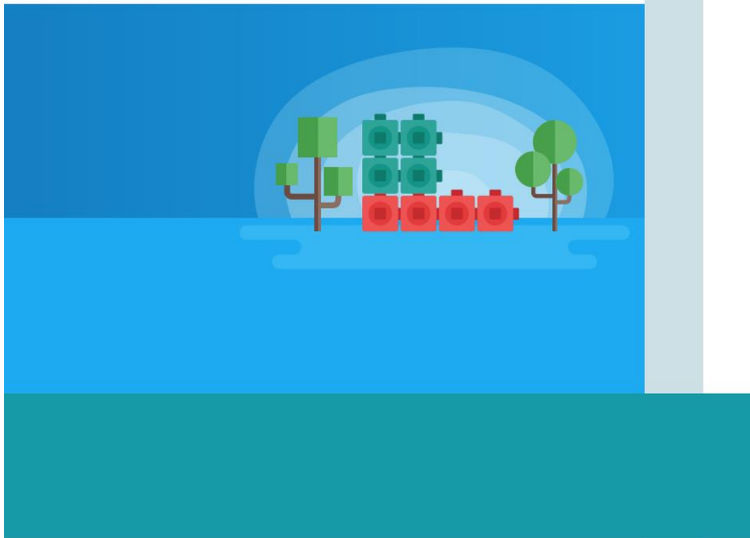
Maths through Stories

Mr Medwell's favourite new website! This site is designed to help children who are struggling to access Maths by making it real and tangible, not just rooted in the abstract! The link below will lead you to some videos and stories that have a mathematical theme. You could explore these videos with your child, pausing periodically to discuss the Maths in each part of the story. Give it a go and tell Mr Medwell what you think! He'd love to get your thoughts on the site!

http://www.mathsthroughstories.org/videos.html

CLICK HERE TO ACCESS THE SCHOOL'S MATHEMATICS CURRICULUM WEBPAGE

Examples of (Emerging) Impact

IMPROVING MATHEMATICS IN THE EARLY YEARS AND KEY STAGE 1
Guidance Report

Education Endowment Foundation

Evidence and resources ⌄   Networks

News > Blog > Blog: Supporting the learning of mathematics at home

Blog: Supporting the learning of mathematics at home

- Finding the mathematics in story books. www.mathsthroughstories.org contains explicit links to mathematics in stories, but you can also consider opportunities in more common story books for mathematical discussion.

Education Endowment Foundation

Mathematics Through Stories, a U.K. organisation that promotes the teaching of mathematics through stories, is another useful source for stories and resources.

Improving mathematics in the early years and key stage 1   13

The Young Mathematical Story Authors (YMSA) Competition

The world's first annual international competition set up to encourage young mathematics learners (8-16 years old) from around the world to embed their mathematics learning in a meaningful and engaging context through creating their own mathematical story picture books.

Two entry categories: 8-11 and 12-16 years old.

The winner in each of these two categories receives an award of £100, and their school also receives £100. The awards are funded by HarperCollins and Charlesbridge – international publishers.

The Young Mathematical Story Authors (YMSA) Competition

Since 2019, the YMSA competition received entries from
around **4,000 students** across over **260 schools** in **23 countries**.

Examples of Primary School Students' Self-authored Mathematical Story Picture Books

Author's age:
8 years old

Topic:
Venn diagram /
Classification

Country:
Thailand
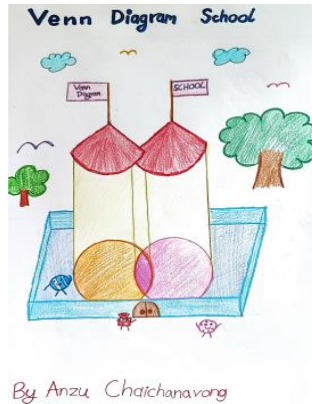
Author's age:
9 years old

Topic:
Division

Country:
India
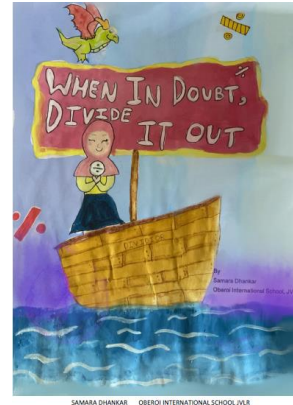
Author's age:
9 years old

Topic:
Perimeter and area

Country:
UAE
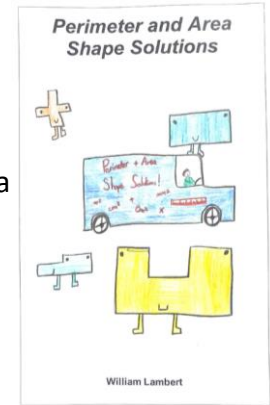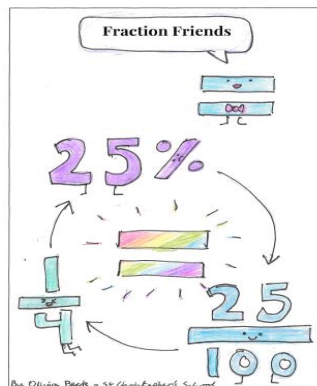
Author's age:
10 years old

Topic:
Fraction and
percentage
conversion

Country:
UK

Author's age:
10 years old

Topic:
Properties of 2D
shapes

Country:
Jersey

Author's age:
11 years old

Topic:
Ratio and
proportion

Country:
UK
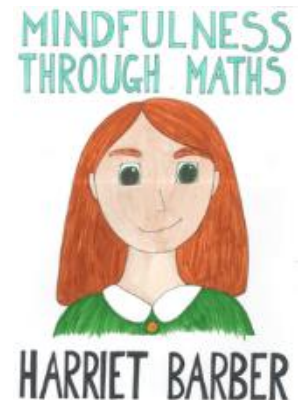
Examples of Secondary School Students' Self-authored Mathematical Story Picture Books

Author's age:
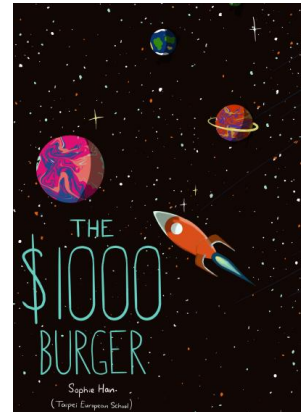12 years old

Topic:
Probability

Country:
Italy
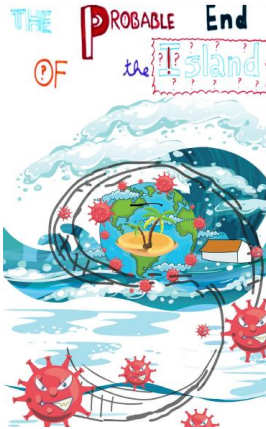
Author's age:
12 years old

Topic:
Base 10 vs Base 2 number systems

Country:
Taiwan

Author's age:
13 years old

Topic:
Statistical correlation

Country:
Maldives
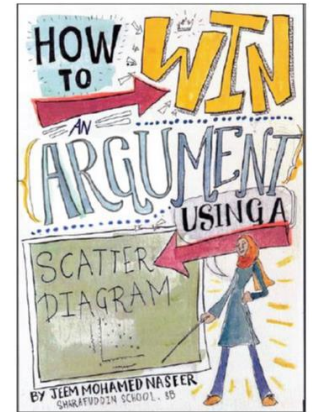
Author's age:
13 years old

Topic:
Power of 10 / Exponents

Country:
New Zealand
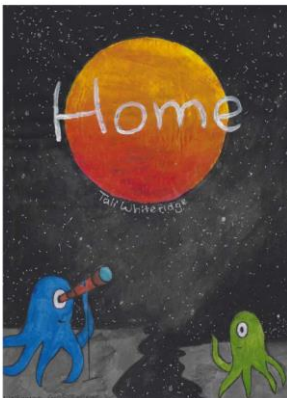
Author's age:
14 years old

Topic:
Quadratic functions

Country:
China
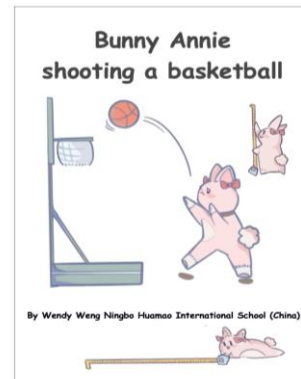
Author's age:
15 years old

Topic:
Trigonometric functions

Country:
USA
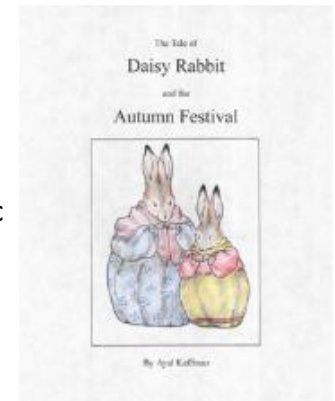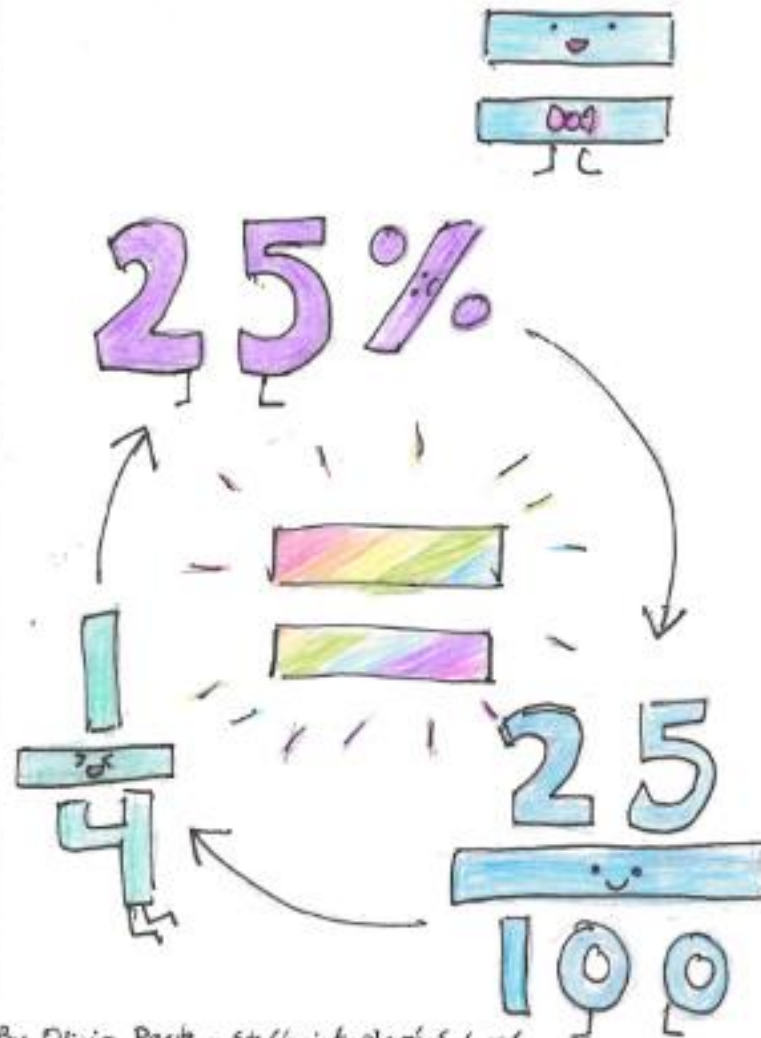
Author's age:
10 years old

Topic:
Fraction and percentage conversion

Country:
UK

It is the first day of school and 25% has just realised that he is the only percentage in the whole playground! He sees all of the fraction friends playing together and feels extremely lonely.

Mr Equivalent (25%'s favourite teacher) saw him sitting alone on the bench.
"What's the matter?" he asked.
"I am the only percentage in the WHOLE school. I feel really alone."
"Well," enquired Mr Equivalent, "Why don't you just convert yourself?"
"What do you mean?" 25% asked.
"Well, to convert is to turn a number from one form into another. In your case, it is to turn a percentage into a fraction."
"Really?" 25% 's face lit up like a Christmas tree. "You can do that?"
"Why of course! Let's get started right away."

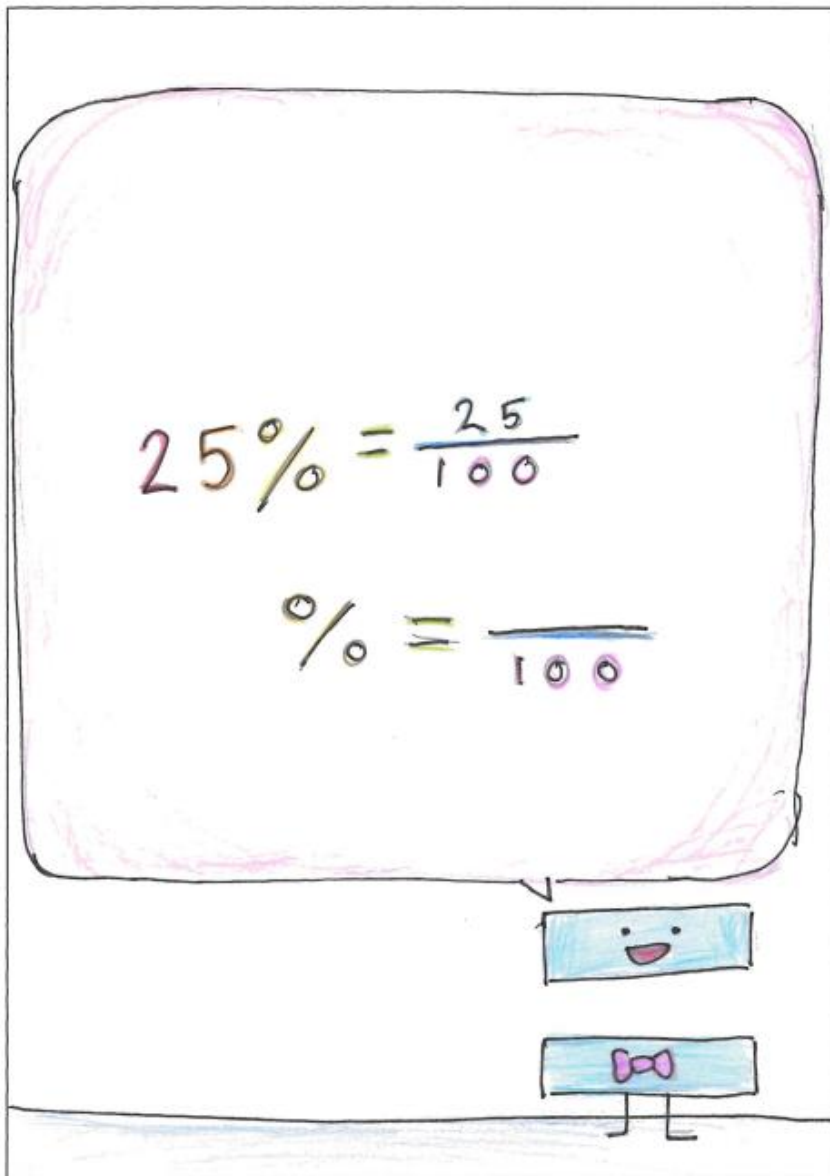"Okay," Mr Equivalent instructed. "The first thing to do is to make you into 25/100, since % means out of 100."
"Right!" 25% (now 25/100) said. "What's next?"
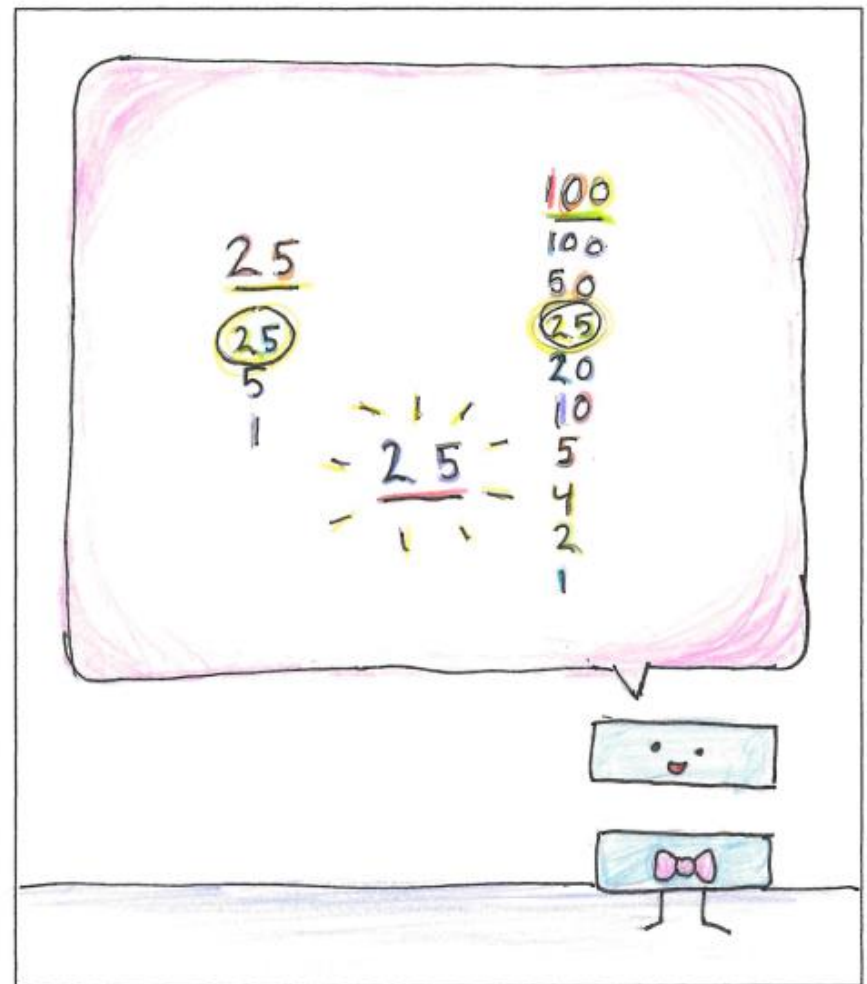
"Next, we need to find the highest common factor (or HCF) of both numbers."
"What does that mean?" asked 25/100.
"Well, a factor is a whole number that divides exactly into another whole number without a remainder. For example, 1, 5 and 25 are all factors of 25. For 100, its factors are 1, 2, 4, 5, 10, 20, 25, 50, and 100. To find the highest common factor, it means to find the largest factor which is shared by given numbers. For example, common factors of both 25 and 100 are 1, 5 and 25, but the largest of those factors is 25, so the highest common factor of 25 and 100 is 25."
"Ok, I get it now. What do we do then?"
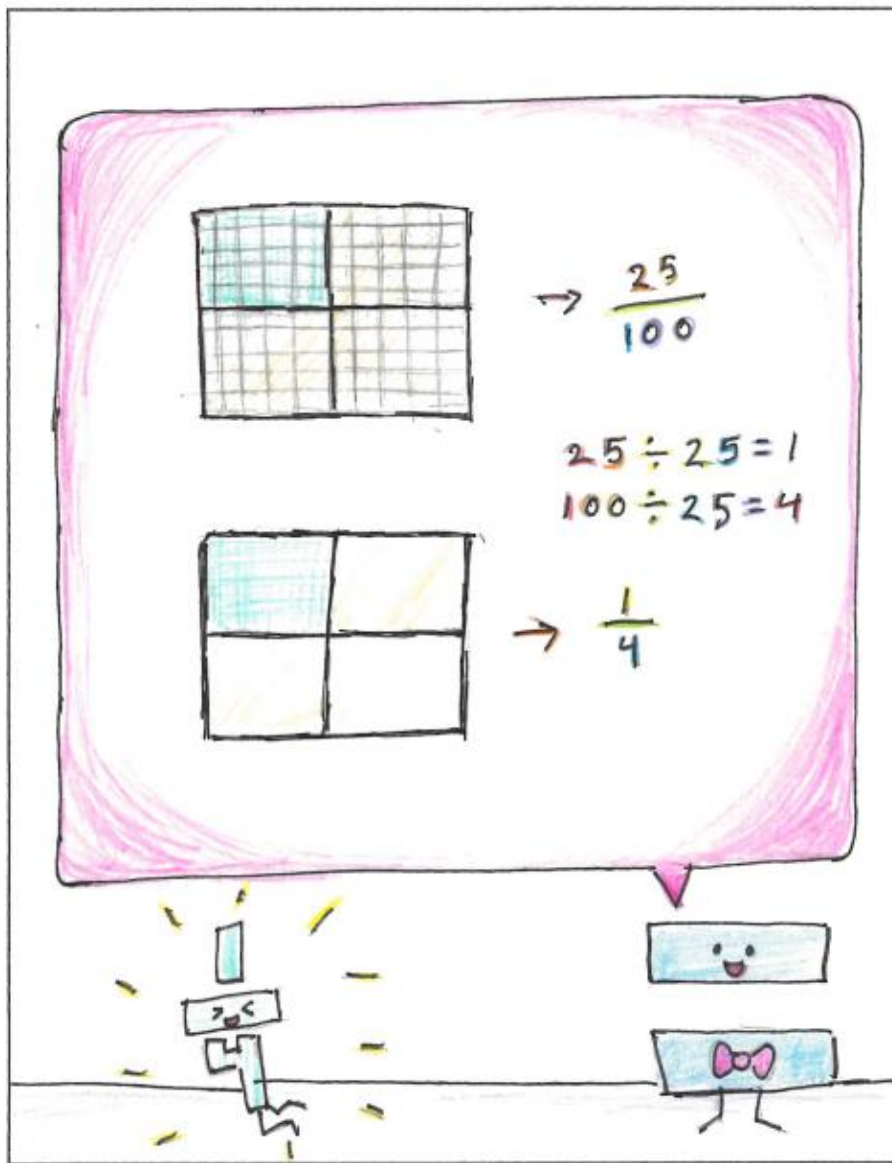
"Then we divide each number by your highest common factor, which is 25." said Mr Equivalent.

"Hmmmm... Well, 25 divided by 25 is 1, and 100 divided by 25 is 4. So I am 1/4!"

"Great job! Are you happy with your new form now?"

"YES!" 25/100 (now 1/4) was jumping with joy!
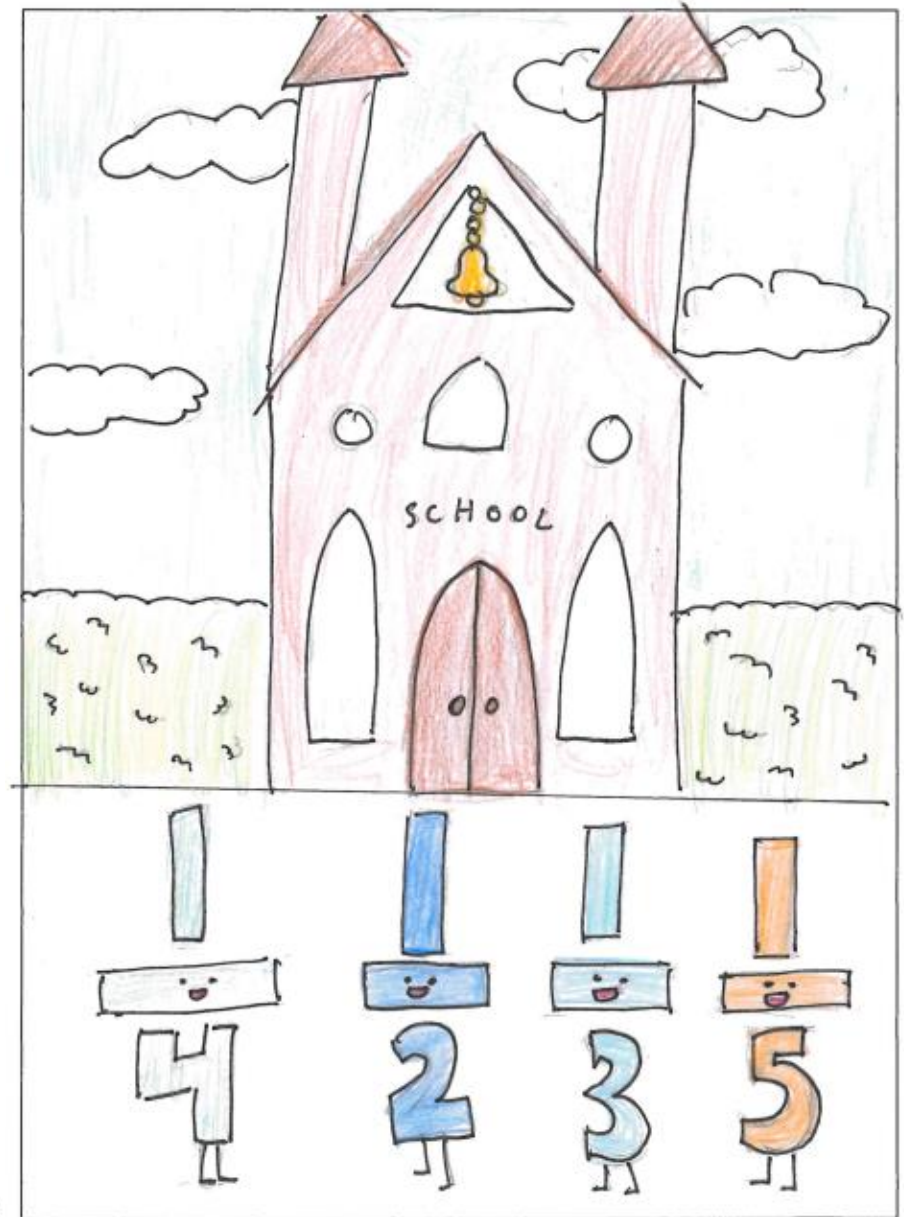
Now he was a fraction, 1/4 didn't feel lonely at all! He skipped back onto the playground and easily made lots of new fraction friends.

MINDFULNESS THROUGH MATHS

HARRIET BARBER

THIS IS NETTIE

Everyone thinks that she is positive all her life but they have NO CLUE of what is hidden inside of her. It feels to Nettie that her whole day is filled with negativity and anxiety. Surely this couldn't be right; no-one could live such a life. If only there was a way to find out the truth.

She wanted to investigate how much time she spends feeling happy, sad or anxious but she wanted to keep those records unrecogniseable to everyone else. It bamboozled her for hours, she had no idea how she could do it.

①

She was overwhelmed. What was Nettie going to do? Exhausted, she drifted off to sleep.
In her dream, she saw sets of colour appear in the night sky as constellations.

They were beautiful. They seemed useful, as if they were there for a reason. Suddenly, she woke up with a jolt. As if it were a god-like force, it came to her. The incredible dream had enlightened her. The answer: RATIO!

②

Flinging her notebook on her desk, she set to work
drawing out her new idea. It looked extravagant in the
morning light.

Now it was relatively simple, she would split her day into
13 segments- one for each hour she was awake.

She would colour in the different
segments to demonstrate how she felt
at that particular time of day.
Once the day drew to a close, she
would then reflect on how she felt
and convert that flower into a ratio to track what proportion
was spent with each emotion.

9:2:2   2:7:4   6:4:3

She then wrote these ratios into her diary so her
feelings could remain private and hidden from the rest of
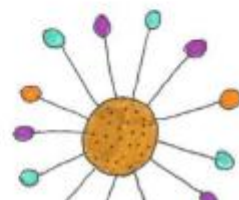the world.

Eventually, after recording her emotions in this way, it
occured to her that however bad her day had seemed, there
would always be...

③

④

Hope

The Tale of

Daisy Rabbit

and the

Autumn Festival

By Ayal Kaffman

It was a brisk autumn day over the lush countryside, where a sharp breath of wind passed through the tall reeds and grasses. The trees in the thickets were laden with rich, auburn leaves which quivered and shook. The sky was pale blue, blending into the hills where mists had only just begun to drift away. The forest floor was damp and soft, covered in brown mushrooms and pine needles. Beneath a winding hedgerow, near the lane, there was a cottage, its door overgrown with plants. It was cozy and warm, and it belonged to Daisy Rabbit.

Daisy Rabbit sat in the kitchen. She was most clever and quite talented with maths. Before her, she had an old and faded book on trigonometry, which she read as she drank her tea and warmed by the fire. Often, she turned to her notebook to write a function or concept. It didn't take long before her daughters woke up, and headed to the kitchen. "G'morning," Clover said, the older of the two. Little Ivy only yawned. "What're you doing mum?" asked Clover, peering at the books. "I'm studying for work today, I've got a bundle of odd jobs to do today before the festival, and they all involve measuring with trigonometry," Daisy responded.

"Come, Clover, sit with me and I'll explain all this," Daisy said. "Sine, Cosine, and Tangent are 3 trigonometric functions used to calculate unknown lengths of sides and measures of angles in right triangles." Daisy Rabbit took out a sheet of paper and wrote down 3 functions. "From an angle," she began, "A triangle has 3 sides. These are the opposite, adjacent, and hypotenuse. The opposite is across from the chosen, non-90°, angle. The adjacent is next to the angle. The hypotenuse is directly across from the 90° angle and is longer than both others. Now, these are the trigonometric functions I will need:"

$Sin(A) = opposite/hypotenuse$

$Cos(A) = adjacent/hypotenuse$

$Tan(A) = opposite/adjacent$

Clover enjoyed maths immensely. Although she had not been able to make heads or tails of these words before, she began to understand. "What does Sin^{-1} mean?" she asked curiously. "$Sin^{-1}(X)$ means the angle whose sin is X." Clover thought for a moment. "D'you think I could come with you today?" She asked, spreading jam on her toast. "Of course, my dear. I'm glad you're interested," responded Daisy. She was always looking to foster her daughters' love of education. "After breakfast, we'll need some items, if you wouldn't mind getting them." Clover swallowed her toast with alacrity before rushing off to grab a surveyor's wheel, a ruler, and a protractor. Soon they were prepared, and off to do a good job.

The day was mild and dark with the sun hiding behind thick, white clouds as Daisy Rabbit and Clover walked through the auburn thicket. "Let's practice the trigonometric functions," Daisy Rabbit said as they came upon a low wall. It was made of stone and covered in ivy. A wooden ladder leaned against it like a stile. Daisy took her wooden ruler and measured the height of the wall and the distance between it and the bottom of the ladder. "The wall is exactly 1 meter tall, and the ladder is **0.70** meters from the base of the wall. Now, little one, do you think you could find the angle between the ladder and the ground and the length of the ladder?"

Calculations for the Angle:
$$TanA = 1/0.7$$
$$A = Tan^{-1}(1/0.7)$$
$$A = 55.01°$$

Calculations for the Length:
$$Sin(55.01) = 1/c$$
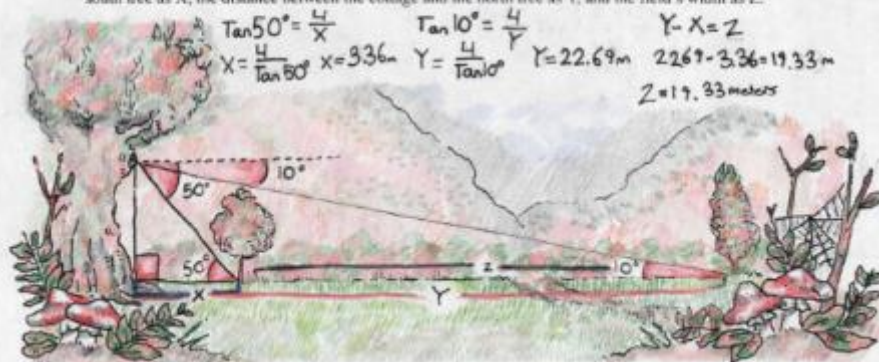$$c = 1/sin(55.01)$$
$$c = 1.22 \text{ meters}$$

On the leisurely walk towards Daisy's first job, she continued to quiz her daughter on the trigonometric functions. Every time that they crossed over a stile, or a wooden bridge, Daisy would stop briefly to find some key measurements and then Clover would make the calculations to find some unknown side or angle. It did not take much time for the sun to start shining with more intensity, and soon the day was warm and sunny. Between the stiles, Clover hummed softly as she pushed the surveyor's wheel down the lane, hearing it clack with every meter that they walked.

It was midday when Daisy Rabbit and Clover arrived at the cottage of Ms. Hawthorn. It was a small house built inside of the oak tree by the stone bridge. They knocked on the ivy-covered door and waited patiently. Daisy Rabbit needed to pay Ms. Hawthorn a visit as the field behind her cottage was to be the location of the Autumn Festival. It was a beautiful and shady spot where the forest grew to the edge of the river. Pale green branches of the weeping willows floated listlessly in the gentle breeze and the golden cowslips quivered upon their stalks. Ms. Hawthorn opened the door and guided them to her room.

In the bedroom, a window looked out upon the field. Daisy's job was to measure the field's width using a tree at the north of the field and a tree at the south. A creek flowed between them, making it impossible to measure with the wheel. Ms. Hawthorn informed Daisy that her window was exactly **4** meters above the flat ground. Then, Daisy Rabbit discovered that the angle of depression, or the angle with which she looked down upon the southern tree, was **50°** and the angle of depression looking upon the northern tree was **10°**. Clover, who wrote this down, labeled the distance between the cottage and the south tree as X, the distance between the cottage and the north tree as Y, and the field's width as Z.

$$Tan50° = \frac{4}{X} \qquad Tan10° = \frac{4}{Y} \qquad Y - X = Z$$
$$X = \frac{4}{Tan50°} \quad X = 3.36m \quad Y = \frac{4}{Tan10°} \quad Y = 22.69m \quad 22.69 - 3.36 = 19.33m$$
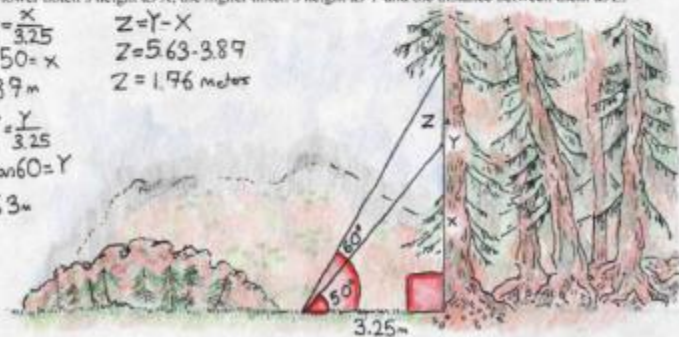$$Z = 19.33 \text{ meters}$$

Once Daisy Rabbit's calculations were complete, and she had found the width of the field between the northern tree and the southern tree, she and Clover said "Good bye" to Ms. Hawthorne and proceeded on their way. Ms. Hawthorne offered them tea and cakes, but they were forced to decline. They then went to the tall fir tree at the western edge of the field. It was very old, with patchy red bark that was peeled away in many places and spongy green moss climbing up its north side. It had only a few sparse branches at its top. "What will we do here?" asked Clover, picking up a pine cone at the base of the tree.

"Here we will hang the village's banner for the festival," Daisy Rabbit answered. The village always put a banner between two notches cut into the tree's side. This practice showed how much the tree grew over the past year, symbolizing the village's growth. "We'll find the distance between the notches, which will be the length of the banner." Clover found that Daisy stood **3.25** meters away from the base of the tree. From her perspective, Daisy found that the angle of elevation, or the angle with which she looked up at the highest notch, was **60°**, and the angle of elevation looking at the lower notch was **50°**. Clover labeled the lower notch's height as X, the higher notch's height as Y and the distance between them as Z.
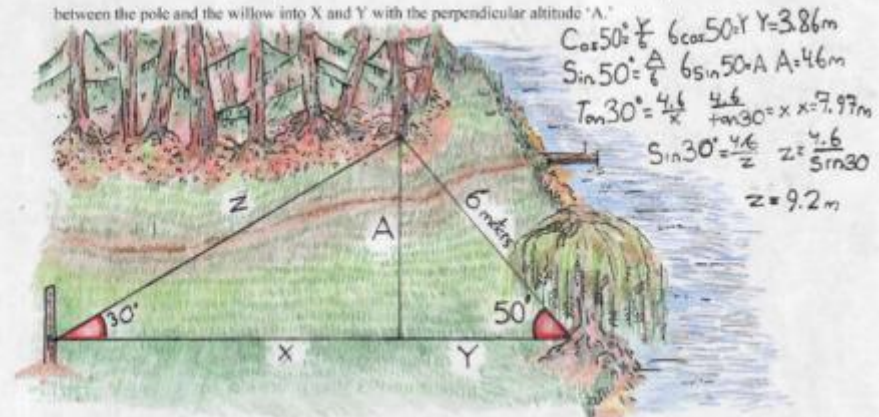
$$\tan 50° = \frac{X}{3.25}$$
$$3.25 \tan 50 = X$$
$$X = 3.89 m$$
$$\tan 60° = \frac{Y}{3.25}$$
$$3.25 \tan 60 = Y$$
$$Y = 5.63 m$$

$$Z = Y - X$$
$$Z = 5.63 - 3.89$$
$$Z = 1.76 \text{ meters}$$

After completing her calculations at the fir tree, Daisy Rabbit and Clover ate upon a thick mat of soft red pine needles. The small wicker basket they brought was full of biscuits and bright red apples. As they ate, some villagers came up to them. "Good day," Daisy said. "Good day," Mr. Rivers said back, his voice carrying a sense of urgency. "We'd truly appreciate some help, Ms. Rabbit, if you'd not mind." Daisy was happy to oblige. At the northern tree, Mr. Rivers explained that they were trying to put rope in a triangle formation about the field so the children of the village could hang their pennants.

They planned on creating the triangle of rope by connecting the willow, the northern tree, and a wooden pole. "The distance between the willow and the northern tree is **6 meters**," Mr. Rivers began, "we also know that the interior angle next to the pole is **30°** and the interior angle next to the willow tree is **50°**. Do you think you could you find the lengths of the other side?" Daisy was very willing to help, and decided to use this opportunity to show Clover how to find missing sides on a non-right triangle. Clover labeled the side connecting the pole and the northern tree as Z, and then was told to split the long side between the pole and the willow into X and Y with the perpendicular altitude 'A.'

$$\cos 50° = \frac{Y}{6} \quad 6\cos 50 = Y \quad Y = 3.86 m$$
$$\sin 50° = \frac{A}{6} \quad 6\sin 50 = A \quad A = 4.6 m$$
$$\tan 30° = \frac{4.6}{X} \quad \frac{4.6}{\tan 30} = X \quad X = 7.97 m$$
$$\sin 30° = \frac{4.6}{Z} \quad Z = \frac{4.6}{\sin 30}$$
$$Z = 9.2 m$$

Once they had finished helping Mr. Rivers and the other villagers with their calculations, Daisy Rabbit and Clover packed up the picnic which they had left by the tall fir tree and continued on their way towards the southern edge of the field. The hour had long since passed noon and already the shadows upon the clouds were becoming darker with a chill settling into the country air. Still, as they walked and pushed aside the tall grass, Daisy would stop to smell the tall pink foxgloves and the yellow cowslips while Clover gathered some small mushrooms in the basket.

When they arrived at the southern gate into the field, Daisy Rabbit explained to her daughter the task at hand. As a result of a general lack of activity in the area, the path which led down from the raised road and into the field itself had fallen into disrepair. It was overgrown and covered in fungus, scattered with rocks covered in moss. The carpenter wanted to build a ramp from the field to the road with an angle of elevation of 30° from the perspective of the field. Daisy Rabbit's job was to find out how long a ramp would have to be to span from the edge of the road into the field if the height of the road was 1.8 meters. Clover decided to label the length of the ramp as X.

$$\sin 30° = \frac{1.8}{x}$$
$$x = \frac{1.8}{\sin 30°}$$
$$x = 3.6 \text{ meters}$$

After completing the calculations necessary for the carpenter to build a ramp at the south edge of the field, Daisy Rabbit and Clover found themselves walking towards their final destination of the day. Daisy was happy with the progress they had made in such a short amount of time. Clover felt that she had gotten a strong grasp of these trigonometric functions. The sky above them was beginning to turn a pink shade, with gold streaking through the clouds when they reached the bank of the river. There, Clover sat upon the soft grass of the bank among the reeds to relax briefly while Daisy explained the task at hand.

Daisy Rabbit explained that they had come to the western edge of the field in order to measure the width of the river. Because so many villagers would be arriving from the west, it was imperative that the hosts provided a wooden bridge for them to walk across with ease. The carpenter's apprentice had taken on this job, but she needed Daisy to get the measurements. Using her ruler, Daisy stood upon the top of the steep bank and found that her perspective was 1.5 meters above the water. She then found that the angle of depression with which she viewed the opposite edge of the river was 25°. Clover labeled the width of the river, from the bottom of each bank, as X.

$$\tan 25° = \frac{1.5}{x} \qquad x = \frac{1.5}{\tan 25}$$
$$x = 3.22 \text{ meters}$$
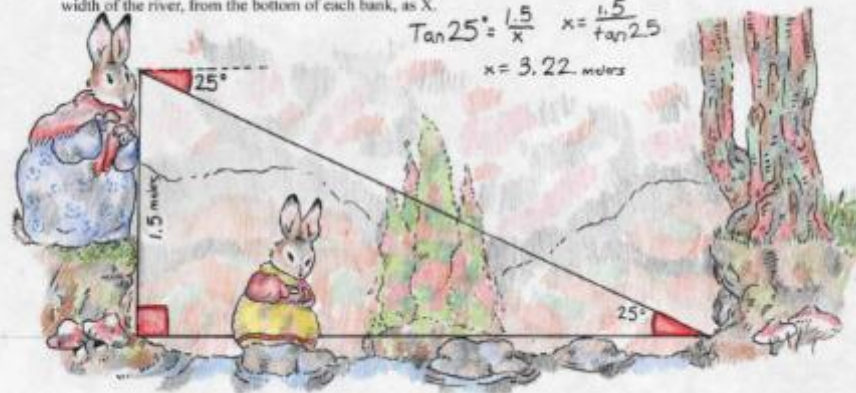
Once Daisy Rabbit and Clover had at last completed the calculations required for the bridge over the river by the meadow, they were finally able to return home. Golden light still lingered ever so slightly over the countryside, but the darkness of the night was beginning to fall. In the distance, beyond the wood, an owl called out into the cold air. The thicket quivered softly as the wind grew in force, whistling through the leaves and tall grasses. The trees grew dark, and all the light but that from the pale moon was extinguished from the forest floor. However, Daisy and her daughter were unafraid. They walked for a while, taking in the cool, night air before reaching the thicket where their cottage lay.

At long last, Daisy Rabbit and Clover arrived at their cottage. When they opened the door, sweet golden light poured out onto the floor and they felt the warmth of the fire upon their faces. Ivy and the sitter were sitting by the stove but stood up quickly to greet them. The wonderful smell of hot stew and freshly baked bread wafted over to them. It was a beautiful night, and it had been a wonderful day, but now they were tired and all too ready for bed.

Only a week after Daisy Rabbit and Clover had completed their calculations, the Autumn Festival was entirely set up. The village carpenters had been hard at work, constructing the bridge over the river and the ramp down from the road so that the meadow would be as accessible as possible. Long tables were covered in linen and laden high with freshly baked breads and pies. There were plates of cheese and bowls of hot soup. The feast's sweet aroma wafted over field on a gentle breeze which caused the banner high in the tall fir tree to flutter. Everyone in the surrounding fields had arrived in their best clothes.

Ivy and Clover spent their day with the other children of the village, engaging with the activities set up to celebrate the good harvest. There was a stand filled with bright red apples which they could dip in sweet honey and sugar, but Clover had to hold Ivy's as she kept getting her paws sticky. There was a table covered in vegetables that were submitted by the village gardeners for a variety of awards. Ivy found herself marvelling at the largest pumpkin, which seemed big enough to live in. Clover's favorite activity, however, was the very last one. As the sky darkened and the festival began coming to a close, all the children got into a carriage filled with hay and watched as the orange countryside flew by them.
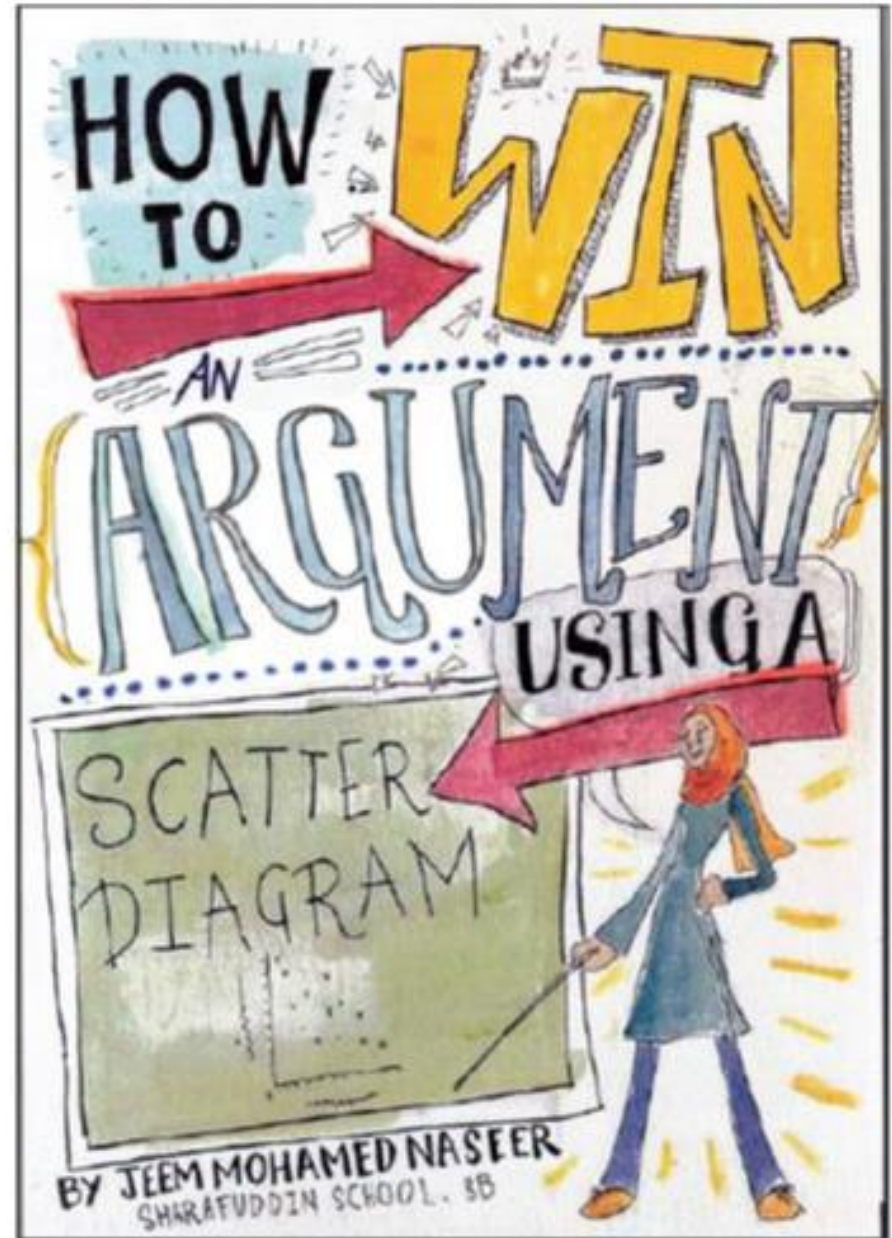
REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Elia, I., Van den Heuvel-Panhuizen, M., & Georgiou, A. (2010). The role of pictures in picture books on children's cognitive engagement with mathematics. *European Early Childhood Education Research Journal, 18*(3), 275-297.

Farrugia, M. T. & **Trakulphadetkrai, N. V.** (2020). Maltese teachers' beliefs concerning the integration of children's literature in mathematics teaching and learning. *Cogent Education, 7(1)*, 1-19. https://doi.org/10.1080/2331186X.2020.1817253

Gunbas, N. (2015). Students' mathematics word problem-solving achievement in a computer-based story. *Journal of Computer Assisted Learning, 31(1)*, 78-95.

Jennings, C. M., Jennings, J. E., Richey, J., & Dixon-Krauss, L. (1992). Increasing interest and achievement in mathematics through children's literature. *Early Childhood Research Quarterly, 7,* 263-276.

Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. National Academy Press.

Lemonidis, C., & Kaiafa, I. (2019). The effect of using storytelling strategy on students' performance in fractions. *Journal of Education and Learning, 8(2*), 165-175.

Livy, S., Muir, T., **Trakulphadetkrai, N. V.**, & Larkin, K. (2023). Australian primary school teachers' perceived barriers to and enablers for the integration of children's literature in mathematics teaching and learning. Journal of Mathematics Teacher Education, 26(5), 5-26. https://doi.org/10.1007/s10857-021-09517-0

McAndrew, E. M., Morris, W. L., & Fennell, F. (2017). Geometry-related children's literature improves the geometry achievement and attitudes of second-grade students. *School Science and Mathematics, 117(1-2)*, 34-51.

REFERENCES

Mink, D. V., & Fraser, B. J. (2005). Evaluation of a K-5 mathematics program which integrates children's literature: classroom environment and attitudes. *International Journal of Science and Mathematics Education, 3,* 59-85.

Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Review of Educational Research, 62(3)*, 307-332.

Prendergast, M., Harbison, L., Miller, S., & **Trakulphadetkrai, N. V.** (2019). Pre-service and in-service teachers' perceptions on the integration of children's literature in mathematics teaching and learning in Ireland. *Irish Educational Studies, 38*(2), 157-175. https://doi.org/10.1080/03323315.2018.1484302

Sianturi, I. W. (2024). Teachers' beliefs on integrating children's literature in mathematics teaching and learning in Indonesia. *Educational Studies in Mathematics*. https://doi.org/10.1007/s10649-024-10334-4

Thompson, A. G. (1984). The relationships of teachers' conceptions of mathematics and mathematics teaching instructional practice. *Educational Studies in Mathematics, 15*, 105-127.

Trakulphadetkrai, N. V. (In preparation). English pre-service primary school teachers' beliefs concerning the integration of children's literature in mathematics teaching and learning.

Van den Heuvel-Panhuizen, M., Elia, I., & Robitzsch, A. (2016). Effects of reading picture books on kindergartners' mathematics performance. *Educational Psychology*, *36*(2), 323-346.

Yang, D.-C., Su, Y.-W., Chen, C.-H., & **Trakulphadetkrai, N. V.** (2022). Taiwanese primary school teachers' perceived enablers for and barriers to the integration of children's literature in mathematics teaching and learning. Educational Studies in Mathematics, 110, 125–148 https://doi.org/10.1007/s10649-021-10115-3

AN INTERNATIONAL SURVEY STUDY EXPLORING TEACHERS' PERCEPTIONS ON USING MATHEMATICAL STORYTELLING: THE CASE OF ENGLAND

Dr. Natthapoj Vincent Trakulphadetkrai

B.A. (Hons), M.Sc. (Oxford), M.Sc. (London, UCL), Ph.D. (Cambridge), QTS, SFHEA

Associate Professor of Mathematics Education, University of Reading
ESRC Policy Fellow, Education Endowment Foundation (EEF)
Founder, MathsThroughStories.org

n.trakulphadetkrai@reading.ac.uk
www.Natthapoj.org   @NatthapojVinceT   /   www.MathsThroughStories.org   @MathsStories