How an Awareness of Metaphor can Inform Mathematics and Numeracy Teaching and Learning

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In this presentation

• Background
• Why metaphor matters
  – Potential of metaphor as an effective numeracy and mathematics teaching and learning tool
• Learning from metaphors:
  – To facilitate a patterns-based approach to numeracy teaching and learning
  – To include both emotion and cognition in learning
  – To create effective learning communities
Background

- Brady & Winn (2014)
- Pre-service teachers wrote a personal metaphor
  - To explore and articulate how they felt about mathematics
- Generated strong and meaningful images
- Revealed complex, often negative, attitudes
- But…exposed a potential preparedness to approach mathematics and numeracy more positively
Why metaphor matters

• Provides insight into often hidden beliefs that shape mathematics and numeracy learning
• Symbolic nature of metaphor allows it to provide insights not readily accessible through more direct methods
• Has the potential to shift deep-seated, often unconscious, fears and attitudes
Revealing hidden beliefs

• We did not ask what the students believed about mathematics
• But rather how they felt about mathematics
  – “Maths for me is like......”
• Often possible to glean information about what people believe based on how they feel
Revealing hidden beliefs

• “Maths is like a jigsaw puzzle. In can be overwhelming at the start with all the pieces mixed up. But when you sort through and find the framework it becomes easier. Focusing on one section at a time to make the bigger picture makes it easier to solve and complete the puzzle”
  – Reveals a belief about the problem-solving nature of mathematics

• “Maths is like baking a cupcake. If you don’t follow the recipe or use the wrong ingredients they don’t turn out properly”
  – Expressing a belief about the utilitarian nature of mathematics
Shifting beliefs

• Ausubel, Novak & Hanesian (1968): the single most important factor in shaping teaching is an understanding of what learner knows

• However, learners absorb attitudes and fears unconsciously (Le Doux, 1996)
  – Which can block learning without the learner realising

• When students unconsciously absorb fear of mathematics, or believe that it is difficult
  – Will impact on their capacity to learn mathematics

• Many students do not realise that they have internalised such beliefs (Pesci, 2003)
Shifting beliefs

- Learning is an intertwined cognitive and emotional process
- These interconnections happen largely on an unconscious level (Pesci, 2003)
- Le Doux (1996) distinguishes between unconscious and conscious emotional memory
  - Unconscious emotional memory often drives behaviour
- Unconscious emotions block conscious, cognitive learning
- “Fight or flight” mechanism
Shifting beliefs

• Students with an unconscious deep-seated fear of mathematics
  – May well be cognitively more than capable of learning it
• Their unconscious fear reaction, will result in conscious, cognitive processing being unable to function
• This is where to symbolic nature of metaphor is critical
Making the unconscious conscious

• Damasio (1999): metaphor is the key to making the unconscious conscious

• Through the creation of a metaphor describing experiences in terms of another representation unconscious memory can be made conscious

• Symbolic nature of metaphor brings to light relevant, unconscious emotions that drive beliefs
Making the unconscious conscious

- Unconscious emotions not controlled at cognitive level
  - Are unlikely to surface through direct questioning

- Cross-domain mapping (Lakoff & Nunez, 2000)

- Refers to the linking of a tangible sensorimotor experience to a more abstract concept
Making the unconscious conscious

• Adey & Shayer (1994): “bridging”
• Bridging involves relating new ideas to other known examples
• Cross-domain mapping that requires understanding one concept in terms of another
  – Fundamental step in the bridging process
Why metaphor matters

• It is much more that a linguistic device (Chapman, 1997)
  – It represents embodied knowledge and lived experiences
• Intricately linked with psychological concept of embodiment
  – The notion that sensory experiences ground a person’s thoughts, feelings and expressions (Meier et al, 2012)
Shifting metaphors and attitudes

- “Maths feels like being stuck in space without a helmet, never-ending, overwhelming and quite fatal”
- “Maths is like an airport: it looks chaotic but everything is actually logical, pre-determined rules”
- Where learners’ metaphors are predominantly negative:
  - A shift to a metaphor that embodies a more positive experience has potential for attitudes to mathematics to shift
Learning from metaphor

• Four strategies for the use of metaphor:
  – To facilitate a problems-based approach
  – To include both emotion and cognition in learning process
  – To create an effective learning community that enables students to shift metaphors
Facilitate patterns-based approach

• Polya (1962): students need to learn to problem solve by discovery
• Schoenfeld (1992): characterisation of mathematics as science of patterns is critical
  – Shifts mathematics learning from content mastery to a problem-solving process
• Metaphor is integral to teaching mathematics using a patterns-based approach
  – Requires learning to think rather than rote replication
Facilitate patterns-based approach

• “Maths is like flying a plane – hard to learn to fly it but once you grasp the theory of how to do it, your are able to fly through problems”

• Key to patterns-based approach is appreciating interplay between a deep-seated, underlying pattern – And the different contexts in which it finds expression

• Metaphor is ideal tool for developing this understanding
Emotion and cognition in learning process

• Generating a metaphor requires learners to engage with their own emotions with respect to mathematics

• “For me mathematics is like jumping into deep water. It is scary at first but if you have already been taught the basics of swimming you can keep afloat”

• “Maths is like shopping for jeans. Frustrating and I usually give up after a while”
Emotion and cognition in learning process

• Explicitly engaging with metaphor is an important strategy for improving mathematics teaching and learning
• Symbolic engagement (Schwab, 1975)
• Wilcox et al (1991): symbolic engagement enables community to shape attitudes to mathematics
  – Encouraging valuing and sharing
• Students need to explore metaphors at both an individual and community level
Create effective learning communities

• Sfard (1998): direct relationship between metaphor and community
• The learning community shapes metaphors
  – May constrict, or expand, student learning significantly
• Use more than one metaphor to guide teaching
• Metaphors and associated learning community are intertwined
Enable students to shift metaphors

• Explicit exploration of personal views necessary for change (Sterenberg, 2007)
• “Maths is like riding a horse wearing a blindfold”
• Importance of community that enables participation through interpersonal exchange (Ju & Kwon, 2004; Szydlik et al, 2003)
• Emphasis on discussion of metaphor and making sense of mathematics in community
Enable students to shift metaphors

• Explicit teaching of link between abstract concepts and real-life problems (Ju & Kwon, 2004)
• Students who only understand how to solve a problem in one context
  – Are unlikely to be able to solve that problem in another, appropriate context
Enable students to shift metaphors

• Providing an explicit metaphor for structuring the space of a collection of examples
  – Facilitates learning to shift metaphor (Watson & Mason, 2005)

• To encourage shifting of metaphor
  – Work through examples carefully selected for their part in the bigger picture
To finish

- Metaphor unlocks crucial, and sometimes hidden beliefs that may facilitate or inhibit mathematics and numeracy learning and teaching.
- Symbolic nature facilitates shifting of deep-seated, often unconscious emotions that block cognitive learning.
- Using metaphor effectively can improve mathematics and numeracy teaching and learning.
References

References