Behaviourism, cognitivism, constructivism, or connectivism? Tackling mathematics anxiety with ‘isms’ for a digital age

Dr Chris Klinger
University of South Australia
chris.klinger@unisa.edu.au
adult learners

- endemic innumeracy
- maths anxiety, negative attitudes, maths-aversion

‘traditional’ approaches don’t work for math-averse students
Learner characteristics – the practitioner’s challenge

- confusion
- lack of confidence
- negative perceptions
- lack of strategies
- narrow focus
- assessment-driven motivation
- little or no appreciation of the concept of mathematics as language
• shallow, or surface learning styles – maybe *atypical*
• maths learning style as reaction to math-aversion i.e. not intrinsic
• past learning experiences as proximal cause
• need for different framework
• need to understand the epistemological basis for adult maths/numeracy teaching…
Epistemology and pedagogy in perspective

**Behaviourism**

- ‘skill & drill’
- focus on procedures and outcomes arranged hierarchically
- mathematical knowledge is external, absolute

  Exposition by the teacher followed by practise of skills and techniques is a feature which most people remember when they think of how they learned mathematics. (Orton, 2004)

- ‘use it or lose it’ impermanence
Cognitivism

- intentional action from mental states
- learner adapts to learning environment
- recursive processes of *assimilation* and *accommodation*
- internal knowledge representations or *schema* (Bartlett, 1932)
- cognitivism augments rather than supplants behaviourist practices
Social cognitivism

• fuses elements of behaviourism and cognitivism with social aspects of learning (Bandura, 1986)
• learning is as much social as it is behavioural and cognitive
• importance of observational learning – comparative observations of self & of others

self-efficacy beliefs

(Bandura, 1997)
Epistemology and pedagogy in perspective

Constructivism

- knowledge cannot be transmitted but is a construct of the mind as a consequence of experiential learning
  - learning is an ongoing process of hypothesizing, rule-creation and reflection
  - no didactic authority
  - teacher as a facilitator of the learning process & information conduit
Social constructivism

- knowledge must necessarily be grounded in social values, standards, mores, language and culture
- social interaction extends the location of knowledge via communicated and shared understandings
Epistemology and pedagogy in perspective

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Flawed, in context of mathematics & numeracy education:

- required curriculum outcomes identical to those of behaviourists and cognitivists
- assumptions that self-directed learners have ‘sufficient prior knowledge and skills’ (Rowe, 2006)
- not reasonable or sensible to expect students to actually discover ‘basic’ mathematical concepts and corresponding procedures
Epistemology and pedagogy in perspective

A Look Inside

New mathematical concepts are introduced in the context of story problems.

Different solution methods are presented to help students understand multiple ways to solve problems while presenting opportunities for them to discuss their ideas.

Problem-Solving Approach
- Understanding the problem
- Solving the problem
- Summarizing the solution

Cartoon characters provide helpful hints as well as important thinking points students need to notice.

Representational models are used to help students understand the structure of the problem and to enable them to construct mathematical equations for solving problems.

Image from: <http://www.globaledresources.com/media/products/books/math_elementary/a_look_inside_large.jpg>; accessed 2/6/2009
Social constructivism

Jane has $\frac{1}{3}$ of a candy bar. She gives $\frac{1}{2}$ of what she has to Mike. How much of the candy bar does she give to Mike? $\frac{1}{6}$ of the candy bar.

The Candy Bar Problem (Davis and Maher, 1990 p75)
Social constructivism

Jane's candy bar problem:

Jane has $\frac{1}{3}$ of a candy bar. She gives $\frac{1}{2}$ of what she has to Mike. How much of the candy bar does she give to Mike? $\frac{1}{6}$ of the candy bar.

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\[ \frac{1}{3} \div \frac{1}{2} \cdot \frac{1}{3} \times \frac{2}{1} = \frac{2}{3} \]

\[ \frac{1}{2} \div \frac{1}{3} = \frac{1}{2} \times \frac{3}{1} = \frac{3}{2} \]

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Connectivism

George Siemens (2005):

- a ‘learning theory for a digital age’
- ‘know-how and know-what supplemented with know-where’
- the ‘capacity to know more is more critical than what is currently known’

- ‘knowledge is distributed across networks and the act of learning is largely one of forming a diverse network of connections and recognizing attendant patterns’ (Siemens, 2008 p10)
Connectivism

- value of the connectivism paradigm in mathematics and numeracy teaching lies in exploiting the properties of network connectivity in complex systems

- pursue opportunities for students to forge links that promote an understanding of mathematics as *language*

- *fluency*: dependence on math rules becomes redundant
Connectivism

- self-referential (reflective) *knowledge network* grows:
  - new connections incorporate nodes of both congruent & disparate knowledge & experience
  - network undergoes periods of *self-organizing criticality* whereby cognitive ‘phase transitions’ yield flashes of emergent deeper understanding
- increasingly, learner become empowered to undertake self-directed learning according to need or inclination
Reframing practice
– a connectivist approach

Connectivism

• utilise existing skills and knowledge-base as leverage
• demonstrate how the context and methods of mathematics are revealed through its application as language
• map these onto familiar concepts and language to identify a common base of understanding
• guide students to cultivate an ‘ear’ (or eye) for dissonance
• promote the ability to self-correct
• be alert to inappropriate language construction/interpretation
• traditional ‘isms’ – behaviourism, cognitivism, constructivism – are in deficit & directly associated with aversive affective behaviours

• connectivism resonates with techniques and approaches known to be successful in alleviating mathematics anxiety

• connectivism invokes the properties of network connectivity in complex systems to explain learning

• provides a theoretical framework to reframe adult numeracy practice