

# **PARADIGM SHIFTS IN MATHEMATICS EDUCATION**

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# **WHAT PARADIGM SHIFTS HAVE THERE BEEN IN MATHEMATICS EDUCATION IN THE PAST 20 YEARS?**

Changes in

1. PHILOSOPHIES OF MATHEMATICS
2. LEARNING THEORIES
3. TEACHING METHODS
4. RESEARCH METHODOLOGIES
5. SOCIAL ROLE OF MATHS TEACHING

# 1. PHILOSOPHIES OF MATHEMATICS

This concerns different answers to the question

## WHAT IS MATHEMATICS?

Traditional views are

**Foundationalist** - mathematics has a permanent secure foundations, and

**Absolutist** - mathematical knowledge and truth is eternal, objective and absolute

**However, new views have emerged**

**Fallibilist, Humanist, Relativist and Social Constructivist philosophies of mathematics**

- **Mathematics is forever evolving and changing as history of mathematics shows**
- **Concepts proofs and proof standards change over history**
- **Mathematical knowledge is invented, not discovered**

# SO THERE IS 'HOT' CONTROVERSY IN AREA (part of the so-called 'Science Wars')

Foundationalists and absolutists	versus	Fallibilists, humanists, relativists and social constructivists
Mathematics is certain, cumulative and untouched by social interests		Maths fundamentally social, with cultural limitations to its claims of certainty, universality and absoluteness.

## **THIS RAISES NEW QUESTIONS (& ANSWERS)**

- ◆ What is mathematics?
- ◆ What new philosophies are there and why?
- ◆ What is impact on teaching and learning maths?
- ◆ What personal philosophies do teachers have?
- ◆ What is basis for choosing topics for school?
- ◆ How do mathematicians work and create new mathematical knowledge?
- ◆ Is maths itself changing as new methods and technologies emerge?

## **2. HOW IS MATHS LEARNED?**

Traditional theories are **COGNITIVE** and **DEVELOPMENTAL**

Mathematics is learned by building up conceptual structures

Experience results in the internal development of knowledge

Newer theories of learning have been

- ◆ **CONSTRUCTIVIST** – which build on cognitive psychology
- ◆ **ENACTIVE** – which stress bodily activity and body-based metaphor
- ◆ **SOCIAL CONSTRUCTIVIST** and **SOCIOCULTURAL** theories – which emphasize language and guided social activities – thinking and learning take place in the ‘space between persons’ (ZPD)

# Heated controversy over past two decades

**Cognitivism**

versus

**Radical Constructivism**

versus

**Enactivism / Embodied Cognition**

versus

**Social Constructivism**

Versus

**Socio-Cultural theories**

To introduce epistemological considerations ... has always been dynamite (E von Glasersfeld).

# NEW QUESTIONS

- ◆ What are these theories of learning mathematics and how do they differ?
- ◆ What observable impact do they have if any on classroom practices?
- ◆ What is role of the teacher in mathematics?
- ◆ What is the role of assessment in maths?
- ◆ How important are attitudes, beliefs and values in learning mathematics?
- ◆ How does the student's identity change through learning mathematics?

### **3. CHANGES IN IDEAS ABOUT TEACHING MATHEMATICS**

- ◆ What is the role of the maths teacher?
- ◆ What teaching methods are best?
- ◆ Are the changing trends in mathematics teaching real progress or just swings of a 'pendulum'?
- ◆ What should be the role of calculators & ICT?

## 'Hot' controversies in teaching (Math Wars)

Problem solving, investigational approach	<b>versus</b>	Traditional teacher-centred approach
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Individual approach	<b>versus</b>	Interactive whole class teaching
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Calculators, mental calculations, child methods	<b>versus</b>	Standard written algorithms in arithmetic
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## **4. WHAT IS BEST RESEARCH METHODOLOGY FOR MATHEMATICS EDUCATION?**

- ◆ What is the function of research in maths education?
- ◆ How does the maths education research community judge knowledge claims?
- ◆ What kind of results are needed?

# CONTROVERSY OVER RESEARCH PARADIGM

SCIENTIFIC RESEARCH PARADIGM AND METHODOLOGY	<b>versus</b>	INTERPRETATIVE RESEARCH PARADIGM AND METHODOLOGY
Generalizations and quantitative data		Case studies and 'thick' descriptions

## **5. HOW DOES MATHS RELATE TO SOCIETY?**

Emergence of social responsibility and politicization of mathematics education

- ◆ What are the aims of mathematics teaching?
- ◆ Whose aims are they and are they valid for all?
- ◆ Does maths teaching contribute to overall goals of society and education?
- ◆ Is mathematics teaching fair to all groups in terms of race, sex, class?
- ◆ What is the role of mathematics in social justice and critical citizenship?

# HEATED CONTROVERSIES OVER AIMS

Different social groups have conflicting aims

Case of competing groups with different aims, values, epistemologies in UK National Curriculum

1. **Industrial Trainers** (authoritarian, back to basics),
2. **Technological Pragmatists** (industry-centred),
3. **Old Humanists** (pure mathematics-centred),
4. **Progressive Educators** (learner-centred),
5. **Public Educators** (social justice centred).