Learning to Teach Primary School Mathematics

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My Principles of and Assumptions about Good Mathematics Teaching

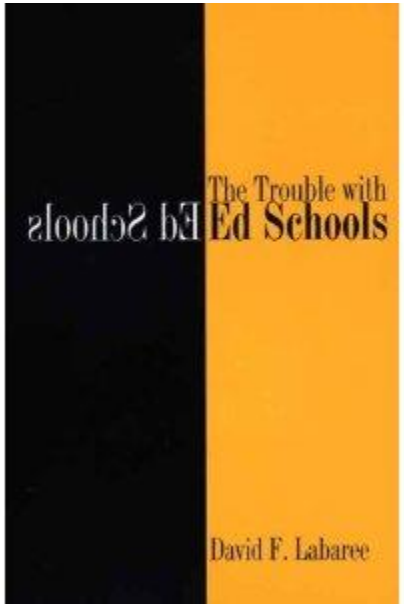
- Take seriously mathematics as a discipline
- Take seriously children's mathematical ideas
- See mathematics as a "collective intellectual endeavour situated within community"
  - (Ball, 1999, p. 29)
- Children construct logico-mathematical knowledge through thinking, and exchanging ideas
  - (Kamii, 2005)
- A teacher works in relation to multiple, complicated and changing students and multiple, complicated and changing contents
  - (Lampert, 2001)
- Diagnostic Teaching is worth aspiring to
  - (Schoenfeld, 2011)

Irish Video

- Mathematics Laboratory
- Site for Teaching, Professional Development and Research
- Third class
- Day 3 of 5
- 25 children

- (Part 2, 0’00 – 1’38” and 4’06” to 7’56”)

Challenge for Teacher Education



- “Teaching is an enormously difficult job that looks easy”
  - (David Labaree)

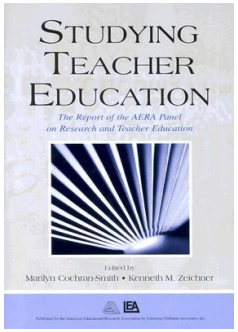
Questions for Teacher Educators

- What do beginning teachers (of mathematics) need to learn?*
- (And what can be left for in-service teacher education?)
- How can prospective teachers learn what they need to learn?
- How can we tell if they are ready to teach?*

Lack of Research Evidence

- Internationally
- “Isolated nature of research programs that appear to be proceeding in various directions and unconnected ways”
  - (p. 168, Wideen et al, 1998)
- Methodological flaws, small-scale, self study
- Poorly funded

- In Ireland
- 18 articles published in Irish Educational Studies in 2010. None had “teacher education” in the title or listed as a keyword.



- “Teacher educators and policymakers go about their work in designing and implementing policies and programs without much regard to the kind of research reviewed in this volume”
  - (Zeichner, 2005, in final chapter of Studying Teacher Education: The Report of the AERA Panel on Research and Teacher Education)

What Should a Beginning Teacher Be Able to Do?

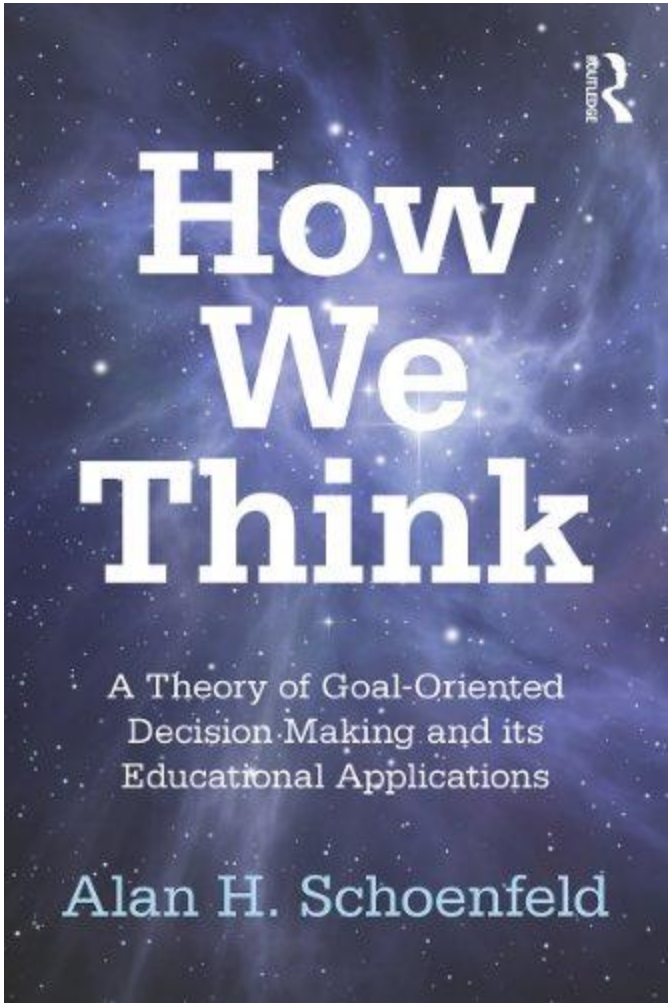
1. Ensure a safe environment for the children in the class
2. Know at least as much content as the children are expected to learn
3. Identify gaps in each child's literacy and numeracy levels
4. Know what children are expected to know in a given subject at a given grade level
5. Explain ideas/concepts in the curriculum subjects being taught
6. Anticipate difficulties that children have in learning particular concepts
7. Identify gaps in each child's subject knowledge and skills
8. Recognise when to call on the professional support of colleagues
9. Recognise when to call on the professional support of other professionals
10. Establish classroom procedures and maintain order in the classroom
11. Lead a class discussion
12. Plan for teaching
13. Justify the reasons for choosing particular teaching materials
14. Justify the reasons for choosing particular teaching strategies
15. Evaluate and modify teaching resources (including those on the Internet)
16. Document clearly and precisely what was taught
17. Assess and record what children learn
18. Write a school report that recognises a child's achievement and identifies scope for development
19. Respond to a parent's questions about teaching
20. Expand children's horizons in at least one area

- (Delaney, 2011)

Examples of High-Leverage Practices

1. Explaining ideas and processes
2. Choosing and using representations, examples, and models of core content
3. Setting up and managing small-group work
4. Recognizing and identifying common patterns of student thinking
5. Selecting and using specific methods to assess students' learning on an ongoing basis

- (Ball, 2011)


How We Think
A Theory of Goal-Oriented Decision Making and its Educational Applications
Alan H. Schoenfeld

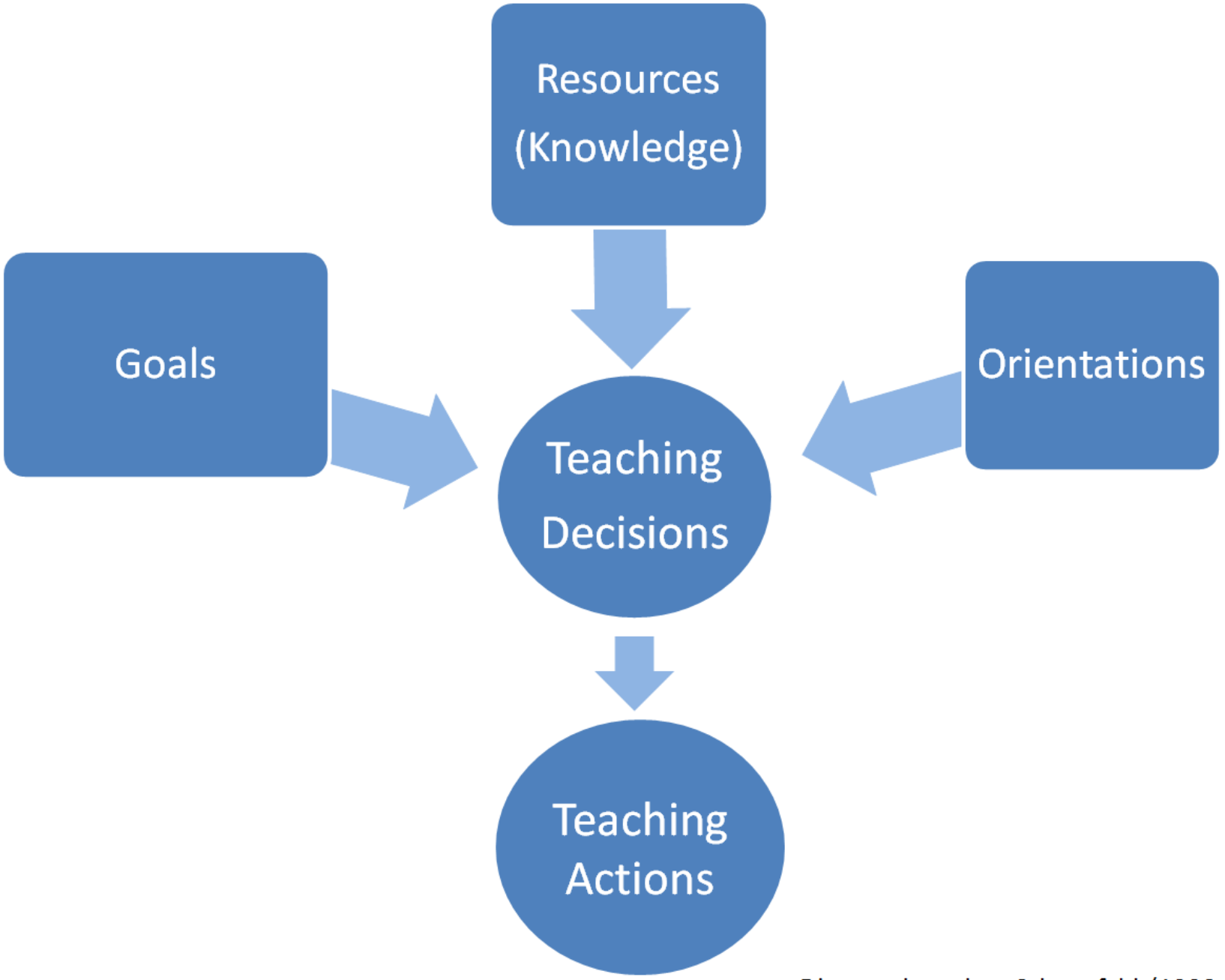


Diagram based on Schoenfeld (1998,

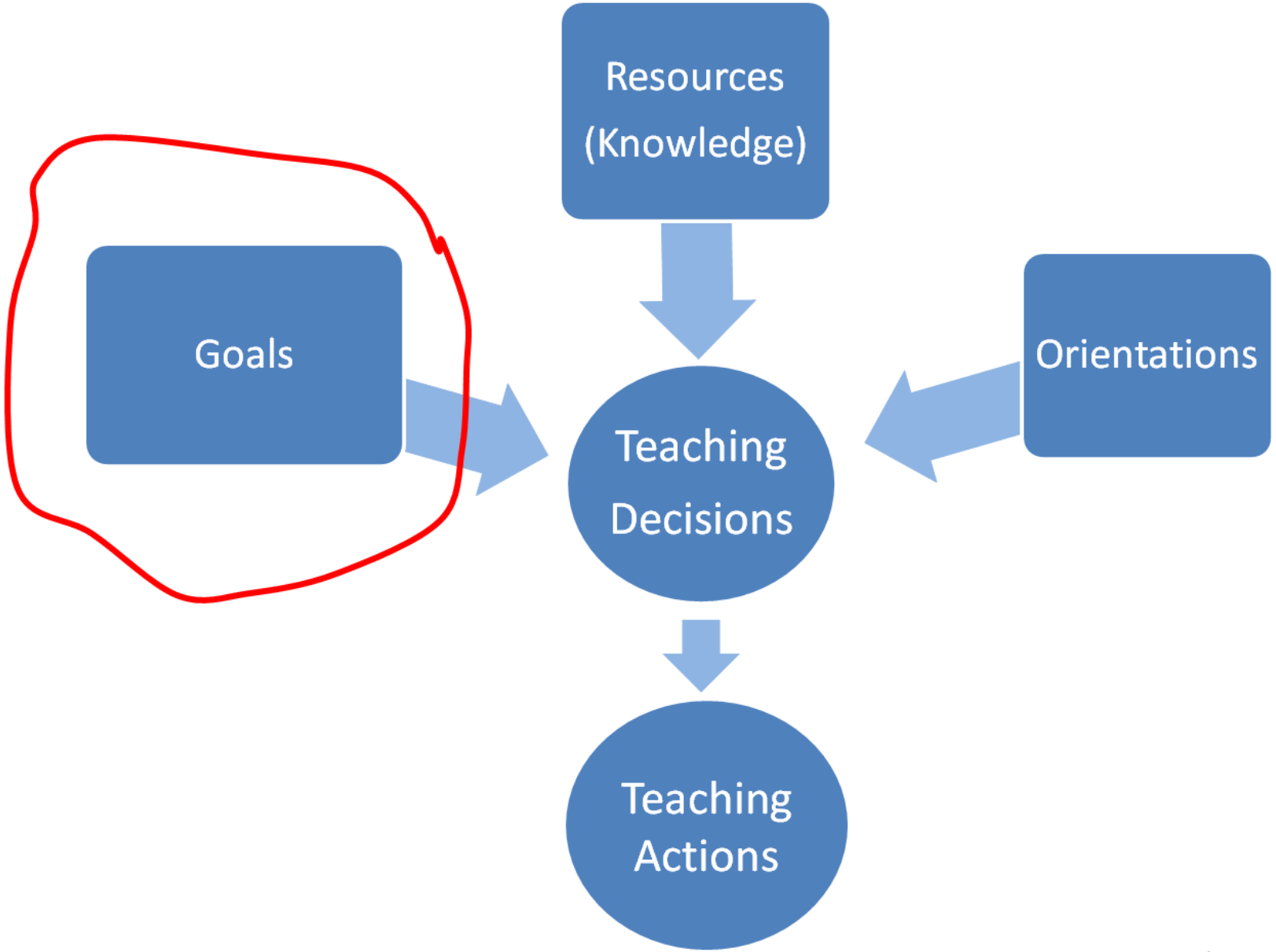


Diagram based on Schoenfeld (1998, 2

GOALS

- What a teacher wants to achieve
- Immediate, medium-term, long-term

  - Help children get the correct answer
  - Satisfy teaching practice supervisor
  - Decide how to respond to a pupil's comment, action
  - Develop children's knowledge of mathematics content and skills

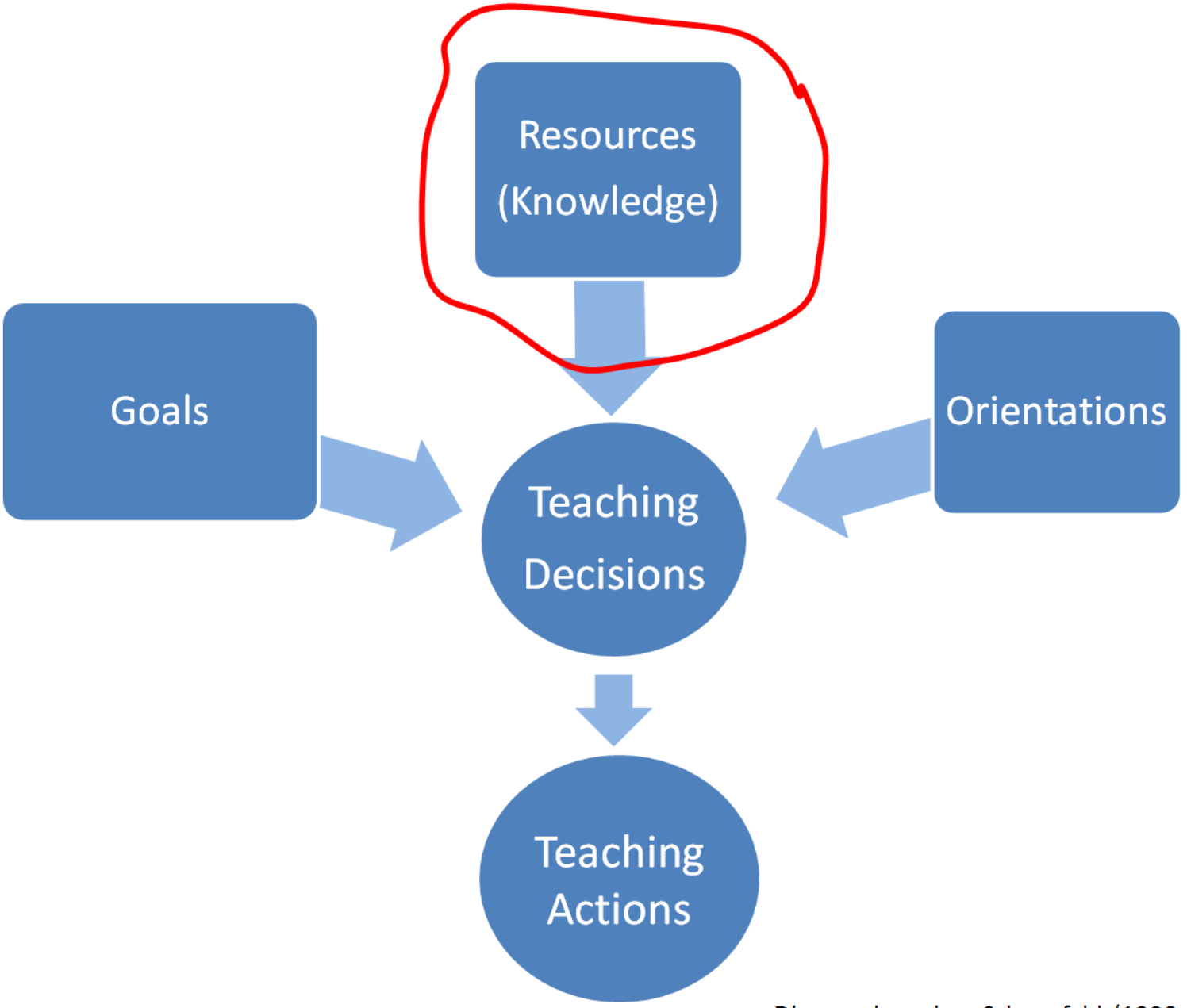


Diagram based on Schoenfeld (1998, 2011)

Mathematical Knowledge for Teaching

Professor Deborah Loewenberg Ball

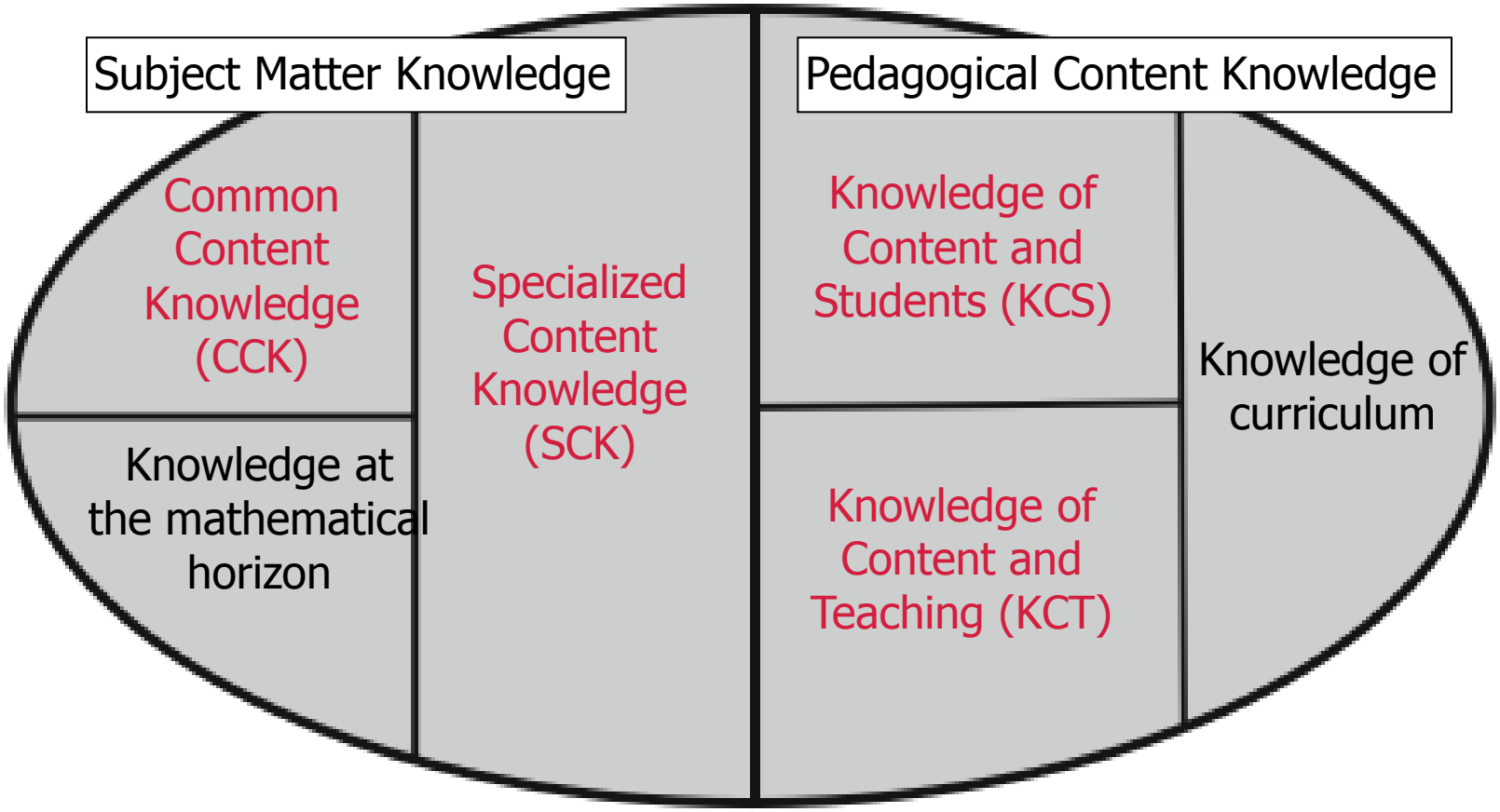
$$\begin{array}{r} 35 \\ \times\ 25 \\ \hline 875 \end{array}$$

How Did this Student Get this Answer?

- 35
- x 25
- 255
- +800
- 1055

Example from Ball

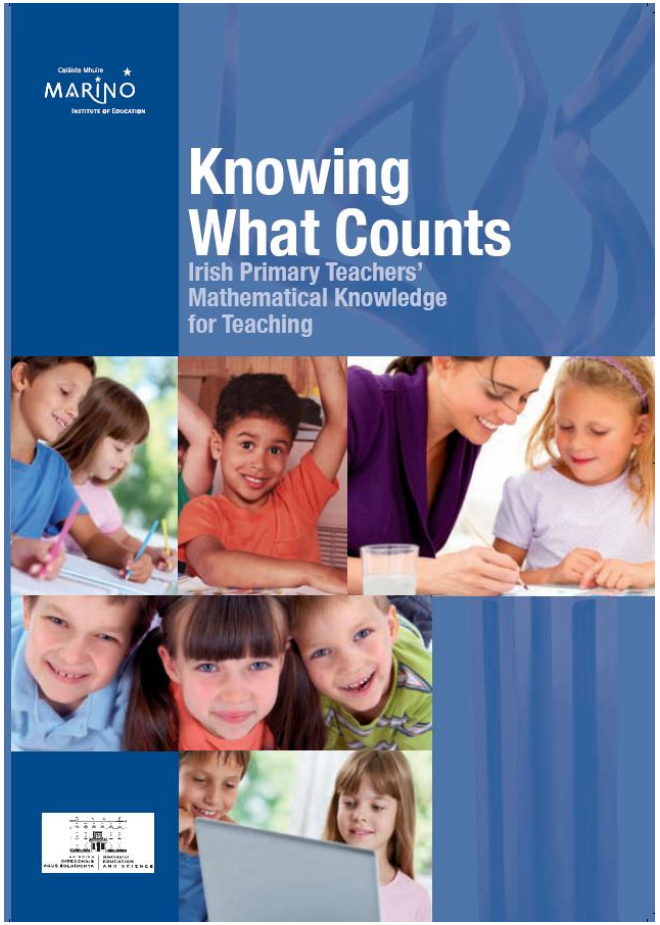
Mathematical Knowledge for Teaching



From Ball, Thames & Phelps (2008)

Research

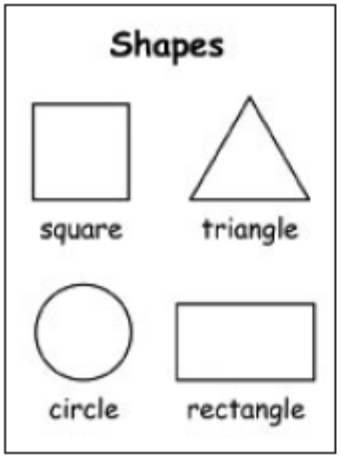
- Adapted U.S. Measures of MKT
- Responses from 501 teachers from a national, random, representative sample of 72 schools
- Follow-up video study
- 10 teachers each taught 4 lessons
- Coded lessons for the Mathematical Quality of Instruction



4. Ms. Miller wants her students to write or find a definition for triangle and then improve their definition by testing it on different shapes. To help them, she wants to give them some shapes they can use to test their definition.

She goes to the store to look for a visual aid to help with this lesson. Which of the following is most likely to help students improve their definitions? (Circle ONE answer.)

a)



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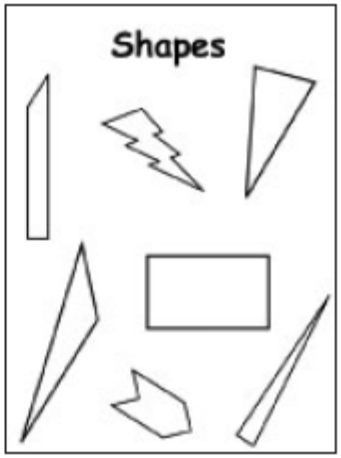
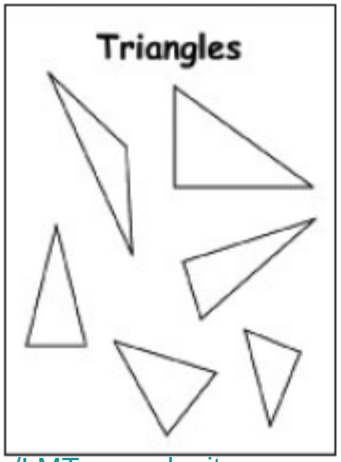
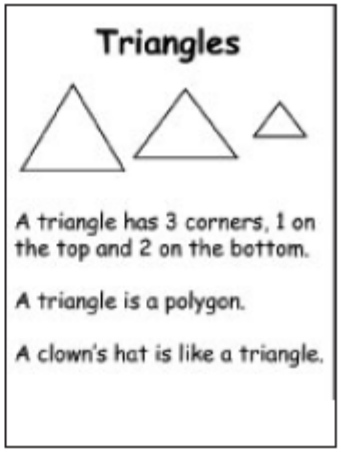


c)



d)



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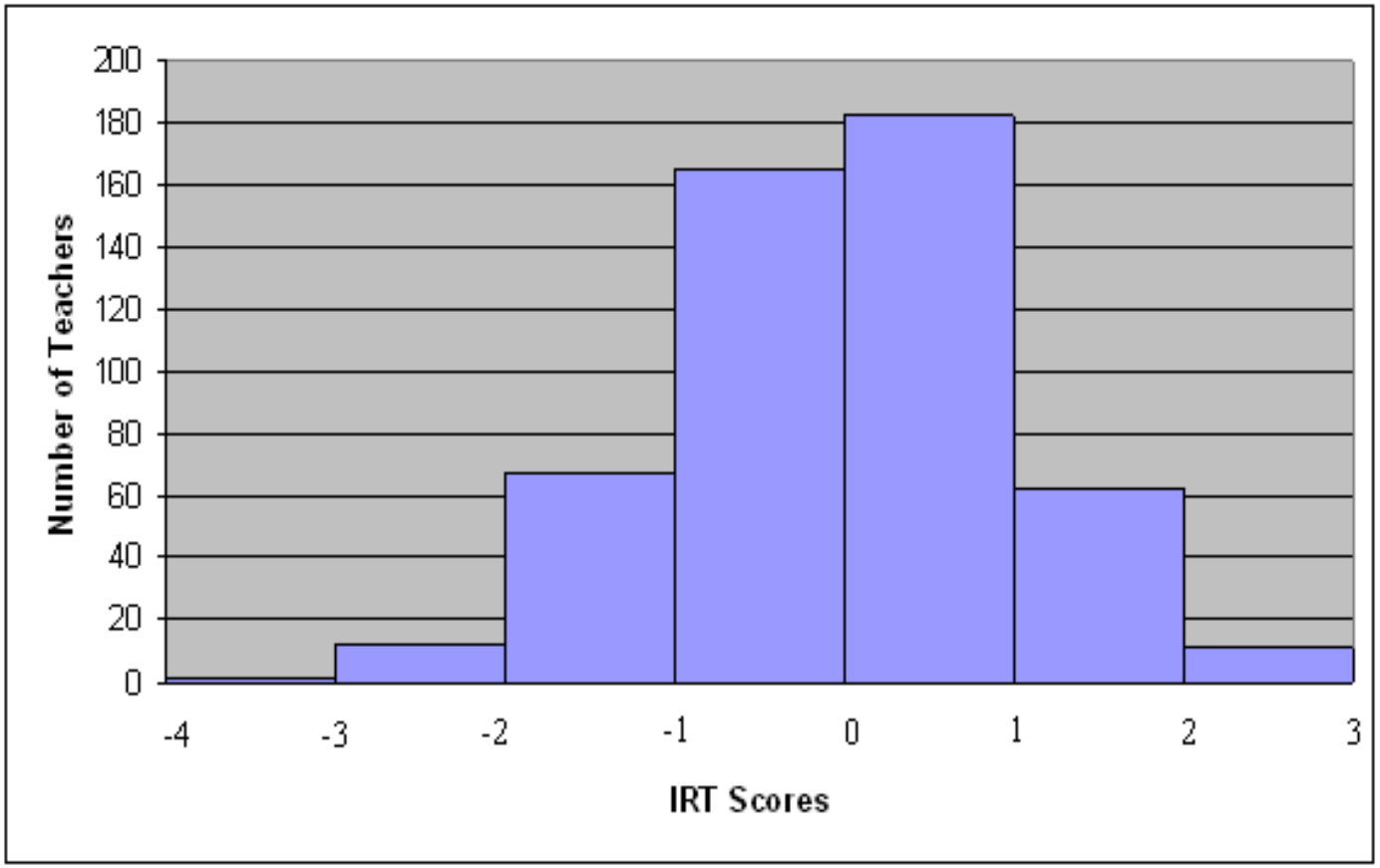
Findings 1: Variation in Irish Teachers' MKT



Findings 2:Strengths and Difficulties

- STRENGTHS
- Identifying and classifying pupils' mistakes
- Representing fractions
- Algebra
- DIFFICULTIES
- Applying definitions and properties of shapes
- Applying definitions and properties of numbers and operations
- Attending to explanations and evaluating understanding
- Linking number and word problems

Recommendations

- Acknowledge that teaching maths is challenging work
- Design, provide and evaluate professional development that is based on practice of teaching
- Use pupils' textbooks and teachers' manuals to support teachers' MKT
- Require mathematics content courses in initial teacher education
- Consider having mathematics specialists in schools
- Provide online supports and CPD for teachers
- Keep parents informed of goals

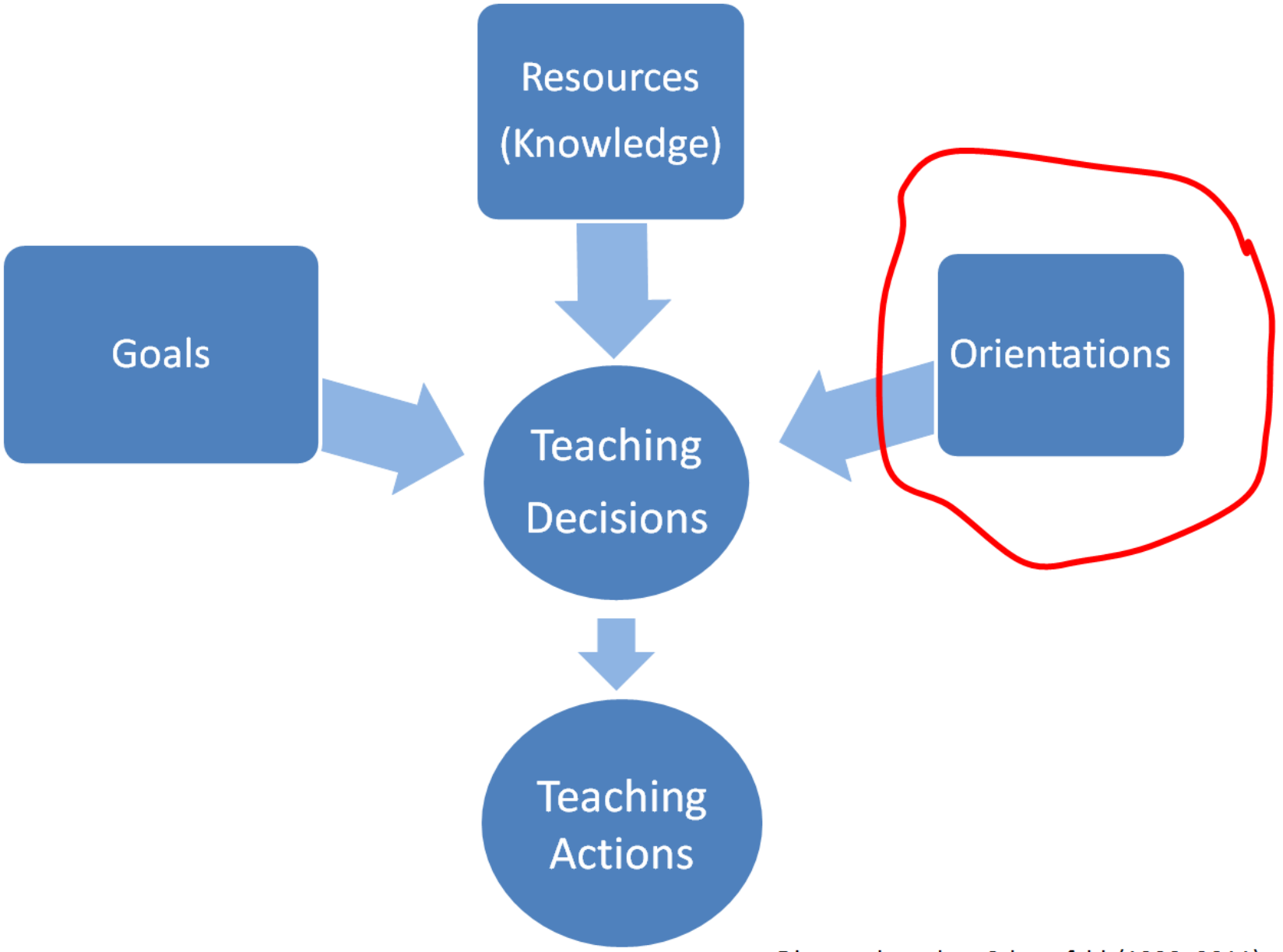


Diagram based on Schoenfeld (1998, 2011)

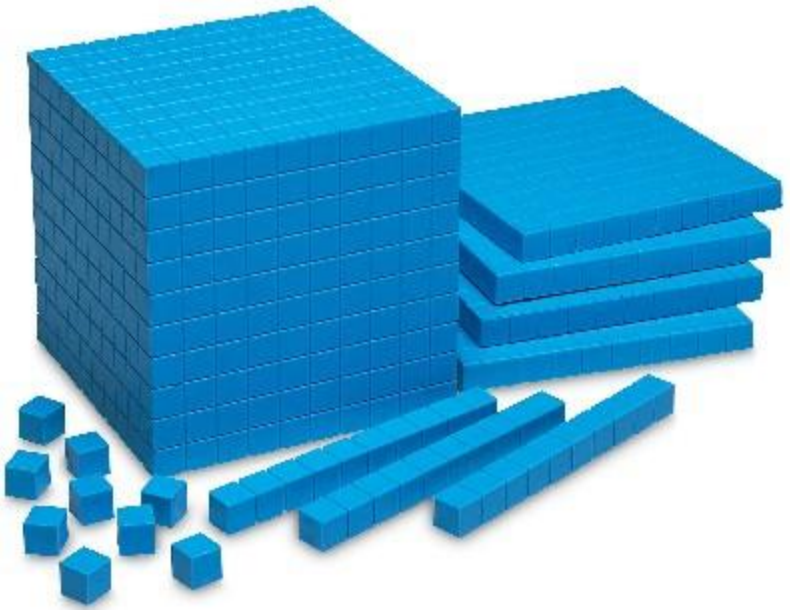
Orientations to Mathematics and to Mathematics Teaching and Learning

- Maths is difficult
- I love the repetition of it
- Being good or bad at maths is genetic
- Maths competence is a gift
- The way I learned maths is the way everyone should learn maths
- Learning maths requires effort
- Maths is relevant to daily living

- Assessing Prospective Teachers' Preparedness to Teach

Approximations of Practice

- Grossman, 2009
- Teaching is just one example of professional preparation
- Clergy, clinical psychologists
- Representation (illustrates) – Decomposition – Approximation (engages)



Use these materials to show how you would demonstrate for children one of the following calculations:

$$431 \div 3$$

or

$$415 - 37$$

Use the whiteboard to demonstrate the written algorithm using the same language used with the materials

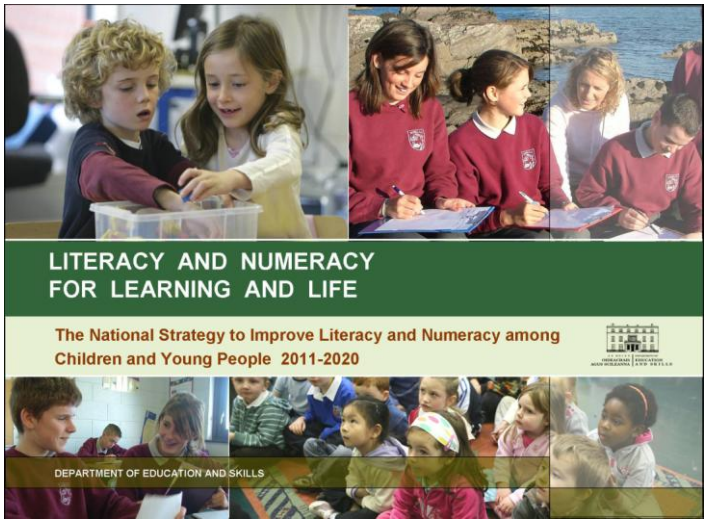
- Manipulating the materials is different to watching someone else manipulate them
- More difficult than it looks
- Get an insight into students' understanding of the logic of the materials
- Explicit marking criteria

OSCE

- Objective Structured Clinical Examinations
- “Assessment format in which the candidates rotate around a circuit of stations, at each of which specific tasks have to be performed, usually involving a clinical skill, such as history taking or examination of a patient. The marking scheme for each station is structured and determined in advance.” (Boursicot & Roberts, 2005)
- Parent-teacher meeting, setting homework, demonstrating an algorithm ...and other high leverage practices

Prospective Teachers Learn and Teach Outside College as well as in College

- Media Coverage
- “Irish Students Drop in Rankings for Literacy and Maths”
  - (Irish Times, 8-12-2010)
- Department of Education and Skills
- Mentor teachers
- Colleagues
- Principals
- Parents
- Textbooks
- Generalists, not specialists



Recommendations for Pre-Service Teacher Education

- Change entry requirements
- Extend the duration of the pre-service programmes
- Produce reflective practitioners capable of enquiry-based learning and ongoing engagement with research and emerging practice
- Programmes to provide courses and learning experiences to develop and assess student teachers' understanding and ability to apply current knowledge, strategies and methodologies in areas including teaching and learning of numeracy; formative, diagnostic and summative assessment; teaching of children with special and additional needs; digital literacy; building partnerships with parents
- Increase time on school-based teaching practice
- Require teachers to demonstrate satisfactory skills in teaching of numeracy
- Replace "academic subjects" with optional courses to develop professional knowledge and pedagogical skills of teachers

Summary

- Teaching is a difficult task that looks easy
- Difficult to find research that can inform practice
- Student teachers' goals, resources (especially knowledge) and orientations determine their classroom actions
- Approximations of practice (as learning and assessment)

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Sample Item

24. Mrs. McKenna is planning mini-lessons for students focused on particular difficulties that they are having with adding columns of numbers. To target her instruction more effectively, she wants to work with groups of students who are making the same kind of error, so she looks at some recent classwork to see what they tend to do. She sees the following three student mistakes:

I)
$$\begin{array}{r} 38 \\ 49 \\ +\,6_{1}5 \\ \hline 142 \end{array}$$

II)
$$\begin{array}{r} 45 \\ 37 \\ +\,2_{1}9 \\ \hline 101 \end{array}$$

III)
$$\begin{array}{r} 32 \\ 14 \\ +\,1_{1}9 \\ \hline 64 \end{array}$$

Which have the same kind of error? (Mark ONE answer.)

a) I and II

b) I and III

c) II and III

d) I, II, and III

Back

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14. Ms. Walker's class was working on finding patterns on the 100's chart. A student, LaShantee, noticed an interesting pattern. She said that if you draw a plus sign like the one shown below, the sum of the numbers in the vertical line of the plus sign equals the sum of the numbers in the horizontal line of the plus sign (i.e., 22 + 32 + 42 = 31 + 32 + 33). Which of the following student explanations shows sufficient understanding of why this is true for all similar plus signs? (Mark YES, NO or I'M NOT SURE for each one.)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

	Yes	No	I'm not sure
a) The average of the three vertical numbers equals the average of the three horizontal numbers.	1	2	3
b) Both pieces of the plus sign add up to 96.	1	2	3
c) No matter where the plus sign is, both pieces of the plus sign add up to three times the middle number.	1	2	3
d) The vertical numbers are 10 less and 10 more than the middle number.	1	2	3

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Back

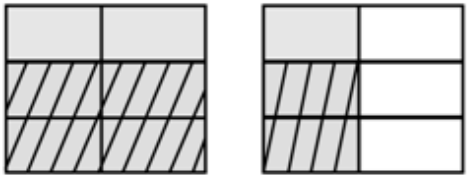
Item 1

17. At a professional development workshop, teachers were learning about different ways to represent multiplication of fractions problems. The leader also helped them to become aware of examples that do not represent multiplication of fractions appropriately.

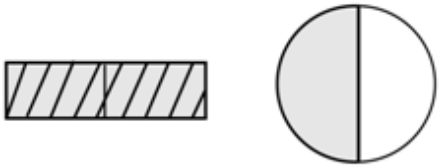
Which model below cannot be used to show that $1\frac{1}{2} \times \frac{2}{3} = 1$? (Mark ONE answer.)

A)

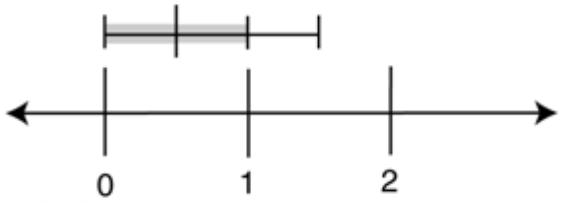
B)



C)



D)



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Back