אבני ראשה
המכון הישראלי למנהיגות בית ספרית
المعهد الاسرائيلي للقيادة المدرسية

הכנס הארצי הרביעי למנהלי בתי ספר ולמפקחים
כ"ב בחשוון התשע"ז 23.11.16

סובב למידה

טעות וכישלון כמנופי למידה

פרופ׳ מאנו קאפור

פרופ׳ לפסיכולוגיה, האוניברסיטה לחינוך של הונג קונג (HKIED)

Learning from Productive Failure

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Two BIG Questions

The Question of Learning:

How do we come to understand something new?

The Question of Design:

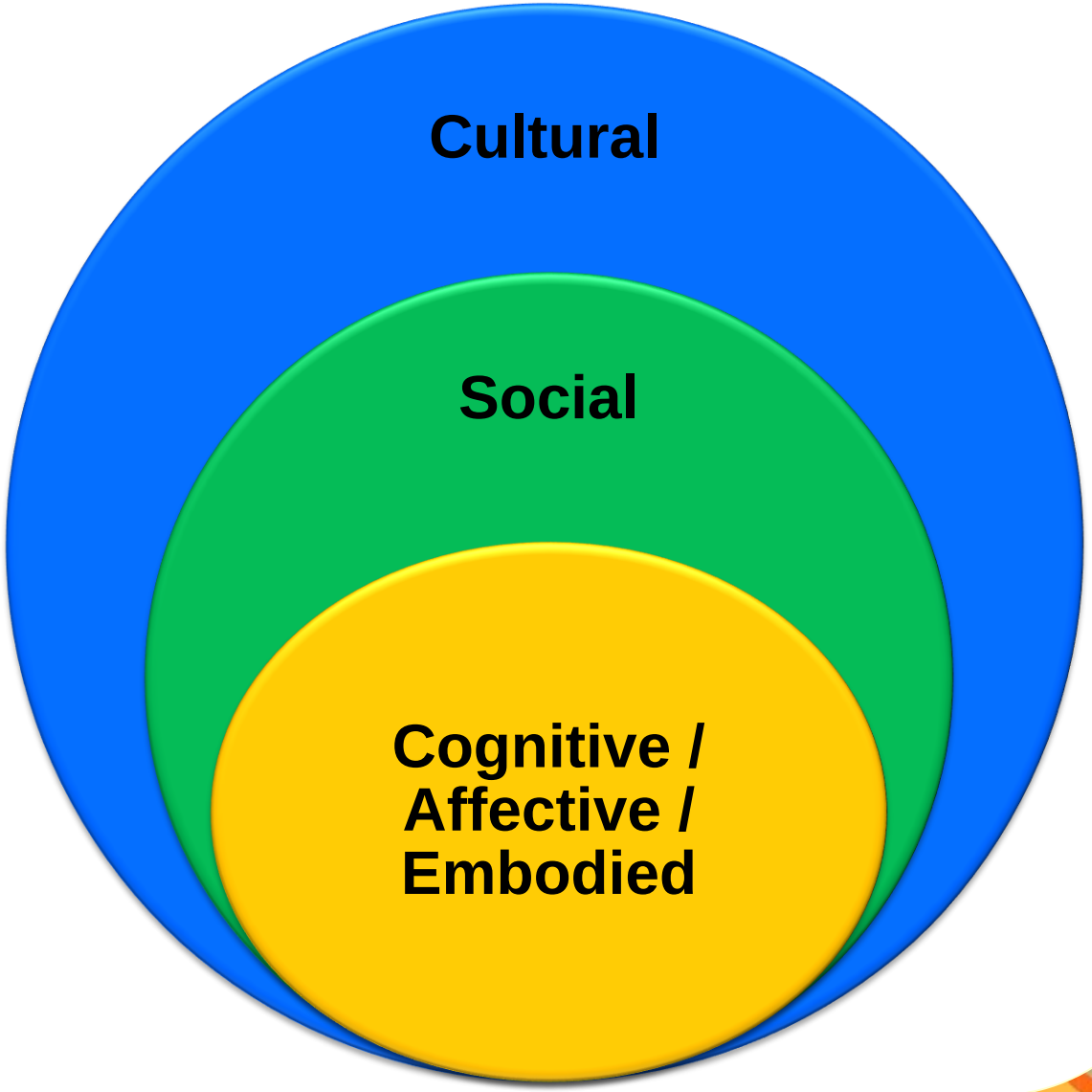
How do we design for initial learning?

What is Learning?

enculturation

participation

mental models



Shared understanding of the problem and goals

Problem of noticing/seeing

novices see different things from experts

Learning goals

developing not just knowledge, but also social participation, and disciplinary dispositions simultaneously

Learning from Failure

If learning from failure is so intuitively compelling, why do we wait for it to happen? Why can’t we deliberately design for it in the initial learning?

The Problem

(Grade 8/9 students)

Who's the most consistent striker?

Year	Mike Arwen	Dave Backhand	Ivan Right
1988	14	13	13
1989	9	9	18
1990	14	16	15
1991	10	14	10
1992	15	10	16
1993	11	11	10
1994	15	13	17
1995	11	14	10
1996	16	15	12
1997	12	19	14
1998	16	14	19
1999	12	12	14
2000	17	15	18
2001	13	14	9
2002	17	17	10

Comparing regularity

Mike Arwen: Mean = $\frac{280}{20}$ = 14 goals / year

Mode = 14

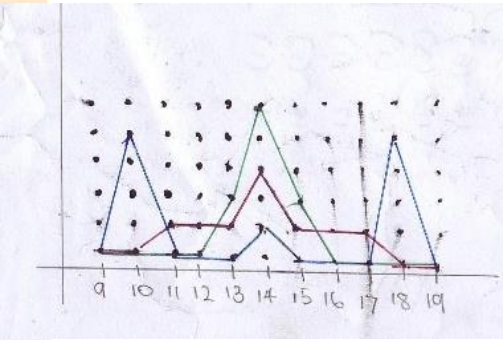
Dave Backhand: Mean = $\frac{280}{20}$ = 14 goals / year

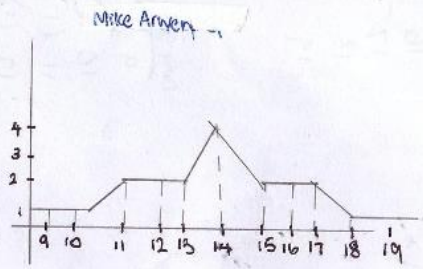
Mode = 14

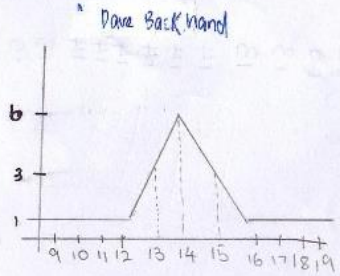
Ivan Right: Mean = $\frac{280}{20}$ = 14 goals / year

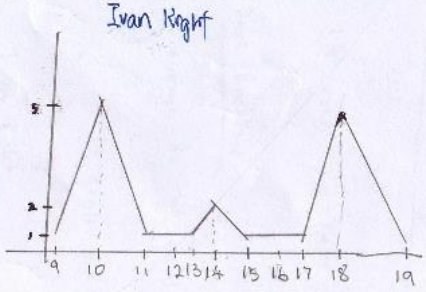
Mode = 18 and 10

	9	10	11	12	13	14	15	16	17	18	19
Mike Arwen	1	1	2	2	2	4	2	2	2	1	1
Dave Backhand	1	1	1	1	3	6	3	1	1	1	1
Ivan Right	1	5	1	1	1	2	1	1	1	5	1

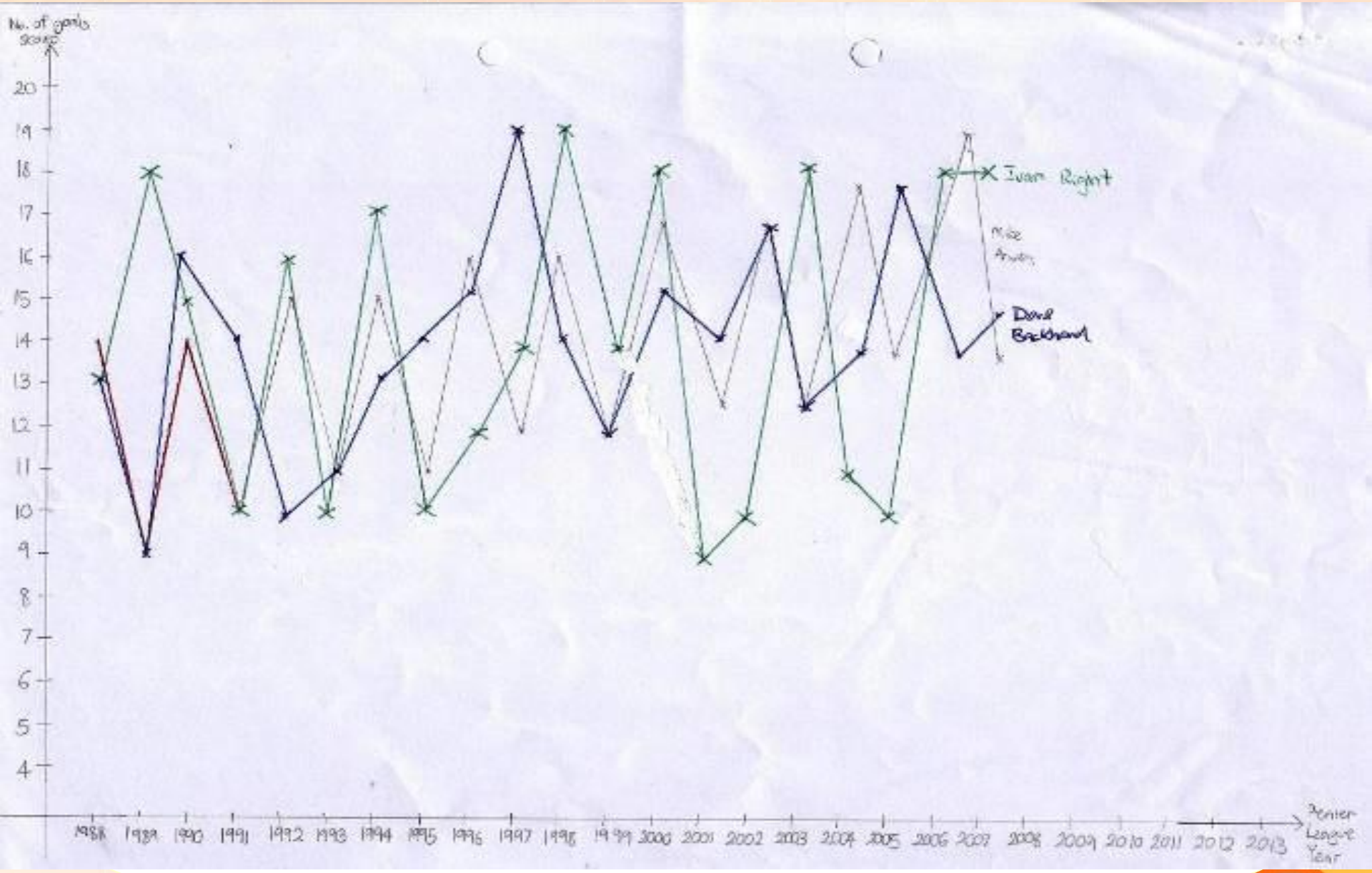








9 10 11 11 12 12 13 13 14 14 14 14 15 15 16 16 17 17 18 19


No. of goals scored
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
Ivan Right
Mike Arwin
Dave Beckham
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Premier League Year

From Question paper: Average = $\frac{280}{20}$

Mike has 8 years < average

4 years = average

8 years > average

Dave has 7 years < average

6 years = average

7 years > average

Ivan has 9 years < average

2 years = average

9 years > average

Frequency of years above, below, and at average

Consistency = years at the mean / years away from the mean

Sum of year-on-year deviation

Mike	Dave	Ivan
9-14 = -5	-4	5
14-9 = 5	7	-3
10-14 = -4	-2	-5
15-10 = 5	-4	1
-4	1	-6
4	2	7
-4	1	-7
5	1	2
-4	4	2
4	-5	5
-4	-2	-5
5	3	4
-4	-1	-9
4	3	1
-4	-4	8
5	1	-7
-4	4	-1
4	-4	8
-4	1	0
5		
-4		
0 ✓ mike	-2	-5

Range amount for:

Mike Arwen: 9 — 19 = 10

Dave Rockland: 9 — 19 = 10] x

Ivan Right: 9 — 19 = 10

Sum of deviations about the mean

Year	Avg	M.A	D.B	I.R	x		
1988	14	14	13	13	0	-1	-1
1989	14	9	9	18	-5	-5	4
1990	14	14	16	15	0	+2	+1
1991	14	10	14	10	-4	0	-4
1992	14	15	10	16	+1	-4	+2
1993	14	11	11	10	-3	-3	-4
1994	14	15	13	17	+1	-1	+3
1995	14	11	14	10	-3	0	-4
1996	14	16	15	12	+2	+1	-2
1997	14	12	19	14	-2	+5	0
1998	14	16	14	19	+2	0	+5
1999	14	12	12	14	-2	-2	0
2000	16	17	15	18	+3	+1	+4
2001	14	13	14	9	-1	0	-5
2002	14	17	17	10	+3	+3	-4
2003	14	13	13	18	-1	-1	+4
2004	14	18	14	11	+4	0	-3
2005	14	14	18	10	0	+4	-4
2006	14	19	14	18	+5	0	+4
2007	14	14	15	18	0	+1	+4
				Total:			

Average of year-on-year absolute deviation

MIKE = $\frac{5+5+4+5+4+4+4+5+4+4+4+5+4+4+4+5+4+5+4}{20-1}$

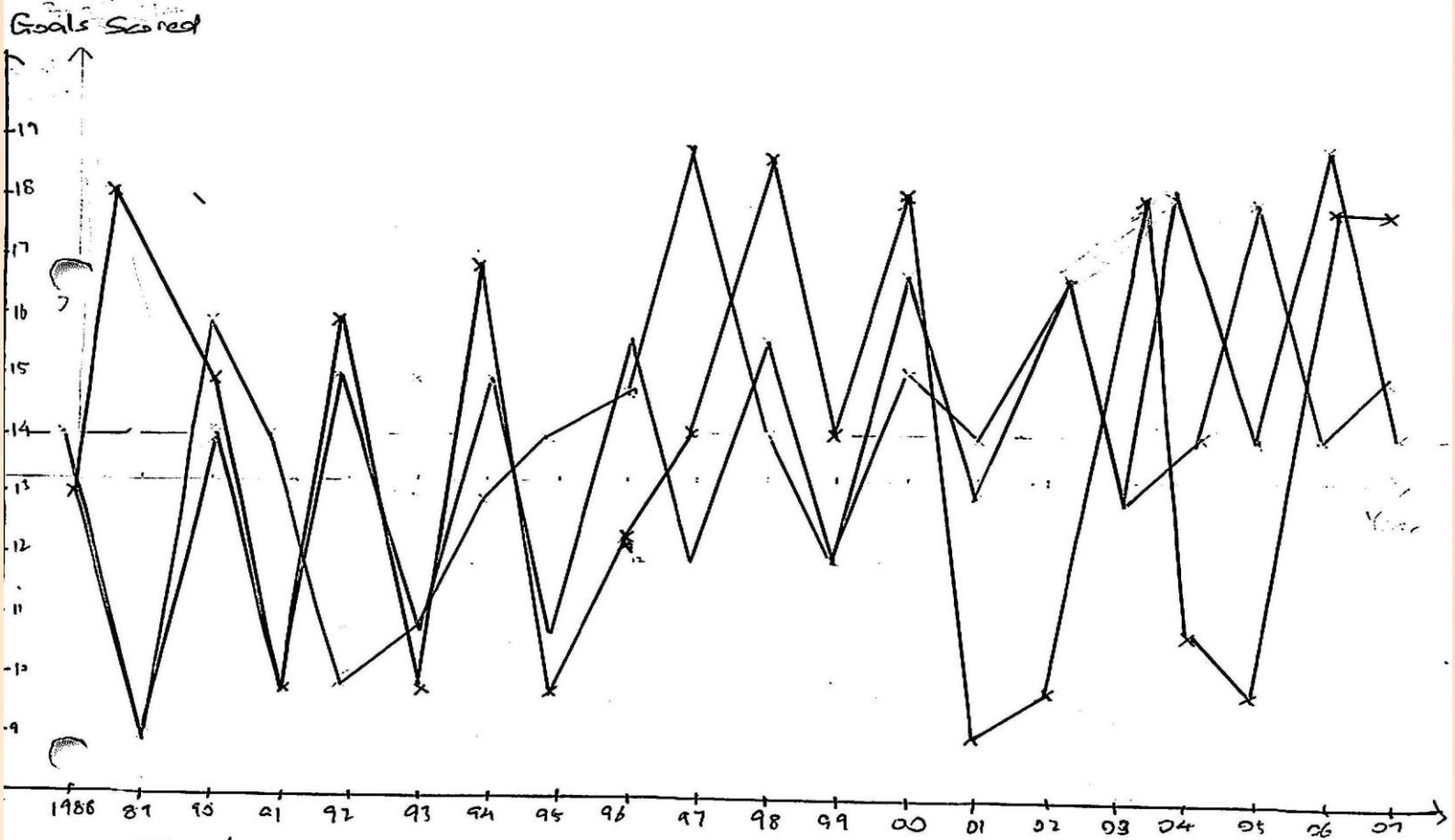
= 84/19 = 4·26

DAVE = $\frac{4+7+2+4+1+2+1+1+4+5+2+3+1+3+4+1+4+4+1}{19}$

= 54/19 = 2·84 DAVE is most consistent ✓

IVAW = $\frac{5+3+5+1+6+7+7+2+2+5+5+4+9+1+8+7+1+8+0}{19}$

= 4·79



Idea 3 Measure Graph Length

MA $\dot{f}_{26} + \dot{f}_{24} + \dot{f}_{17} + \dot{f}_{26} + \dot{f}_{17} + \dot{f}_{17} + \dot{f}_{17} + \dot{f}_{25} + \dot{f}_{10} + \dot{f}_{13} + \dot{f}_{13} + \dot{f}_{26} + \dot{f}_{17} + \dot{f}_{17} + \dot{f}_{17} + \dot{f}_{26} + \dot{f}_{17} + \dot{f}_{24} + \dot{f}_{24} = 83.26$

DB $\dot{f}_{17} + \dot{f}_{50} + \dot{f}_{5} + \dot{f}_{17} + \dot{f}_{3} + \dot{f}_{5} + \dot{f}_{2} + \dot{f}_{2} + \dot{f}_{17} + \dot{f}_{26} + \dot{f}_{5} + \dot{f}_{10} + \dot{f}_{2} + \dot{f}_{5} + \dot{f}_{10} + \dot{f}_{2} + \dot{f}_{17} + \dot{f}_{17} + \dot{f}_{2} = 56.54$

IR $\dot{f}_{26} + \dot{f}_{13} + \dot{f}_{26} + \dot{f}_{37} + \dot{f}_{51} + \dot{f}_{50} + \dot{f}_{50} + \dot{f}_{5} + \dot{f}_{5} + \dot{f}_{26} + \dot{f}_{26} + \dot{f}_{17} + \dot{f}_{82} + \dot{f}_{24} + \dot{f}_{65} + \dot{f}_{50} + \dot{f}_{2} + \dot{f}_{65} + 1 = 94.54$

∴ Dave Backhard is the most consistent player as he has the shortest 'stretched-out' graph, showing consistency over time.

Azaac Aiken 3

Designing for Productive Failure

(Kapur & Bielaczyc, 2012)

GENERATION & EXPLORATION

PHASE I

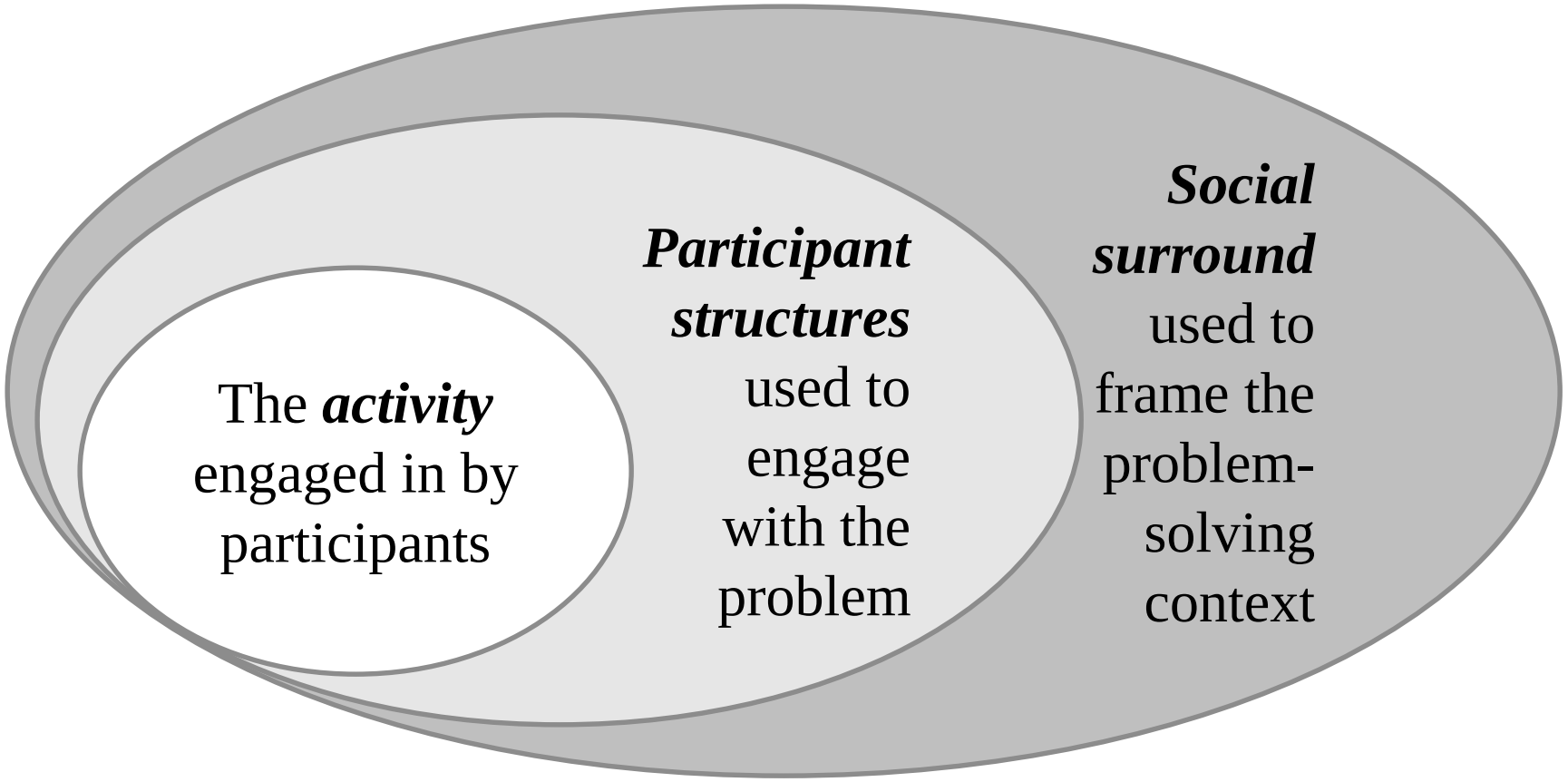
- Complex problems
- Collaboration
- Affective support for persistence

CONSOLIDATION & KNOWLEDGE ASSEMBLY

PHASE II

- Consolidation
- Knowledge Assembly

Three layers of the PF design
(Kapur & Bielaczyc, 2012)



Embodied Mechanisms

Cognitive

1. Activation
2. Noticing
3. Awareness of gaps
4. Sensitivity
5. Selection

Affective

1. Situational interest
2. Goal Orientation
3. Frustration
4. Persistence

Social

1. explanation & elaboration
2. Shared representation
3. Multiple perspectives
4. vicarious learning

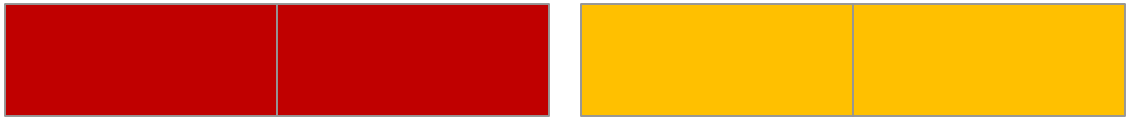
Cultural

1. Failure as normative
2. Failure as positive
3. Effort and Growth
4. Disciplinarity: ways of thinking and being

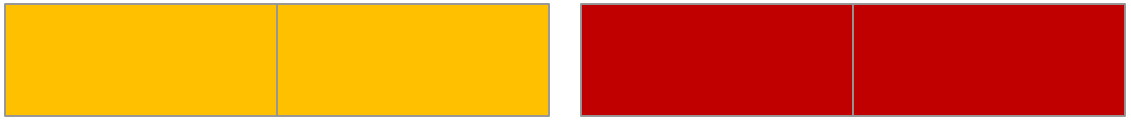
Productive Failure vs. Direct Instruction

Target Concepts:
1. Average Speed (Kapur, 2010; Kapur & Bielaczyc, 2012)
2. Standard Deviation (Kapur, 2012, 2013, 2014)

Productive Failure Problem solving followed by instruction



Direct Instruction Instruction followed by problem solving



Quasi- and controlled pre-post experiments with the following dependent variables:
1) Procedural Knowledge
2) Conceptual Knowledge
3) Transfer

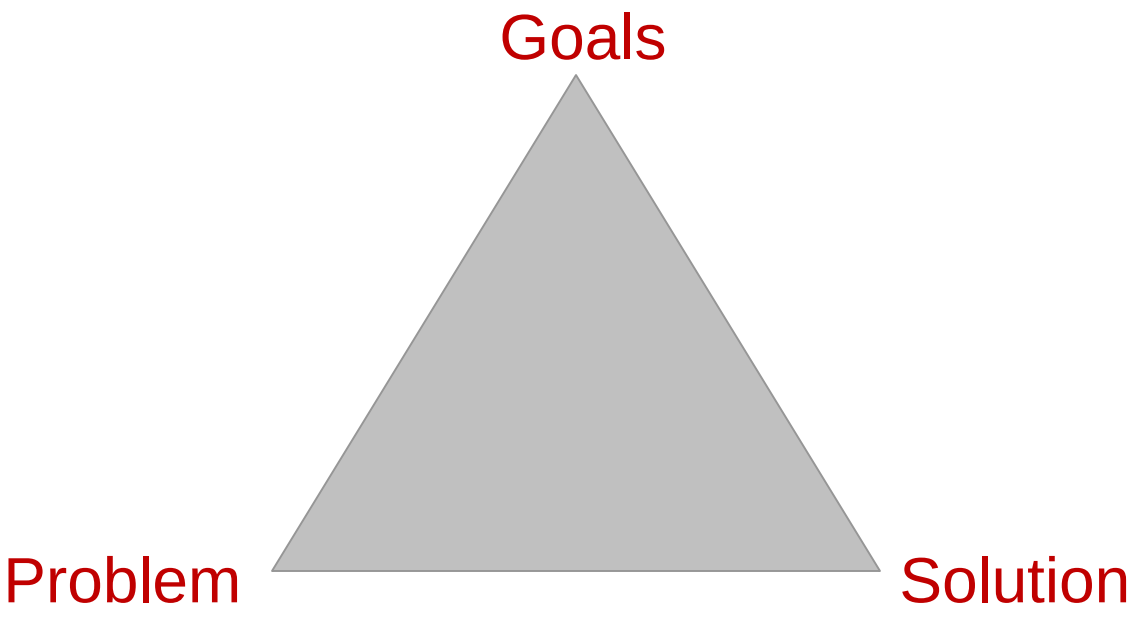
Key Findings: Student Learning

Findings on student learning trigger shifts in teacher learning:

- PF outperformed DI on conceptual understanding and transfer without compromising procedural knowledge (Kapur, 2010, 2012, Kapur & Bielaczyc, 2012)
    - *The basic knowledge fallacy*
- DI constrains design ability (Kapur, 2014)
    - *The creativity fallacy*
- Students that seem strikingly dissimilar on general and math ability (PSLE) appear strikingly similar in terms of their design ability (Kapur & Bielaczyc, 2012)
    - *The ability/attribution fallacy*

Working with Teachers & School Leaders

Developing a shared understanding of the:



Shared Goals?

a. Mathematics knowledge to be able to perform well on exams
b. a + deep conceptual understanding
c. b + ability to transfer to novel situations
d. c + mathematical thinking and reasoning
e. d + 21CC skills such as inventiveness, critical thinking, collaboration, persistence, resilience, and so on.

Key Findings: Teacher Learning

- Domain Knowledge
  - *I learnt the math better…*
- Pedagogical & Design Knowledge
  - *can't ask someone to teach swimming if they have not entered water…*
- More shifts in teacher beliefs:
  - *Teachers consistently underestimate students' design ability*
    - *The expertise paradox*
  - *PF teachers consistently report that they will use more time to teach the same concept*
    - *The efficiency fallacy*
  - *Scaffolding requires failure!*

School Leaders

- Additive Mindset
- Instant Tree Mentality
- The need to engage in PD themselves!
- Unit of change: pedagogy or culture?

In Ending…

Learning vs. performance…

Productive Success	Productive Failure
Unproductive Success	Unproductive Failure

THANK YOU

Q&A