The Science of Learning: The Field and its Work

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Outline

- PART 1: The Learning Sciences
- PART 2: An Example
- PART 3: Enter Neuroscience

The Learning Sciences

Learning as:

- associations
- mental models
- social participation
- enculturation

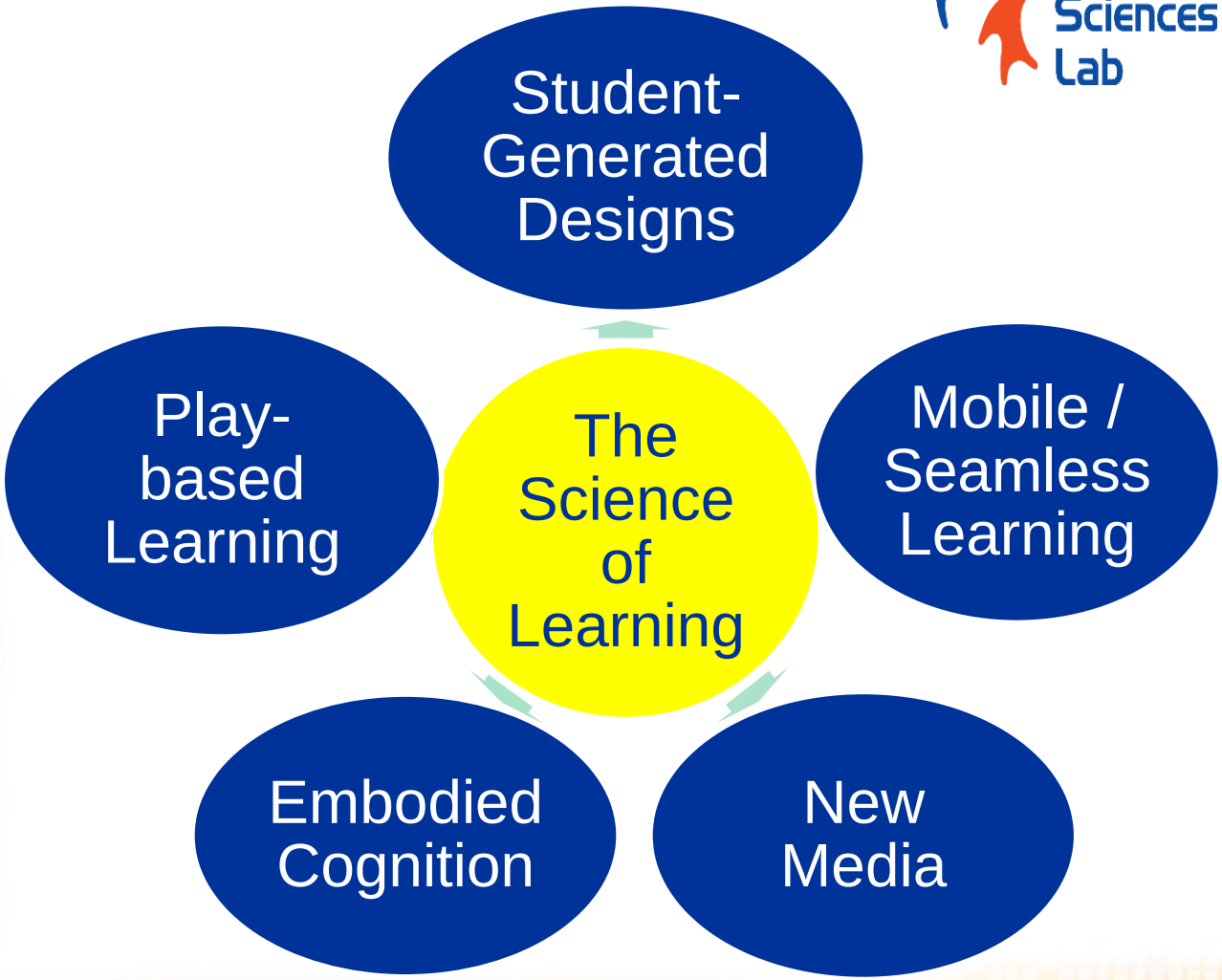
What would a “good” science of learning look like?

- Learning in-situ
- Learning across scale (levels, time)
- Explanatory cum transformational
- Interdisciplinary

The Learning Sciences Lab @NIE/NTU

- established in 2005
- **interventionist** research agenda
- Worked with **100+** schools, **1000+** teachers, and **10,000+** students

Research Areas



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PART 2: An Example
Learning from Productive Failure

If learning from failure is so intuitively compelling, why do we wait for it?

Why can't we deliberately design for and test it?

Theoretical 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

What is Productive Failure?

Understand what students know about a novel concept that they have not been taught yet

Afford opportunities to activate and differentiate prior and intuitive knowledge….to generate, explore, critique, and refine representations and solution methods (RSMs) for solving complex problems

Invariably, such a process leads to failure (in relation to a desired goal)…

But, this may precisely be the locus of deep learning… provided some form of structure follows subsequently

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

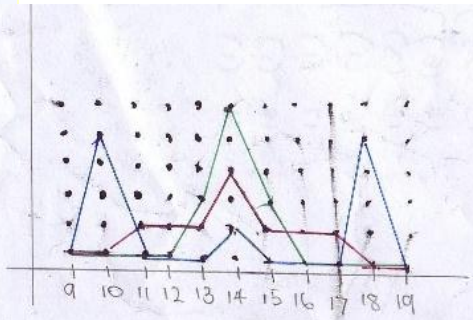
Dave Backhand : Mean = $\frac{280}{20}$ = 14 goals / year

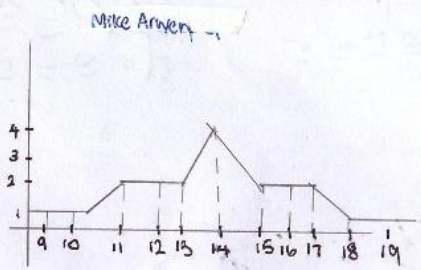
Mode = 14

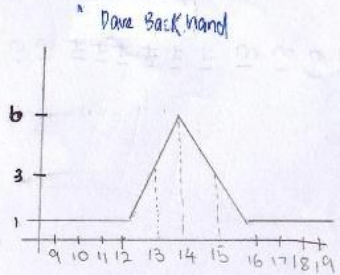
Ivan Right : Mean = $\frac{280}{20}$ = 14 goals / year

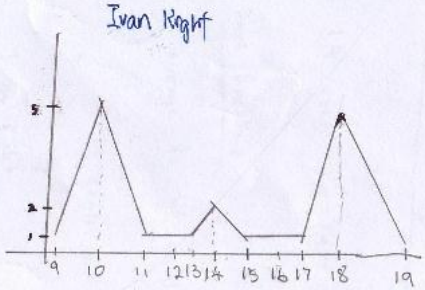
Mode = 18 and 10

	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

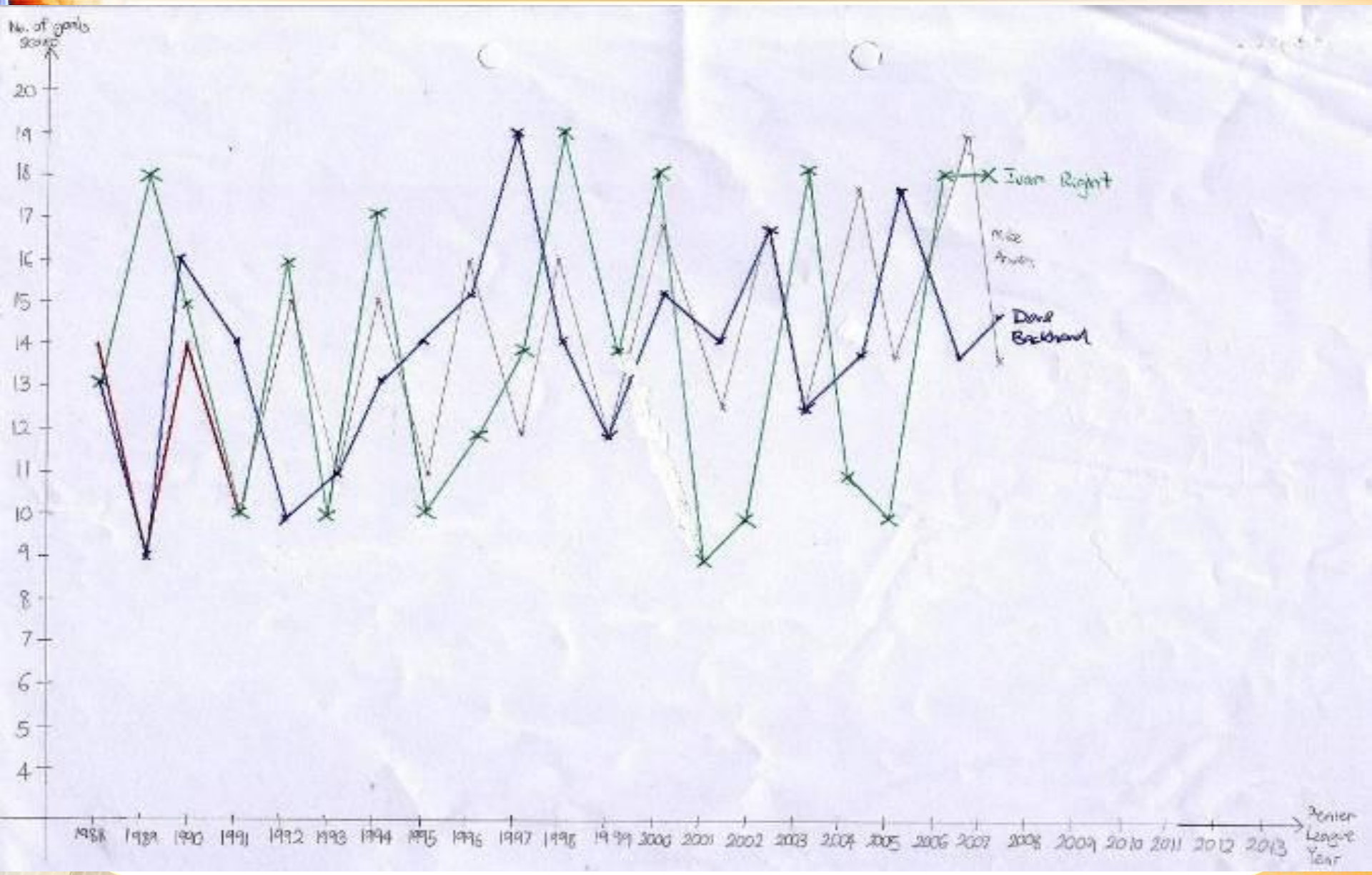


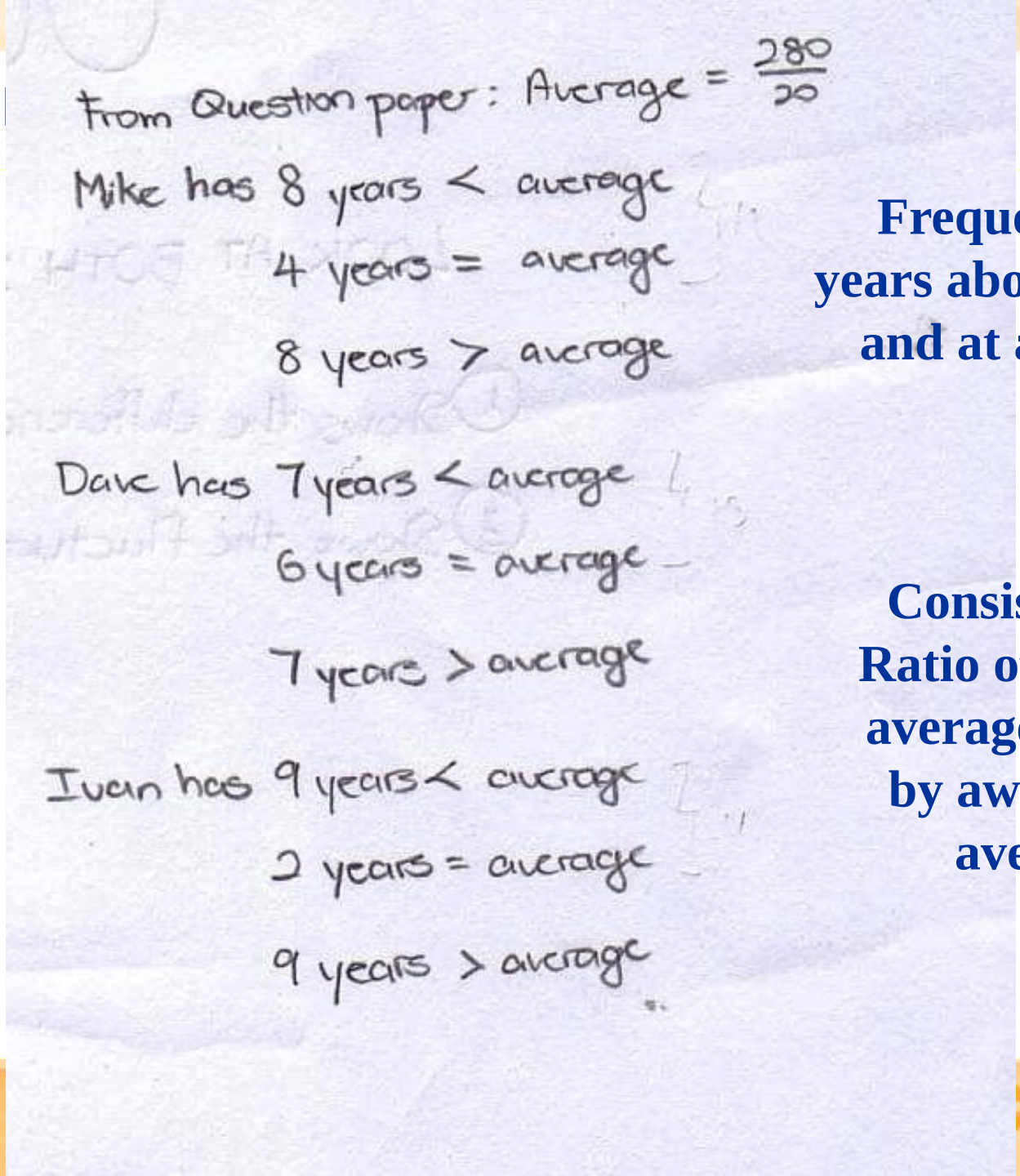






9 10 11 11 12 12 13 13 14 14 14 14 15 15 16 16 17 17 18 19





Frequency of years above, below, and at average

Consistency = Ratio of years at average divided by away from average

Sum of year-on-year deviation

Mike: 9−14 = −5; 14−9 = 5; 10−14 = −4; 15−10 = 5; −4; 4; −4; 5; −4; 4; −4; 5; −4; 4; −4; 5; −4; 5; −4

0 ✓ mike

Dave: −4; 7; −2; −4; 1; 2; 1; 1; 4; −5; −2; 3; −1; 3; −4; 1; 4; −4; 1

−2

Ivan: 5; −3; −5; 1; −6; 7; −7; 2; 2; 5; −5; 4; −9; 1; 8; −7; −1; 8; 0

−5

Range ~~Mike~~ amount for:

Mike Arwen: 9 − 19 = 10

Dave Backhand: 9 − 19 = 10

Ivan Right: 9 − 19 = 10

] X

Sum of deviations about the mean

Year	Avg	M.A	D.B	I.B	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: 0 0 0

Average of year-on-year absolute deviation

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

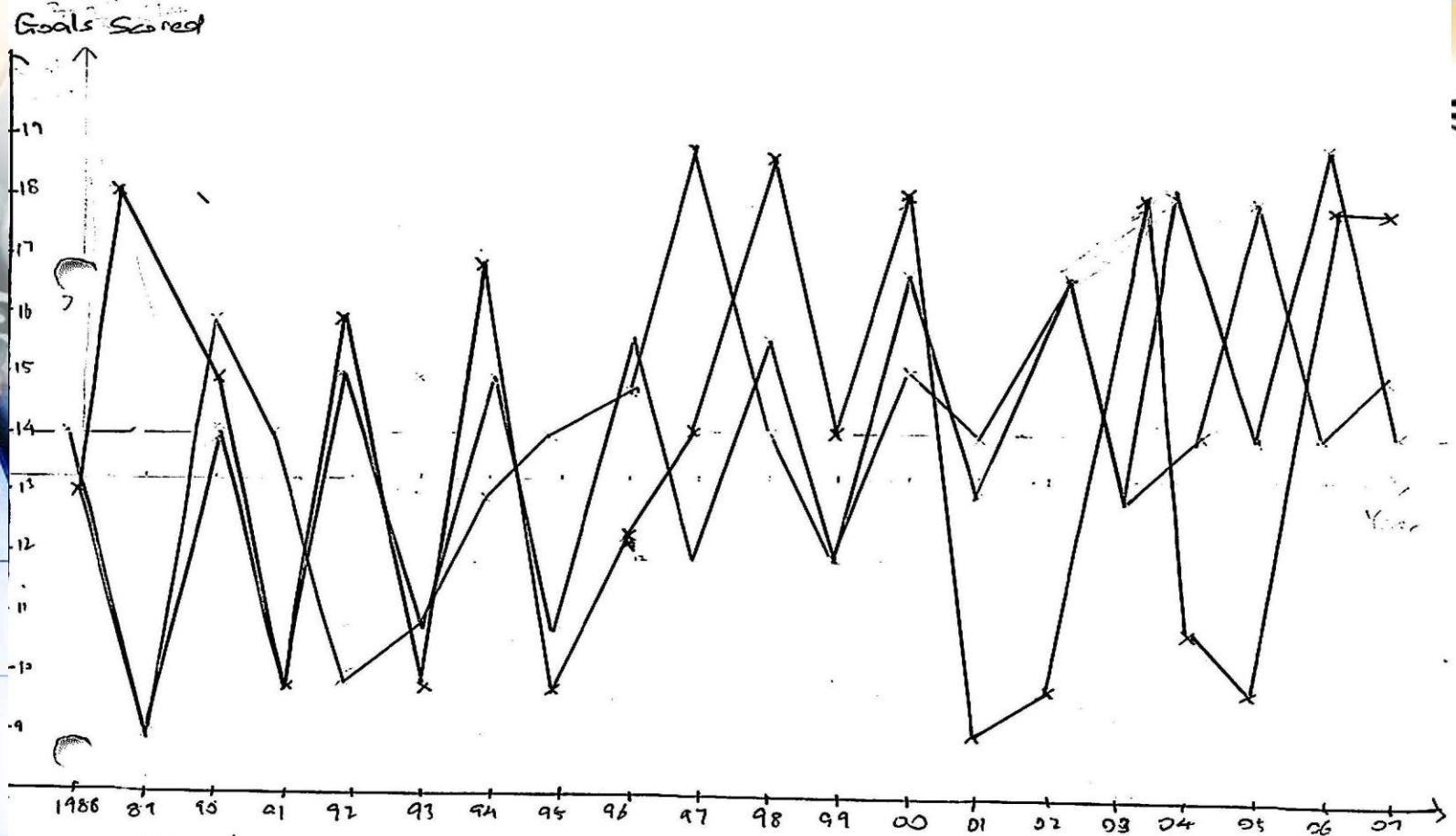
= 84/19 = 4·26

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 ✓

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

= 4·79



Idea 3 Measure Graph Length

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

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 $\dot{f}_{26} + \dot{f}_{13} + \dot{f}_{26} + \dot{f}_{37} + \dot{f}_{57} + \dot{f}_{50} + \dot{f}_{50} + \dot{f}_{5} + \dot{f}_{5} + \dot{f}_{26} + \dot{f}_{26} + \dot{f}_{17} + \dot{f}_{82} + \dot{f}_{24} + \dot{f}_{65} + \dot{f}_{50} + \dot{f}_{2} + \dot{f}_{65} + 1 = 94.54$

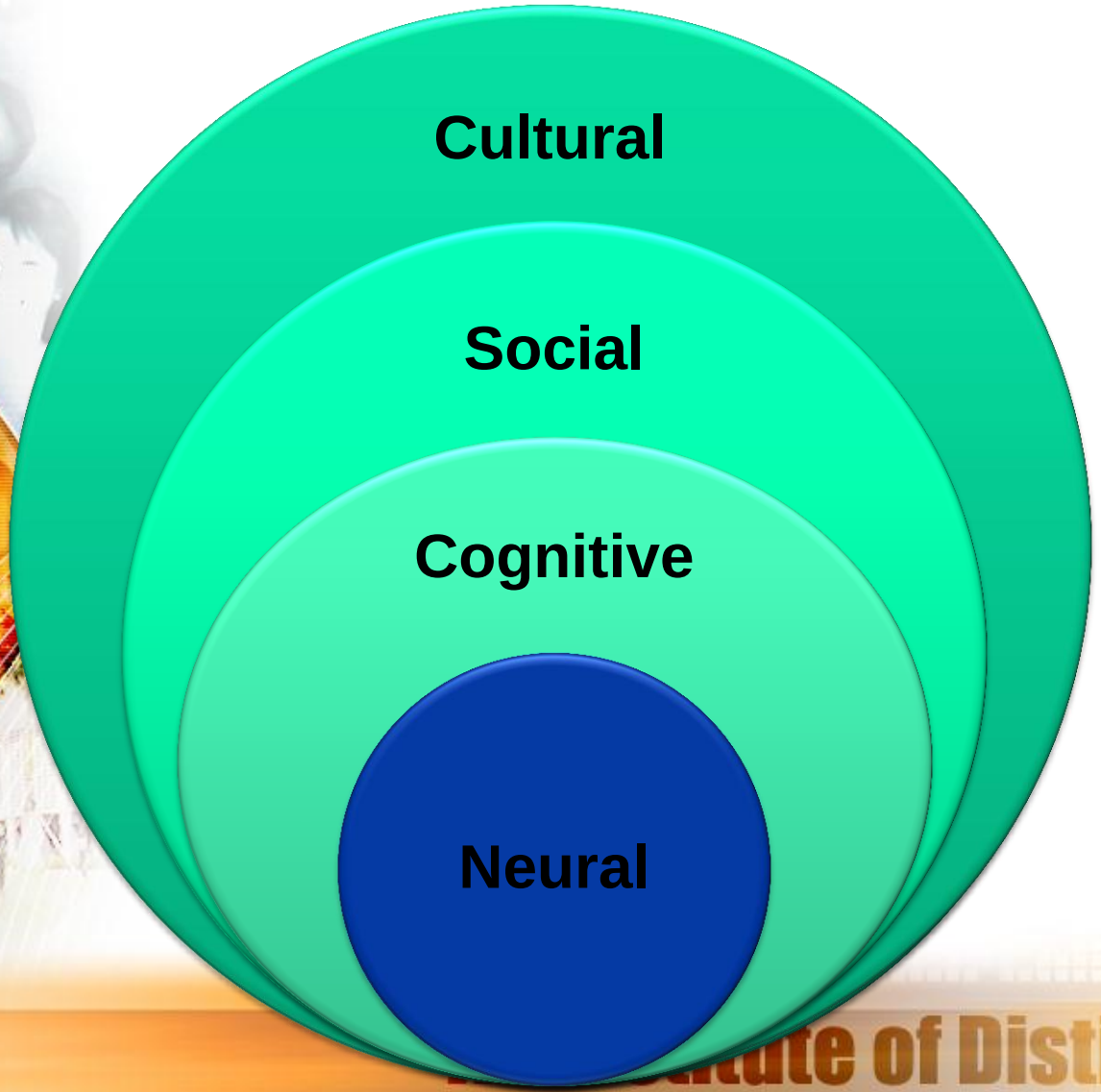
∴ Dave Backhard is the most consistent player as he has the shortest 'stretched-out' graph, showing consistency over time.

Azaac Aiken 3

Key Findings

- Learning as knowledge gain
  - Better student learning
  - Better teacher learning
- Learning as social participation
  - Learning to collaborate vs. collaborating to learn
  - Learning to generate ideas vs. generating ideas to learn
- Learning as enculturation
  - Alignment of classroom norms and expectations
  - Designing for disciplinarity
  - Resistance from students and teachers

PART 3: Enter Neuroscience



What would a “good” science of learning look like?

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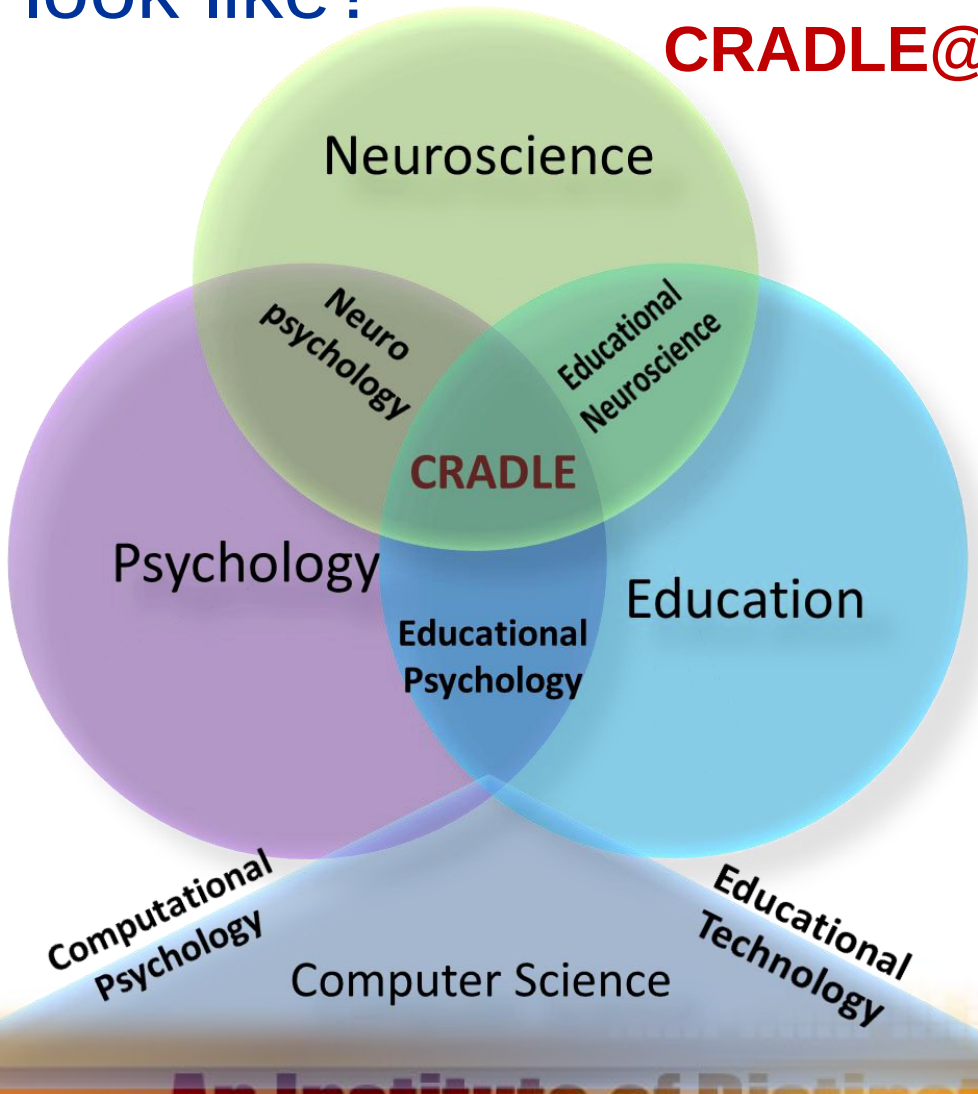

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Thank you

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