Tufts University School of Medicine

CTSE Center for Translational Science Education

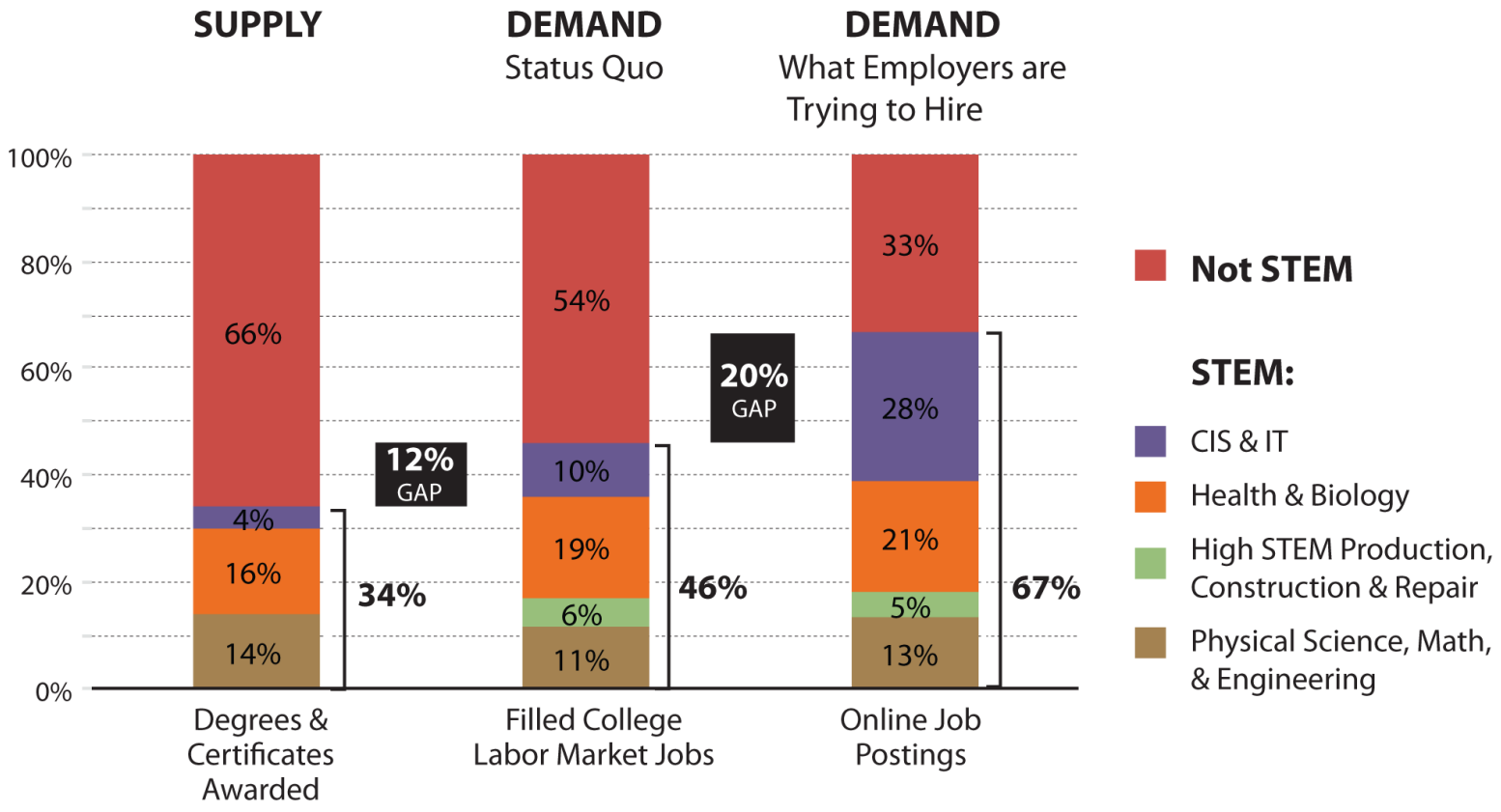
Providing practical solutions to bring benchtop and bedside to desktop

The Great Diseases Partnership:

bringing cutting-edge biomedical science to the high school biology classroom

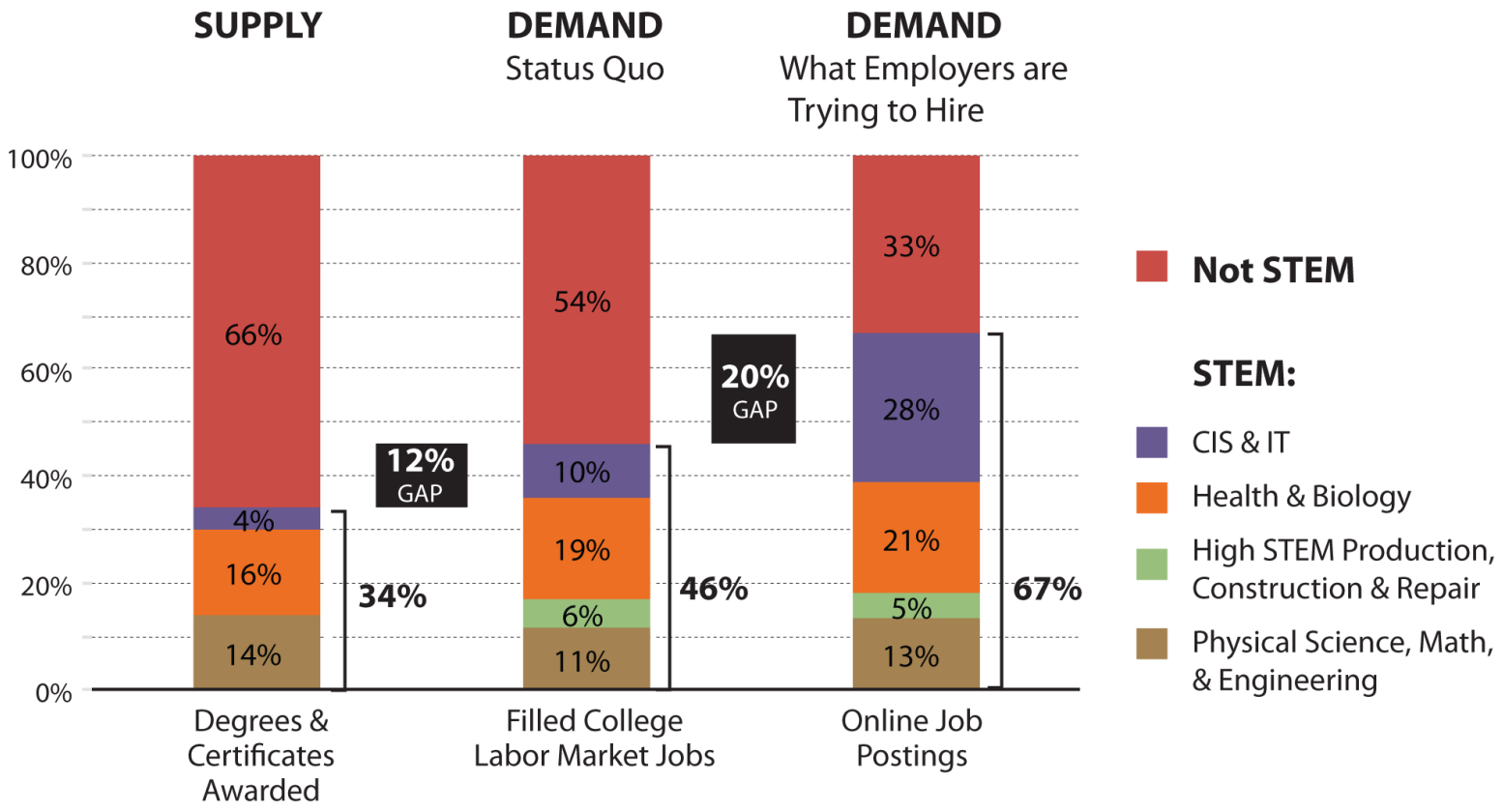
Karina Meiri and Berri Jacque

Massachusetts' STEM gap



Expanding the Pipeline for all 2013

Massachusetts' biomedical STEM gap



9 out of 10 jobs in health and biology are in <u>health</u>

Three distinct cohorts:

- High level (PhD) need more diversity
- Mid-level – need more participants
- General population – needs better health literacy

Narrowing the STEM gap

- Engagement
- Preparation

Engagement: How students value STEM

PERCENTAGE OF US STUDENTS AGREEING OR STRONGLY AGREEING:	
I find science helps me understand things around me	**80%**
Science is very relevant to me	**66%**

PISA 2007, 10th grade

How students value learning about things that affect them

PERCENTAGE OF BOSTON HIGH SCHOOL STUDENTS* AGREEING OR STRONGLY AGREEING:	
The importance of studying something that can affect your day-to-day behavior	**100%**
The value of studying something that can affect you directly	**92%**

***n = 124**

Students especially value learning about health and disease

PERCENTAGE OF BOSTON HIGH SCHOOL STUDENTS* AGREEING OR STRONGLY AGREEING:	
The importance of studying something that can affect your day-to-day behavior	**100%**
The value of studying something that can affect you directly	**92%**
The value of studying diseases in general	**98%**

***n = 124**

Narrowing the STEM gap

- Engagement
- Preparation

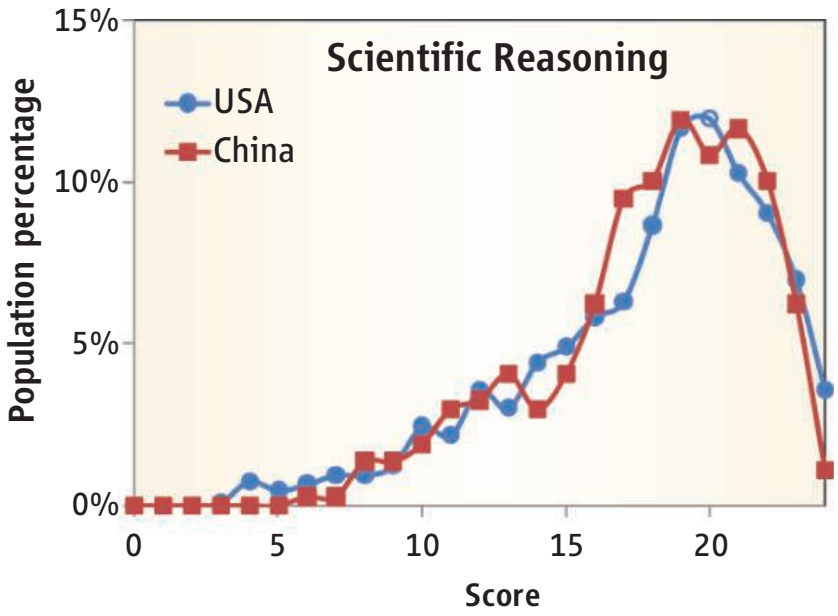
Preparation: Need practice to achieve advanced benchmarks

PERCENTAGE OF STUDENTS SCORING AT OR ABOVE EACH BENCHMARK IN SCIENCE					
Education system	**Average**	**Low (>400)**	**Intermediate (>475)**	**High (>550)**	**Advanced* (>625)**
Singapore	590	96%	87%	69%	40%
Massachusetts	567	96%	87%	61%	**24%**
US	522	93%	73%	**39%**	9%
Ghana	396	22%	6%	1%	0%

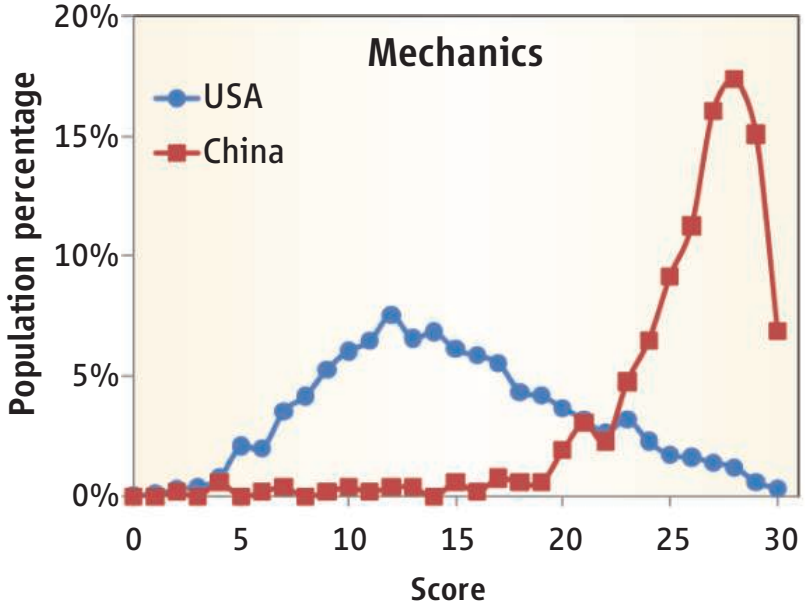
***Advanced:** Students apply knowledge and understanding of scientific processes and relationships and show some knowledge of scientific inquiry.

https://nces.ed.gov/TIMSS/

Preparation: need practice to solve problems in context



General scientific reasoning



Scientific reasoning in context

1st year college students

Bao, L. *Learning and Scientific Reasoning.* Science, 2009. **323**(5914): p. 586-587.

Solution?

Can we leverage student interest in health and disease to provide preparation that fosters

Workforce participation

and

Health literacy?

How?

- Cohort 1 – High achievers who aren't self-selecting.
- Cohort 2 – Midlevel participants who need exposure.
- Cohort 3 – General population, need health literacy.

To reach the largest population -
need classroom-based intervention.

A collaborative approach to real-world science in the classroom

CTSE bridges the divide between biomedical scientists and K-12 educators, to bring the up-to-date science behind health and disease into the high school classroom.

The Center for Translational Science Education (CTSE) bridges the divide between biomedical scientists and K-12 educators, to bring the up-to-date science behind health and disease into the high school classroom. By building partnerships among specialists in biomedical science and health, teachers and educational researchers, we design, support implementation of, and rigorously evaluate life-relevant curricula, engaging students in authentic science practice, promoting self-efficacy in scientific problem solving, and impacting health literacy. Our partnerships among academic and industry researchers and teachers design and implement authentic research-based activities that promote the skill sets required for the diverse careers in biomedical and health sciences needed by 21st century economies.

News

Read our latest paper in *Academic Medicine*.

July 19th-23rd: Graduate Course 'Teaching Infectious Diseases'

Sponsors

NIH National Institutes of Health

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
SUPPORTED BY THE NATIONAL INSTITUTES OF HEALTH

National Institute of Allergy and Infectious Diseases

CUBIST

CTSE Center for Translational Science Education

Providing practical solutions to bring benchtop and bedside to desktop

The Great Diseases Project

- **Designs** engaging, rigorous, real world, health-focused biology curricula for 10^{th} – 12^{th} grade students

- **Provides** extensive support for teachers

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD

Supported by the National Center for Research Resources, a part of the National Institutes of Health

CTSE Center for Translational Science Education

Providing practical solutions to bring benchtop and bedside to desktop

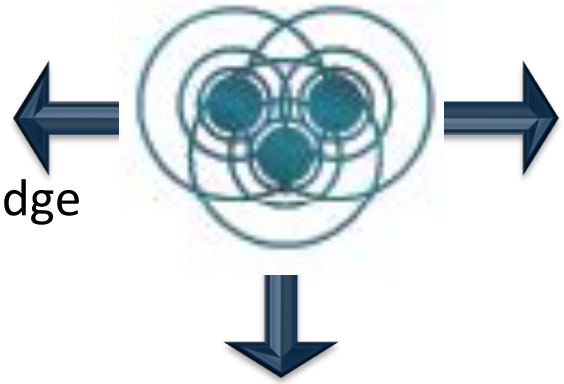
The Great Diseases Partnership

A collaborative learning community

BOSTON Public Schools
Focus on Children

Curriculum development by partnership

Teachers
Pedagogical content knowledge
Assessments



Scientists
Novel content knowledge
Evidence-based reasoning

Life-relevant curricula

Workforce Preparation

Engagement
Performance

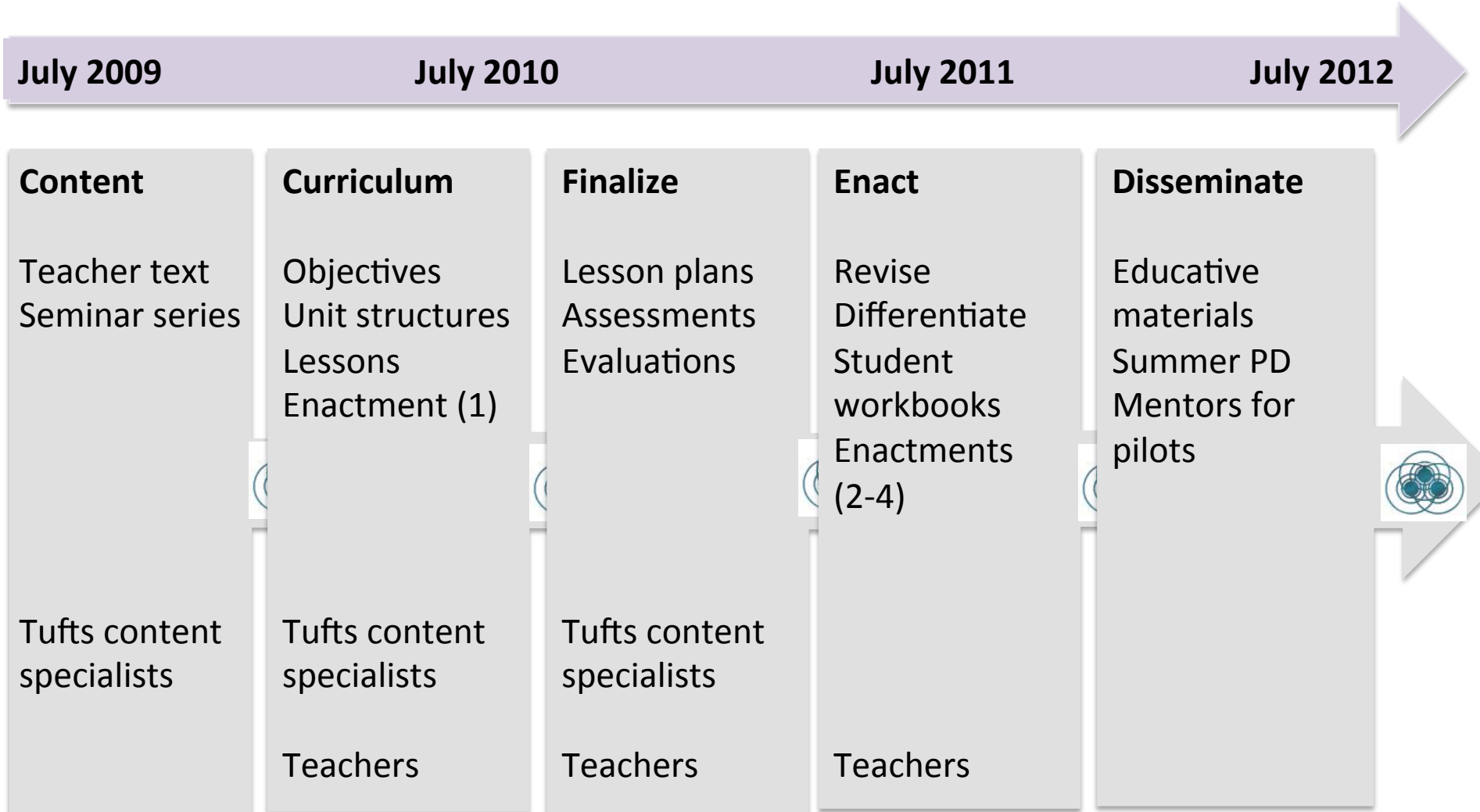
Health Literacy

1. Engage the Boston Public Schools

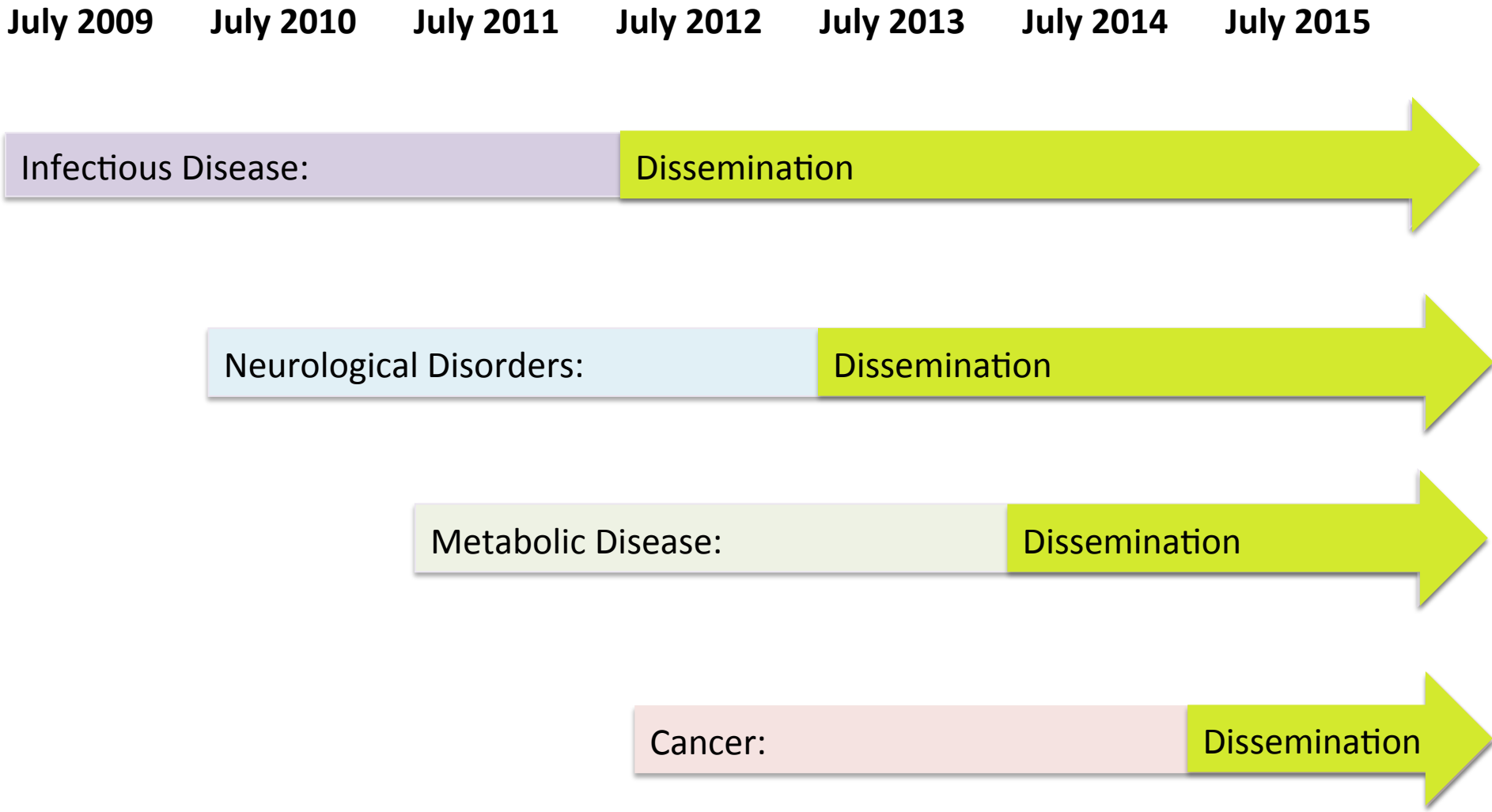
Boston Latin School
Madison Park School

BOSTON Public Schools
Focus on Children

2. Curriculum development by partnership



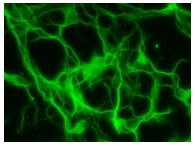
3. Module development and dissemination



The Great Diseases Curriculum

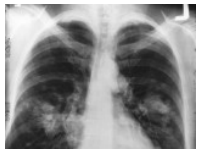
An inquiry-based modular biology II curriculum for 10^{th} – 12^{th} graders

- Infectious diseases (2012) ✔



- Neurological disorders (2013) ✔

- Metabolic diseases (2014)



- Cancer (2015*)*

Module 1: Infectious Disease
35 comprehensive lessons

Unit 1: Why should we care about infectious disease?

Unit 2: What does it mean to have an infectious disease?

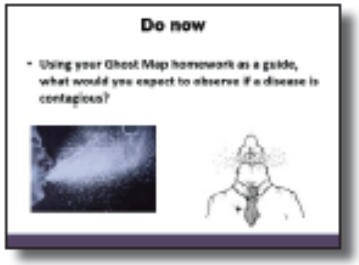
Unit 3: When does a microbe become pathogenic?

Unit 4: How do pathogens make us sick?

Unit 5: How do we get better?

Overall lesson format:

1. DO NOW



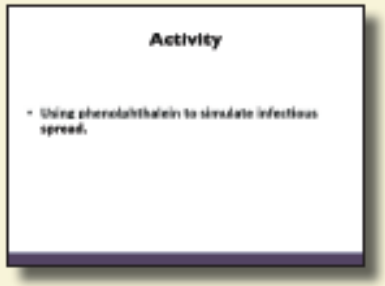
Ask the students:

What are the four problems that must be solved?

1. We need to prove that the disease can spread from person to person.
2. We need to be able to associate the disease outbreak with a source of infection.
3. We need to isolate an infectious agent that is found at both the source of the infection and in the infected person.
4. We need to show that the infectious agent we have isolated can cause disease.

2. Activity

In the Phenolphthalein simulation the students use correlations to pinpoint the source of spread of the indicator chemical.



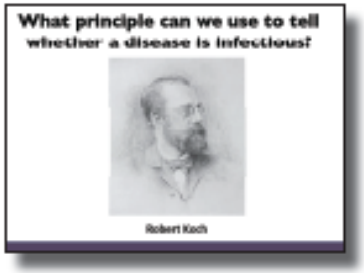
After the activity analogize the spread of the indicator solution to disease and guide the students to think about how population characteristics affect the spread.

Ask the students:

How would increases in the human population affect diseases spread by contact?

- Increased population density will force more people into contact with each other.
- Increased population density may force more people to expand into new habitats where they will encounter novel infections.

3. Wrap Up



Important points:

If you are running behind , this slide and the rest can be moved to the next lesson.

- Returning to the idea of correlation and causation. In the activity it was clear that the appearance of color in one cup was caused by adding liquid from another cup. This is causation.
- In reality causation is not so evident because we usually can't see the transfer of infectious agents.

Multiple inquiry-based pedagogies

Lessons:

- **Socratic discussions**
- Student-led teach-backs (jigsaws)
- Small group work
- Projects

Labs:

- Hands-on
- Interrupted case studies

The biomedical teaching gap

- Teachers also have limited biomedical and health literacy

- Addressing the problem:

Modeling for Fidelity (MFF)

NIAID

Professional development

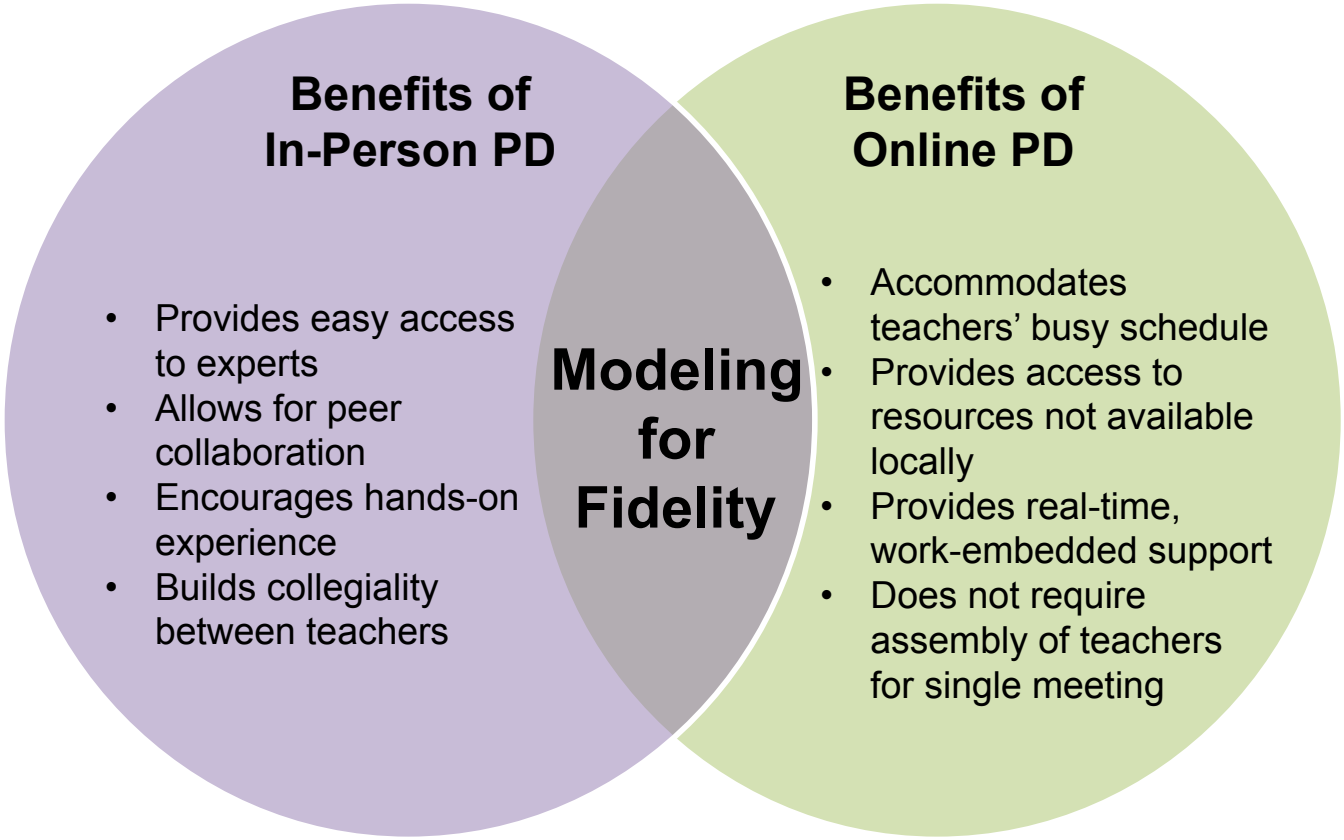
Best practices

- Extended duration
- Contextualized rich in content
- Sustained mentor interactions

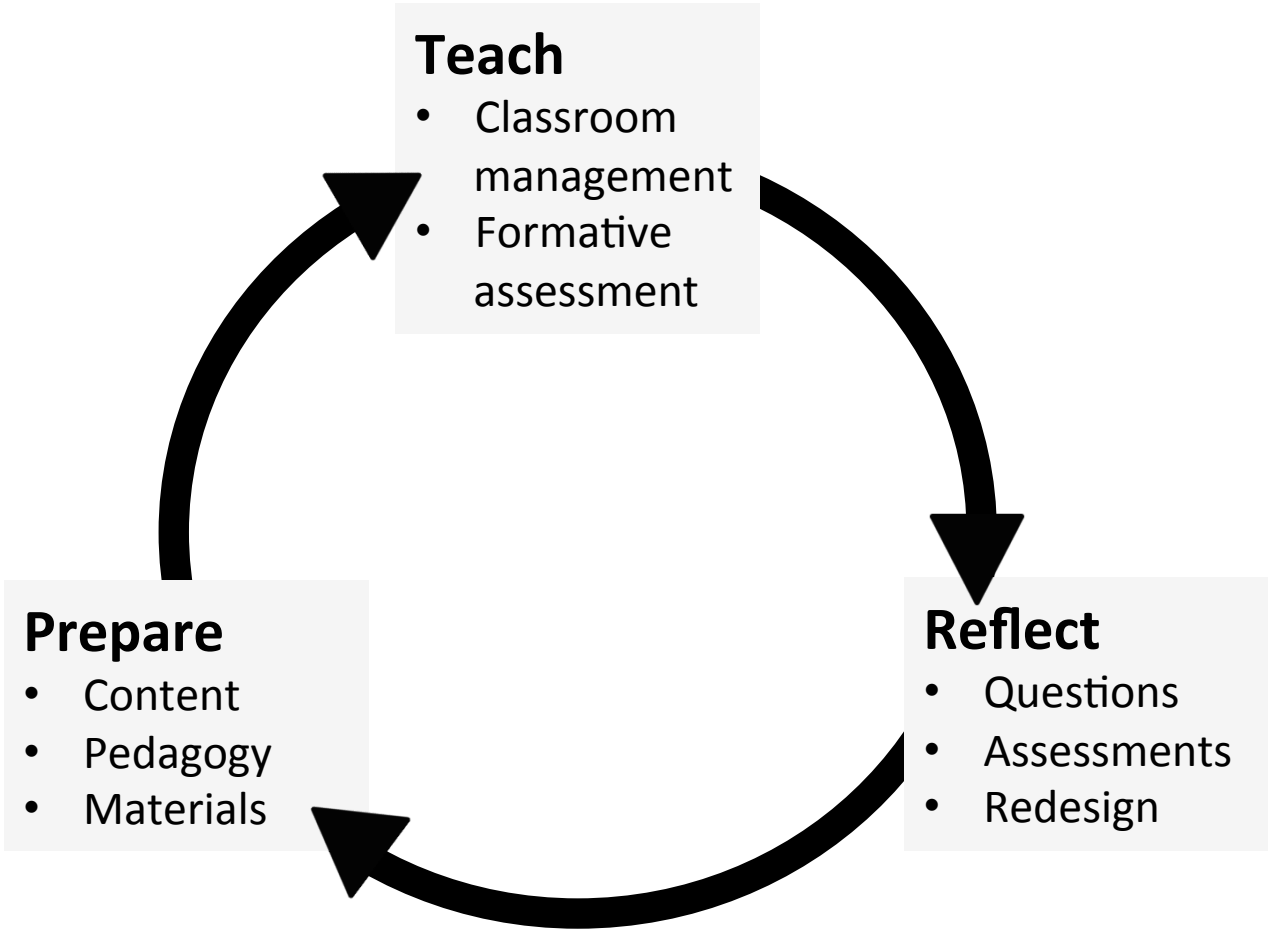
Actual practices

- Limited duration
- Focus on pedagogy
- Limited mentor interactions

Professional development in-person and online



Modeling for Fidelity



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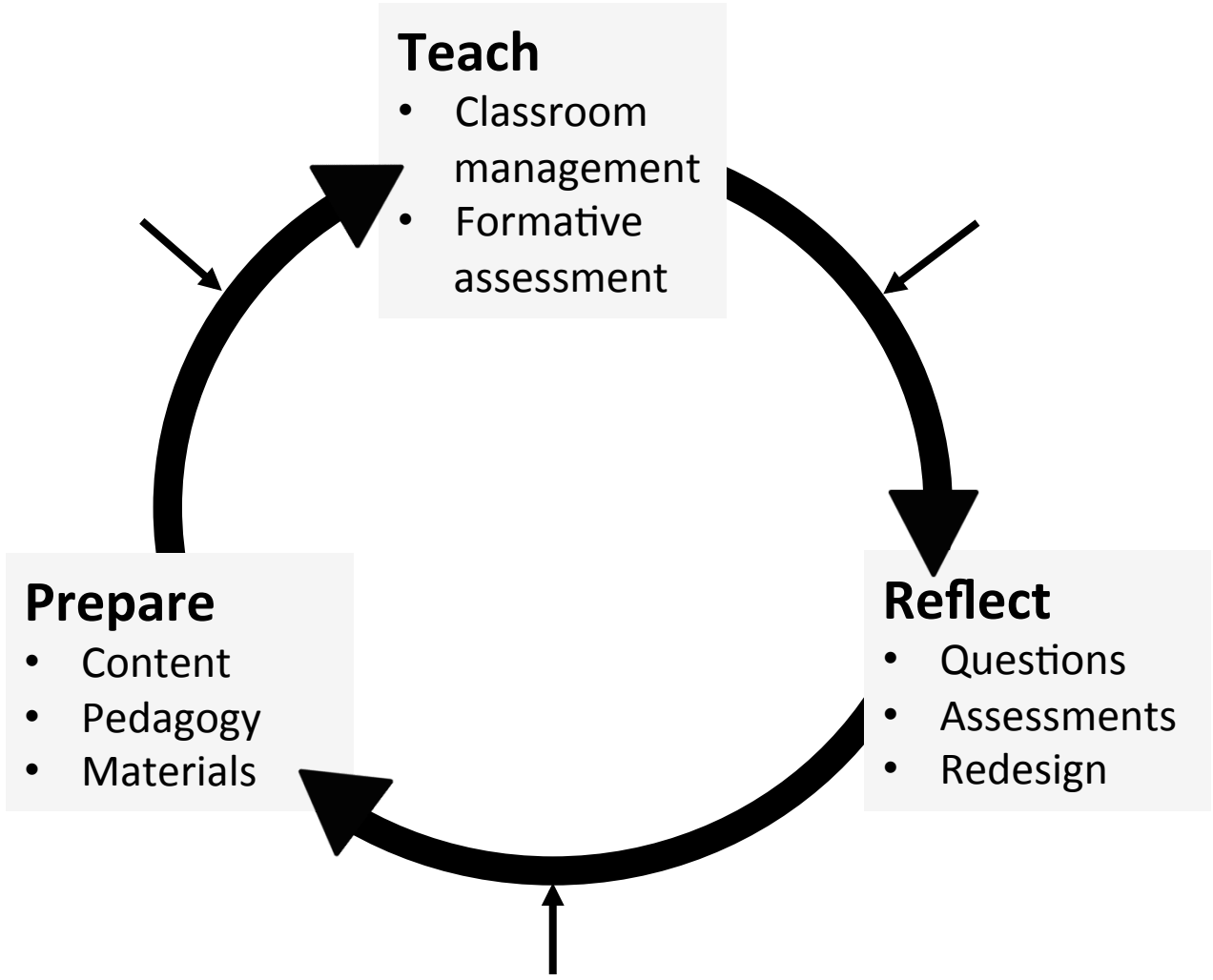

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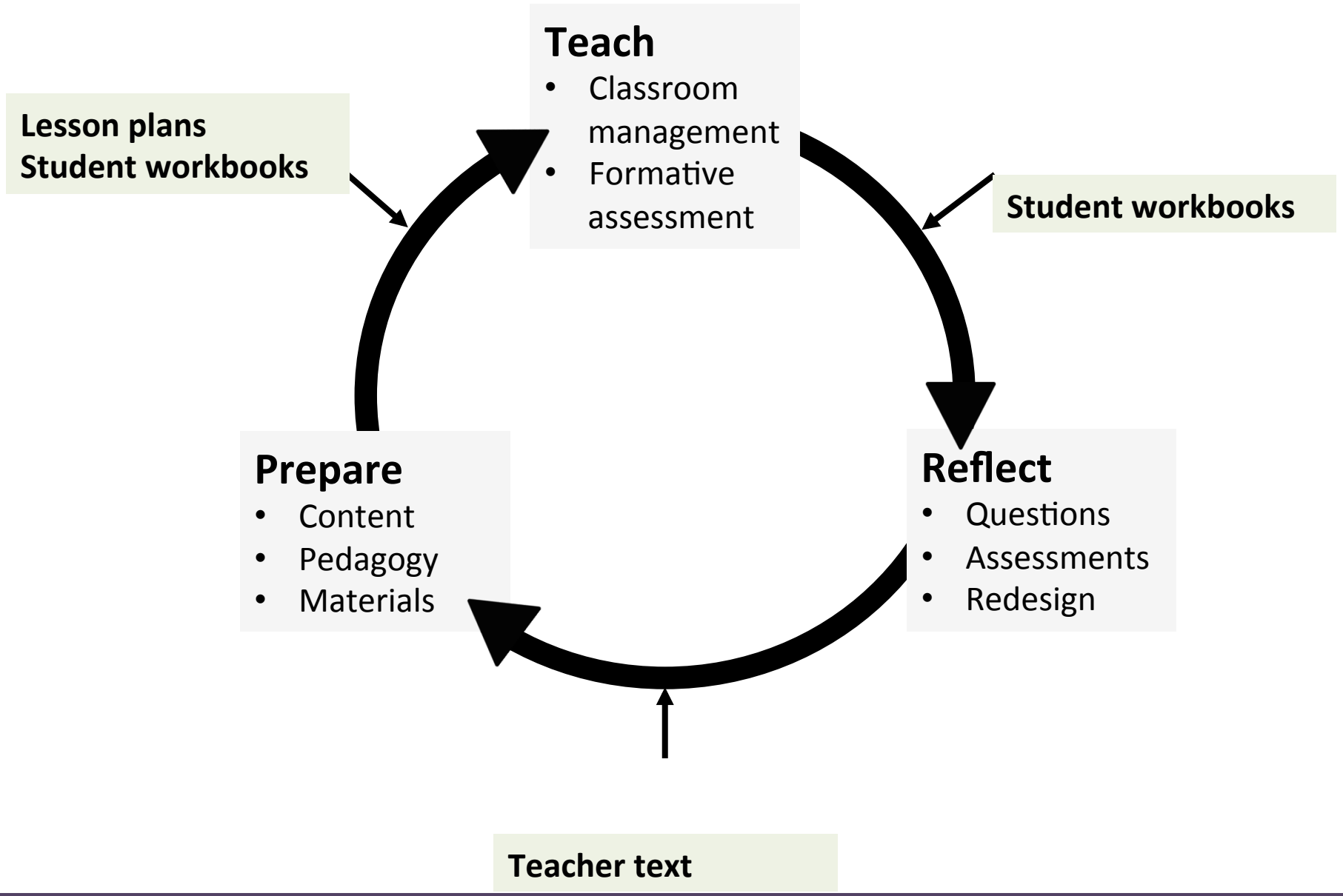
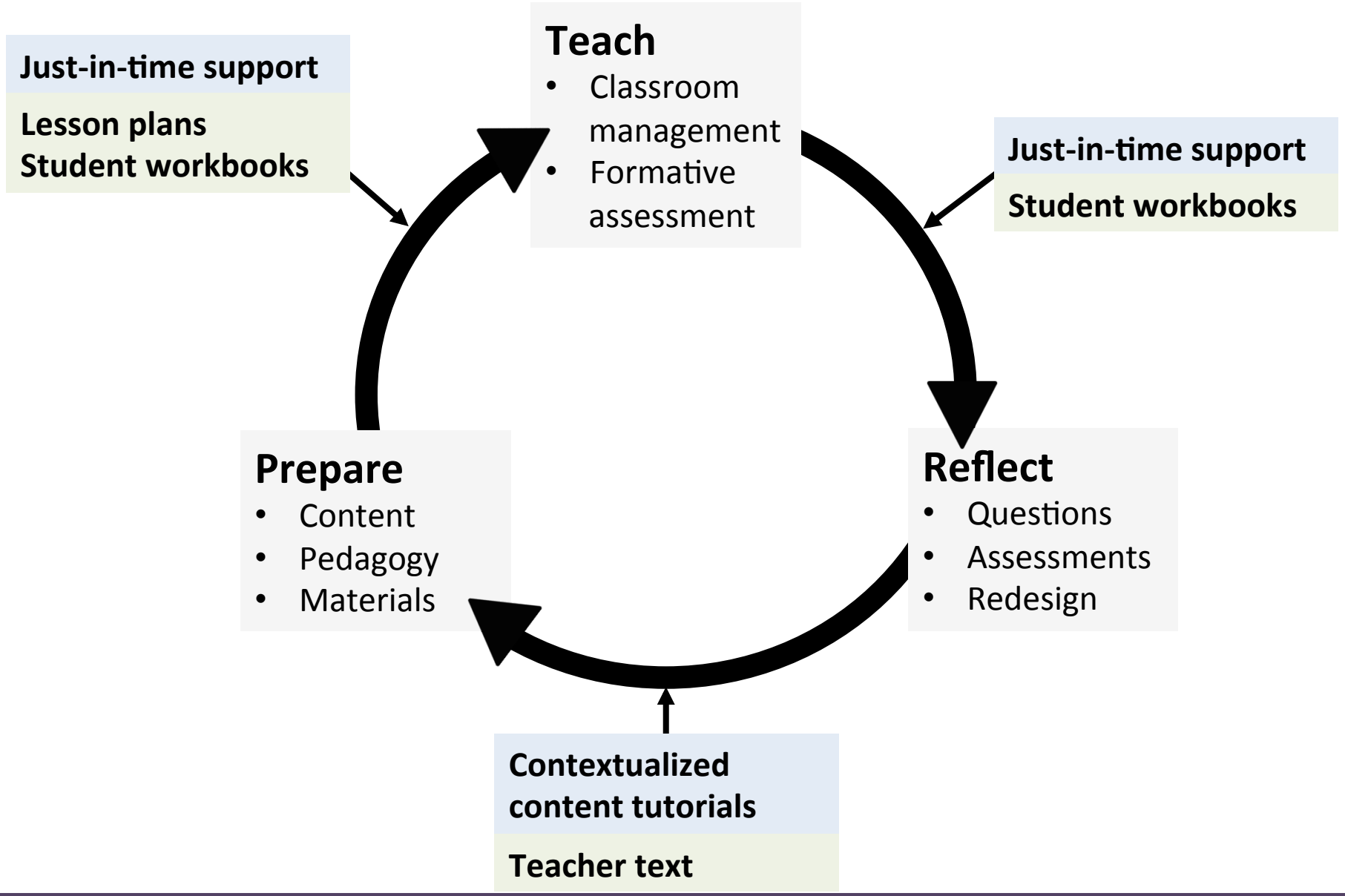


Modeling for Fidelity



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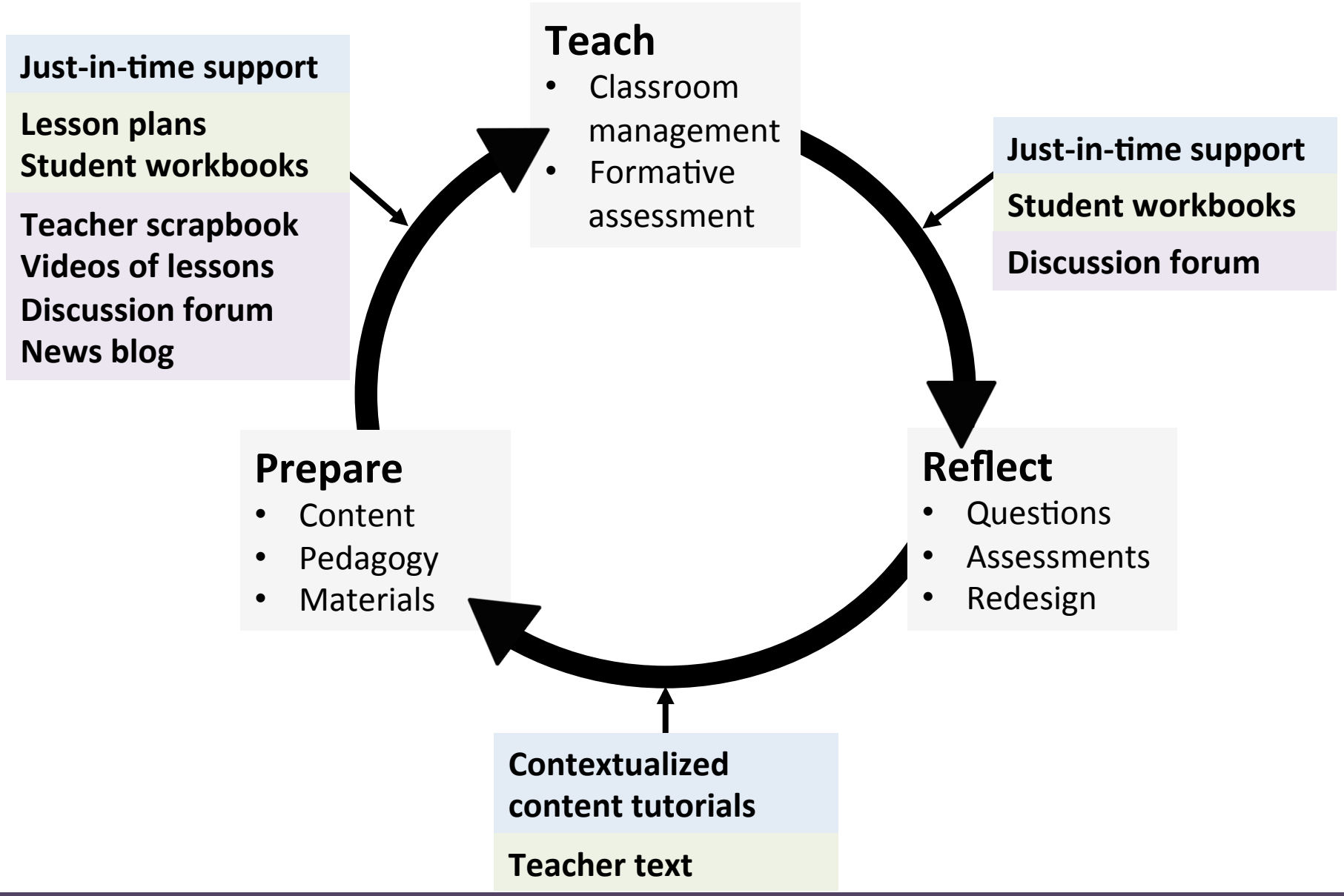

How do we measure the quality of MFF?

- **<u>Direct</u> - change in teacher practices in the classroom**
  - Teacher self-reporting
  - Observation

- **<u>Indirect</u> - student outcomes**
  - Performance
  - Engagement

How do we measure the quality of MFF?

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  - Performance
  - Engagement

What we measure:

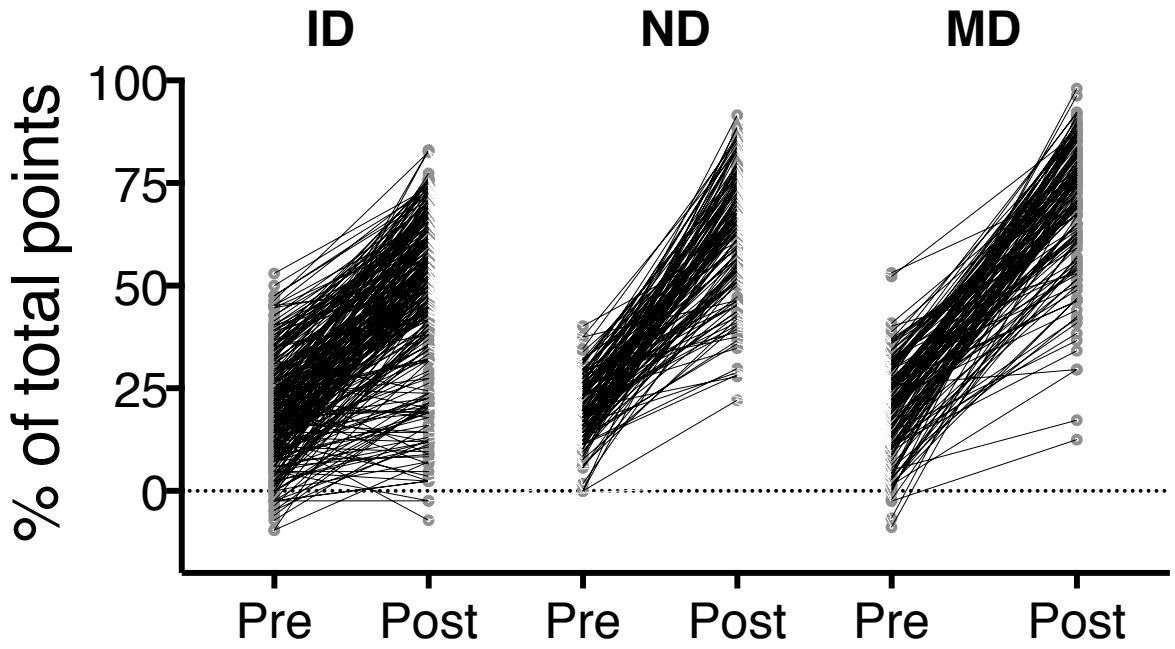
- **Student engagement**
  - Attitude
- **Student Performance**
  - **Conceptual content knowledge inventory**
  - **Problem solving skills**
- **Health literacy**
  - **Self-efficacy**
  - Claims evaluation and risk assessment skills

Student engagement

What is the first word that comes to mind about the Infectious Disease module?

*Data from 3 schools

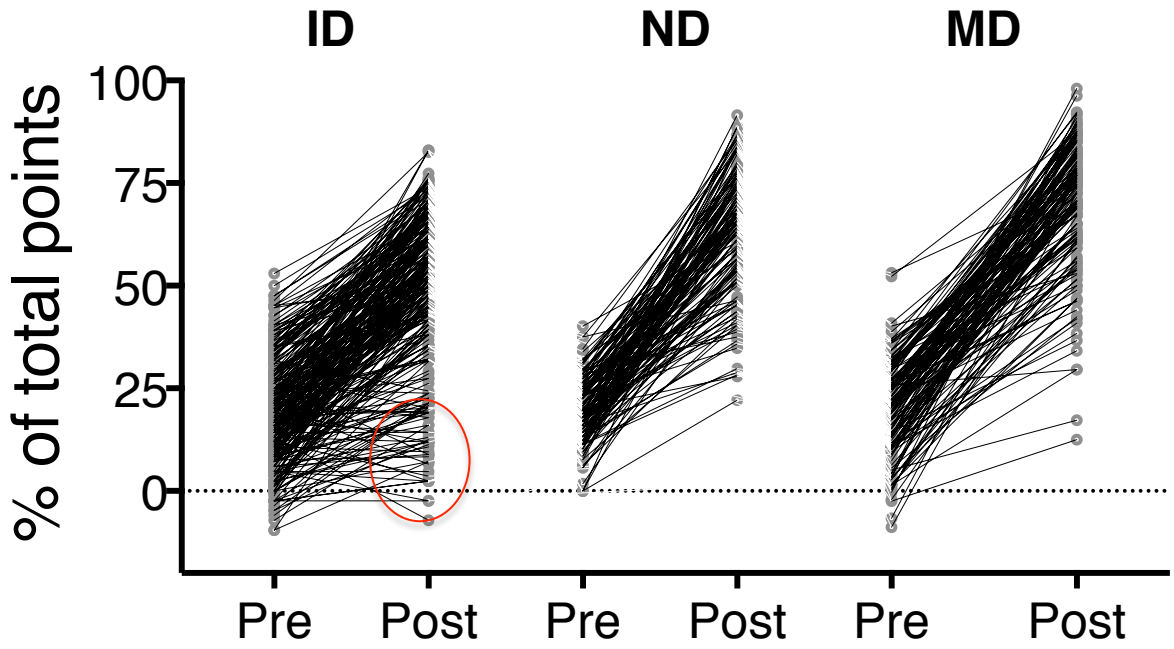
Conceptual content knowledge and problem solving skills



Module	Average Pre (SD)	Average Post (SD)	Effect Cohen's d	Chronbach Alpha
ID (n = 286)	18.8 (12.6)	48.0 (19.7)***	1.8	0.86
ND (n = 142)	19.5 (7.9)	62.9 (14.9)***	3.6	0.81
MD (n = 160)	20.6 (11.0)	70.5 (15.5)***	3.7	N/A

***p<0.0001

Conceptual content knowledge and problem solving skills



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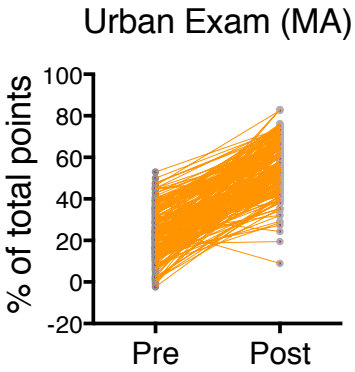
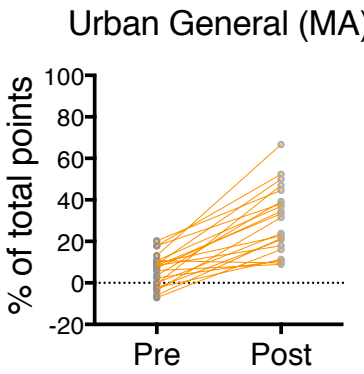
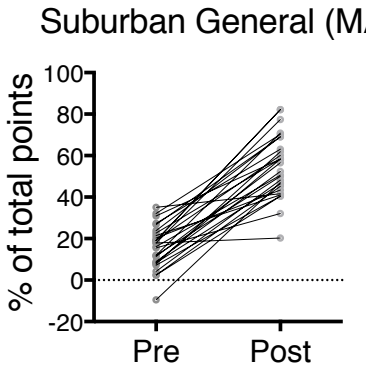
ID content knowledge and problem solving skills by school

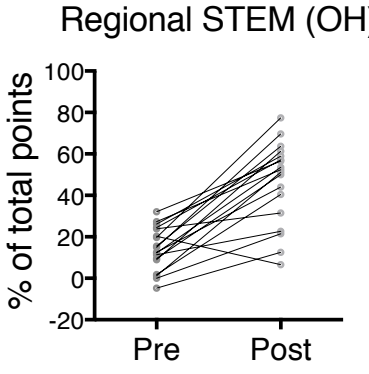
Gold Standard PD





Modeling for Fidelity



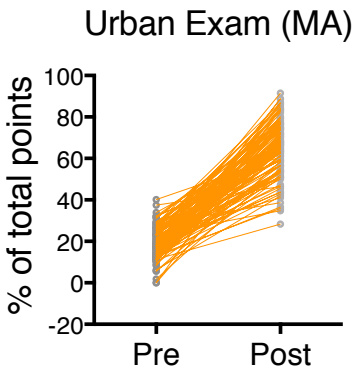


***p<0.0001

Berri Jacque

ND content knowledge and problem solving skills by school

Gold Standard PD



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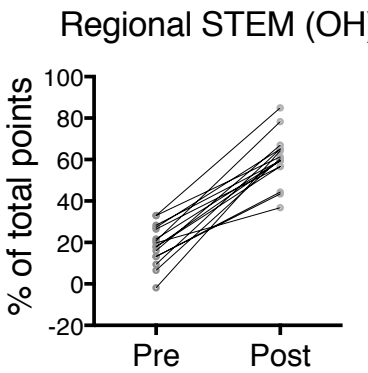
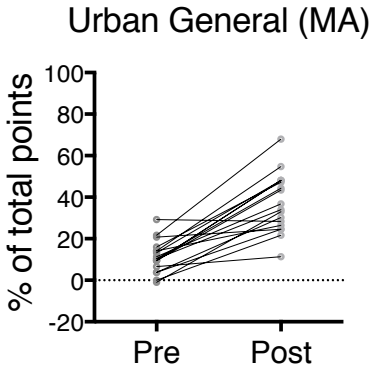
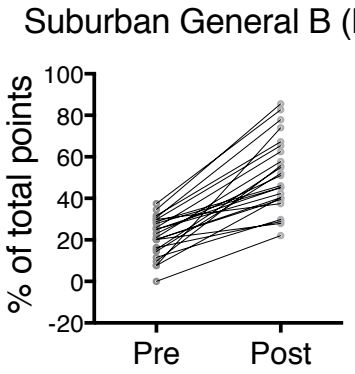






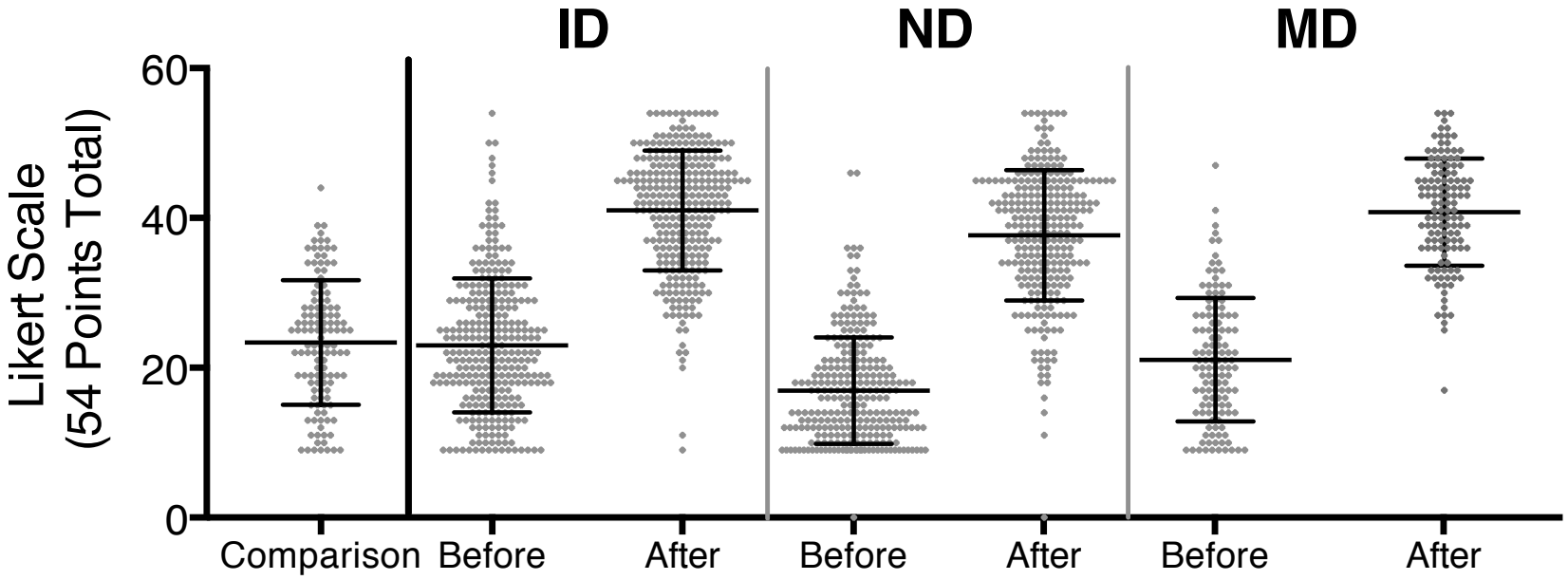
***p<0.0001

Katie Malanson

Knowledge and problem solving: Gold standard vs MFF PD

School	Pre		Post		
Infectious Diseases	**Mean:**	**(SD)**	**Mean:**	**(SD)**	**Cohen's d**
Urban Exam High School	22.9	11.7	56.2	12.7	2.7
Suburban High School A	15.7	10.2	54.9	14.9	3.1
Urban High School	5.8	7.9	30.4	16.1	1.9
Regional STEM High School	14.3	10.4	46.2	19.9	2.0
Total	18.9	12.6	48.0	19.7	1.8
Neurological Disorders					
Urban Exam High School	19.1	7.5	65.3	13.0	4.4
Suburban High School B	21.4	9.6	51.3	17.6	2.1
Urban High School	11.3	7.6	37.4	14.0	2.3
Regional STEM High School	18.9	9.6	60.1	12.0	3.8
Total	18.6	8.3	60.0	16.3	3.2

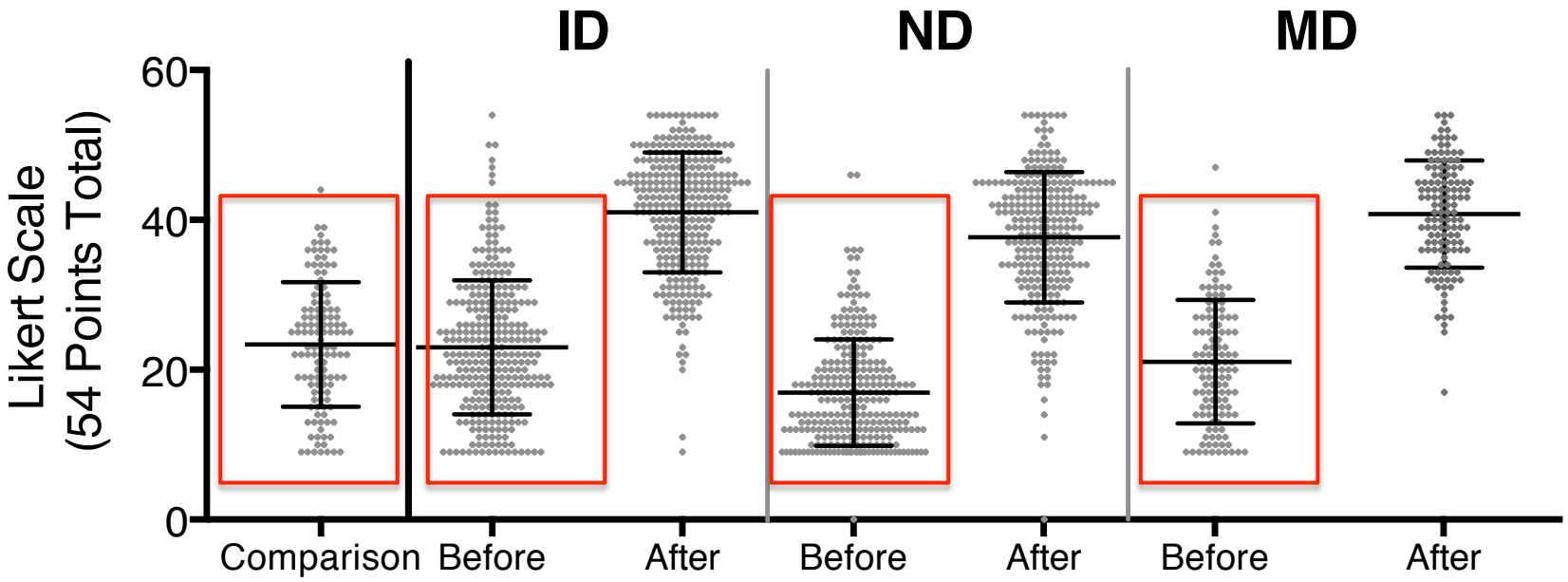
Self-efficacy



Module	Average Pre (SD)	Average Post (SD)	Effect Cohen's d	Chronbach Alpha
ID (n = 293)	23.0 (8.9)	41.0 (8.0)***	2.12	0.90
ND (n = 269)	17.0 (7.1)	37.7 (8.7)***	2.61	0.93
MD (n = 125)	21.0 (8.3)	40.7 (7.2)***	2.55	0.90
Comparison (n = 124)	23.1 (8.1)			0.90

***p<0.0001

Self-efficacy



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MD (n = 125)	21.0 (8.3)	40.7 (7.2)***	2.55	0.90
Comparison (n = 124)	23.1 (8.1)			0.90

***p<0.0001

Self-efficacy instrument

	Before Mean	After Mean	Comparison Mean
My understanding of how infectious diseases begin	2.38 (1.1)	4.75 (1.1) ***	2.39 (1.2)
My understanding of how infectious diseases spread	2.89 (1.2)	4.97*** (1.0)	3.25 (1.3)
My skills at identifying an infectious disease	2.11 (1.1)	4.35*** (1.0)	2.20 (!.0)
My skills at making accurate judgments about infectious diseases	2.15 (1.0)	4.23*** (1.1)	2.26 (1.1)
My skills at how to find correct information about infectious disease	2.57 (1.3)	4.53*** (1.1)	2.93 (1.4)
My understanding of how to connect different data to form an hypothesis about an infectious disease	3.32 (1.1)	4.27*** (1.1)	2.46 (1.3)
My skills at using data to understand infectious disease	2.32 (1.2)	4.20*** (1.1)	2.44 (1.3)
My knowledge of how the body works to prevent the spread of infectious disease	2.65 (1.2)	4.83*** (1.1)	2.73 (1.2)
My knowledge of how the environment affects the spread of infectious disease	2.53 (1.2)	4.65*** (1.0)	2.70 (1.3)
Total (54 points)	**21.78 (8.31)**	**40.54*** (8.2)**	**22.8 (9.0)**

Principal components analysis (PCA)

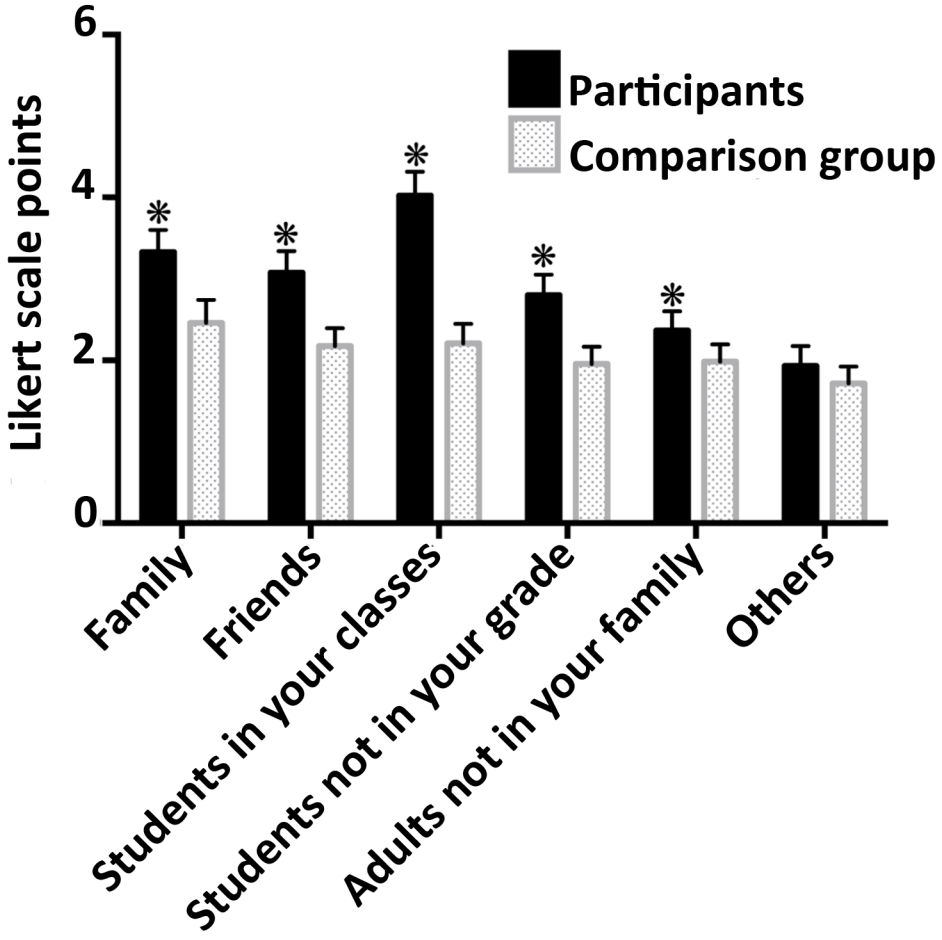
	One Year Ago		Currently	
	1	2	1	2
My understanding of how infectious diseases begin		0.74	0.88	
My understanding of how infectious diseases spread		0.76	0.84	
My skills at identifying an infectious disease		0.86	0.83	
My skills at making accurate judgments about infectious diseases		0.77	0.82	
My skills at how to find correct information about infectious diseases		0.72	0.82	
My understanding of how to connect different data to form an hypothesis about an infectious disease		0.79	0.85	
My skills at using data to understand infectious diseases		0.80	0.86	
My knowledge of how the body works to prevent the spread of infectious disease		0.74	0.87	
My knowledge of how the environment affects the spread of infectious disease		0.74	0.80	

Reliability Statistics	
Lambda	0.97
Cronbach's Alpha	0.91

Self-Efficacy: Gold standard vs MFF

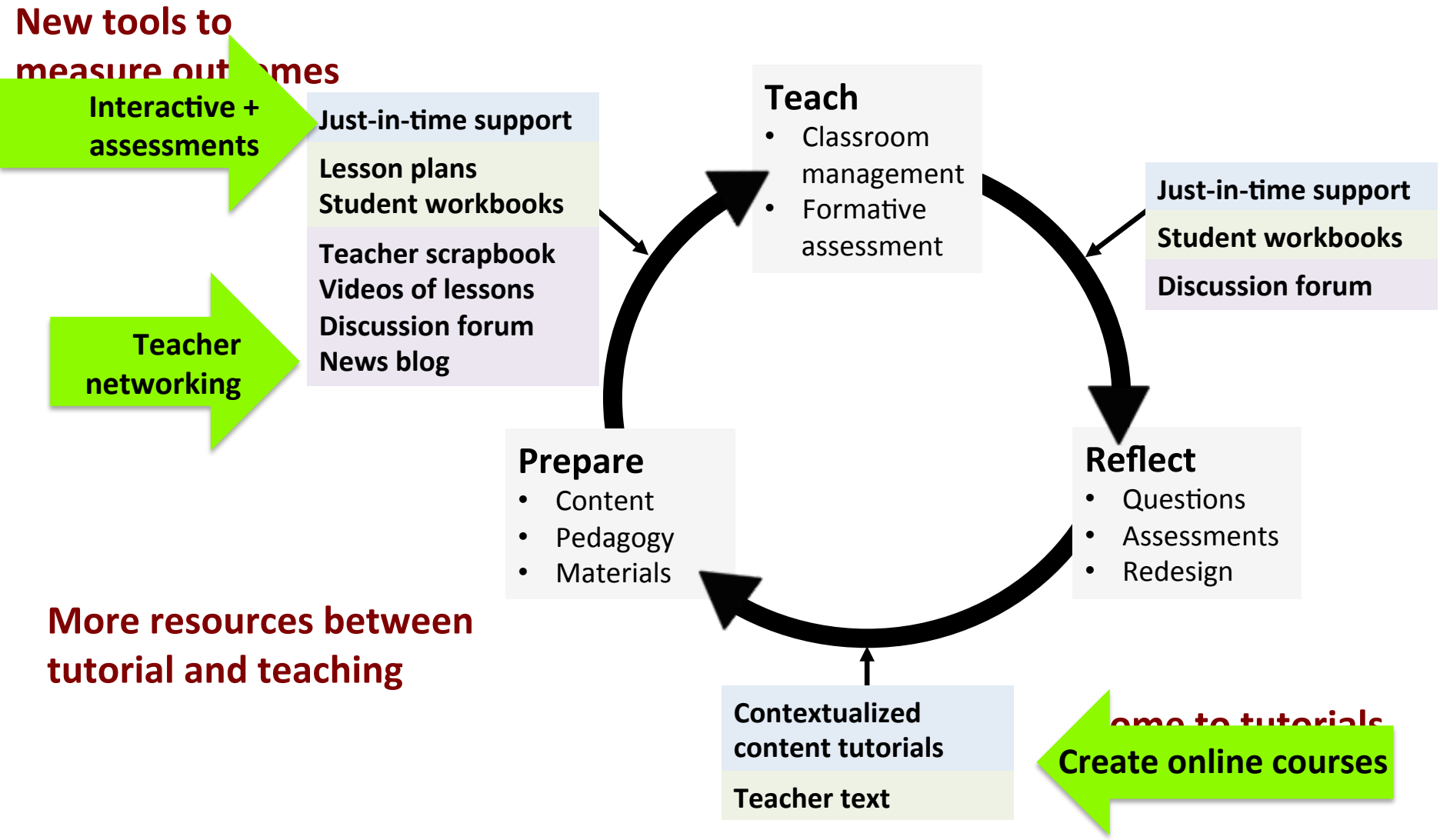
School	Pre		Post		
Infectious Diseases	**Mean:**	**(SD)**	**Mean:**	**(SD)**	**Cohen's d**
Urban Exam High School	22.1	8.4	41.2	7.6	2.4
Suburban High School A	24.4	8.8	40.2	7.6	1.9
Urban High School	18.8	6.7	41.5	8.2	3.0
Regional STEM High School	21.2	8.9	39.9	6.7	2.4
Total	21.8	8.3	40.5	8.2	2.3
Neurological Disorders					
Urban Exam High School	17.3	7.0	37.8	8.7	2.6
Suburban High School B	16.8	8.0	36.1	8.0	2.4
Urban High School	19.2	9.1	42.7	9.6	2.5
Regional STEM High School	16.9	7.7	33.3	11.6	1.7
Total	17.0	7.1	37.7	8.7	2.2

Does the health knowledge leave the classroom?



*p<0.05

The next step is scaling up



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Questions and thoughts?

http://sites.tufts.edu/greatdiseases/

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