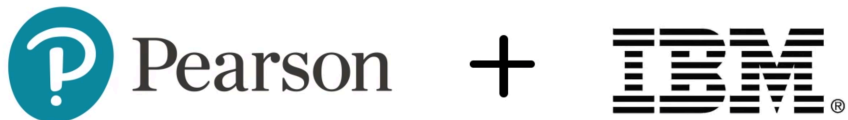


IBM Research

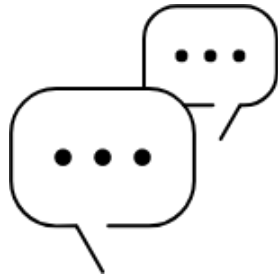
# Dialogue-Based Tutoring at Scale

Design and Challenges

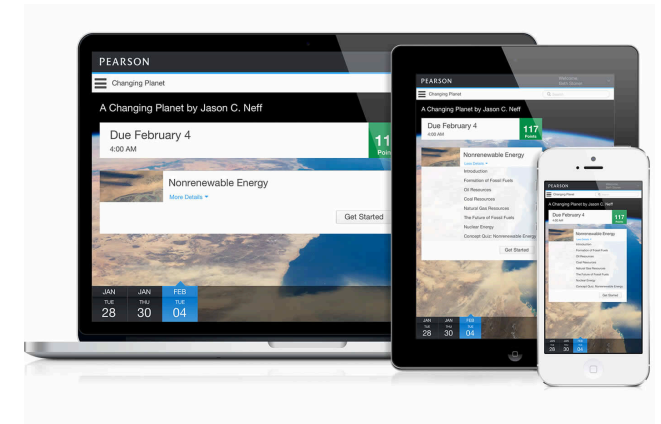
Maria Chang, Matthew Ventura, Jae-wook Ahn, Peter Foltz, Tengfei Ma, Tejas I. Dhamecha, Smit Marvaniya, Patrick Watson, Cassius D'helon, Amy Wetzel, Andy Packard Haas, Kaitlyn Banaszynski, John Behrens, Gailene Nelson, Sharad C. Sundararajan, Ravi Tejwani, Shazia Afzal, Nirmal Mukhi



# Pearson + IBM Partnership



Machine Learning  
Natural Language Conversation

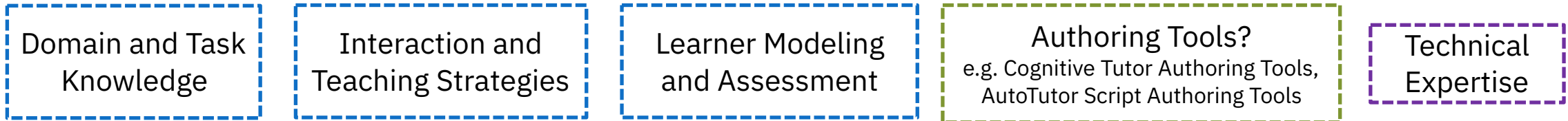


High Quality Content  
Interactive Learning Environments

# Dialogue-Based Intelligent Tutoring Systems

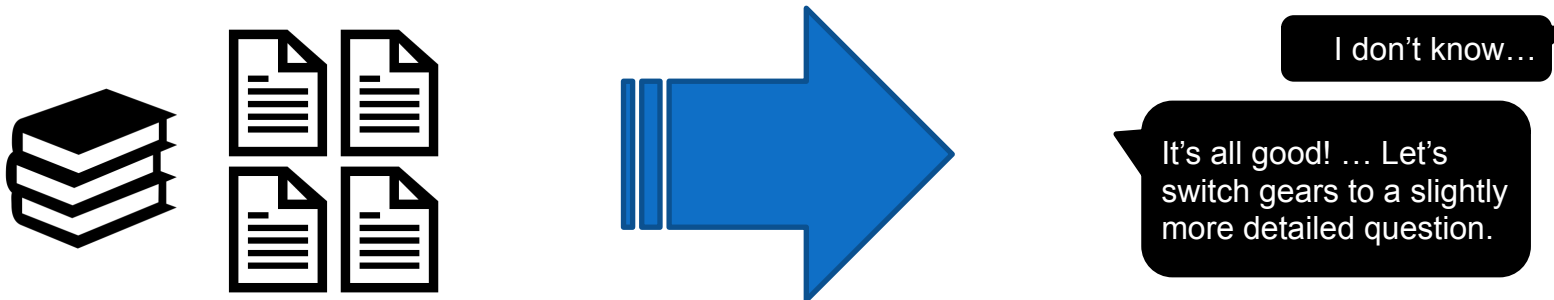
- Decades long history. Some notable implementations:
  - SCHOLAR (Carbonell, 1970) – widely considered the first intelligent tutoring system; natural language dialogue about South American geography; used semantic networks
  - SOPHIE (Brown et al., 1973) – question answering during circuit design/troubleshooting; *learning by doing* environment
  - CIRCSIM (Kim et al. 1989; Lulis et al. 2004) – dialogue about reflex blood control; later with analogies
  - AutoTutor and family (review, Nye et al. 2014) – dialogue-based tutoring across multiple domains over many years, including
    - Physics: AutoTutor-3D, Why2/AutoTutor, DeepTutor
    - Biology/Medicine: MetaTutor, GazeTutor, GuruTutor
    - Writing/Reading: Writing-Pal, iStart
- Demonstration of efficacy, along with other ITS types (Steenbergen-Hu & Cooper, 2014), especially over self-reliant, non-interactive alternatives

...scaling to new domains is *a lot* of work:

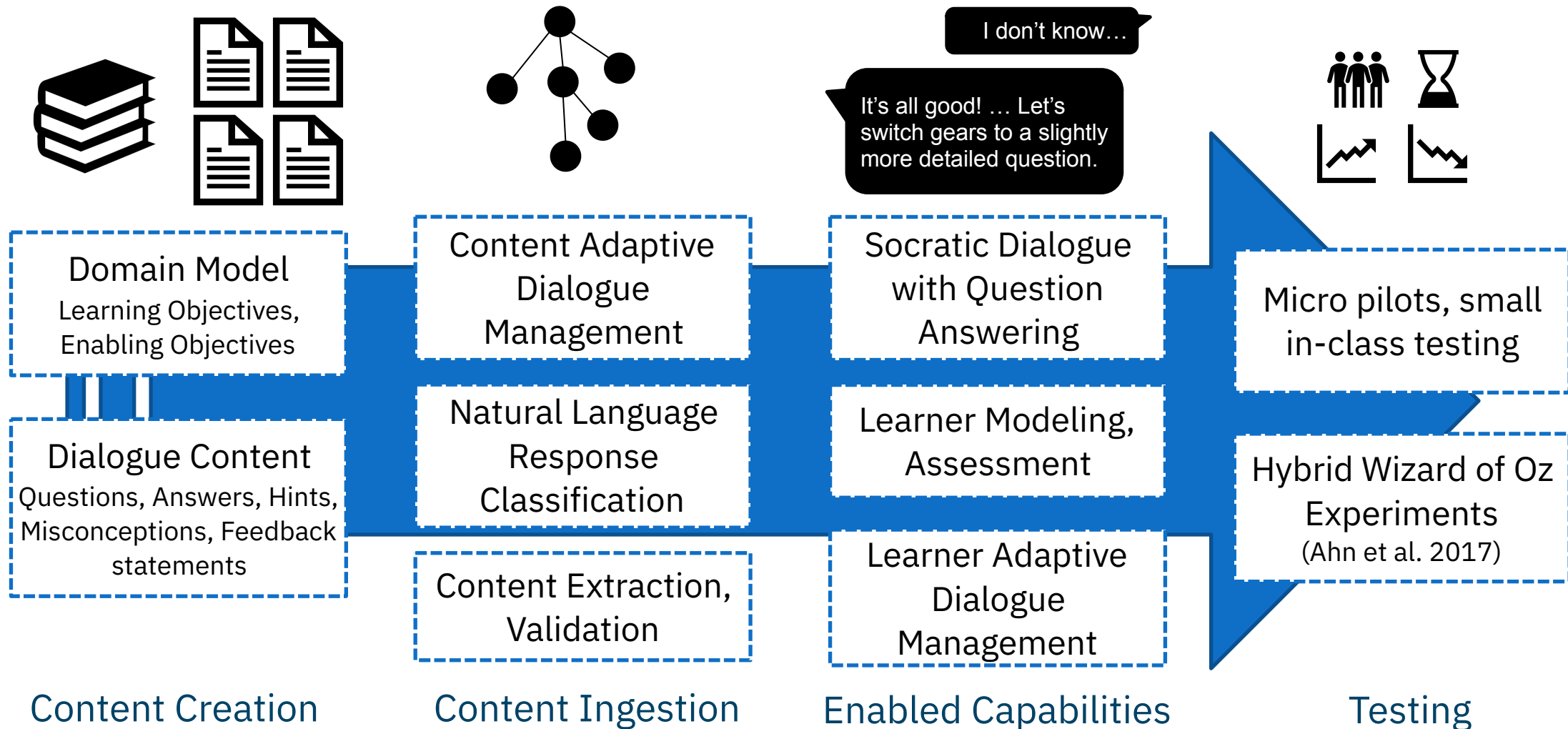


### *Our Approach:*

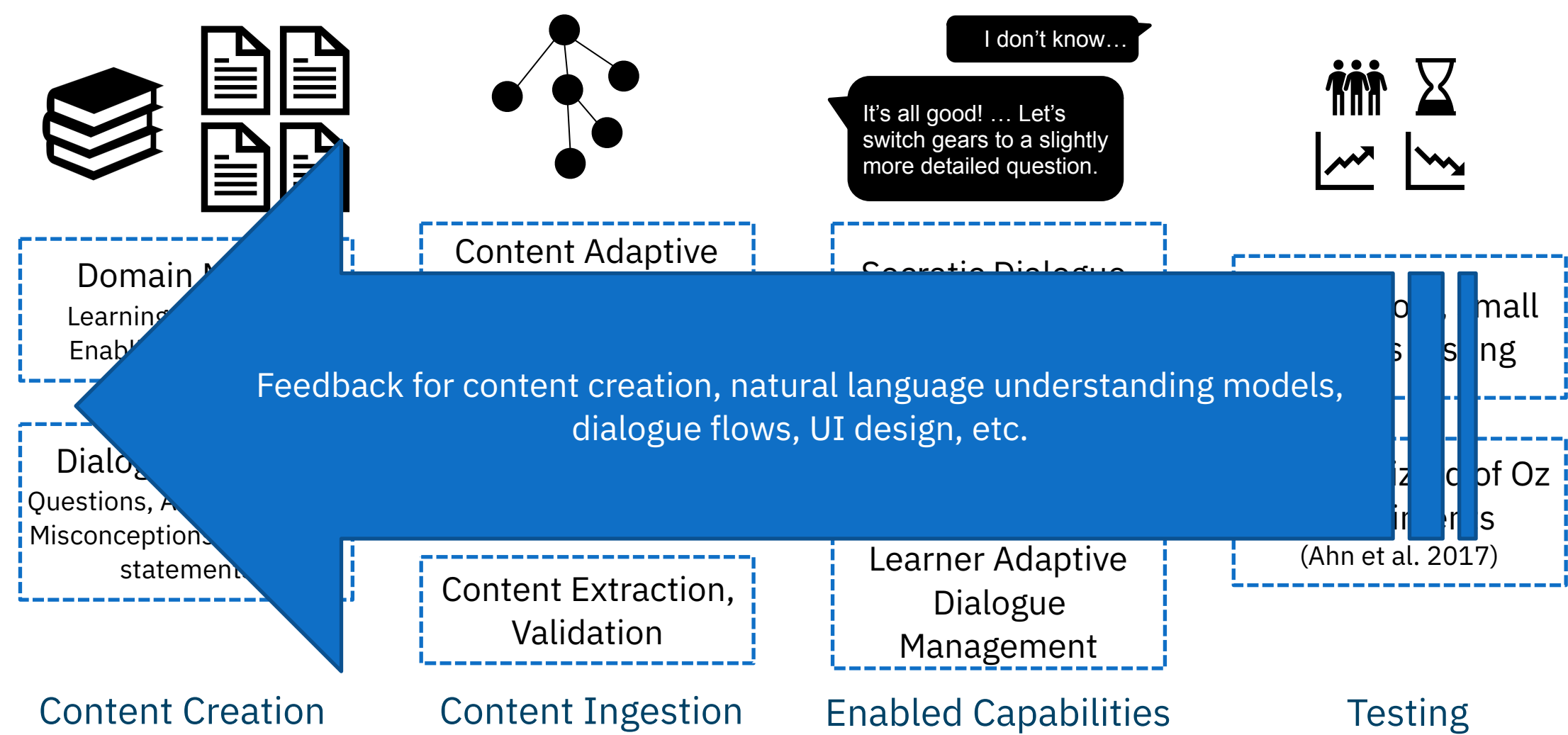
*Leverage existing content creation pipelines to create Watson Dialogue-Based Tutoring systems for new domains*



# Watson Dialogue-Based Tutor



# Watson Dialogue-Based Tutor



## Progress on Journey to Scale

- Developed Watson Dialogue-Based Tutors for 10 titles (i.e. textbooks) in approximately 18 months
  - Dialogue capability for >300 tutor-initiated questions per textbook title
  - These tutors have been used by over 500 students across 10 higher education institutions so far
- Goals
  - Keep models relatively stable but continually seek improvements
  - Accelerating returns
- Projection: 30 new titles per year

# Example Interaction

←

21.4: How Are Trends in Aging and Mortality Emerging As Critical Issues in Many Societies?

⌵

🔍

⋮

### Aging of the Baby Boomers

**LO 21.4.2: Discuss how the aging of the baby boom generation contributes to the overall graying of societies.**

💡 At the end of this section, review with Watson:  
Describe social theories.

The baby boom refers to the period following World War II from 1946 to 1964, during which the United States experienced a notable, extended, but ultimately temporary spike in fertility. Those born between 1946 and 1964 are referred to as the baby boom generation. The baby boomers' A refers to persons born during the same period of time. The baby boom cohort are now beginning to enter old age, with many implications for American society.

We can see the U.S. baby boom in the second graph of Figure 21.2 (seen earlier in this chapter), which shows that the U.S. total fertility rate stood at 3.4 in 1950, rose to a peak of 3.7 in 1955, and fell in later years. The baby boom can also be seen very clearly in the age pyramid for the United States. Let's take another look at the age pyramids displayed in

💡

#### Review with Watson

Analyze migration from a sociological perspective.

Let's take some time to review the previous section and make sure you are ready for your quiz.

Let's Chat

☰

22.1: What is Immigration, and How Do Governments Regulate It?

⌵

🔍

⋮

(Pavoni et al. 2014, figure 3).

Americans are deeply divided over what to do about unauthorized immigrants. Some states, most notably Arizona, have moved aggressively to try to remove illegal residents from the country and send them back to their homeland, a policy known as deportation. The Obama administration has also quietly pursued a policy of deporting immigrants who are located through raids on the employers who hire them. But others think that immigrants who have lived in the United States for a number of years and paid their taxes should have a pathway to citizenship. As highlights, a recent survey on the public's priorities for immigration policy found that 33 percent of Americans would prioritize law enforcement and better border security, 23 percent favor a pathway to citizenship, while 41 percent think both policies should be given equal weight. Here are more details about trends in public attitudes.

💡

#### Review with Watson

Analyze migration from a sociological perspective.

Let's take some time to review the previous section and make sure you are ready for your quiz.

Let's Chat





20.3 - Describe factors associated with the environmental justice movement.

Mastery Meter:



Learning Objective

**Describe factors associated with the environmental justice movement.**

**Describe environmental racism.**

**Explain why impoverished neigh...**

**Describe how the environmental...**

Hi, I'm Watson, your digital tutor! I'll chat with you and ask questions about your readings to help improve your understanding.  
Let's review this topic...

What factors are associated with the environmental justice movement?

idk

Sure, that's ok.

What is the primary goal of the environmental justice movement?

The primary goal is equal protection from environmental harm

Keep going! There's a little more to the answer.  
Let's figure this out. Can you fill in the missing word?

The primary goal of the environmental justice movement is achieving equal protection from environmental hazards for all people, regardless of \_\_\_\_\_ race \_\_\_\_\_, class, or geography.

Good job! The primary goal of the environmental justice movement is achieving equal protection from environmental hazards for all people, regardless of race, class, or geography.

What is a secondary goal of the environmental justice movement?

idk



Type here...



## 20.3 - Describe factors associated with the environmental justice movement.

Mastery Meter:



Learning Objective

**Describe factors associated with the environmental justice movement.**

**Describe environmental racism.**

**Explain why impoverished neighborhoods often suffer greater environmental harm.**

**Describe how the environmental...**

What is a secondary goal of the environmental justice movement?

idk

Sure, that's ok. A secondary goal of the environmental justice movement is giving community members a voice in shaping decisions that affect their environment and their health.

There are 4 key facts left in this review.

How are civil rights involved in the environmental justice movement?

I'm not sure

It's all good! A faction of the environmental justice movement focuses on environmental issues as a violation of civil rights.

Let's switch gears to a slightly more detailed question:

Why do impoverished neighborhoods suffer greater environmental harm from polluting industries?

Because poor people don't have the resources to fight the industries

That doesn't sync up with what I have.

Why do polluting industries like to place facilities on land near impoverished neighborhoods?

Why do impoverished neighborhoods suffer greater environmental harm from polluting industries?

That question is part of the current topic, so I can't answer it here. Try asking another question.

What creates environmental racism?



Type here...





20.3 - Describe factors associated with the environmental justice movement.

Mastery Meter:



Learning Objective

**Describe factors associated with the environmental justice movement.**

**Describe environmental racism.**

**Explain why impoverished neighborhoods often suffer greater environmental harm.**

**Describe how the environmental...**

from polluting industries.

Because poor people don't have the resources to fight the industries

That doesn't sync up with what I have.

Why do polluting industries like to place facilities on land near impoverished neighborhoods?

Why do impoverished neighborhoods suffer greater environmental harm from polluting industries?

That question is part of the current topic, so I can't answer it here. Try asking another question.

What creates environmental racism?

Environmental racism is due to institutional and structural factors that lead to the greater likelihood that nonwhites will live in high-pollution areas. I hope that helps.

Let's get back to my question:

Why do polluting industries like to place facilities on land near impoverished neighborhoods?

How am I doing?

You're doing well, but let's keep working at it!  
Let's go back to my question:

Why do polluting industries like to place facilities on land near impoverished neighborhoods?



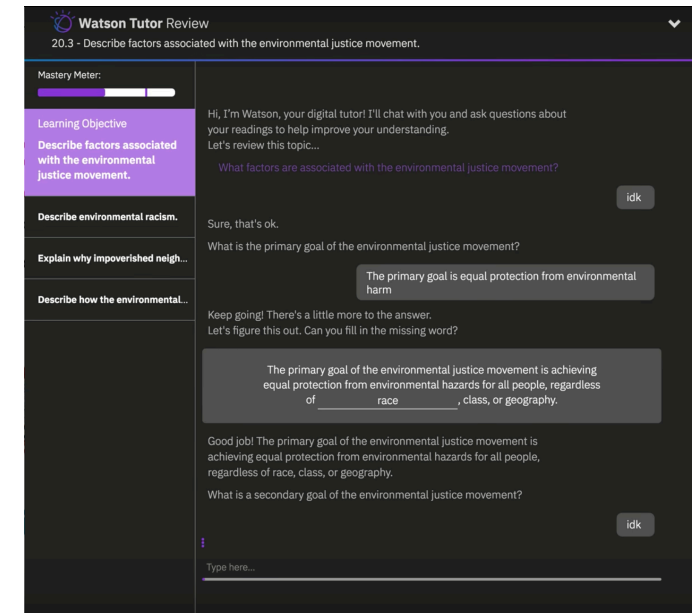
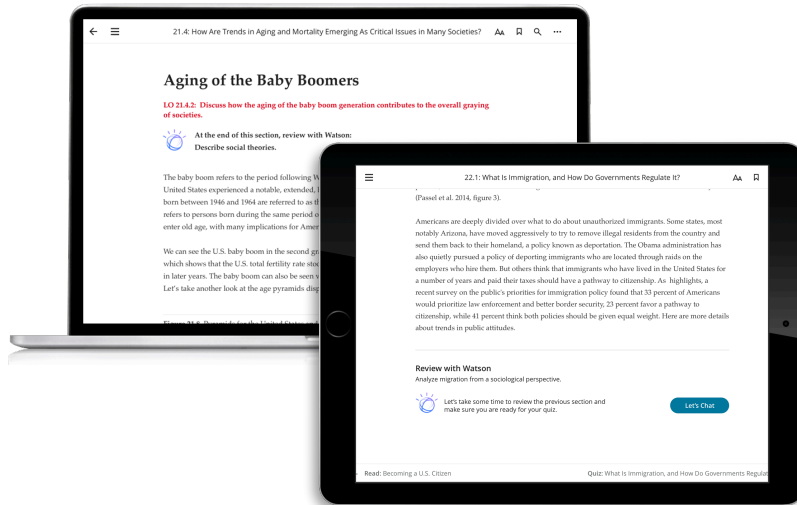
Who won the world series?

Type here...

## Challenges and Future Work

- Content creation still labor intensive
  - Subject matter experts continue to author and validate automatically extracted content
  - However, subject matter experts do not need technical expertise on the inner workings of Watson Dialogue Based Tutor
- Response classification
  - General natural language challenges are applicable, e.g. textual entailment, coreference resolution, metaphors
  - Education can be a use case to drive natural language understanding research
- Automated knowledge extraction and representation to support richer learning experiences
  - Less supervision in extraction tools means even less human effort

# Thank you!



Pearson Revel with Watson:  
<https://www.pearson.com/revel-with-watson>

AIED Interactive Demo: <https://aied2018.utscic.edu.au/interactive-event/>