

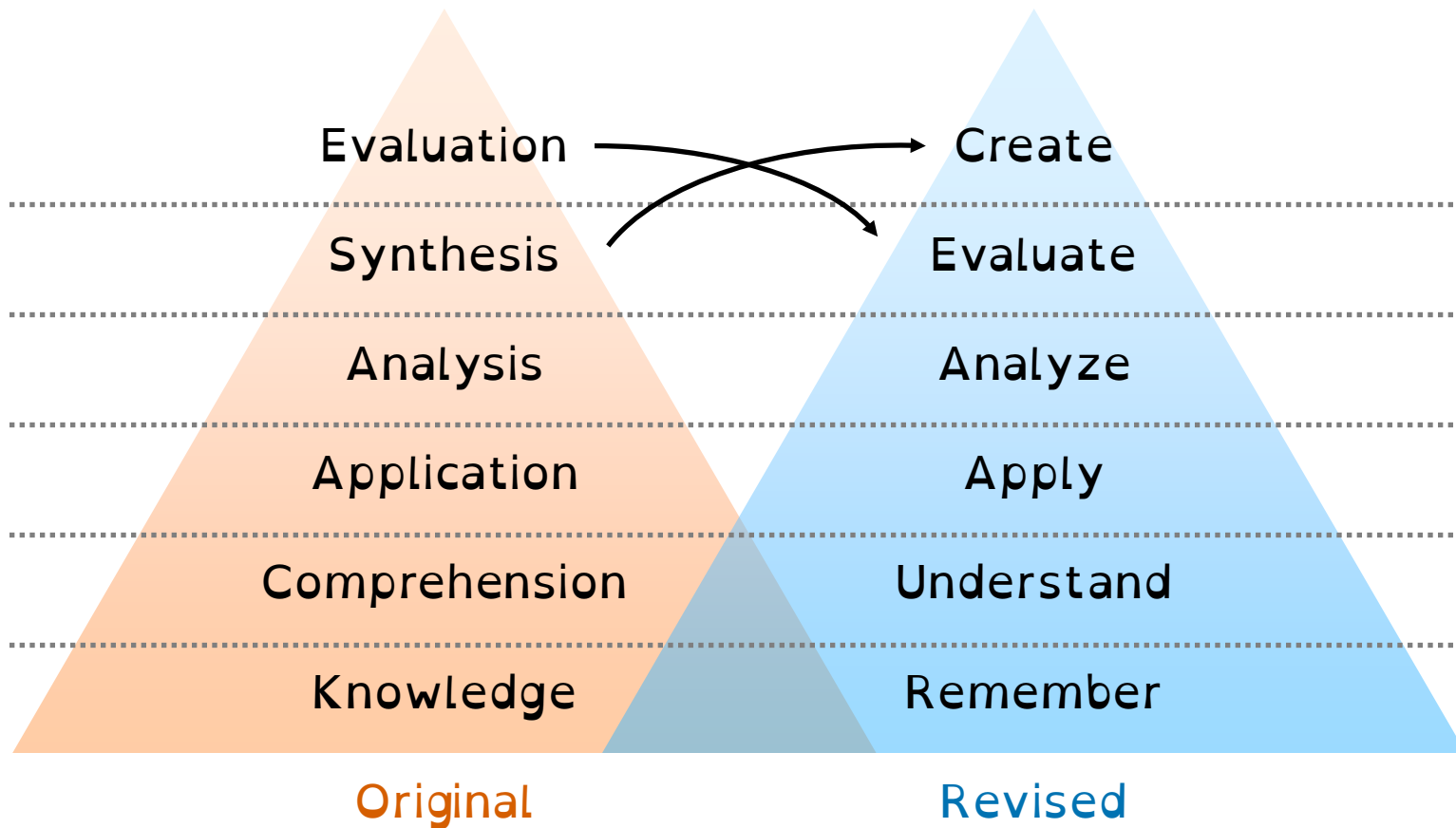
**A two-dimensional,  
non-hierarchical framework of  
Bloom's taxonomy for biology**

UC STEM Lecturer Education Consortium  
September 20, 2014 | Irvine, CA

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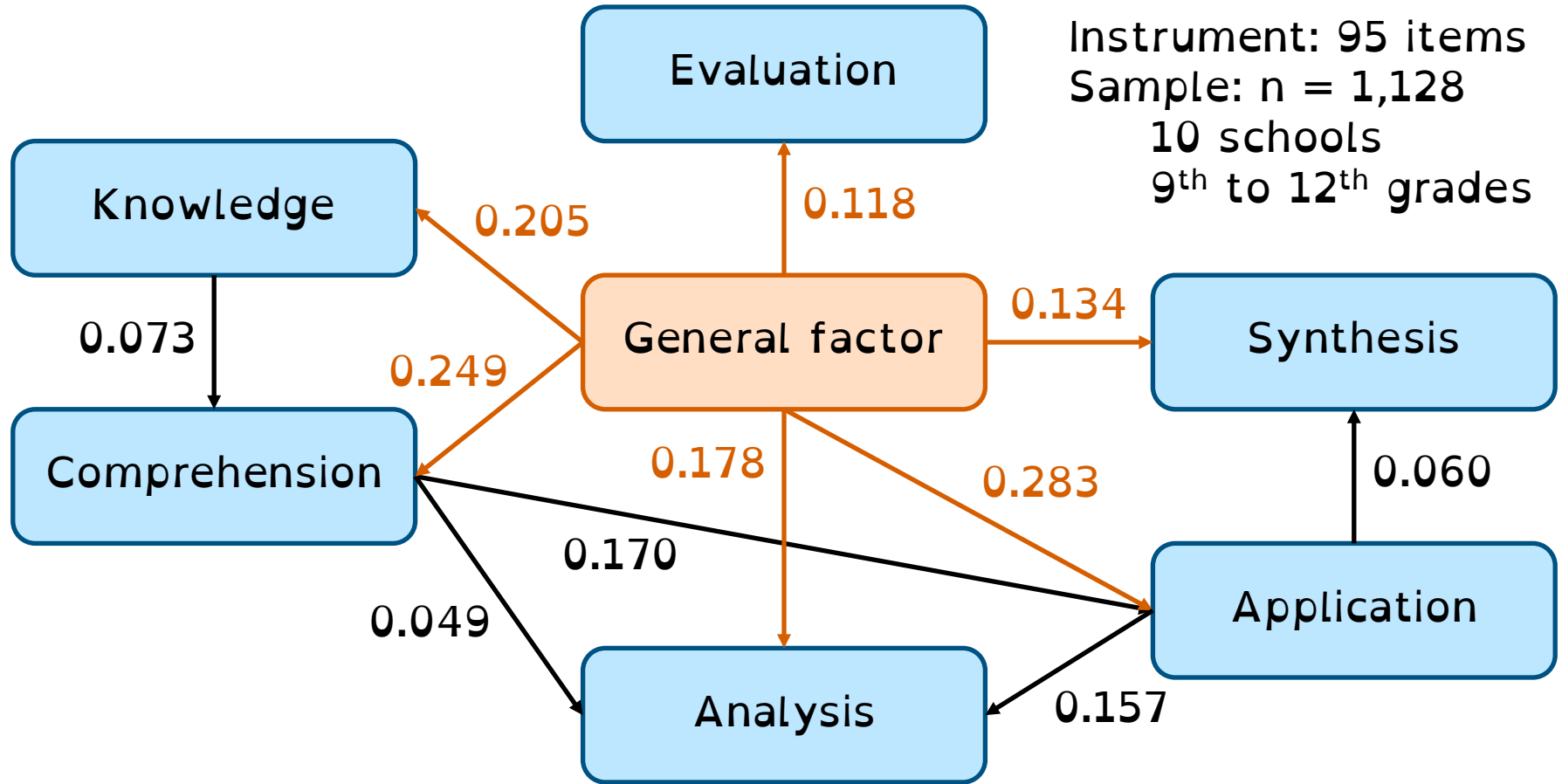
# Bloom's taxonomy of educational objectives



# Rationale: Why bother with a developed framework?

1. Biology discipline-based education literature focuses on original Bloom's taxonomy
  - Original Bloom's taxonomy is psychometrically invalid

# Underlying structure of original Bloom's taxonomy



# “Knowledge” is not consistent with the taxonomy

## Model 1

Knowledge → Comprehension → Application  
→ Analysis → Synthesis → Evaluation

Model	$\chi^2$	p	RMSD	Largest first derivative
1	380.34	<0.05	0.041	Knowledge → Synthesis
2	124.77	<0.05	0.018	Knowledge → Analysis
3	42.00	<0.05	0.017	Knowledge → Evaluation
4	23.10	<0.05	0.007	Comprehension → Analysis

## Model 4

Comprehension → Application → Analysis → Synthesis → Evaluation

# Revised Bloom's taxonomy: Two dimensions

	A. Factual	B. Conceptual	C. Procedural	D. Metacognitive
1. Remember				
2. Understand				
3. Apply				
4. Analyze				
5. Evaluate				
6. Create				

# Rationale: Why bother with a developed framework?

1. Biology discipline-based education literature focuses on original Bloom's taxonomy
2. Develop guidelines and rubric for revised Bloom's taxonomy for biology
3. Analyze underlying structure to revised Bloom's taxonomy (at least in biology)

# Data collection and analysis

## Data source

- Total of 1,432 items
- Public sources: AP Biology and MCAT practice problems
- Introductory and advanced biology courses at Northwestern: biochemistry, cell biology, genetics, immunology, molecular biology, plant biology, and physiology

## Coders

- Undergraduates who completed at least half of the introductory biology course sequence at beginning of project
- Selected from an application based on course grades and written responses to open-ended questions



# Coders training and reliability

## Training:

- Read literature
- Write our own problems
- Develop coding scheme
- Discuss 110 items

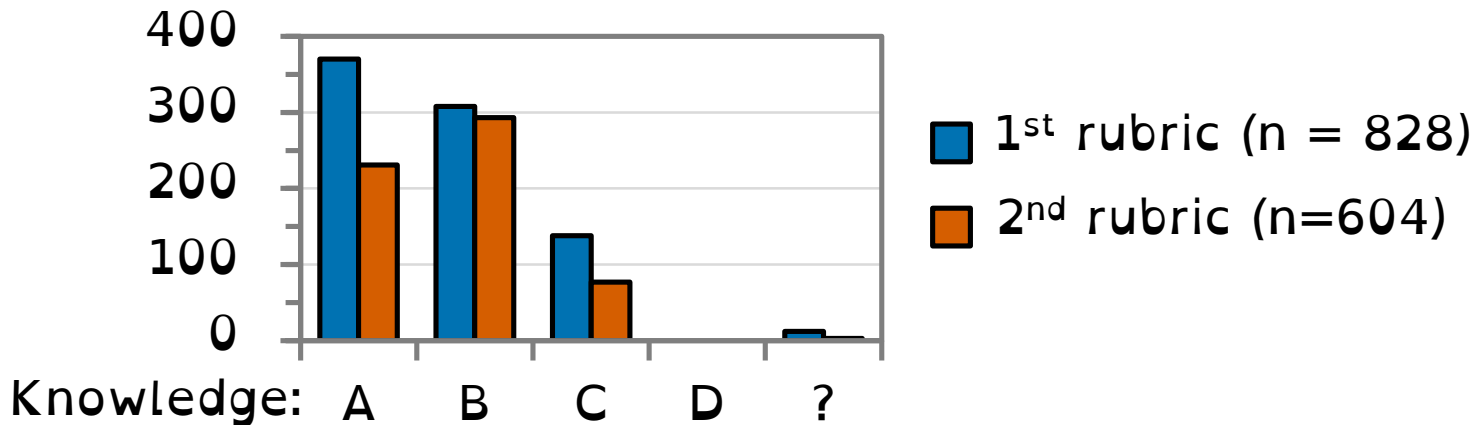
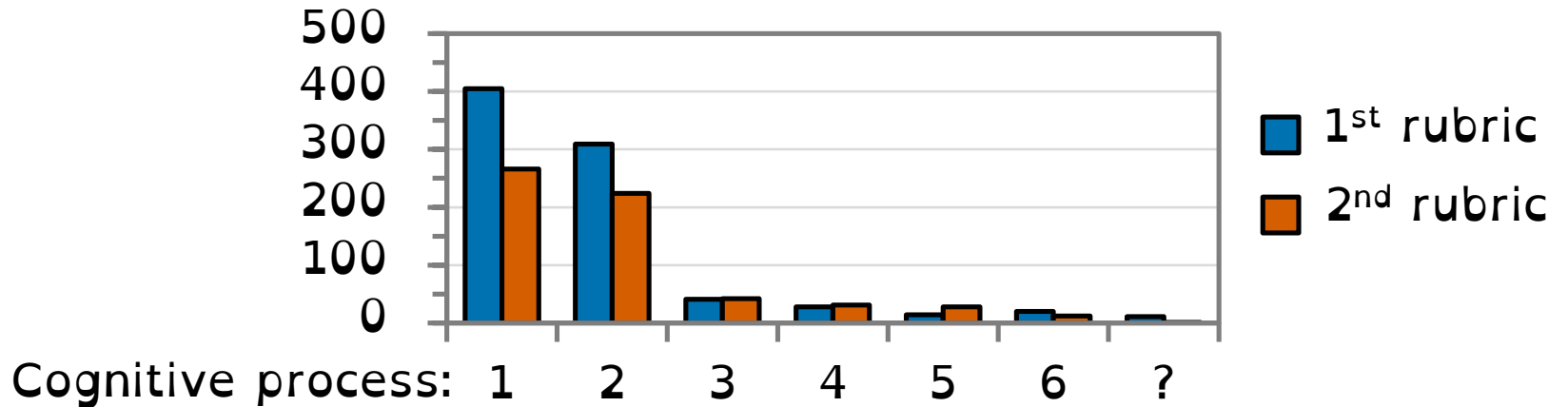
## Coding:

- Adjust coding scheme (1<sup>st</sup> rubric)
- Code and discuss 718 items
- Revise coding scheme (2<sup>nd</sup> rubric)
- Code and discuss 604 items

Reliability: Inter-rater agreement | Cohen's K

	Training 1	Coding 1	Coding 2
Cognitive process	0.44   0.23	0.76   0.60	0.72   0.58
Knowledge dimension	0.43   0.14	0.70   0.52	0.73   0.55

# Dataset: Distribution in the two dimensions



# Anatomy of Bloom's taxonomy for biology

## 1. Remember: Retrieve relevant information

	<b>Alternatives</b>	<b>Definition</b>	<b>Features</b>
1.1 Recognizing	Identifying	Identify something in an unaltered form	
1.2 Recalling	Retrieving	Retrieve relevant information from memory	

## 2. Understand: Construct meaning from given information

	<b>Alternatives</b>	<b>Definition</b>	<b>Features</b>
2.1 Interpreting	Paraphrasing, converting, translating	Change from one form of representation to another	

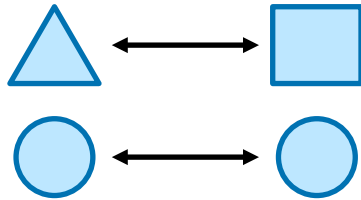
# Examples for Bloom's taxonomy for biology

6. Create: Put elements together into a novel pattern; use knowledge to solve novel problems or situations related to topic (6.1 generating, 6.2 planning, 6.3 producing)

# Understand vs. analyze: How are they different?

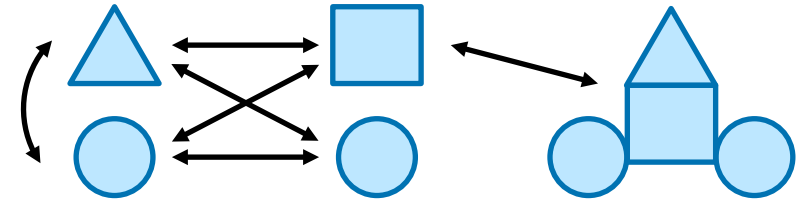
## 2. Understand: Construct meaning from given information

- 2.3 Classifying
- 2.6 Comparing
- 2.7 Explaining



## 4. Analyze: Deconstruct material and understand parts and relationships

- 4.2 Organizing
- 4.1 Differentiating
- 4.3 Attributing



# Knowledge dimension of Bloom's taxonomy

## A. Factual knowledge

- Aa. Terminology
- Ab. Specific detail or element

## B. Conceptual knowledge

- Ba. Classifications and categories
- Bb. Principles and generalizations
- Bc. Theories

## C. Procedural knowledge

- Ca. Discipline-specific skills and algorithms
- Cb. Discipline-specific techniques and methods
- Cc. Criteria for determining when to use a procedure

## D. Metacognitive knowledge

- Da. Strategic knowledge
- Db. Cognitive tasks, contextual and conditional knowledge
- Dc. Self-knowledge

# Acknowledgements



Tori  
Larsen



Alex  
Yee



Faculty  
colleagues



NORTHWESTERN  
UNIVERSITY

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