

# Cognitive alignment within introductory biology courses

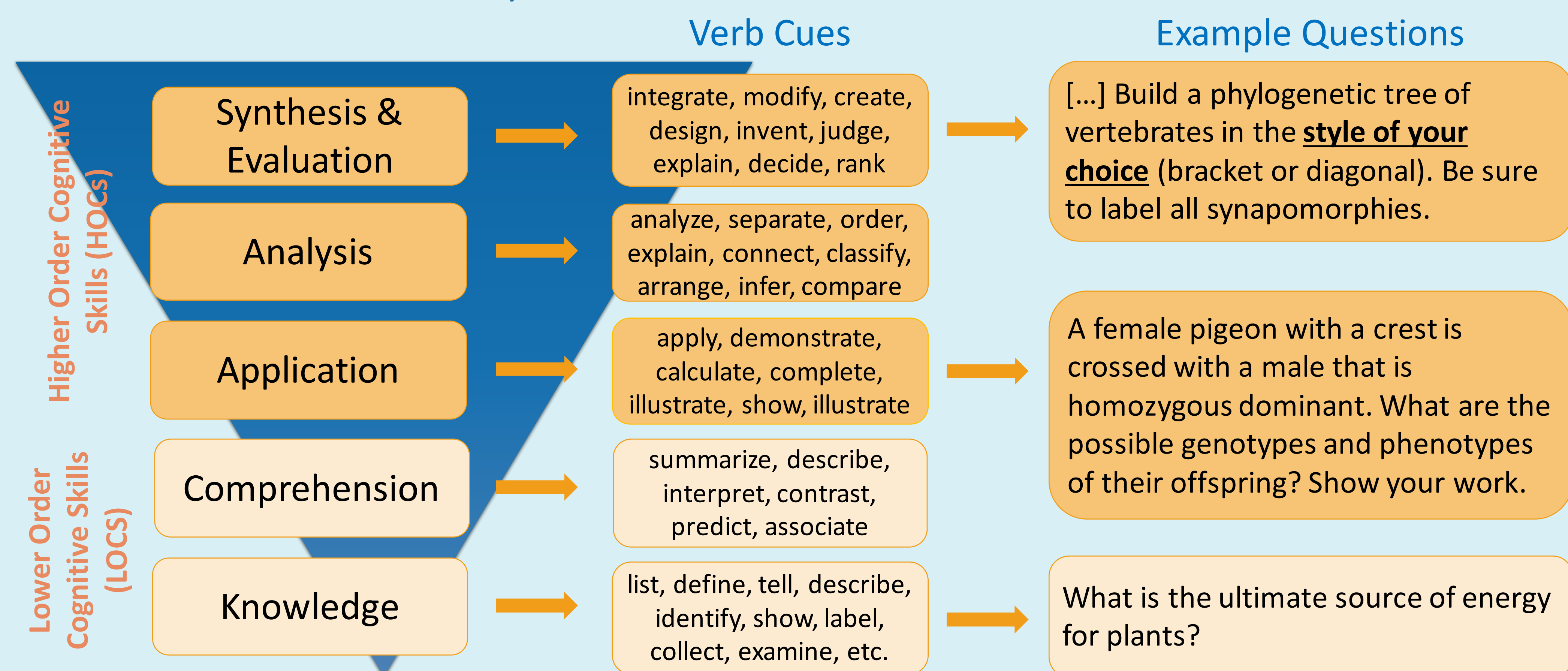
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## Biology is more than facts

- Academics and industry place a premium on biology students' ability not only to know information, but to retain and apply their knowledge to solve problems and come to conclusions effectively
- Prior research used Bloom's Annotated Taxonomy (seen below) to explore the cognitive skill levels of assessments used in Introductory Biology [1,2]
  - Assessments overwhelmingly assessed students at Lower Order Cognitive levels (LOCS)
  - Alignment of course objectives with assessment practices was lacking [1]
- We explored the cognitive skill levels targeted in a two-course introductory biology sequence at a large, research intensive University. Specifically, we:
  - Characterized the cognitive skill levels of course objectives, formative and summative assessments
  - Quantified the alignment of course objectives, formative and summative assessments
  - Compared the cognitive skill levels of summative assessments across learning environments (online, face-to-face)

## Bloom's Annotated Taxonomy



## Research Goals

Our overall goal is to investigate the cognitive skills of introductory biology and the alignment across assessments and learning objectives

Goal 1: Characterize the cognitive skill levels of summative assessments

Goal 2: Quantify the alignment between formative (homework) and summative assessments

Goal 3: Examine the alignment between course objectives and summative assessments

Goal 4: Compare the cognitive skills assessed in traditional online courses

## Methods

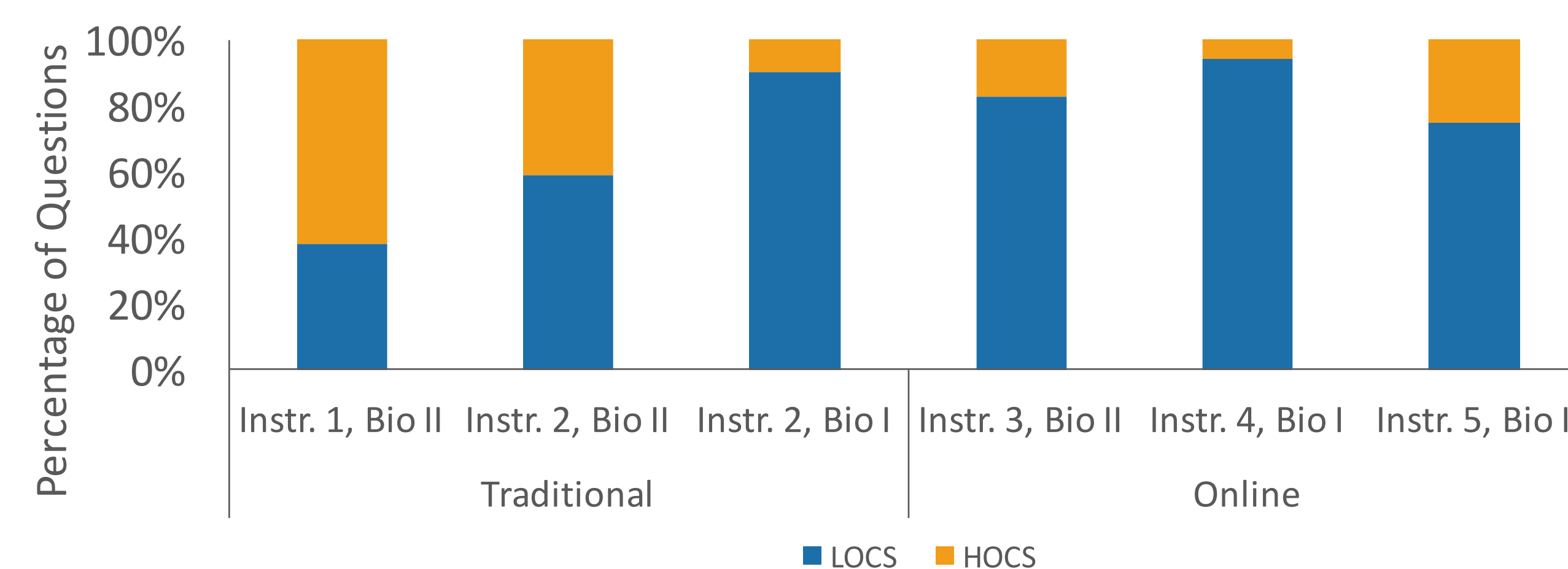
We collected all course objectives, formative and summative assessments used in introductory biology I and II taught in Fall 2014 and Spring 2015

- Sections, n = 6 (3 online, 3 traditional)
- Instructors, n = 5
- Summative assessment items, n = 984
- Formative assessment items, n = 288
- Course objectives, n = 23

Two independent raters used Bloom's taxonomy to code over 20% of the items

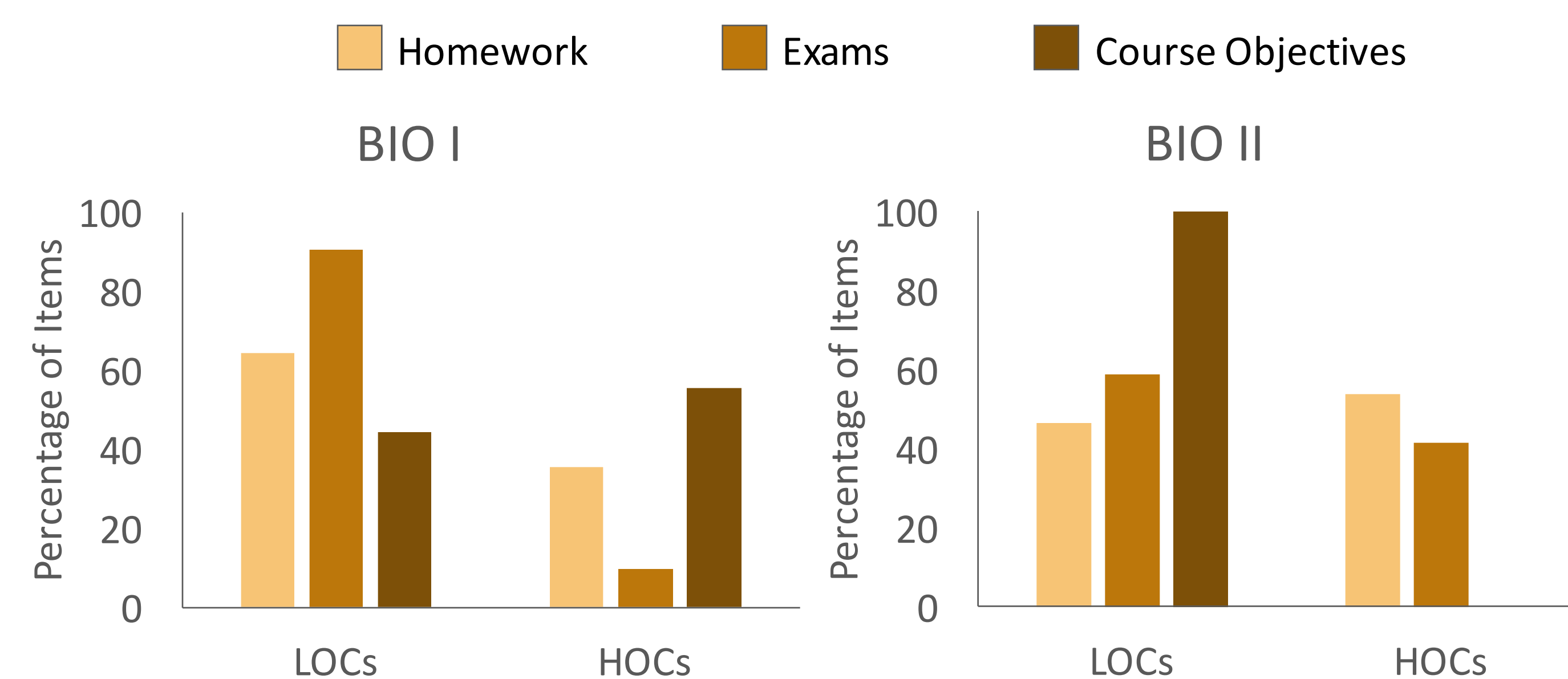
- Agreement was 74%
- Discrepancies were discussed until a consensus reached
- A single rater coded the remaining items

## Cognitive levels of summative assessments



- Theoretically, the courses should be similar in cognitive levels since students are receiving the same course
- However, there is great diversity in the cognitive levels across the six introductory biology classes

## Alignment



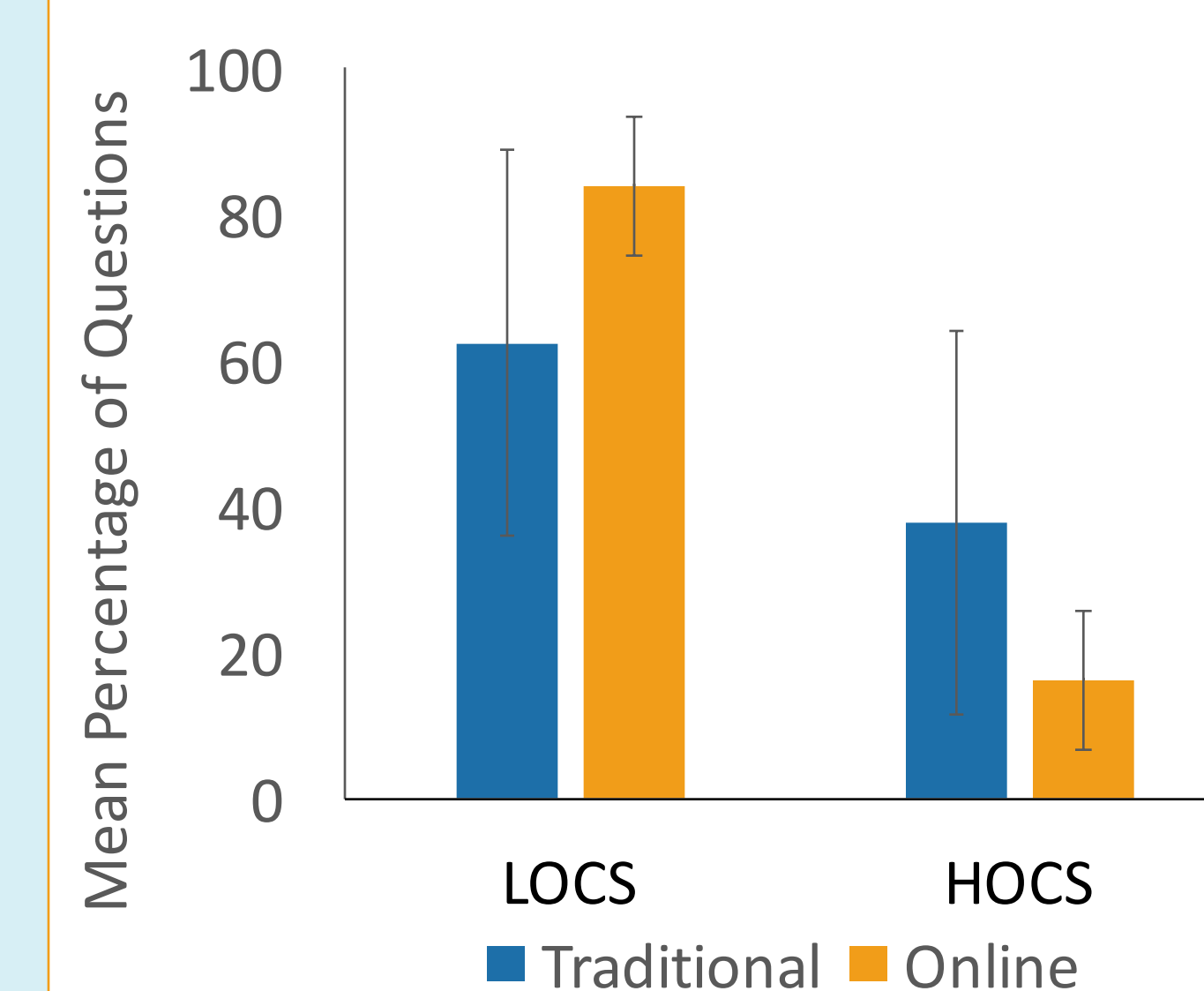
We focused on a single instructor's consecutive introductory biology courses

- The cognitive skills targeted by assessments and course objectives varied across each section
- For both courses, LOCS and HOCS were distributed discordantly across course objectives, homework, and exams

	$\chi^2$	p-value
BIO I	45.9	$p < 0.0001$
BIO II	162.4	$p < 0.0001$

- BIO I and II lack alignment between assessments and course objectives

## Online vs traditional



- Online and traditional courses approach students' learning using primarily LOCS questions on summative assessments
- There is major variability in cognitive skill across learning environments
- There is a significant difference in the distribution of LOCS and HOCS for online and traditional ( $\chi^2 = 89.2, p < 0.0001$ )

## Conclusions

Everything that encapsulates a course, such as in-class instruction or group work, has not been completely captured in our data, but our data does show:

- Great diversity of cognitive skill items within one introductory biology course
- Students may experience different learning environments from section to section dependent upon instructor or type of course

Our culminating goal is to help professors better align their summative assessments, homework, and course objectives to improve future students learning outcomes.

## Future Directions

- Provide professors with feedback on the cognitive skill levels of their course assessments
  - Repeat study to see if feedback helped instructors better align course objectives and assessments
- Assess student success by item
- Examine of student study skills throughout course

## Acknowledgments

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## References

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