Bloomed! Examining the assessment of students' visualization skills

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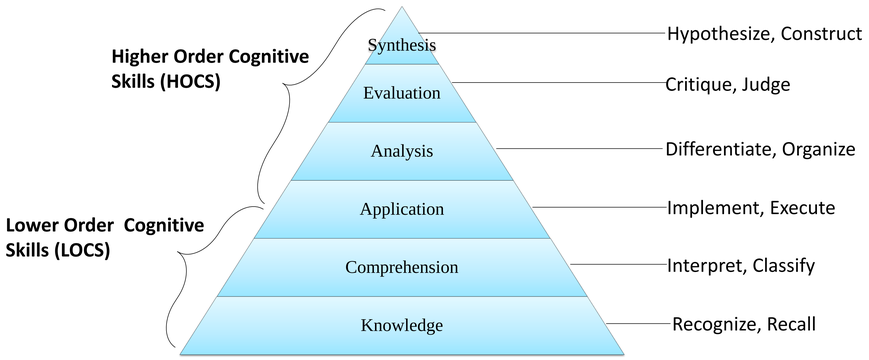
Introduction

Visual literacy - the ability to comprehend and communicate using images is one of the vital skills needed to become a good scientist or researcher. There are national calls for instructors to explicitly teach visualization skills to help students develop their visual literacy.[1]



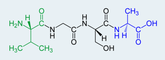
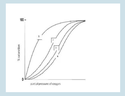
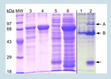
One possible framework for encouraging the development of visualization skills involves the use of Bloom's levels of cognition. One assumption of Bloom's taxonomy is that the cognitive levels are hierarchical. This study focuses on using Bloom's Taxonomy to examine student performance on questions containing visualizations.

Hypothesis: We predict that if Bloom's taxonomy is indeed hierarchical, students who perform well on HOCS questions will perform equally well on LOCS questions.

Methods

Fall 2012 BIOC 460 Class:
2 Exams
4 Quizzes

① Bloomed and organized into visualization types

Visualization	Example
Symbolic	TGACTGGATA
Schematic	
Graphs	
Cartoons	
Realistic	

Student performance data for each visualization question

② Analyzed in Excel

Relevant Performance Variables

Variable	Definition
AvgHOCS	Total points on (overall, unit 2 and unit 3) HOCS visualization questions divided by the total points possible on all HOCS visualization questions
AvgLOCS	Total points on (overall, unit 2 and unit 3) LOCS visualization questions divided by the total points possible on all LOCS visualization questions

③ Analyzed using R Statistical Program

R Scatterplots

Visualization

Bloom's levels and visualization types of assessment items

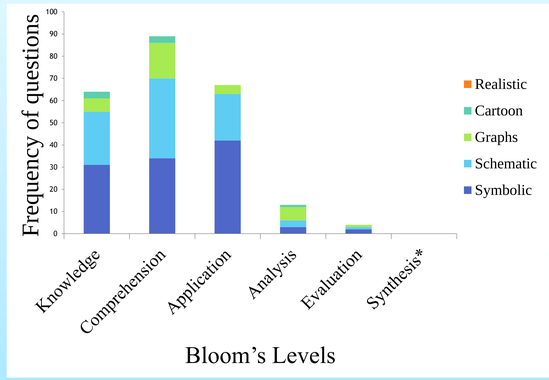


Figure 1. Breakdown of 169 assessment items from Fall 2012 BIOC 460 into Bloom's levels and visualization types.

* Students developed this cognitive level through a semester-long group project.

Results

- BIOC 460 assesses at all Bloom's levels, but predominately at the lower three levels.
- Majority of visualization-based assessment items make use of symbolic and schematic representations.
- Analysis level visualization items mainly utilize graphs.

Discussion and Further Directions

- Future work will be done to further examine whether Bloom's taxonomy is a useful framework for assessing visualization skills.

Select References

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2. Momsen, et. (2013). Using assessments to investigate and compare the nature of learning in undergraduate science courses. *CBE – Life Sci Educ* 12, 239–249.
3. Crowe A, Dirks C, Wenderoth MP. 2008. Biology in bloom: implementing Bloom's taxonomy to enhance student learning in biology. *CBE-Life Sci. Educ.* 7:368–81
4. Anderson et. al. (2001). Taxonomy for learning, teaching, and assessing. New York: Longman, Inc.

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Bloom's levels

Comparison of average HOCS and LOCS scores

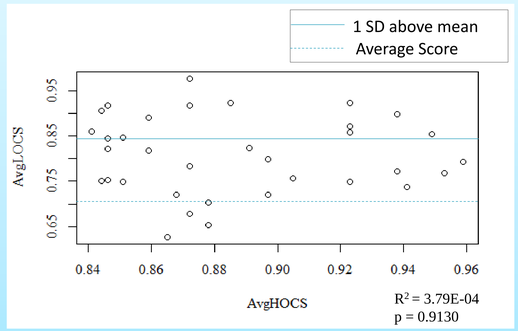

Figure 2. Comparison of average HOCS and LOCS scores for the 34 students who performed well (1 SD above mean) on HOCS questions shows they do not perform as well on LOCS visualization assessment items.

Comparison of unit 2 average HOCS and LOCS scores

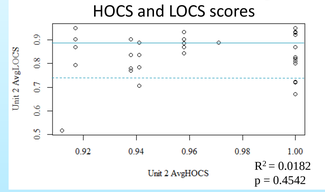

Figure 3. Comparison of unit 2 average HOCS and LOCS scores for the 33 students who performed well (1 SD above mean) on unit 2 HOCS questions shows they did not perform as well on unit 2 LOCS visualization assessment items.

Comparison of unit 3 average HOCS and LOCS scores

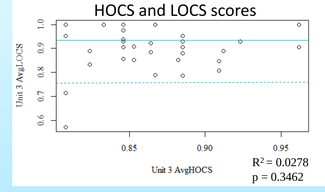

Figure 4. Comparison of average unit 3 HOCS and LOCS scores for the 34 students who performed well (1 SD above mean) on unit 3 HOCS questions shows they do not perform as well on LOCS visualization assessment items.

Results

- High-performing HOCS students were those that performed at least one standard deviation above the mean.
- There did not appear to be any correlation between performance on HOCS or LOCS questions among high-performing HOCS students.

Discussion and Further Directions

- The results suggest that visualization skills may not be hierarchical.
- Low number of HOCS questions may be a limitation of this study.
- Content areas were roughly categorized therefore future work should refine classification of items by content.
- Future work may include examining
  - performance on non-visualization tasks to see if hierarchy is similarly absent.
  - each visualization type separately to see if there is any suggestion of hierarchy.