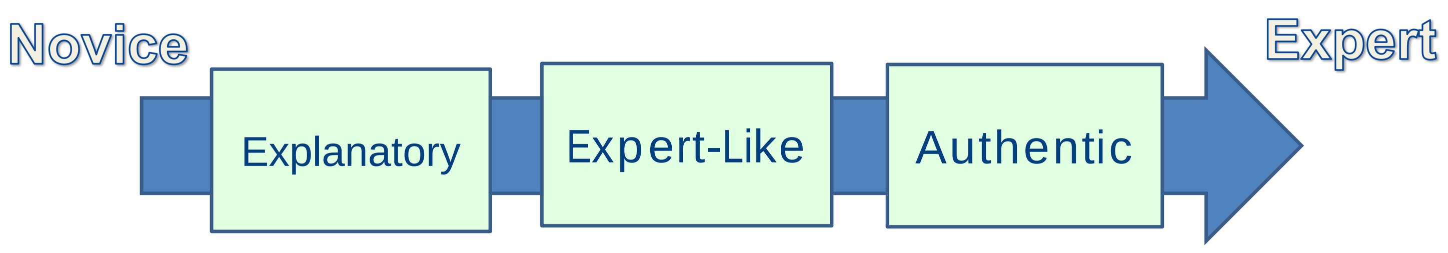
Show me the data: An exploration of photographical data representation in undergraduate life sciences

Jessie Arneson[1], Erika Offerdahl[1], Amanda Kliora[2], Mary Derting[3]

1. Department of Chemistry & Biochemistry, North Dakota State University;
2. Bethel University; 3. Murray State University

Visual thinking – the ability to interpret and communicate via visualizations such as graphs, diagrams, and figures – is a necessary skill for practicing life scientists. Realistic images are considered to have a greater impact on students than graphs or equations as they lie closest to the real-world experience and are often thought of as truthful evidence of a concept (Pozzer and Roth 2003). Not only are these abstractions prevalent within undergraduate science textbooks, a look at primary literature showed that approximately a third of those figures contain realistic images (~30% photographs and ~10% conventional cartoons). In order to develop skills to understand the nature of expert figures, students should be increasingly exposed to more expert-like representations.



Instructional Visualizations

Objective: Determine the degree to which textbook figures provide a scaffold for the development of expert visualization skills.

Methods

An analysis of the primary literature confirmed that the general function of expert visualizations is to serve in the creation of a scientific argument; they function to either show data or propose a model.

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Figures and captions pulled from primary literature were analyzed for function and used to develop a coding rubric.

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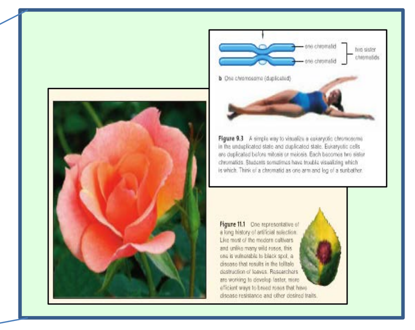
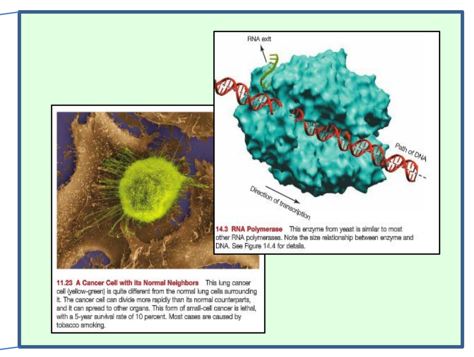
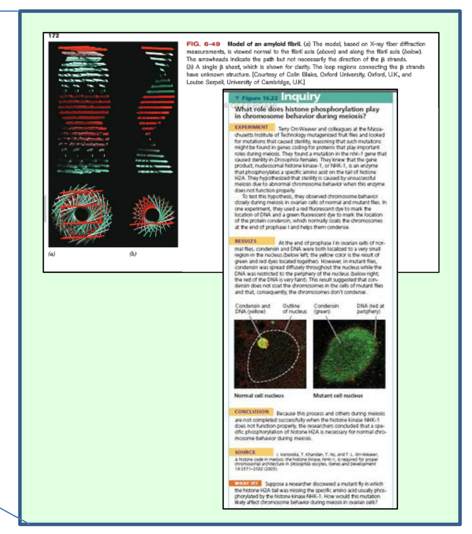
Coding Rubric

Decorative (DECO)	Either lacks a caption or relevance to the material is not made explicit	
Illustrative (ILL)	Relates to something observable, but does not represent the actual concept in part or in whole. Ex: Analogies; related examples	
Explanatory (EXP)	The actual concept is being represented	Explanatory Model (EMOD): A molecular mechanism or structure is explained "as truth"
		Authentic Example (AEX): Depicts actual structure or laboratory result NOT in context with research
		Procedural (PROC): Image presented in context with GENERALIZED procedure
Expert-like (EXL)	Image is presented in a manner similar to what is found in primary literature	Authentic Model (AMOD): A molecular mechanism, structure, or interaction is HYPOTHESIZED
		Data (DATA): Depicts evidence collected in context with research
		Reproducible Protocol (RPRO): Image is presented in context with SPECIFIC procedure







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The function coding rubric was then applied to introductory biology and biochemistry textbook figures.

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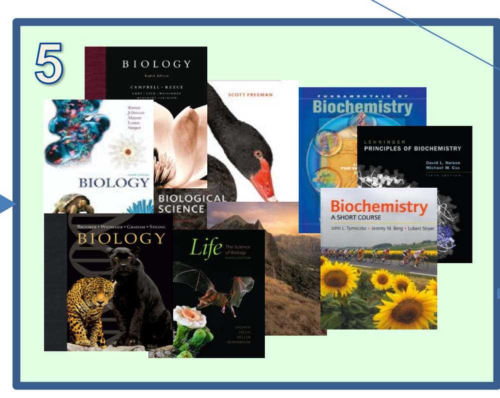
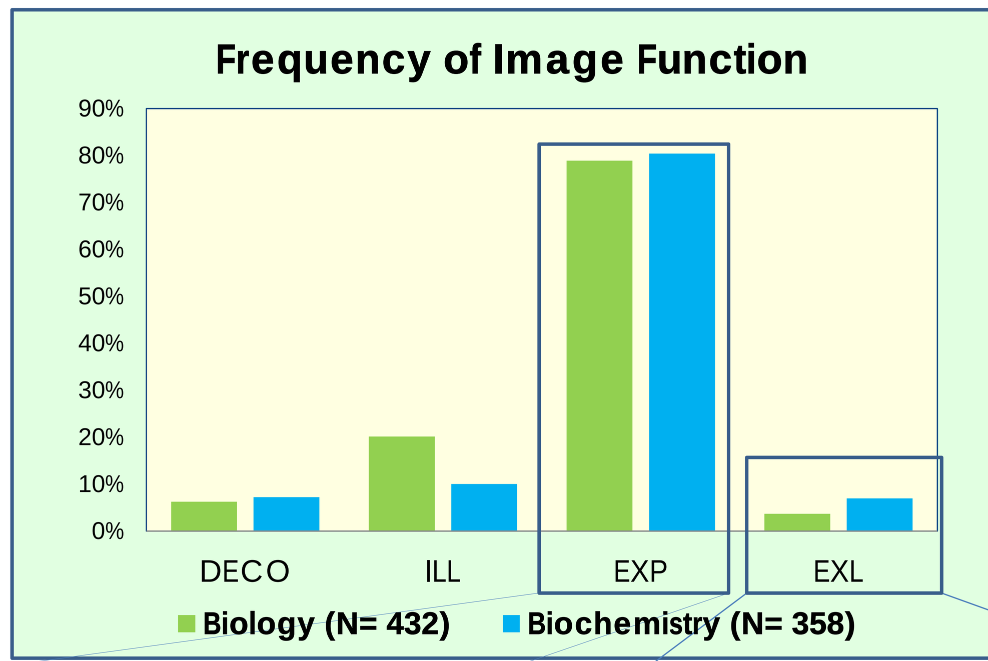
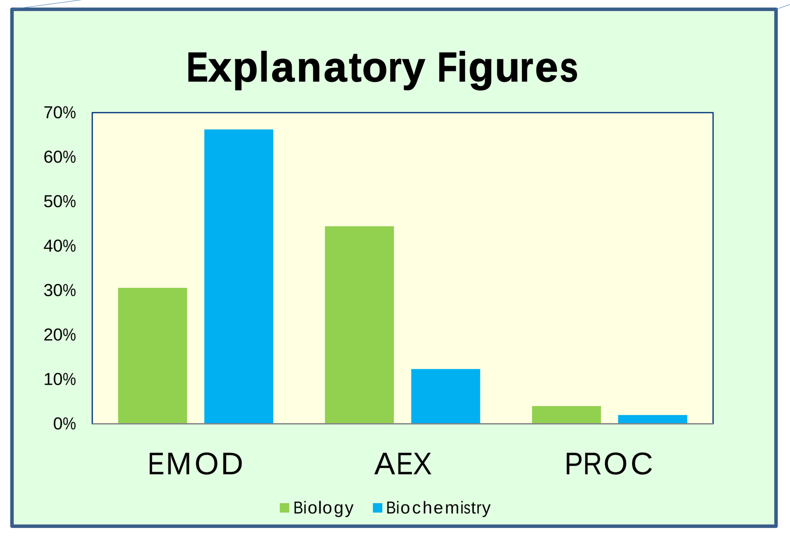


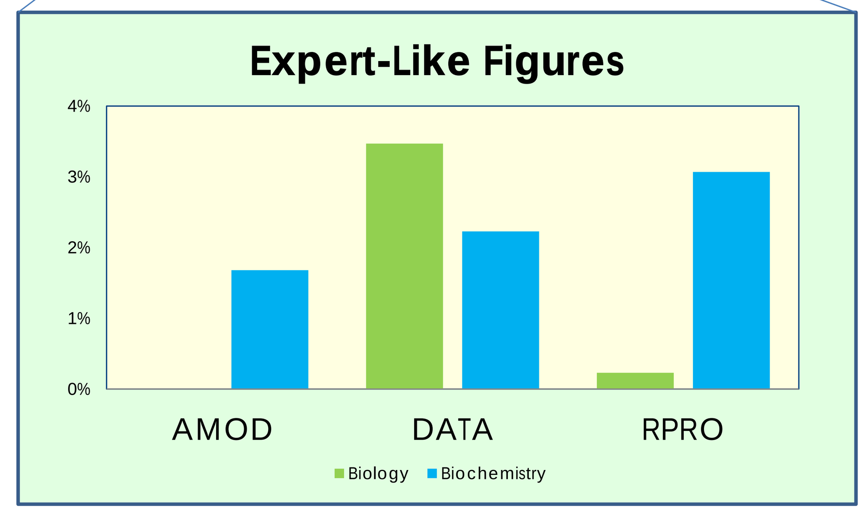
Examples of each general category are featured above.

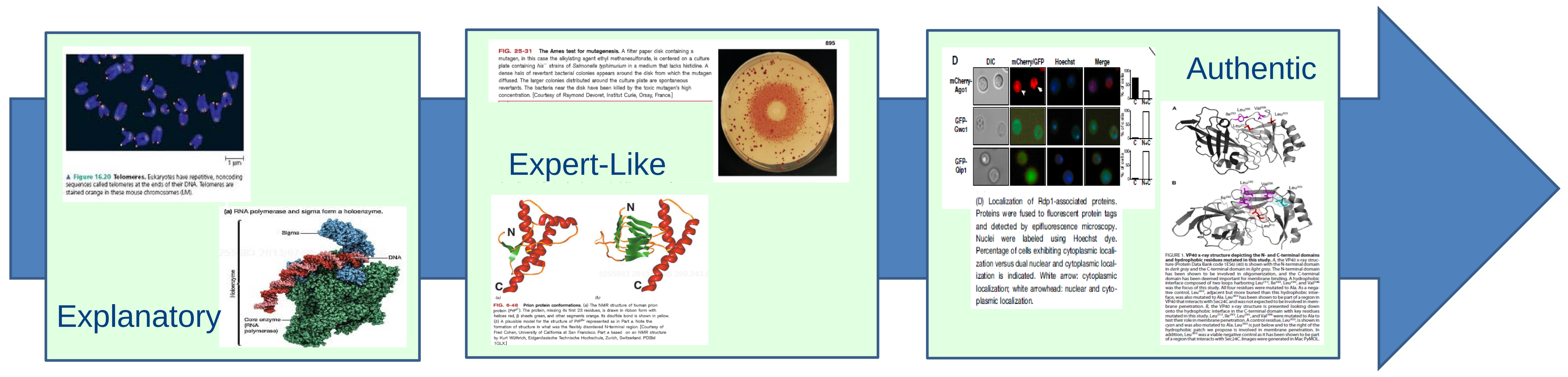
Results

- Little evidence for scaffolding from introductory biology to junior-level biochemistry as there is little difference in the function of realistic images.
- Few realistic images actually communicate data in an expert-like method.
- While some represent data, very few hypothesize or present the process of scientific research.









In crossing a curriculum, instructional visualizations should provide scaffolding for students to interpret authentic scientific representations. Textbooks primarily contain explanatory figures, with few expert-like and virtually no authentic images.

Discussion and Future Directions

- **The results of this study suggest that scaffolding is absent when considering undergraduate textbooks in the molecular life sciences.**
- **Similar work needs to be done regarding the authenticity of graphs in textbooks.**
- **If the role of textbooks is simply explanatory, instructors need to supplement authentic figures to explicitly target expert visualization skills.**

Select References

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Please contact jessie.arneson.1@my.ndsu.edu for more information.

Funding for this project was provided by NDSU Advance FORWARD program (NSF HRD -0811239), ND EPSCoR (NSF EPS-0814442), and NSF CHE-1062701.

We would also like to thank Drs. Jennifer L. Momsen and Lisa M. Montplaisir for their feedback and advice, and Jordyn Hull and Jan Ohm for work leading into this project.