# DIAGRAMS, GRAPHS AND CHARTS IN BIOLOGICAL COURSES A SYSTEM OF CATEGORIES IN THE OVERLAP OF MATHEMATICS AND BIOLOGY

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A main communication concept that can be found in everyday life and in different courses in school are representations like graphs, charts and diagrams. They are used for visualization, to show qualitative and quantitative connections between the data and its context. In our research program, we investigate statistic representations in the overlap of mathematics and biology. Statistical data always has a context and to read the data, it can require a basic knowledge of the applied topic. One main aspect of the project is to determine how students can read these representations and examine how they respond to the way they are designed.

Roth et al. (1999) investigated inscriptions in high school biology textbooks and scientific journals. Their research was mainly focused on graphs and scattered plots to determine out about their frequency and what practice is required to read them. A subsequent study about diagrams in a biological environment was presented by Lachmayer et. al. (2007). They proposed a model of cognitive abilities and their description of diagrams as depictional representations is based on the work of Schnotz (2001). To analyze how you can read statistical data in general, Curcio (1987) distinguished three levels how to read a graph. His model considers the context of the data: reading the data, reading between the data and reading behind the data. A fourth level that reaches further was added by Shaugyness (2007): reading beyond the data. In the current project these different competence levels are considered to include the biological component of the multiple representations.

To achieve an overview of statistical representation in biology courses, a sample of over 70 diagrams, charts and graphs was taken from schoolbooks designed for different types of secondary schools and levels. To acquire more multiplicity a textbook for university students was also investigated.

For a further and deeper analysis of these visualizations I developed a system of categories. The six categories are obtained on mathematical and biological motivation of the diagram, chart or graph. A commonly used distinction different from this is to categories reps in graphs, pie-charts, bar charts a.o. (Kattmann, 2006).

The poster suggested for presentation will focus on the system of categories and depict ways of presentation of data with biological context. Further analysis considered the different ways of the design and how the diversity of the mathematical correctness between the categories. Regarding also graphics in the representations based on the system of categories I found, a further classification can be made: diagrams that are mostly motivated by the biological content and diagrams that are

motivated by a mathematical approach. There can a transfer to Curcios competence-model be achieved. To read the biologically motivated diagrams knowledge of the context is required. Therefore you need to *read beyond* the data in order to *read* the data. That means that you need to know the biological subject behind the data to get all the information that are provided in the diagram or graph.

I will present a variety of ways how such diagrams and graphs are designed and then you see that a main aspect belongs to the used graphics. There are several levels how the graphics are integrative part of the representation (e.g. the bar of the chart are presented as milk cans or a picture of a cow is next to the graph). A tendency is visible, that with an increased number of graphics included and part of the syntax of the representation (like bars as a milkcan), the accuracy of numerical value represented decreases (then the volume of the cans don't correlate with the represented kilogram of milk).

The next step in progress after this theoretical observation is to find out how students actually distinguish between the categories of the representations and if they respond to the different ways of the included graphic. Is there a connection between the categories and the ability to read the data or beyond the data? Therefore students were interviewed interpreting some diagrams, charts and graphs to see how they cope with the data and their biological context. The results of the interviews are required for an intervention study, to promote the reading competence of graphs, diagrams and charts with biology as applied topic.

## REFERENCES


Curcio, F. R. (1987). Comprehensions of mathematical relationships expressed in graphs. *Journal for Research in Mathematics Education, 18,* 382-393.

Kattmann, U. (2006). Diagramme. In H. Gropengießer & U. Kattmann (Eds.), *Fachdidaktik Biologie. Die Biologiedidaktik begründet von Dieter Eschenhagen, Ulrich Kattmann und Dieter Rodi,* pp. 340-356

Lachmayer, S., Nerdel, C. & Prechtl, H. (2007). Modellierung kognitiver Fähigkeiten beim Umgang mit Diagrammen im naturwissenschaftlichen Unterricht. *Zeitschrift für Didaktik der Naturwissenschaften, 13,* 161-180.

Roth, W.-M.; Bowen, G. M.; McGinn, M. K. (1999). Differences in Graph-Related Practices between High School Biology Textbooks and Scientific Ecology Journals. *Journal of Research in Science Teaching, 36,* 977-1019.

Schnotz, W. (2001). Wissenserwerb mit Multimedia. *Unterrichtswissenschaft, 29,* 292-318.

Shaughnessy, M. (2007). Research on statistics learning and reasoning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning,* 957-1010.