

USING CONCEPT MAPS IN AN INTERNET EXPLORATION ENVIRONMENT FOR PHYSICS: HYPERPHYSICS

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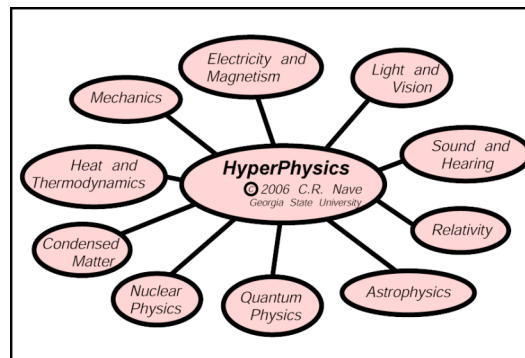
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Abstract: Concept maps are potent navigational tools for organizing an exploration environment to aid in content learning. An extensive physics exploration environment called HyperPhysics has been maintained on the internet since 1998 and has provided considerable experience in the construction and maintenance of an educational resource on the web.

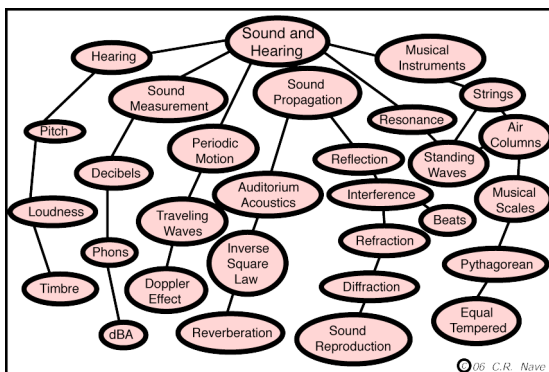
1 Introduction

Soon after the publication of *Learning How to Learn* by Novak and Gowin, some high school and university physics teachers in the Atlanta area began to explore the use of concept maps in teaching physics. In the interest of supporting and continuing the learning of these high school teachers, the HyperPhysics Project was initiated. Concept maps were chosen as the main organizational strategy. When placed on the Internet in 1998 as a freely accessible exploration environment, those concept maps were implemented as active image maps in HTML. In this form, with a series of mouse clicks one could navigate quickly throughout the wide range of subject matter.

The use of this internet resource increased rapidly to the point where file accesses now exceed 50 million per year. The HTML form also lends itself to placement on a compact disc, and HyperPhysics has been distributed to 63 countries in this form.

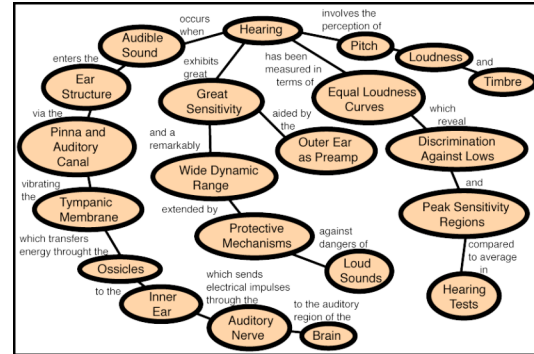


2 Use of Concept Maps for Content Organization

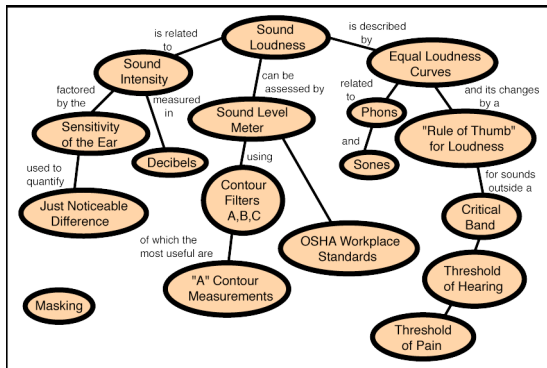


Before reaching the point of detailed learning in a large subject like physics, the learner must navigate to the specific subject of interest. Simplified concept maps implemented as active image maps can place specific subject areas within a few quick mouse clicks. They can act as an active table of contents, becoming more specific with each mouse click.

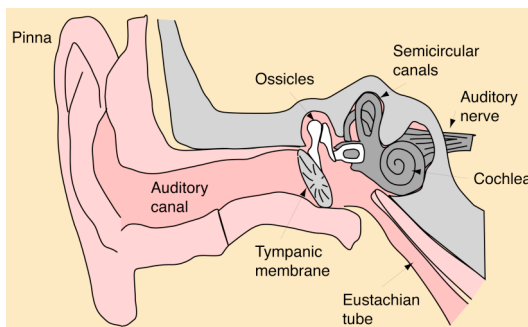
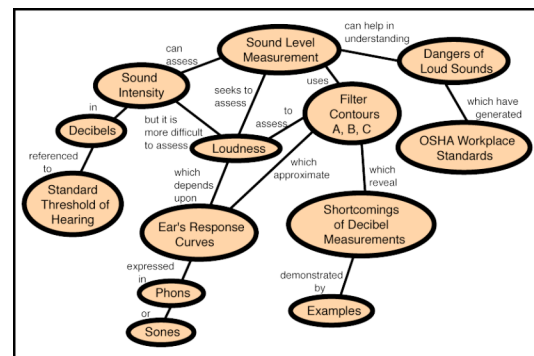
As the subject narrows, the concept map structures add more relational detail on the links to more closely approach the goal of visualizing the content through the relationships between key concepts. The concept map can guide the student to new concepts or provide guidance for foundation building on related topics.



In addition to narrowing the topic, successive concept maps can also be used to “drill down” or deepen the topic. While specific detail may not always imply a deeper or more professional level, the concept map approach does make it possible to guide exploration to a more advanced level.



The branching process with active concept maps can continue quickly until you have reached specific applications. Active concept maps provide a flexible framework for moving from generalities to details. It is very different from the process of moving linearly through a book.



The use of image maps in HTML makes possible the use of other types of graphics when appropriate, as in the exploration of the ear and the hearing process. The liberal use of hypertext linking with concept maps and other active graphics provides a rich exploration environment.

The use of concept maps as the main branching points in exploration has led to something akin to a neural network with thousands of crosslinks between different aspects of the broad subjects of physics and astronomy and some parts of related science disciplines. The exploration of a subject in this environment is profoundly different than an exploration in a printed book. If the progress through a book can be described as linear, then perhaps concept-map-guided exploration can be described as multi-dimensional and non-linear.

A printed textbook is usually constrained to target a subject at a consistent level of difficulty or sophistication. But with active concept maps one can put a set of logically connected concepts together and span a considerable range of levels of difficulty. One can envision a multi-level resource that has material appropriate for the beginning learner and the working professional. An active exploration environment puts in the hands of the user the power to choose a path appropriate to their current level of knowledge.

An active concept map has the potential to aid in the learning process by providing in a single collection of related concepts both the paths to review and foundation building and the paths to the next levels of advancement in learning. The same concept map could also provide links to a variety of applications. Since the links to new concepts can be made instantaneously, one can explore more advanced material to see what new skills or knowledge are required to master it. Then branching back to the concept map one could then use it to find the background material and begin to build the capability for advancement.

Advancing in the study of physics requires the development of the knowledge of mathematics as a tool along the way. This need is addressed in the concept map approach of HyperPhysics by including links to the mathematics appropriate to the topics being discussed. If more review of mathematics is needed, a learner can use the associated HyperMath environment to see the broader perspective of the mathematics involved. An additional strategy used is to include many calculations implemented in Javascript where a student can substitute numbers and obtain numerical answers. These Javascript calculations can serve as practice, or can allow beginners in the subject to explore numerically the effects of changing the physical factors in some experiment.

One aspect of a neural net is that if you continue to follow its branches you will find a termination point where a specific task is accomplished. With an exploration environment based on active concept maps, one can likewise continue to follow branches until a termination point is reached. Many of those termination points involve some numerical calculation, and often a Javascript calculator is provided in HyperPhysics to help with numerical exploration. The framework of multiple linked concept maps allows a user to proceed from basic principles to specific applications of those principles.

For the learner who prefers to look at the specific applications first, a concept map framework can also serve well. One can quickly navigate to the applications of interest and use the concept maps to work backward to the relevant background principles. Using sound as an example, one could move quickly from an interest in the ear and hearing backward to the nature of sound waves. From an interest in a particular musical instrument, concept maps could lead you back to an understanding of the principles underlying its performance. By providing an efficient exploration mechanism and relevant branch points, active concept maps put much power in the hands of the learner.

Concept maps as frameworks for study and exploration certainly seem to appeal to many persons. The use of the concept map approach of HyperPhysics has grown dramatically over the past several years. To the extent that requests for CD versions is a valid sample of interest and use, the map below shows a widespread response to this concept map approach to exploring physics.

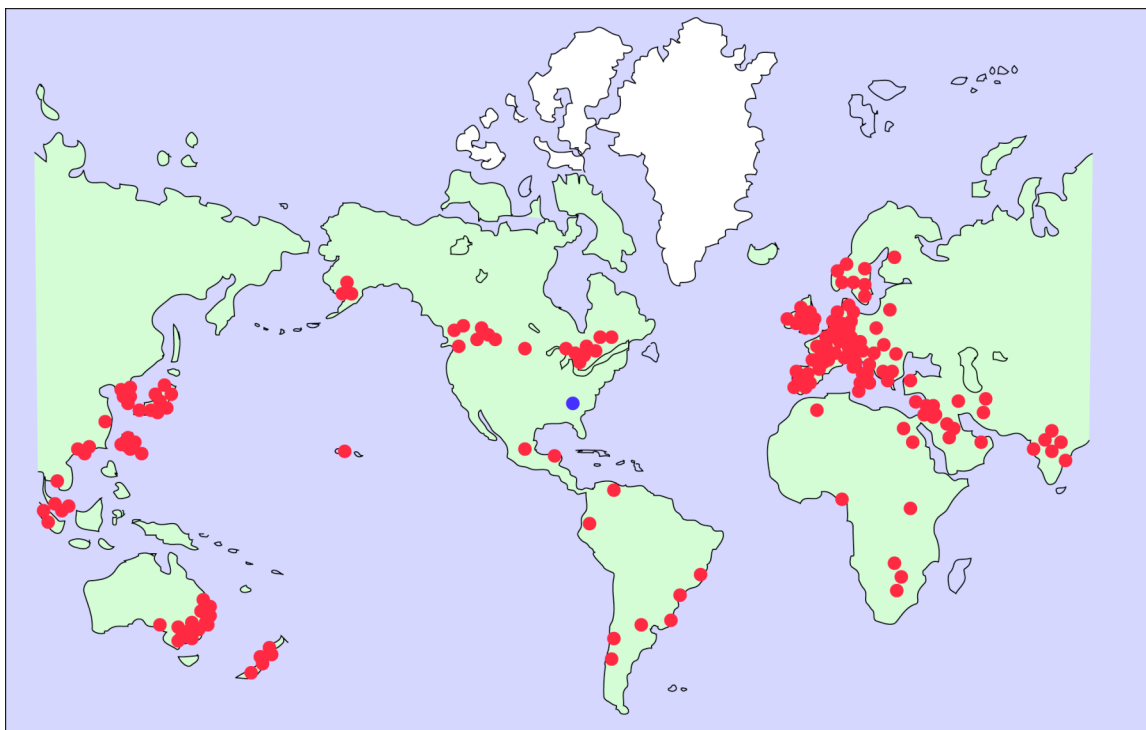


Figure 1: Distribution of HyperPhysics Cds, utilizing a concept map approach to exploring physics.

3 References

Nave, Carl Rod, HyperPhysics, Georgia State University, <http://phy-astr.gsu.edu>

Novak J. D., & Gowin, D. B (1984). *Learning How to Learn*. New York: Cambridge University Press.