Interactive Visualization of the Next Generation Science Standards
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Abstract
Sponsored by Tanze, Inc., our application is an interactive Visualization of the Next Generation Science Standards (NGSS). "The Next Generation Science Standards establish learning goals in science that will give all [K-12] students the skills and knowledge they need to be informed citizens, college ready, and prepared for careers." Our application allows the display and manipulation of a 3-dimensional representation of the NGSS. This gives teachers and curriculum designers an improved experience when viewing the NGSS on zSpace® iPad, Android, and web platforms. zSpace is an immersive, interactive 3D display. The zSpace version of the application allows users a level of interaction that is not present in existing textual representations.

Our representation of the NGSS will allow teachers and administrators to use the 3D capabilities of the zSpace computer to visualize this graph. Users can manipulate the graph along all three axes. Our application on the iPad allows users to manipulate a 3D representation of the NGSS.

Usability
Visualization of the NGSS is optimized for human intuition via the use of cognitive levers. It is targeted toward teachers and curriculum designers that are exploring or have adopted the NGSS. We've designed the tool to cut through the complexity of the NGSS. Viewing the NGSS focuses on visualizing the performance expectations and the connections between the performance expectations, an important part of the NGSS that would otherwise be difficult to keep in context in a strictly text-based document format.

Our visualization offers two methods of interaction. The first method is accessible through the zSpace hardware, which uses a combination of trackable eyewear and a trackable stylus to produce an image that has depth relative to the user's surrounding. The second method is offered through the iPad hardware which displays an image that has depth relative to the screen display on the iPad. This display on the iPad uses the touch interface to interact with the graph.

Technologies Used
Back-end
- SimpleJSON for parsing the data.
- Unity C# to build an internal representation of the NGSS data.

Front-end
- NGUI for user interface.
- zSpace virtual holographic display, stylus, glasses
- iPad, Finger Gestures for generating meaningful interaction.

Figure 1: 3-Dimensional Display
Figure 2: User Interface

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Overview
The NGSS is a set of national education standards built on an international science education basis. These standards contain content and practice across science disciplines and grades. Our visualization of the NGSS separates the standards into nodes. Each node corresponds to a performance expectation for a student at some grade level or grouping of grade levels. The performance expectations are comprised of three dimensions: Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs), and Crosscutting Concepts (CCs). The SEPs are behaviors that scientists engage in as they investigate and build theories about the natural world and the set of practices that engineers use as they design and build models and systems. The DCIs focus on the K-12 science curriculum instruction and assessments. The CCs are divided into four domains: the physical sciences, the life sciences; the earth and space sciences; and engineering, technology, and the applications of science. The CCs tie together the broad diversity of science and engineering core ideas. They provide students with connections and tools related to different disciplinary content.

For example, Fig. 2 displays different pieces of the performance expectation named "K-ESS3-2," which refers to a performance expectation in the DCI of Earth and Space Science that deals specifically with Earth and human activity. Fig. 2 shows how students can demonstrate understanding of K-ESS3-2. The SEPs for K-ESS3-2 include "Asking Questions and Defining Problems" and "Obtaining, Evaluating, and Communicating Information." The associated DCIs are "Natural Hazards," of the earth and space sciences DCI, and "Defining and Delimiting an Engineering Problem," of the engineering, technology, and the applications of science DCI. One of the CCs includes "Cause and Effect," where "Events have causes that generate observable patterns."

The third section of Fig. 2 is comprised of the three types of connections: connections to performance expectations within the same grade; connections to performance expectations within other grades; and connections to information presented in the Common Core State Standards. There are over 1000 connections between the performance expectations. Our 3D representation of the connections gives a better understanding of the connections than a text-based representation of the connections. Figure 1 shows a 3D visualization of the connections where the different node shapes and colors correspond to different DCIs associated with the corresponding performance expectations.