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TEACHING WAVE MOTION USING A VARIETY OF APPROACHES

During the school year 2003-2004, I became part of a field test team for Professor Martin Mason of Mount San Antonio College who had compiled coursework for teaching wave motion based on the use of LabVIEW software using inexpensive probes. During this year, I taught 2 sections of Honors Physics composed of senior students who had already completed 2 years of science and 1 section of Physical Science composed of sophomores who had done no science at high school and who were weak in Math. Rosary High School is an all girl's high school and we felt that the wide variety of students taught would make them ideal for field-testing.

As wave motion is a concept that occurs frequently during the physical science curriculum, I will concentrate the majority of my report on my teaching of the sophomore class. For the Honors Physics curriculum, I used much of the same material, but in a more advanced way but I will give the comments made by these students.

I decided to link my wave concept teaching with types of waves familiar to Southern California, such as earthquake waves and sea waves after I had gone over the basic types, properties and behaviors of waves, as these waves illustrate both transverse and longitudinal waves. I started off with some kinesthetic exercises such as the crowd wave and line pushing to explain the differences between the two types and then the students made the Giant Spaghetti Wave across the front of the school. We then discussed the Northridge earthquake as many students were frightened by it when small and still had vivid memories. Most could remember the two parts due to the differences in speed between the s and p waves. We watched parts of appropriate Nova films and I used suggestions by Lawrence Braille when preparing a student guide. I then discussed water waves and students made their own waves in pie pans. An excellent DVD has been issued on the great western surfing waves and how wind, weather and underwater topography cause them. As many of the students surf, this DVD caused considerable comment. I also used one of the ESPN2 Sportsfigures on waves in this context. An excellent video that I used in preparation for a slinky lab is the high school Mechanical Universe episode on waves. At this point, I set up our best ripple tank, which is made by Pascoe and has been very reliable. I used this to demonstrate to illustrate the four properties of waves – reflection, refraction, diffraction and interference. They also investigated different waveforms and properties with slinkies.

The students then examined reflection and refraction for light waves using lenses, periscopes, mirrors of all shapes and sizes and other optical equipment. One demonstration that they particularly enjoyed was the disappearing beaker using vegetable oil. We also looked into the electromagnetic spectrum and its various parts. An excellent video from NASA called "Infra Red" was much enjoyed, they had not appreciated the link between heat and infrared.

At this point, I used an ESPN2 video, “The Sounds of Summer” which uses baseball to compare and contrast light and sound waves. This enabled me to move into Martin’s work. The first exercise seeks to find out the prior knowledge of the students and they completed this section either on their own or in pairs. Then they were able to carry out the lab work using the LabVIEW program developed by Martin and the simple microphones acquired by Martin at low cost. They used a variety of sound sources including their own voices and simple sources such as train whistles. They found the program extremely easy to manipulate and were able to derive data from it. We also used the Vernier Labpro software and equipment in a similar manner to compare the two systems. The responses of the two classes were different. The Honors Physics classes used the LabVIEW system to move easily to the greater amount of data available from the Vernier experiments that they were carrying out. The Physical Science introductory class was more comfortable using the LabVIEW system and was not ready to use the greater sophistication of the Vernier experiments used. They were more comfortable developing other experiments with the LabVIEW system as they enjoyed deriving the different wave motions and seeing relationships between different sound sources. I think that the analysis of the Vernier graphs required obvious math skills that they were uncomfortable with, whereas they found the LabVIEW graphs easier to understand as they had some part in developing them. One of the exercises that they found interesting was to see the differences between noises and sounds and different sorts of sounds. They came to appreciate that a sound has a definite wave pattern and sounds could also be quite complex. The train whistle, for example, was seen to be a compilation of different sounds, whereas the good singers among them could produce a simple wave. I found it interesting that they could pick up on the frequency and wavelength variables as they could see them develop on the screen. They then had little trouble using the equation $v = \lambda f$ in physical science and seeing how the variables could alter whereas the same equation in a math book sent them into hysterics.

I could easily spend all my teaching time on waves as the concept carries through any science curriculum. I found that waves seemed to appear in all sorts of places and became very intrigued myself. Next year, I intend to use the material again using the lessons I have learned and perhaps develop the material. The students found Professro Mason’s material extremely user friendly and enjoyed working on it. From a teacher perspective, the equipment is very cheap and easy to obtain and make.

I found out about the students’ perspective at the end of the school year quite by chance. At the end of the semester final, I asked my students to describe and explain their favorite lab. Six out of the twenty two chose the wave experiments, which is a high percentage. Yenni Munoz surprised me the most. Yenni is one of our special needs students who has trouble processing information. In addition, she is an ESL student. However, she has a wonderful voice and sings in the choir. Here is part of her

answer: “I enjoyed all of the labs and demos this year, but the one I’ve liked the most was the lab that involved sound. We were to speak, sing, or whisper different words into a little mike hooked up to a computer. It showed us the different waves that were traveling and the way they looked like on the screen. Then it would play the sound back. I thought it was fun and educating at the same time”