# Nanotechnology and Closed Captioned videos: Improving opportunities for teaching science to ESL students

**David Devraj KUMAR**
**College of Education, Florida Atlantic University**
**2912 College Avenue, Davie, Florida 33314, USA**
**E-mail: david@ad.fau.edu**

**Kimberly SCAROLA**

**Pembroke Pines Charter School**
**12350 Sheridan Street, Pembroke Pines, Florida 33026, USA**

Received 11 Apr., 2006
Revised 30 Jun., 2006

## Contents



## Abstract

This paper argues in favor of Closed Captioned Video technology for incorporating nanotechnology as part of teaching science to English as a Second Language (ESL) students. Nanotechnology deals with particles with diameters 1-50 nm and provides a macro-context for science instruction. Closed Captioned Videos provide an effective tool for presenting nanotechnology information in a meaningful way to ESL students. Implications for science curriculum and instruction are discussed.

# Introduction

In this twenty-first century, we live in a global society dominated by science and technology. With the ever-increasing demands from various business, industry and government sectors for improving science education, there are calls for extending science education to every student including students for whom English is a second language. In the United States, there is considerable support for research and development in nanotechnology as well as meeting the needs of English as a Second Language Learners (ESL) in the classroom. Integrating video technology as a part of classroom instruction is critical to helping ESL students visualize challenging science concepts. When Closed Captions are added to existing video technology, ESL students are offered an additional layer of contextual language support aiding comprehension of nanotechnology.

# Nanotechnology

Nanotechnology is one of the fastest growing fields in the world with considerable impact on all walks of life. Nanotechnology is an interdisciplinary technology for producing materials of extremely high precision and dimension of the order of 1-50 nm in diameter. As Rao (1999) described, "if you take a piece of solid matter (say a metal) containing an Avogadro number of atoms [6.022 x 1023 atoms in a gram mole of any chemical substance] and go on dividing it to smaller bits, you will ultimately end up with an atom of the substance. Before that, you will reach a stage of very tiny particles containing 100 to 10,000 atoms. Such particles with diameters of 1-50nm (10-500 Angstrom) are referred to as nanoparticles. Nanomaterials exhibit properties entirely different from bulk materials and constitute materials of the future" (p. 59). As bulk matter gets smaller in size, the ratio of surface atoms to unit mass increases (Table 1). (As an analogy, due to increased surface area finely powdered table salt crystals dissolve in water faster than the same quantity of bulk salt crystals.) A decrease in size facilitates the manifestation of more quantum effects in the form of optical, electrical, and magnetic properties (The Royal Society and The Royal Academy of Engineering, 2004).

*Table 1. Size and Percent Surface Atoms*

| Particle Size | Percent Surface Atoms |
|---|---|
| 30 nm | 5% |
| 10 nm | 20% |
| 3 nm | 50% |

(Data Source: The Royal Society and The Royal Academy of Engineering, 2004)

Examples of nanotechnology include nanocrystals, quantum dots, and nanotubes. Combining two or more molecules of silica and aluminum, will result in the formation of nanocrystals used in commercial grade heat and rust resistant coatings. Nanocrystals of the order of 10nm in size with semiconductor properties are also known as quantum dots. Quantum dots take advantage of the size and arrangement of nanocrystals that affect the physical properties of materials such as color. For example, the color of nanogold is usually orange (<1nm) or red (3-30nm), depending on the size and arrangement of gold aggregates. Clear sunscreen containing nanosized zinc oxide particles allows the passage of visible light and absorbs ultraviolet rays. Bulk zinc oxide in regular sunscreen scatters visible light and appears white in color. Carbon nanotubes are allotropes of carbon (e.g., C60 Buckminsterfullerene) with diameters ranging from 1.2 nm to 30 nm exhibiting various chemical, physical, electrical and mechanical properties. They contain two-dimensional sheets of "graphenes" (graphites) rolled up into a tube with fullerene caps at the ends. Nanotubes are considered stronger than hardened steel and Kevlar. Carbon nanotubes are finding applications in a variety of technologies ranging from miniaturized telecommunication devices to water purification filters. Electronic fibers made of carbon nanotubes are potentially suitable for weaving in cell phone devices and computers as part of garments (Georgia Tech Research News, 2004).

## Teaching Science Anchored in Nanotechnology

Nanotechnology contains a wealth of motivating and challenging information to help students actively engage in learning science. If carefully applied through videos, nanotechnology can provide a macro-context suitable for active construction of knowledge by learners (Kumar, 2006a). The rationale behind video-based macro-contexts follows: they provide a meaningful learning context deliberately embedded with data to enable the learner to immerse in an information rich audio-visual environment, revisit the same information from multiple perspectives, and work towards success (Sherwood, Kinzer, Hasselbring, Bransford, Williams, and Goin, 1987: Kumar and Sherwood, 1997). On the other hand, how to revise the science curriculum in such a manner that all students are presented with engaging lessons on contemporary developments in science and technology through videos, and are motivated to learn science remains a challenge. Particularly, in English speaking countries, fully integrating English as a Second Language (ESL) students in science education remains a growing problem. Often ESL students fall behind in science lessons. In this context, how to teach contemporary science containing developments such as nanotechnology to ESL students is a critical question, and further discussion will argue for using Closed Captioned Videos as a solution.

## Closed Captioned Videos

Closed captions are the text equivalent of the spoken portion of a video presentation designed to aide people with a hearing impairment. “Captioning allows people to see the words, read the words, hear them being said, and see them in context with the action on the television screen. They work together to produce a very rich learning environment” (Daniel, 1993, p. F3). In the US, children spend an average of 30 hours per week watching TV and it is a challenge to motivate them to read. “You can get them to do both at the same time – through captioned television” (Anderson, 1998, p. 2).

## Closed Captioned Videos and ESL Students

According to the US Federal Communications Commission (FCC), “for individuals whose native language is not English, English language captions improve comprehension and fluency. Captions also help improve literacy skills. You can turn on closed captions through your remote control or on-screen menu.” (Federal Communications Commission, 2006). Closed Captioned Videos provide a simultaneous audio and written visual context facilitating different types of learning styles and comprehension of difficult to understand terminologies to ESL learners resulting in a “strong sense of achievement.” (Spanos and Smith, 1990).

# Rationale

One of the critical issues in science education is teaching science to ESL students. As noted earlier, since nanotechnology is interdisciplinary in nature, it is not easily understood without a visual component. Nanotechnology requires a curriculum that deals with basic as well as applied sciences delivered through interactive learning environments (Uddin and Chowdhury, 2001).

Closed Captioned Video provides audio, visual and textual support for introducing related scientific concepts, teaching vocabulary in context, showing examples and non-examples, and viewing real-world applications of nanotechnology. The current disadvantage is the lack of video materials suitable for K-12 usage.

With the implementation of Federal Communications Commission legislation, the Telecommunications Act of 1996 in the United States requiring closed-captions for television and video programming, educators in America have the means to make Closed Captioned Videos available for K-12 classrooms.

# Implications for Curriculum and Instruction

When science educators are presented with the topic of nanotechnology, they would want to know if this subject matches their curriculum standards. For example, in the state of Florida some of the possible concerns of teachers may include the following. Will nanotechnology be on any of the achievement test called the Florida Comprehensive Assessment Test? Will it be specifically incorporated into the new revised state Science Education Standards? Who will disseminate information about nanotechnology to curriculum developers? These are a few curriculum concerns dealing with nanotechnology.

How can teachers implement nanotechnology in classrooms if the curriculum standards do not address it specifically and the curriculum materials are not yet developed? How many teachers have even heard of nanotechnology? Perhaps starting nanotechnology introductory lessons with the youngest students (Pre-K and K) all the way through 12th grade could help to establish groundwork for introducing nanotechnology to the nation at large. When introducing any new unit of study, effective teachers try to catch the attention of their students with a "hook". This may be a counterintuitive demonstration, pictorial riddle, or puzzle. We need to develop "nanotechnology hooks" to capture the attention of students.

How can teachers teach if they do not understand nanotechnology themselves? Kumar (2006b) in a nanoscience and nanotechnology quiz among prospective K-9 teachers noticed a low overall average score of 61.3%. The quiz represented various types of knowledge of nanoscale science and technology including the chemical make up of materials such as sunscreens, etymology, and an understanding of physical scale. The study found a lack of understanding of the basic physical scale of nanoscience and nanotechnology, and the etymology of the term "nano" among prospective teachers. Unless science teachers can keep pace with the rapid advances in science and technology it will be virtually impossible to update science instruction.

Currently there are no widely available science materials for K-12 that specifically teach nanotechnology topics. In the case of videos on the subject of nanotechnology, most of them are beyond the scope of K-12 science because they are very short in length, they do not have any captions or subtitles, and some have no audio at all. The good news is that such existing videos can be edited, captioned and have audio tracks added that might contain dialogue easy enough for an ESL learner to comprehend.

The participation of teachers in addressing nanotechnology information in the school science curriculum is critical. If Closed Captioned Videos of nanotechnology are created with input from teachers they might be more open to the idea of using them among ESL students. Assuming that Closed Captioned Videos become widely available in the near future, the instructional challenges for science teachers might include determining ESL appropriateness of captioned nanotechnology videos and instructional time blocks for viewing such videos in conjunction with hands-on laboratory assignments, and implementing ESL accommodation strategies for captioned viewing.

## End Note

Closed Captioned Videos useful for teaching science to ESL students are critical to presenting nanotechnology in science teaching and learning. ESL curriculum materials dealing with nanotechnology are long overdue. Science teacher preparation programs should consider incorporating nanotechnology based science lessons through Closed Captioned Videos aimed at ESL students. Every effort should be made to increase opportunities for teaching science to ESL students.

# References

Anderson, N. (1998). TV Captions Can Also Be a Learning Tool. *Los Angeles Times,* (Jan 7, 1998) 2.

Daniel, J. (1999). Getting a Read on the Subtitled Life of a Close-Captioned Junkie. *St. Louis-Post Dispatch,* (Sept 5, 1993) F3.

Federal Communications Commission. (2006). Retrieved June 29, 2006 from http://www.fcc.gov/cgb/consumerfacts/closedcaption.html.

Georgia Tech Research News. (2004). New class of fibers: Composites made with carbon nanotubes offer improved mechanical & electrical properties. Author, April 2, 2004. Available at: http://gtresearchnews.gatech.edu/newsrelease/nanofibers.htm.

Kumar, D. D. (2006a). *Problem-based science learning anchored in nanotechnology*. A presentation at the Researching Practices Conference, Faculty of Education, Cambridge University, UK.

Kumar, D. D. (2006b). *Nano quiz performance of prospective teachers*. A presentation at the annual meeting of the Association for Science Teacher Education, Portland, OR.

Kumar, D. D., & Sherwood, R. D. (1997). Hypermedia in science and mathematics: Applications in teacher education, problem solving and student testing. *Journal of Educational Computing Research*, 17(3), 249-262.

Rao, C. N. R. (1999). *Understanding chemistry*. Hyderabad: Universities Press (India) Limited.

Sherwood, R., Kinzer, C., Hasselbring, T., Bransford, J., Williams, S., & Goin, L. (1987). New directions for videodiscs. *The Computing Teacher*, 14(6), 10-13.

Spanos, G. and Smith, J. (1990). Closed Captioned Television for Adult LEP Literacy Learners. *ERIC Digest*. (ED 321623).

The Royal Society and The Royal Academy of Engineering. (2004). *Nanoscience and nanotechnologies: Opportunities and uncertainties*. London: The Royal Society and The Royal Academy of Engineering.

Uddin, M., and Chowdhury, A. R. (2001). *Integration of nanotechnology into the undergraduate engineering curriculum*. A paper presented at the International Conference on Engineering Education, Oslo, Norway.