Chapter 20
New Augmented Reality Applications:
Inorganic Chemistry Education

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ABSTRACT

In this Chapter, the authors will present an Augmented Reality (AR) system for teaching Inorganic Chemistry to university-level students. Augmented Reality (AR) is a computer related research area that allows users to see views of the real world enhanced with computer-generated text and visual information. AR with 3D models can be used as an educational aid to help students gain spatial intuition. This is really important and useful in disciplines like Inorganic Chemistry, where solving problems related to 3D crystal structures, understanding these structures or facing symmetry related problems can be supported by computer generated 3D graphics. AR is an immersive technology that can improve education offering more interaction and realism. It can also be applied to real-time online and in-classroom teaching. Our system is based on inexpensive webcams and open-source software. A survey the authors conducted after using it in the classroom shows great acceptance of the system and improved results when solving Inorganic Chemistry problems related to 3D structures. This opens up new possibilities of self-assessment and interaction.

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INTRODUCTION

Nowadays, there is a change in the learning-teaching process and how people understand it. Students are no longer mere receptacles for information and knowledge, but they are also an active part of the process. New advances in Information Technologies have become significant contributors to this change.

For example, recent advances in Computer Graphics and Computer Hardware have introduced Information Technologies into the classroom. PowerPoint presentations, for example, are being used pervasively in classrooms around the world. The problem of this technology is that the student remains a passive element of the learning process. Information Technologies must be used to better and more effectively involve the students in their own education.

Augmented Reality (AR) is a fairly new area of Computer Graphics that relies on other computer-related disciplines like hardware, computer vision, and sensing and tracking. It allows the user to view the real world with superimposed computer generated annotations and graphics. AR systems may be used by multiple users at the same time. This provides the opportunity for collaborative applications, like engineering design, architecture, multi-user games, and education, among others.

AR can be used in education to show the students models that cannot be seen in the real world. Two examples are: planets and galaxies that are too big, and atoms and molecules that are too small. Another example is multiple types of chemical, physical and engineering processes like reactions, explosions, computational fluid dynamics, and motion simulations that cannot be easily taught to the students using traditional means like transparencies and the chalkboard.

We are interested in applying AR to Inorganic Chemistry education at the university level. Specifically, we want to show the students different material and compound structures, symmetry and unit cells, and modes of vibration where movement is important. We want to show all of these in 3D, and we want to allow the students to move and manipulate the models. The goal is to teach them spatial intuition and a 3D understanding of the chemical structures, a key skill for the students to understand and solve Inorganic Chemistry problems.

We thus introduce an AR system for teaching university-level Inorganic Chemistry. Our system renders material and compound structures as well as other inorganic models for better understanding by the students. The system allows multiple users and different 3D models of chemical structures. The system is used to teach both theory and laboratory classes. During the laboratory classes problems are solved that require the students to develop a good 3D spatial understanding. Our experiments demonstrate that the students like the system. They even want to take it home, so they can use it as a self-assessment tool and as a tool for online learning in real time. They also suggested improving the system by adding stereo imaging.

Although our system was developed for Inorganic Chemistry, other disciplines may benefit from it. For example, it can be applied to mathematics, organic chemistry, theoretical physics, astronomy, applied physics and engineering. Its simplicity and ease of use make it suitable for university students and younger students, like secondary, junior-high and high-school students. Moreover, we have used our system to teach Chemistry classes to 11-12 year old students. We did that as part of a program aimed at bringing younger students to our University. The experience was highly positive, and students showed great interest since they were able to interact with the structures as a game, learning and playing at the same time.

Summarizing, our goal is to introduce Augmented Reality into Inorganic Chemistry education. There are two reasons why: improve the students' understanding of materials structures using AR, and provide the professor with a tool to better explain those structures that require a good