Biomaterial Applications Database for Primary and Secondary Education

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Statement of Purpose: In an effort to increase the number of young adults who pursue STEM careers, the Colleges of Engineering and Science at Texas A&M host an annual teacher summit. Science teachers from around the state are provided a day of interactive, experiential learning and the resources to carry over the summit topics into their classrooms. The members of the Cosgriff-Hernandez lab are currently preparing a session for next year's teacher summit wherein teachers will be taught new ways to educate their students in chemistry, math, and physics with fun, polymer-based demos. Following the session, the teachers will be given a survey that will be used to assess the effectiveness of the demos and lesson materials and provide guidance in improving future outreach demonstrations.

In addition to presenting demos at the teacher summit, our lab members are actively developing new modules for STEM lessons on polymer applications. While we lead a monthly science club meeting at the local middle school, we are additionally generating biomaterial modules out of our middle school lessons that consist of a video for instructors, experiments and assessments that are aligned to specific biomaterial objectives. In addition to including worksheets for each experiment, each module consists of a video tutorial focused on providing the teacher background knowledge on the experiment and guidance through the demo. The video demo includes checks for understanding that the teacher may implement in the classroom to give a quick evaluation of the classroom's engagement. To supplement the video lessons, we have created end of lesson assessments that teachers can use to track their students' understandings and align objectives with the state subject curriculum. While these modules target a middle school level, they can be manipulated to match the rigor of the desired grade level. Ultimately, we hope to create a database of teacher-friendly tissue engineering modules that are available to educators and utilized in their classrooms, thereby bridging the gap between higher level academia and the foundations set in both primary and secondary classrooms.

Methods: Recently, the Cosgriff-Hernandez laboratory has fully developed 2 biomaterial modules: Hydrogels for Wound Dressings & Hydrogels for Medicine Delivery. The Hydrogels for Wound Dressings module introduces concepts of hydrophilicity/hydrophobicity, ionic and covalent bonding, viscosity, and device design. Within this module, students are introduced the design requirements involved with a wound dressing for a diabetic ulcer: the dressing must be easy to implement, fill the wound, keep the wound bed moist, and must be easy to remove. Students are provided with sodium acrylate polymer powder and their goal will be to determine how much water must be added to the dry polymer to make an effective wound dressing that satisfies the design requirements. **Figure 1** depicts the hydrogels created in a classroom. Because this gel is formed via ionic bonding, students will then experiment by adding different concentrations of salt water and observe the effects on the gels. The assessment for this lesson addresses objectives aligned with chemical bonds, hydrophilicity/hydrophobicity, and viscosity.

Figure 1. Hydrogel Wound Dressing experiment in classroom.

Our second module, Hydrogels for Medicine Delivery, is designed to discuss the application of hydrogels for medicine release. Students will be asked to help design a pill to deliver a new medication that can be taken orally to treat cancer, Cancer-No-More. Using crosslinked gelatin containing a colored dye, students will track diffusion rates. Their goal will be to determine the effects on release time of taking two small pills compared with one large pill. By participating, students will gain an understanding of how pills can be designed to deliver medicine in their bodies at the proper time. The assessment for this module is aligned to objectives involving polymers, hydrophilicity and diffusion.

Each module will build upon and augment the students' existing biology and chemistry lessons with discussion and observation of specific objects and will incorporate grade-appropriate algebra, arithmetic, and statistics. This allows the module to be easily adopted into a variety of curricula. The assessments incorporate scaffolding, with incrementally increasing rigor, thereby allowing for facilitated mastery of the material. Furthermore, the modules are very practical with materials that can be purchased at convenience stores or online for approximately $10. These modules will allow students to integrate their knowledge of biology and chemistry, along with engineering, to spark interest in biomaterials-based careers. While both of these modules involve specific biomaterial applications, they also help reinforce the foundation of the scientific method and can be altered to create a more advanced lesson for high school students.

Conclusions: The development of this biomaterial applications database allows us to contribute to primary and secondary education by providing lessons addressing current research topics that are understood at the students' level. In order to further develop this database, we will begin creating modules using the state curriculum to backwards plan and identify applicable biomaterial lessons that align directly to what teachers must incorporate in their classroom.