Genetic Disorders: An Integrated Curriculum Project

> These inventions...brought the academic study to life in a way very familiar to technology education teachers.

Leaders in technology education have been promoting collaboration with teachers in other disciplines and integrated curriculum projects for decades (DeVore & Lauda, 1976; Maley, 1959; and Starkweather, 1975). Likewise, the Technology for All Americans Project (ITEA, 1995) also calls for cross-disciplinary and integrated study. One area of technology education that has received the least actual implementation is Biotechnology. Though four other clusters of content are frequently represented in secondary schools (Manufacturing,

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Construction, Transportation, and Communication), Biotechnology is frequently combined as a minor part of one of these four or simply ignored. There are several reasons for this lack of attention to Biotechnology. It is likely that many teachers feel that they lack the knowledge and skills needed to teach Biotechnology. Many schools do not have appropriate equipment and supplies in the Technology Education department to present a well-developed Biotechnology program. There are also fewer existing curriculum resources and vendor-available pre-packaged resources in this area, that have stood the test of time, than exist for the other four areas of technology. Many districts choose to leave Biotechnology as the responsibility of the Science Department, Health Department, Agriculture Department, or other units and confine technology education to the more traditional areas listed above.

At the same time that our own leadership in technology education has been striving for integration, collaboration, and inclusion of Biotechnology, leaders in several other curricula areas have been promoting the study of *technology* within their respective disciplines and various levels of interdisciplinary activity (AAAS, 1993; NCDPI, 1999; NCTM, 1995; NCSS, 1994). There are some well-developed materials and several demonstration sites showing good ideas at work, but neither Biotechnology as a curricula area of technology education nor curriculum integration and collaboration between technology education and other disciplines is widespread.

The unit of study described here, developed by Doug Greenberg (a Science teacher at Southeast Raleigh High School), is an effective means to study an area of Biotechnology through corroboration among faculty and students in an integrated approach. Technology education and science are both studied in this unit along with significant links to health, social sciences, language arts, communication skills, mathematics (statistics), and other areas of the curriculum. The unit of study centers on the topic of genetic disorders.

The Assignment

Students, in their science class, were assigned to research information concerning a genetic disorder of their choosing. The research was to be broad and use various sources, but it had to minimally include reading all of the information on the website of the primary official support or research organization or association concerning the selected genetic disorder. Following attainment of a preliminary understanding of the nature, causes, effects, and prognoses of the disorder, students were required to identify and contact a willing "pen pal" who has the chosen genetic disorder. Contact could be made via any of several forums including e-mail, postal service, video conferencing, or other means.

Students were not simply "turned loose" on the community to go "snooping." The teacher had first contacted the organizations to alert them that the project was being conducted and seek their input and cooperation. Students were also instructed in how to seek information via questions that were tactful, unobtrusive, and considerate. Role-playing activities were used in class to help students become sensitive in their interviewing techniques. To further insure that the affective instruction was effective before clients were contacted, students had to submit a script of the questions they intended to ask prior to the contact, and a full printed transcript of both sides of each conversation or interview was required by the teacher. All interviews were to remain confidential except as authorized by the client.

A research paper was required as well as a videotaped oral presentation incorporating PowerPoint or other technology. During the interviews with clients, one key point students were to discover was a need or difficulty caused by the disorder that might be solved or coped with via technology. Students were then to "invent" something (device, aid, technique, etc.) that would help the client. These inventions were presented via sketches and technical drawings and modeled with mock-ups, working prototypes, or other types of models. Collaboration between technology education teachers and their students helped with plans and construction of the actual models.

Specific information the students were to gain in the interviews included:

1) The name of the genetic disorder (including informal names as well as scientific ones),
2) The protein that causes the disorder,
3) The genetic defect that causes the disorder (what chromosome?),
4) The manner in which the genetic defect is inherited (sex chromosomes, autosomal chromosomes, etc.),
5) Signs and symptoms of the disorder (other than genetic tests) and typical age of presentation of these signs,
6) Types of persons most affected (gender, race, etc.),
7) Environmental factors which may be causative or which exacerbate the symptoms (alcohol, drugs, folic acid deficiency, lead-based paints, presence of chemicals, air quality, water quality, allergies, etc.),
8) Quality of life assessment (what is a typical day like for the client?),
9) Life expectancy, and
10) Information shared by the client or of interest to the students.

The research paper could take the form of a homepage. The paper or homepage was due two days before the scheduled oral presentation.

In addition to the required elements, students could augment the assignment in several ways — some of which yielded extra credit. Actually building the "invention" for the client to use was an option. To enable this option, students were encouraged to seek donated materials from local businesses (thereby involving the community in the project). Donations to the associated charity, which were also generated by student efforts, resulted in community involvement and extra points. Inventions that were recognized in a formal contest or event (such as TSA conferences, science fairs, VICA, or others) also earned extra credit. Lastly, since our community was hosting the International Special Olympics this year, students who volunteered to help conduct the games could earn extra credit. All of these means of involving the community with the program, and the students in the community, were seen as special strengths of this unit of study because they help to promote the school and its programs—especially those involved with the project.

The "Inventions"

The word "inventions" must be used somewhat loosely here because some of the devices or aids which students conceived may already be in existence or may be simply impossible. However, as many technology education teachers have discovered, getting students to think creatively about technology and its applications is a very valuable way to help them understand technology. The "design brief" assignments prevalent in so many technology classes actually simulate what students are applying in the real world with this aspect of the genetic disorders project. Here are some examples of "inventions" proposed by the students in the first semester of the project:

1) A glove which detects blood sugar levels or other blood chemistry levels without a painful finger prick;
2) Electronic device incorporating a receiver, a translator, and a transmitter to detect and interpret the brain waves of a person with Mobius Syndrome and then speak for them with the clarity that they cannot produce themselves;
3) Specially configured computer keyboard to help a dwarf type faster with smaller and sometimes "chubby" hands;
4) A "game-style" board that a person with Tourette's Syndrome could wear with a pointer they could use to highlight messages such as "don't want to talk now," "leave me alone," or "I need to rest";
5) A special bed for Multiple Sclerosis patients, which has a roll-out sink unit with a freshwater supply tank, sprayer, and graywater holding tank and can be rolled to an installed sink for servicing;
6) A foot extender to enable more normal walking and driving for dwarfs or other people with shorter than average legs;
7) An ID card with a barcode that would allow hospitals to read all needed chart data and medical history for an Alzheimer's patient; and
8) Special glasses, which spray a fine mist of moisturizer into the eyes of clients who have Sjogren's Syndrome and cannot produce tears.

It is clear that these students have done some very creative thinking in development of these inventions and that this aspect of the assignment made a major impact on the effectiveness of the interviews. Seeking information about the clients' needs might help them add an aspect of genuineness and relevance to the assignment that far surpasses that of the typical technology education design brief or the traditional liberal arts "term paper." Hearing the needs from real people certainly must have inspired these students to go the extra mile in their work.

Foot extender to enable a dwarf to drive.

The Project Expands

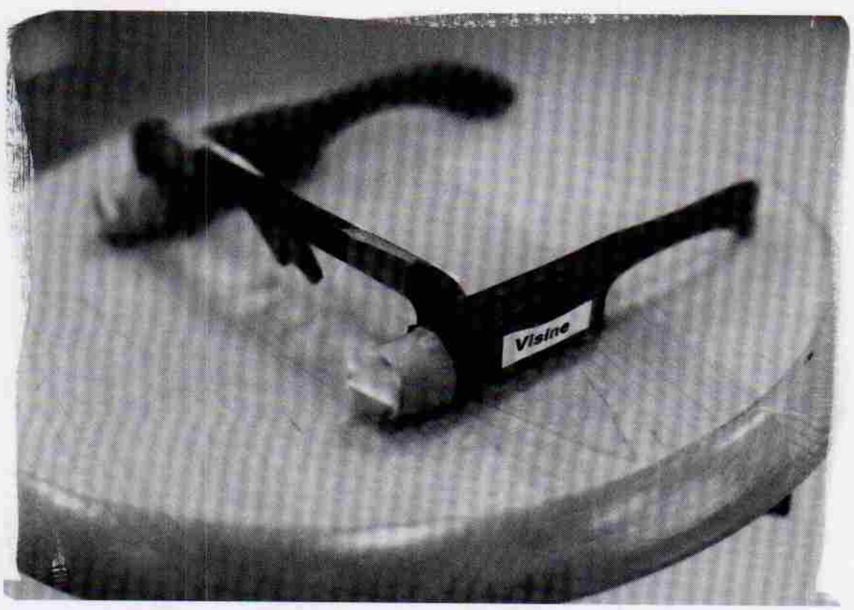
The results reported here were obtained in the first semester of the project. Plans for the coming year include seeking greater involvement with the technology education teachers and their classes, allowing more time for the construction of the inventions, and encouraging videoconferencing as the means of conducting interviews. During the first semester, many of the models or prototypes were not as well constructed as they could have been due to lack of time and facilities. However, working with the technology education classes will solve this problem and add to the meaning and reality of the assignment. In the optimal situation, the students would be enrolled in both the science and technology classes. Such students will have good access to both venues for their study and construction of models. However, for those students who are in the science class but not enrolled in the technology class, technology students may serve as "engineering consultants" to help develop the invention ideas and then help the science students construct their prototypes and models. This solves the problem of technologically illiterate students coming to the technology laboratory and expecting to be allowed to use the band saw without prior safety training — their "engineering consultants" can do the hazardous work and help them understand what is or is not possible. Here again, the situation is actually a role play of what occurs in the real world of industry because frequently the design engineers propose things that simply will not work until the consulting technicians in the production shops help to refine those ideas into workable prototypes. The importance of this aspect of the design process should be pointed out to both the science and the technology students.

Involvement of teachers in the other disciplines of the school should follow. Mathematics teachers could use these results and information to teach elementary statistics. Certainly, the linkages with language arts and communications are clear. Social science teachers should point out the impacts of PL 94-142 and its effect on the lives of disabled people and all citizens who, since its enactment, have had to learn how to help accommodate their needs instead of hiding them away. Health teachers should help students understand the causes of genetic disorders and how to cope with them when they are present.

At Southeast Raleigh High School, a science teacher led this exemplary integration project. There is no reason why the same project could not be used as a catalyst for curriculum integration, a vehicle for the study of Biotechnology, and an important learning unit by technology education teachers. Technology education classes could expand the discussion to include the pros and cons of advanced bioengineering technology and the ethical considerations associated with such techniques. These discussions, and the design/production techniques and considerations, will likely be given far more attention in the technology classes than in the science classes. Thus, though they cooperate and deal with the same theme topics, both science and technology classes will have their own important thrust and content.

Summary

The study of genetic disorders by science students evolved into a large scale integrated learning activity with a very strong link to technology education. Through their research, students came to understand the needs of persons who have the disorders and were able to conceive "inventions" to help them. When these inventions were drawn and students constructed models or prototypes, they brought the academic study to life in a way very familiar to technology education teachers. The community involvement promoted by this project has many potential positive effects for the school and its programs. It is recommended that technology education teachers use an approach such as this to attain the goals espoused in our new content standards (ITEA, 2000) which call for the study of Biotechnology, curriculum integration, and corroboration with teachers in other disciplines.



Eye misting glasses for Sjogren's Syndrome patients.

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