Applying the Design Process to Curriculum Development in Technology Education

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Introduction

This paper is written from the perspective of both an action researcher and curriculum designer. It is drawn from my observations, experience, and research as a project manager and instructional designer with the NASA Classroom of the Future Program™ at the Center for Educational Technologies (CET) of Wheeling Jesuit University. This report represents a preliminary summary of findings and reflections for further research. Presenting what has been accomplished so far will provide an opportunity for input and possible offers for collaboration from others who are doing similar research in this area.

In 1999, a machine trades instructor at a county vocational magnet high school received a "School to Work" grant from the Ohio Department of Education. With this funding he brought a group of students to the Challenger Learning Center at the CET. From this initial contact a partnership formed between the CET and the high school teachers and their administrative supervisors. This collaboration centered on a mutual interest in developing math, science, and technology enrichment activities related to the International Space Station.

The purpose of this paper is to describe the collaborative work between the CET and the vocational technical teachers and administrators and their efforts to create technology education curriculum activities related to the International Space Station. This paper will compare initial curriculum products and lesson plans with the most recent curriculum developments to demonstrate the gradual shift toward activities more in line with the Standards for Technological Literacy: Content for the Study of Technology (ITEA, 2000). The paper will identify social and organizational hurdles and challenges that have been encountered in the process of implementing new teaching strategies in the technology education area.

Questions addressed in this study are:

1. How does a vocational technical program like the one described in this context fit into the new technology education standards?

2. How does the implementation of the new technology education standards affect the options available for students in vocational technical programs?

3. What alternative solutions for improving the teaching and learning in technology education emerge from this study?

Aims of Research

The goals for this research are multi-faceted. On one level are immediate needs to help teachers and administrators increase student enrollment and attract more diverse students (minority and female students) in an updated and hopefully more appealing Tech Prep program. Another imperative is to get teachers and students involved in the implementation of the newly revised Standards for Technology Literacy (ITEA, 2000). Getting involved in the process of implementing the new technology content standards offers this group a way to be connected with a national, organized movement designed to “improve the overall quality of curriculum content, instructional program, teaching methods, the physical environment of technology education labs, the preparation and quality of teachers, and safety procedures” (Dugger, 1999).

A less tangible but also significant goal behind this research is to reflect on the process involved with shifting the model for technology education design activities from the more traditional technology problem solving model shown in Figure 1 to the design process outlined in Figure 2. The revised model reflects the professional development design process that has been effectively used for mathematics and science education reform (Bybee, 2001). This involves working with the school administrators and curriculum supervisors to engage in a shift in focus from project goals with primary emphasis on machining and performance skills to an emphasis on problem-solving skills and cognitive abilities. While precision skills and abilities are still an important component, the shift to getting teachers and students involved in the design process depicted in Figure 2 is designed to bring content depth to project work.

In the case described here, the content depth is expanded on two levels. On one level the link with the International Space Station through design and model-building gets students engaged in the complexities of designing structures for the extreme environment of space and for constructing components in orbit. This context offers many standards-based links with science, math, and engineering design. The content addressed in these areas of science, math, and engineering design is not easy to implement into existing curriculum without learning opportunities for the teachers and adjustments to the existing curriculum.

Content is also added in this case by connecting the model-building activities with a service-learning (Michael, 2001) context. Instead of building the block models of the space station merely for display purposes, the students are now engaged in designing and building diorama kits of the space station to be used as teaching tools for elementary and middle school students. A new dilemma for the teachers and students is that they must now deal with conflicting ideas and, unlike building models for display, this manufacturing activity models real-world problems that require making choices and compromises that won’t please every constituent.

Figure 1: Skill-focused design process.

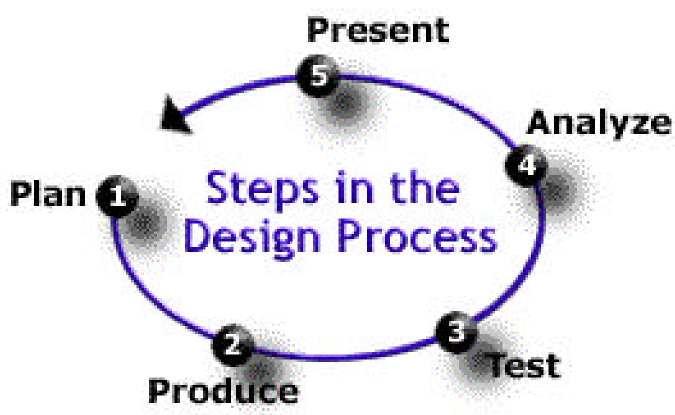
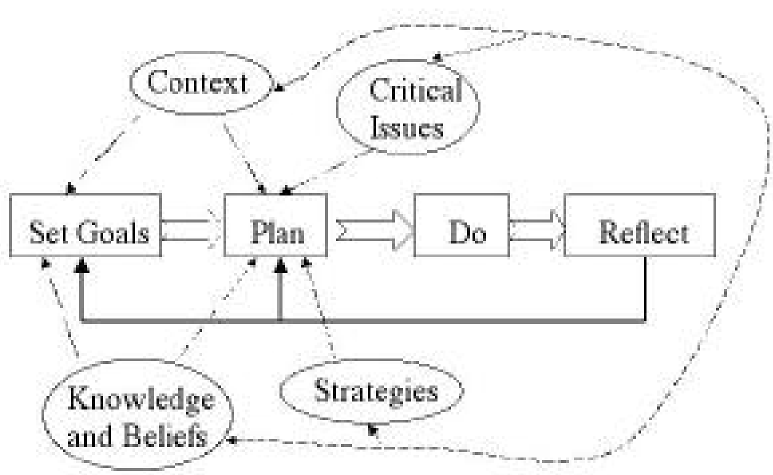


Figure 2: Goal-focused design process as depicted by Bybee (2001).



Method

In this study vocational high school teachers and students in the Tech Prep program get involved in problem solving tasks of a different nature than what they are accustomed to in the traditional curriculum. For example, the block model design challenge presented on the Web at http://www2.cet.edu/iss is primarily focused on what Custer (1999) would describe as technological problem solving involving procedural and trouble shooting skills. The initial design challenge developed by the CET and vocational technical teacher partners follows the design process outlined in Figure 1. In this design challenge, students address aspects of the design process that involve using sets of established principles and practices within certain constraints for particular, defined purposes.

The CET team and NASA partners were pleased with the quality of the student products that emerged from the block model design challenge, but this activity did not open the doors for the kind of innovation in teaching methods and curriculum development that the new technology education standards (ITEA, 2000) prompted. This action study examines how the continued dialogue and professional collaboration led to a shift toward the design process as outlined in Figure 2 and a design challenge more in line with the technology literacy goals.

Subjects Involved

The school system and collaborating non-profit curriculum development organization are located in the southeast Ohio and northern "panhandle" of West Virginia. Both of these regions have a rich history of coal mining, steel manufacturing and related industries. Since the 1980's, these industries have reduced production, many of the steel mills have shut down, and many manufacturing industries have left the area. As a result of these socio-economic factors, student enrollment in the machine trade and related manufacturing areas has gradually decreased. Student interest in the International Space Station, however, suggests that alternative curriculum modules centering on technology innovations might stimulate student interest in the manufacturing program.

The primary teacher and administrative collaborators in this project are two teachers at a regional vocational technical magnet high school and the regional director of the Tech Prep program. The two lead teachers involved are instructors in machining trades and computer aided drawing and technical drafting. Other teachers in the areas of general science, information systems, automotive collision and painting, carpentry, and clerical services have also been involved in integrated multi-disciplinary aspects of this project. The regional Tech Prep director has been involved in overseeing new curriculum activities, promoting cross-school sharing of ideas, and promoting successful aspects of this project to other schools.

The Challenger Learning Center flight directors at Wheeling Jesuit University's CET critiqued the first version of the space station diorama kit and used the revised version of this kit with 181 fourth through seventh graders at a one-day summer camp.

Thirty-two elementary through secondary teachers and two pre-service post secondary teachers participating in the CET West Virginia In-Step professional development program participated in a hands-on, scenario-based evaluation of the diorama kits. Teachers were presented the kits to review within a problem-based learning scenario context in which they were asked to serve on a school board curriculum review task force. In this role they were asked to examine and evaluate the diorama kits for possible use the in elementary through high school curriculum. They were asked to respond five questions in a one-hour hands-on activity in which they worked in teams of two to build and critique the diorama model kit. The questions, representing an abbreviated evaluation of the problem posed, were beamed to the teachers via Palm™ M150's. The teacher responses were beamed back to the research before the end of the one-hour activity period. Here are the questions:

1. Is this a worthwhile project? Under what conditions would this project be worth supporting?
2. How much support and guidance should be provided to students?
3. What kind of and how much direction should be given to teachers using this kit?
4. How can this kit be used to promote inquiry learning?
5. What grade level should use this kit? Under what conditions?

Results

Being involved in the design, development and testing of the diorama kits to be used by teachers as an educational resource moved the vocational teachers and students into a different design process model. This model is reflected in the design process diagram illustrated in Figure 2. The design issues associated with this activity contain new kinds of problems that are not just technical in nature. The diorama kit activity is more in line with the design challenges proposed in the technology education standards (ITEA, 2000).

In this activity technology is situated in a social and content context. On one level, the teachers must determine who their primary audience will be. They must examine the feedback collected from the teachers to determine where is the best fit for this product? The data collected from the teacher interviews, student test, and Challenger Learning Center summer camp shows that different teachers expect and want different things. The design team of teachers and students will have to discuss the social and market issues and will have to come to consensus as a team on the decisions they make.

Another level of problem solving that emerges from the action research is that teachers and students want the model to highlight one or more aspects of the scientific research being conducted on the U.S. space station laboratory. Teacher and student survey reports indicate that they think the diorama is a great way to get students motivated and interested in the science-related to living in space and the research being conducted on Destiny. They recommend that the vocational design team do more in the instructions and kit design to point to these science issues.

The context of the diorama kits also provides a design thinking and communication challenge via the development, testing, and refinement of the instructions that accompanies the kit (Funk, 2001). Teacher and student survey reports show that responses to the current instructions varied greatly. For example, one elementary school teacher reported that the instructions were "self explanatory" while a middle school technology education/social studies teacher reported that the instructions were "hard to understand."

Implications for Future Research

Technology education programs like other disciplines acknowledges the need to add more problem-solving, creative thinking, and cooperative learning activities into their curriculum (Newberry, 1999). Students need repeated experiences to understand problem solving, to derive a solution and try out ideas in concrete form (Welch, 1997). Students need opportunities to debate, discuss, and assess their thinking about technology (Custer, 1999). The diorama kit activity offers the students in the vocational training program an opportunity to experience all these things. In addition, having teachers and students use something that the vocational team created as an educational resource is a great morale boost for these students. Almost every (30 out of 32) teacher participant saw the diorama kits as valuable educational resources that they would use.

Through student-centered approaches in which teachers, like their students, become lifelong learners, teaching may truly be re-conceptualized (Spencer, p. 79). By engaging in reflective thinking practices and dialoguing with others, teachers and curriculum developers in this case were able to better examine their personal biases and assumptions as well as learn more about their students' background and experiences. This collaborative partnership with iterative development, dialogue, and reflective practices offers teachers an alternative way to explore new strategies for improving teaching methods, curriculum content, and opening the doors for all students.

Results of this research point to future technology challenges for the collaborative team to explore. Further research will study what is needed to support the implementation of these new kinds of problem solving activities and what new opportunities are made available from the school to support these changes.

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