AC 2011-2385: DEVELOPING AND ASSESSING STEM CURRICULUM WITH THE INTENT OF PROMOTING TECHNOLOGICAL LITERACY

Scott Bartholomew
Geoff Wright, Brigham Young University
Ron Terry, Brigham Young University

Ron is a Professor of Technology and Engineering Education at Brigham Young University. His scholarship centers on pedagogy, student learning, and engineering ethics and has presented/published numerous articles in engineering education.

Developing and Assessing STEM Curriculum With the Intent of Promoting Technological Literacy

Introduction

Science, technology, engineering, and mathematics (STEM) teacher training and curriculum development are key components of President Obama's STEM educational initiative. This study outlines one method that was used to address both these issues. In this study we sought to investigate a method of teacher and curriculum development focused on technology standards described in *Standards for Technological Literacy: Content for the Study of Technology*.[1]

Curriculum development is a key component of teacher training and teacher responsibilities. Often curriculum is developed around an activity or unit that a teacher wants their students to experience and be part of. A new method of design has become increasingly popular in recent years; backward design is a method of design that begins with the end in mind.[2] The main principles of this process call for curriculum developers to first determine what students should know and be able to do at the completion of a unit. Great success has been found in the backward design movement, and teachers are finding opportunities for implementation of backward design in their classrooms.[3-5]

In 2002, the International Technology and Engineering Educators Association (ITEEA) updated their earlier published book: *Standards for Technological Literacy: Content for the Study of Technology* (*STL*).[1] This document helped to set forth the expectations, benchmarks, standards, and learning outcomes related to technology for learners in the 21st century. Sadly, these standards have been widely underused. In an associated study to this project, the PI's surveyed all 50 state's technological literacy standards. Only 30% of the states cited the *STL* and ITEEA's standards within their technology curriculum standards. Often times the ITEEA standards do not correlate, line-up, or relate to the specific state standards for education.[6] Hence the impetus of this study: to enlarge technology education pre-service teacher understanding of curriculum development and content by having them develop *STL* centered curriculum.

Methodology

In a graduate class at Brigham Young University (BYU) in the spring of 2010, six students and two professors explored how the curriculum and teacher development of technology educators could be enhanced. All class members had a background in technology and engineering education and were candidates for a Masters degree in Technology and Engineering Education at BYU. As part of the study, students studied ITEEA's technological literacy standards found in the *STL*, created unit and lesson plans for each standard, participated in a study related to the use of the literacy standards, critiqued peer lessons, and implemented lesson plans at the middle and junior high school level.

Technological Literacy Standards. ITEEA's *STL* was the primary resource used to guide the STEM curriculum development. The purpose for using the *STL* was because it outlines the primary standards and benchmarks for Technology and Engineering Education for many of the

K-12 school districts around the United States. The graduate students worked in collaboration with their professors and classmates to develop unit plans with associated lesson plans and instructional activities and rubrics based on each of the technological literacy standards.

Unit & Lesson Plans. Often, technology and engineering education teachers design lesson plans to fit a particular project.[7] For the purpose of this project, students were expected to take a backwards design approach and design their lesson plans from a given standard.[2] Each standard would have an associated unit outline and five corresponding lesson plans. Students were required to tie each lesson and unit plan to: 1.) a standard found in the *STL*, 2.) a Utah State Curriculum learning objective, and 3.) associated state Classification of Instructional Programs (CIP) codes[8], thus bridging the gap between national standards and state benchmarks.

The students' unit outlines contained a timeline for each class, instructional goals, projects, and assessments. Lesson plans contained lesson timelines, materials required, learning goals, anticipatory sets, instructional methods and descriptions, activities, expectations, and assessments.

A copy of the unit and lesson plan templates can be found in the appendix. Samples of lesson and unit plans can be obtained from the authors.

Survey. Following the creation of lesson plans, students were surveyed regarding their experience. Students were asked specifically about ITEEA's standards, their experience in creating lesson plans, the use of the lesson plans in public schools, general perceptions of the technological literacy standards, and how this experience influenced their teacher development. Survey results were compiled and analyzed for significant trends, feelings, and perceptions. Table 1 contains the questions and summary responses for the survey.

Lesson Critique & Review. Each student was required to have their work (unit and lesson plans) critiqued by a professor and by a panel of three peers. Lesson plans were reviewed and improved through group collaboration and extensive scrutiny. Students were expected to "practice" the lesson and explain procedures, while the panel and professors analyzed for connection to ITEEA's standards. When unit and lesson plans had been approved by the professors and panel of graders, the plans were compiled with other completed lesson plans and uploaded to a private server for public access to other technology and engineering educators. This database of lesson plans will soon be made available to the public.

Lesson Implementation. In the Fall 2010, several lesson plans were implemented in local middle schools. Lesson plans created as part of this study were implemented in one *Intro to Technology* class. Student achievement and understanding of technology literacy were then compared to that of other students taking another *Intro to Technology* class where the lessons were not implemented. Upon completion of the unit, student grades and teacher field notes were compared. Middle school students in both classes also completed a posttest assessment to determine if there was a measurable difference in what students learned from the newly developed technology lesson plans when compared with what was learned in the previous curriculum.

Table 1. University Student Survey with Questions and Responses (Respondents answered each question based on a Likert scale from 1-5)

Question	Response
Rate the level of impact your experience in class had on your current Lesson Plan preparation. (1-5 scale, 5 = very impactful; 1 = very unimpactful)	3.75
How likely are you to use the lesson plans created by YOURSELF? (1-5 scale, 5 = very likely; 1 = very unlikely)	3.75
How likely are you to use the lesson plans created by YOUR CLASSMATES? (1-5 scale, 5 = very likely; 1 = very unlikely)	2.75
How widely used are the STL's across the country in lesson planning? (1-5 scale, 5 = very frequently used; 1 = very infrequently used)	1.5
Are the STL's used in classrooms across the country? [In Lesson Planning] (1-5 scale, 5 = very frequently used; 1 = very infrequently used)	2.25
Are the STL's used in classrooms across the country? [In Class Assessment] (1-5 scale, 5 = very frequently used; 1 = very infrequently used)	1.75
Are the STL's used in classrooms across the country? [In collaboration with other teachers] (1-5 scale, 5 = very frequently used; 1 = very infrequently used)	3.5
Are the STL's used in classrooms across the country? [In personal reflection] (1-5 scale, 5 = very frequently used; 1 = very infrequently used)	1.75
Are the STL's used in classrooms across the country? [In Unit/Activity planning] (1-5 scale, 5 = very frequently used; 1 = very infrequently used)	2.25

Findings

Survey Results. Several noteworthy findings were recorded from the university student survey. Although students regarded ITEEA's technological literacy standards as very important, if not fundamental, the students surveyed do not believe that this is the opinion or belief being practiced today across the country by technology and engineering education teachers. Students regarded the development of lesson plans, which correlated to ITEEA'a standards as very effective (4.5 average; Likert scale, 5 = very effective and 1 = very ineffective) for their development as a teacher, yet students perceived that nationally in the U.S., the use of the ITEEA standards in lesson planning was very infrequent (1.5 average; Likert scale, 5 = very frequent and 1 = very infrequent). One student responded:

> "*States need to align their core/standards with the national Standards for Technological Literacy. Teachers use state standards and not national ones because they know that they get accredited by the state and that's where the money comes from." Another student observed, "Teachers don't know who is supposed to use the Standards for Technological Literacy. Nobody thinks they are supposed to use them except for tech teachers, and they follow a different curriculum."*

When students were asked, "How often do you believe the ITEEA technological literacy standards are used across the country in class assessment?" and whether teachers use the

standards for professional development, unit and lesson planning, their responses were consistent with the notion that the standards are not being used.

Test Results. Middle school students in two *Intro to Technology* classes were both taught the Energy & Power unit as outlined in the Utah State Core Standards. Students in one class received the lesson prepared as part of this study. Students in the remaining class received a different lesson used for the Energy & Power unit. Students in both classes involved in the study completed a posttest following the Energy & Power unit in the *Intro to Tech* class. The posttest was based on Utah state's *Intro To Technology*'s standardized test. Each class was given the same test and students were allowed to complete the test using as much time as needed. Tests results were recorded and class averages obtained. Students involved in the class receiving lessons based on the ITEEA standards scored 16% higher (84% average) than those receiving lessons with no connection to the ITEEA standards *(68% average)*. While we readily admit that there are many variables that were not or could not be accounted for in this study, we believe that it is important to note that a 16% increase on a state developed test is significant – and must be considered when developing *Intro To Technology* lesson plans.

Personal Observations. As part of the study a teacher was surveyed regarding his experience using the technological literacy standards specific lesson plans. The surveyed teacher noted: "When lesson plans have a clear tie to ITEEA's standards and the CIP codes, they have a better direction. We stop doing activities for activities sake alone and start doing them because the activities help students reach a specified benchmark."

Conclusion

As teachers develop a backward design approach and formulate lesson plans with the end goal, benchmark, standard, or ITEEA's technological literacy standards-related objective in mind, we believe teachers will move to a new level of competence and ability to help students. We also believe that student performance levels will increase as they are taught in ways that relate directly to the identified technological literacy standards. However, we feel that before major changes can occur, there must be an alignment between state and national standards. This alignment must take place to facilitate teachers as they plan, prepare, and organize their curricula.

References

1. ITEA, Standards for Technological Literacy; Content for the Study of Technology, Reston, VA: ITEA, 2002.
2. McTighe, J. and Thomas, R. S., *Educational Leadership; Backward Design for Forward Action*, VOL 60; PART 5, 2003, pages 52-55.
3. Wiggins, G. and McTighe, J., "What is Backward Design?," in *Understanding by Design*, 1st edition, Upper Saddle River, NJ: Merrill Prentice Hall, 2001, pp. 7-19.
4. Wiggins,G., McTighe, J., Understanding by Design, Prentice Hall, ISBN 013093058X, 2001.
5. Wiggins,G. & Jay McTighe, *Understanding by Design Professional Development Workbook, Association for Supervision and Curriculum Development* (ASCD), Alexandria, VA, 2004.
6. Wonacott, M.E., "Technological Literacy," *ERIC DIGEST*, No. 233, 2001.

7. Boss, S. and Krauss, J., *Reinventing Project-Based Learning: Your Field Guide to Real-World Projects in the Digital Age*, Eugene, OR, ISTE; 2007.
8. Classification of Instructional Programs, retrieved, February 2011 from: http://nces.ed.gov/ipeds/cipcode/Default.aspx?y=55

APPENDIX

Lesson Plan Template

Lesson Plan Title	

Grade Level	

CIP Code	

Lesson Plan Abstract

National Standards for Technological Literacy
STL Number STL Sub Codes

State Standard

Timeline of Lesson (minutes.)

Materials

Learning Goals

Anticipatory Set

Content

Instructional Methods

Assessments

Assignments

Quizzes/Tests

Unit Plan Outline Template

Unit Title	

Grade Levels	

CIP Code(s)	

Unit Description

National Standards for Technological Literacy

State Standards

Timeline of Unit

Lesson Title	Length (min)	Abstract

Learning Goals
Students should learn: