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From the Editor

Random Encounters with Visions and Leadership

I realized as I reflected over 40 years ago upon my undergraduate education that much of what I had learned about the world and about life came outside of the planned curricular experiences that I had through the formal courses that I completed. When I finished my doctorate some 26 years ago, I made the same reflections and concluded that those random interactions and encounters in the hallways of academia with my professors and peers, as well as custodians and secretaries, were very significant learning experiences. I estimated that fully 25% of what I had learned in my doctoral study came from those unplanned encounters. At this point, I would argue that well over half of what I learned came this way. There is some logic for this change in proportion over time, for much of what I learned in the formal classroom environment has become obsolete and meaningless, but those informal interactions remain timeless, for they taught me to challenge my thinking, to hone my skills in defending a point of view, and to learn how other people think – and consequently to value the wonderful diversity of the human being.

With three children in school when I started doctoral study and no clear idea of how I was going to finance the endeavor, I certainly would have been a candidate for doing my degree via distance learning if that mode had existed. It undoubtedly would have been more convenient and cost effective than moving my family "back East" to Ohio State University from a small rural town of 13,000 in Oregon. Though there are arguments supporting the viability and opportunities for interaction using the technology of distance learning, I cannot imagine that it even "distantly" compares to what I enjoyed in my doctoral study, especially through those random encounters. Times and values have change, I know, but I am thankful. Enough said.

Those "random encounters" have occurred throughout my career and they have continued to help me formulate my thoughts, develop new ideas, and stay motivated and excited about this awesome field in which we work. After a few years of attending the ITEA conference, I realized that the random encounters there with members of my profession, akin to my conclusions about education, were often more significant than the planned special interest sessions. In fact, virtually every one of the From the Editors I have written between these covers came from these random encounters, albeit not always from "academics." Two of them I would like to share presently. The first occurred during the annual conference of the Technology Education Association of Pennsylvania last

November in a discussion with William Michael. I have known Bill for the past five or so years, prior to having any idea that I would one day end up in Pennsylvania with him. Bill is coincidentally a mentor to Mike Voicheck, one of my former students from Virginia Tech, who now teaches with Bill at North Penn High School near Philadelphia. In our random encounter, we ended up talking about vision – who in our profession has vision and who does not. This idea filled my mind for several days after the conference and continues to pop up today. Who among my colleagues have vision? How do I know if they have vision? Do I have vision? What is my vision? Do I need to have vision to be successful and contributory?

Most in our profession would agree that William E. Warner was visionary. His *Curriculum to Reflect Technology* (1947) is still considered to be a seminal document in moving our field to where it is today. It is still quoted and referenced in contemporary writings. Yet that document consisted of several sections and most of those sections was written by one of Warner's doctoral students at Ohio State. Certainly Warner influenced those students' thinking as he laid down the principal elements of a philosophy that guided their ideas and writing. At the same time, though, I have to think that the converse was true, that those students significantly affected Warner's thinking as well. Though some students of Warner remember him as a "lecturing professor" who tended to be a "fountainhead of knowledge" and rather egotistic as well, logic tells me that Warner had a very interactive side to him, especially when he was formulating new ideas. My "vision" of Warner's interactive style is evidenced in the initiation ritual for the Epsilon Pi Tau Honor Society in which it is mentioned that he and a group of graduate students gathered around a conference table and formulated the basic tenets of the organization he founded in 1929.

The other random encounter occurred with Perry Gemmill, the Chair of our department, in the hallway of the building in which we work. He mentioned some of the leaders of our field who were prominent when we were both fledglings in the profession and how awestruck we were about them. We then both wondered if leaders of this magnitude exist today. Had our minds become so calloused that we simply did not recognize them? Were they in our midst but they simply did not stand out? Did we take our leaders for granted? To what extent had we realized our own leadership potential, perhaps obligation, to the profession? Such a discussion is probably a rather normal occurrence when one matures in their career, wondering whether you are as good as those that came before and if those who follow are as good as you are.

The notions of vision and leadership began to come together in my mind. One of the first thoughts that I had was that every successful teacher is also a successful leader – leadership is simply a quality that good teachers have to have. Yet not all good teachers are good visionaries. Very good teachers/leaders are teaching obsolete content.

Likewise, there are wonderful visionaries who are not good leaders or good teachers. They have developed future-oriented ideas that make good sense, but they cannot articulate them in a classroom or a conference presentation situation.

Drawing an analogy from the business world, they did not know how to market their ideas. Then I thought about the professor who zealously espouses the idea that hands-on activities and problem solving opportunities are key to effective learning in our field, but then communicates this notion to students via a series of passive, dull lectures. I can also recall academicians presenting their visions of an ideal curriculum and laboratory facility at a conference, but when I had the opportunity to visit, there was no apparent connection between their vision and their practice. I also decided that there are lots of exceptional leaders out there who are not visionary, but support those who are by obtaining resources and providing encouragement for them – unsung, but certainly not insignificant.

I reflected about the people in our profession who were leaders and visionaries - the ones that Perry and I discussed in the hallway. Donald Lux, Willis Ray, Donald Maley, and Paul Devore are examples among several people who came to my mind. I pondered who might be their equivalents today. I also pondered how things have changed in our profession and in society in general, leading to some observations and contrasts. Each of these people was a philosopher. Each one was connected with a university and all were land grant institutions. They all spent nearly their entire careers developing, honing, and solidifying their respective philosophies. Their fundamental beliefs remained constant over time. They all published their works in both journals and in books. They all continue to be cited, as Warner is, in contemporary writings. All put their philosophies into educational practice either directly or through their students. All except one translated their philosophies into curricular documents that were readily accessible to the profession. The philosophies of each were controversial within the profession and generally incompatible with one another. In varying degrees, they were controversial. Most important, each of these individuals *believed in something* and was deeply *passionate about those beliefs*. What's more, their differences were exciting topics of conversation and analysis.

Things are not the way they were back then. The power and influence of professors in land grant universities, where new ideas are often incubated and fostered, has slipped dramatically. There are but a handful of technology education programs in land grants today and the number of faculty within these programs is but a trifle of what it was when my exemplars were in the zeniths of their careers. Regional universities have been increasingly emphasizing research supported by external dollars and rewarding scholarship in an attempt to fill the voids left by the land grants, but most are unwilling or unable to reduce the time they expect faculty to devote to teaching. What's more, most of the faculty in these institutions have a multitude of responsibilities outside of technology education and in many cases the majority of the students they teach are in other fields of study.

As the stronghold of the land grants began to slip, state departments of education began to take over some of the slack, moving from supporting the dissemination of the new knowledge and practices that came from the land grants, to actually developing that new knowledge themselves. This phenomenon was relatively short lived, though, as federal funding to states dried up. There was no ebb in the need for curricular and instructional materials development, though, so the International Technology Education Association began to play an increasingly significant, corresponding role. Even before this, professional organizations, originally founded to support engineers, scientists, mathematicians, architects, and the like in their professional development, began to expand their outreach to the elementary and secondary schools. The objectives for these initiatives at first seemed to center on fostering the future of the professions they represented by engendering interest among students in related careers. Then they expanded into influencing the curriculum itself, with instructional materials and sometimes by even more direct means. Today virtually all professional organizations seem to have an elementary/secondary school outreach effort and resources allocated to it. Many organizations with a technical purpose are embracing the notion of technological literacy and some are doing so totally independent of us.

So I sit back and think about the contemporary leaders of our profession. I am convinced that there are top quality people leading us today and they are no less significant or capable than those in the past. Our professional organization, representing the members and the profession in general, has become one of the principal developers of new knowledge in the field. This is unprecedented in our history. The Center to Advance Teaching Science and Technology (CATTS) is a consortium of states under the auspices of ITEA and the membership. The states have input into what is being developed and those doing the developing cut across a wide swath of our profession, including international experts. It is truly a participative effort. In addition, the significant curriculum development going on outside of CATTS is more likely than not being accomplished by consortiums of several universities and a number of individuals within them, or by independent organizations.

The leaders of the past left a personal legacy with the profession. That legacy is recorded in history by their publications and by the impact that they had on the profession today. The test of their foresight and vision can be measured in part by citations of their work in contemporary literature. Helping to record that history is a wonderful legacy that results from the dedication and hard work of the Editorial Board members of this journal who have served over the years.

I wish conclude with some observations regarding leadership, vision, and legacy. First, the legacy for the future may well be left by organizations and the collective people within them rather than by individuals, contrary to what has been true to a large extent in the past. Second, preparation for careers versus the development of technological literacy is once again becoming an issue in the field, after years of relative reconciliation. Third, how we embrace engineering and include engineering concepts in our curricula are occupying much of the field's resources and energy right now and this represents the vision for quite a number of people in the field. Fourth, with the exception of the two points above, the philosophy of the field seems to be reaching a nominal level of homeostasis, though the need for curriculum development will most certainly continue. Fifth, the contemporary leaders of our field have not had the consistency of focus of their predecessors due to the dynamics of the times and the increasingly faster pace of change in technology, society, and political climate. Due to a variety of pressures, many leaders have had to become opportunists, jumping after whatever seemed to look promising and had resource potential. This may explain why it seems increasingly difficult to understand what our leaders today really believe about our field compared to those in the past. Sixth, perhaps waxing optimism, those who leave a legacy to the next generations may well do so in their research rather than in their philosophical tenets and curriculum development. Drawing a parallel to the medical profession, Dr. Benjamin Spock comes to mind as a philosopher while Dr. Jonas Salk is a researcher. Seventh, perhaps the most lasting legacy will be left by those individuals and organizations that operate globally: collaborating, promoting, synthesizing, and further developing the collective efforts of those around the world. Finally, only the test of time will reveal who the visionaries and leaders of today really are. Erroneous visions and dead-end paths of leadership leave a legacy only if they caused damage. On the other hand, as Nanus (1992) stated, “There is no more powerful engine driving an organization toward excellence and long range success than an attractive, worthwhile, achievable vision for the future, widely shared” (p. 3).

JEL

Reference

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Articles

The Nature and Provision of Technology Education in Ireland

Anthony Carty and Pat Phelan

Introduction

In an increasingly technological world, technology education programs designed to meet the needs of the demanding technological environment must be planned and coordinated efficiently. In response to this changing technological environment, the provision of technology education in Ireland is currently undergoing development. The educational process in Ireland is government driven, as in other European countries. Technical subjects have been included in the Irish curriculum since 1885 as manual instruction and educational handicraft. These subjects were entitled Metalwork, Woodwork and Technical Drawing. The introduction of Technology as a subject in its own right occurred in 1989, based on the rationale that technology education was seen important for economic success.

The introduction of Technology as a subject enabled schools that did not already offer such subjects the opportunity to provide a less resource intensive version of the subject than those already offered; namely, Metalwork/ Engineering and Woodwork/Construction studies. Initially £5000 was allocated for the purchase of equipment per school, however this proved inadequate with over 50% of schools spending between £10000 and £58000 for initial setup (McGuiness, Corcoran, and O' Regan, 1997). The coordination of its introduction was conducted quickly between 1987 and 1989. McGuiness et al (1997, p.83) recommended that a "*longer and better sequenced programme of preparation be planned for the extension of Technology (the subject) to the Senior Cycle….*" During this period the Irish economy was realigning under a National Recovery Programme. Resulting in the '*Celtic Tiger'* era that saw an increase in gross domestic product and a decrease in unemployment rates.

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Irish Educational System Overview

The Irish educational system is divided into three levels, primary (ages 4-12), secondary (ages 13-18) and third (ages 18+). The focus of this paper is concerned with the provision of technology education within the secondary level that is compulsory. Secondary level education is divided further into two cycles, with national certification awarded upon successful completion: the Junior Certificate (ages 13-15), also known as the Junior Cycle, and Leaving Certificate (ages 16-18), also known as the Senior Cycle. Compulsory schooling age is 16, or the completion of three years of post-primary education, whichever is the latter (Education [Welfare] Act, 2000).

To attain a Junior Certificate at least eight subjects must be examined. They include Irish, English, mathematics, history, geography, and civic social and political education (CSPE), as well as at least two other approved subjects. The Leaving Certificate subjects are broken into domains: languages, sciences, business studies, applied sciences (including technology subjects) and social studies. Candidates are required to include not less than five subjects, of which Irish must be one, but due to high competition it is recommended that seven subjects be examined (Rules and Programmes, 2002, p. 7-11).

Technology Education Curriculum Design

Technology education is provided through four subjects at the Junior Certificate level. The subjects are offered at two levels, Higher-Level (HL) and Ordinary-Level (OL). To date three of these subjects are continued into the Leaving Certificate. At the Junior Certificate, 75 hours per year are allocated to a single technology subject and 95 hours for a subject at the Leaving Certificate level. Table 1 displays the technology education subjects that are offered in the Irish curriculum, assessment weightings, year that the syllabus was last updated, and the revised or new syllabi titles along with the implementation dates.

De Vries in Layton (1994, p. 33-35) outlined eight categorized approaches to technology education in Western Europe. The category that best fits Ireland presently is the "*craft-oriented approach*" with a possible movement towards a "*design approach*" in some subjects. It may be argued that the approach can be different for each individual technology subject offered at the school depending on teacher pedagogy and resources available in the technology room.

The aims of technology education in the Irish educational system cannot be ascertained from specific subject aims, but from a more holistic view of all technology subjects within the curriculum. The aims listed below are extracted from a Consultation Document on technology education at Junior Certificate level.

- To contribute to a balanced education, giving students a broad and challenging experience that will enable them to acquire a body of knowledge, understanding, cognitive and manipulative skills, and competencies, and so prepare them to be technologically literate and creative participants in society.
- To encourage and enable students to integrate such knowledge and skills, together with qualities of co-operative enquiry and reflective

thought, in developing creative solutions to technological problems and needs—using appropriate materials, equipment and resources to produce artifacts and systems—with due regard for issues of health and safety

- To facilitate the development of a range of communication skills, which will encourage students to express their creativity in a practical and imaginative way and in a variety of forms, including verbal, graphic and model, and involving the use of appropriate media
- To provide a context in which students can explore and appreciate the impact of past, present and future technologies on the economy, society, and the environment.

NCCA Consultation Document, 2003, p. 2

Table 1
Technology Subjects Offered at Secondary Level Education and the Assessment Procedures (date of last revision shown in parentheses)

Junior Certificate 75 hrs./yr./subject Approx. age 13-16	**Leaving Certificate** 95 hrs./yr./subject Approx. age 16-18
Materials Technology (Wood) *(1989)* Assessed 300 Total points Theory 100, Practical 200 = 130 project + 70 portfolio HL 150 project + 50 portfolio OL	**Construction Studies** *(1985)* Higher level 600 Total points 300 theory + 150 practical skill test + 150 design project Ordinary level 500 points 200 theory + 150 practical skill test + 150 design project
Technical Graphics *(1989)* Assessed 300 Total points 120 short questions 180 long questions Both HL and OL	**Technical Drawing** *(1985)* Assessed 400 Total points Paper I 200 Paper II 200 Both OL and HL
Metalwork *(1985)* Assessed 400 Total points Theory (written) 100 HL/OL Practical = 300 points 150 practical project + 150 practical test HL 300 practical project OL	**Engineering** *(1985)* Higher level 600 Total points 300 theory test + 150 practical skill test + 150 points design project Ordinary level 500 points 200 theory test + 150 practical skill test + 150 points design project
Technology *(1989)* Assessed 400 Total points Design task 200 + Theory 200 HL Design task 240 + Theory 160 OL	**Equivalent in Planning** New Syllabus forwarded to the DES for examination in 2009

Note: OL refers to Ordinary Level and HL refers to Higher Level

Management of Technology Education in Ireland

The Department of Education and Science (DES) provides all syllabi documents. The Minister of Education and Science is responsible for the enactment of educational policy and direction. The DES delegate's curriculum development, teacher guidelines, and syllabi production to a statutory body named the National Council for Curriculum and Assessment (NCCA). In 2003 the DES passed the responsibility of examinations to the State Examinations Commission (SEC). The SEC prepares examination scripts, assessment material, corrections and the publishing of results and statistical data. Coordination of these bodies according to Gleeson (2004) has been fragmented, leading to tensions within the DES, which is further reflected in the syllabi as being separate from implementation and assessment.

Recent Developments in Technology Education in Ireland

Technology education is undergoing substantial planning and re-evaluation in Ireland. It must be stated that technology education subjects are not compulsory in Irish secondary schools. In England, for example, Design and Technology is included in the foundation (statutory) subjects at Key Stages 1-3 (ages 8-14) and is an entitlement in Key Stage 4 (ages 14-16). Likewise, Craft studies are listed as part of the core curriculum for Finland. An examination of technology education at both Junior Certificate level and Leaving Certificate level is presently occurring.

Junior Certificate

A Board of Studies was formed by the NCCA to "review all technological subjects at Junior Certificate level" (a total of four) by order of the Minister for Education in 1998. In March 2003 the Board published an interim consultation document. This document outlined the rationale for technology education in the Junior Cycle and possible framework configurations of subject content and learning outcomes. The framework was comprised of a core and options selection. Feedback from the consultation process was limited. After the consultation period the Board reported back to the NCCA. The NCCA recommended that special consideration be given to subject teacher associations' response to ensure that the response by the Board to the NCCA was consistent with the limited views expressed in the consultation period.

The Final Report published in September 2004 displayed and compared different framework configurations all based on the same concept of core and option. This model reflects the proposed revised Leaving Certificate syllabi for technology. The document focused on content outcomes and subject matter organization. The Junior Certificate interim consultation document listed the partners involved in the review process; which were drawn from subject teacher associations, teacher unions, school management bodies, the DES Inspectorate, and members from the NCCA. The stakeholders of technology education using the categories proposed by Layton (1994, p. 13-18) are economic instrumentalists*,* professional technologists, sustainable developers, girls and women, defenders of participatory democracy, and liberal educators. A comparison between the NCCA's Board of Studies membership and Layton's stakeholders' reveals a difference.

An issue emerged following the publication of NCAA's Final Report (2004, p. 11) in that Technical Graphics was excluded from their review. The Board recommended that Technical Graphics be considered as a stand-alone technology subject, specifying that it should be revised in parallel with the other three technology subjects.

Leaving Certificate

Three revised technology education syllabi for the Leaving Certificate and a new Technology syllabus were forwarded by the NCCA to the DES. Lynch (2004), Director of the NCCA, wrote in a letter to the subject teacher associations that the delay of implementation may lead to a systematic approach and that the Minister has recognized the major budgeting costs associated with it. The experience gained from the introduction and implementation of Junior Cycle Technology (subject) outlined by McGuiness, Corcoran, and O'Regan (1997) for a longer and better sequence of events leading to the implementation of future technology subjects is occurring. In December 2005 the Minister announced funding for new technology equipment and the introduction of the Leaving Certificate in the subject of Technology and the revised Technical Drawing renamed Design and Communication Graphics, which will first be examined in 2009 (see Table 1).

International Comparisons

Finland and England were selected to form the international perspective in contextualizing Ireland's curriculum as they have high levels of technology education research and are within the European Union. England is Ireland's nearest neighbor and their technology education system differs significantly from Ireland's. Finland's educational system is similar to Ireland's in some respects, the population is similar, and they are currently implementing a new National Core Curriculum, which is consistent with the policies of the NCCA in Ireland.

England

Design and Technology is the umbrella name given to the suite of subjects (7) offered at General Certificate of Secondary Education (GCSE) Key Stages 1-4 in England (Table 2). Design and Technology is listed in the foundation subjects for Key Stages 1-3, therefore the subject is compulsory. The educational responsibility rests with the Department of Education and Skills (DfES) and is compulsory until the age of sixteen at the end of Key Stage 4. The DfES sets attainment targets (levels 1-8) that are to be achieved; they are effectively a statement of what the pupils must know. The Qualifications and Curriculum Authority (QCA) is a statutory body advising the Secretary of State for Education and Skills in relation to curriculum matters and setting accreditation levels. The DfES is not involved in licensure as this is performed externally by awarding bodies such as the Assessment and Qualifications Alliance (AQA), Edexcel Foundation, and the City and Guilds of London Institute (CGLI). These bodies arrange and develop syllabi documents in accordance with the specifications of the curriculum, design exam scripts and marking schemes, and are responsible for corrections/grading.

Table 2
Design and Technology subjects offered in England

Subject	Notes
Electronic Products Food Technology Graphic Products Product Design Resistant Materials Technology Systems and Control Technology Textiles Technology	Assessment • 40 % Written/Theory • 60% Project/Practical • All subjects These subjects are offered at two tiers called foundation and higher. Subjects are also offered as short courses that are worth half a complete subject in the GCSE exam. Specifications are updated annually.

Finland

Technology education in Finland is taught through "*craft*" (EURYBASE, 2005), in the national core curriculum. The craft subjects are organized into two main subdivisions, technical work and textile work. The curriculum states that students in grade 3-7 (age 9-13) must receive an integrated education of both technical and textile work, though Lavonen and Autio (2003) question this implementation. Compulsory education in Finland is from age 7-16 (9 years) and ending with grade nine. The teaching is split similarly to the division between primary school and secondary school in Ireland. One teacher teaches all subjects up to grade 6 (13 years), individual subject teachers deliver instruction after grade 6. According to Lavonen and Autio (2003), 310 hours are spent on "handicraft" in compulsory education, in comparison to 225 hours in Ireland.

The Components of Technology Education

The key components of technology education in Ireland as outlined by the NCCA are design and communication, materials and processing, energy and control, health and safety, and technology, society, and the environment. These key components are necessary to form a broad and balanced technology education. The Final Report of the Board of Studies (2004) suggested that more emphasis or "significant weighting" (in assessment points) must be placed on materials and processing with the integration of other subject areas. From these key components, a technology education model may be formulated.

Technology Education Models

Technology education has evolved from the technical and manual instruction subjects of the early 1900's (Durcan, 1972). The mode of technology education currently employed in the Irish curriculum is subject oriented. Subjects in the curriculum are broken into knowledge domains, technologies, sciences, and humanities. This approach is similar to the arrangement in England and Finland to a certain degree. It separates the subjects of science and mathematics from technology, although they are fundamental components.

Heywood (1986, p. 234) proposed a model for an inclusive approach for technology education in Ireland and is shown in Figure 1. The composition of value systems, economics, technologies, and society, integrated into the educational system was derived from a comparative study of developments in Europe, such as the development of school engineering science in the UK. The study was financed by the Christian Brothers. Marino Curriculum Services requested the Minister to finance a pilot project through which practicing teachers used Heywood's model during an in-service program, but financing was not provided. The in-service diploma required the development and evaluation of a technology education program for Transition Year pupils (the year between the Junior and Leaving Certificates). This was the only year in the curriculum in which innovation could occur without reference to the Department. Steffens (1991) of the Berlin Technological University was requested to evaluate the diploma, and noted in his paper that this initiative was unrelated to the developments by the Department of Education at this time.

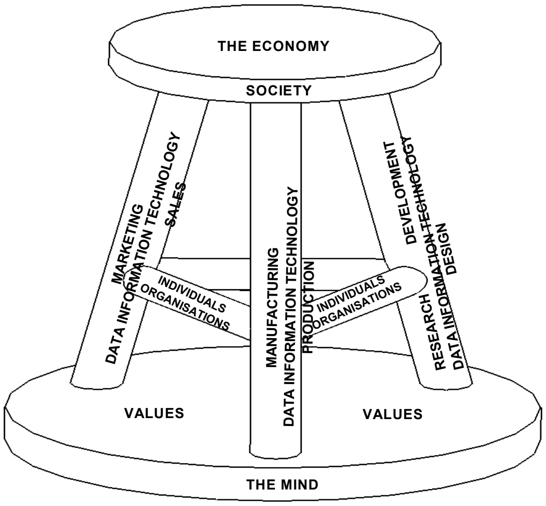

Figure 1. Heywood's (1986) technology education model

The model in Figure 2 of technological capability found in the Junior Certificate Technology Syllabus (1989, p.12) displays that knowledge and skills are derived from four areas, craft and materials, communications, energy and control, technology and society. They lead into the task loop of design, production, and evaluation, hence resulting in technological capability. The dichotomy between processing skills and designing is evident in the model. Hennessy (2000, p. 50) commented that the emphasis on the acquisition of facts and development of fixed material processing skills is passive, and that this content-process model of teaching with the "after-the-fact fashion" of design in which pupils modify a component, usually concerned primarily with appearance issues, distorts the fundamental principles of both technology and design. Kimbell (1982) wrote that pre-specified processing skills teaches attitudes of obedience and conformity, "the very qualities that the design course demands will be crushed out of the child by the emotional and intellectual constraints" (p. 49).

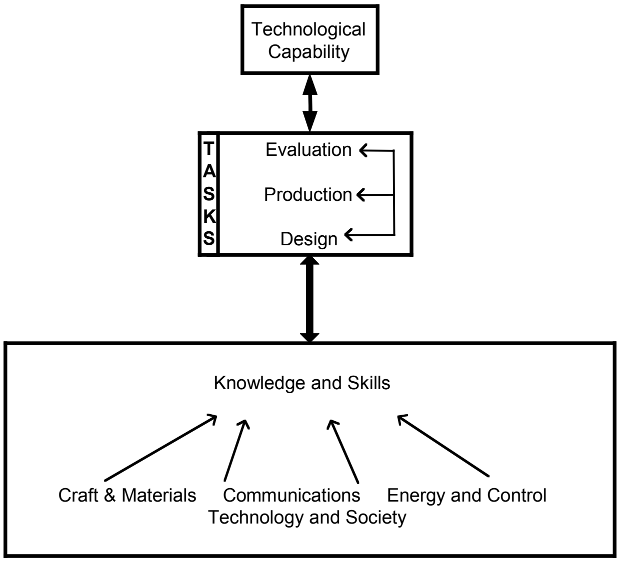

Figure 2. Current technological process model in Ireland

The conceptual model proposed by Savage and Sterry (1990, p. 21) for technology education in Figure 3 is well recognized internationally. This model is similar in content and design with the proposed content framework model proposed by the NCCA in Figure 5. An analysis of the Savage and Sterry model displays that it understands technology education to be a '*doing*' activity as opposed to a body of knowledge or an applied science.

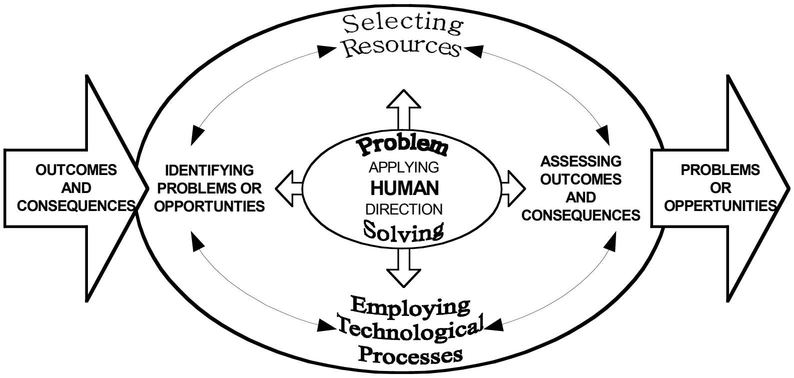

Figure 3. Savage and Sterry (1990) technology education model

Black and Harrison (1986, p. 134) offered another concept and model of technology education based on Task-Action-Capability known as TAC (Figure 4). The task is dependent on the resources of knowledge, skill, and experience. The vertical arrows display the interaction between knowledge and concept (content) with the skills of construction and design (process). The parallel arrows display the interaction between this and the task. Outside the task box is influencing factors such as inquiry and inventiveness, which are personal, as well as intrapersonal factors such as judging and valuing. This combination allows for “development of capability and awareness”, from the “experience of tackling tasks” which Black and Harrison deem essential.

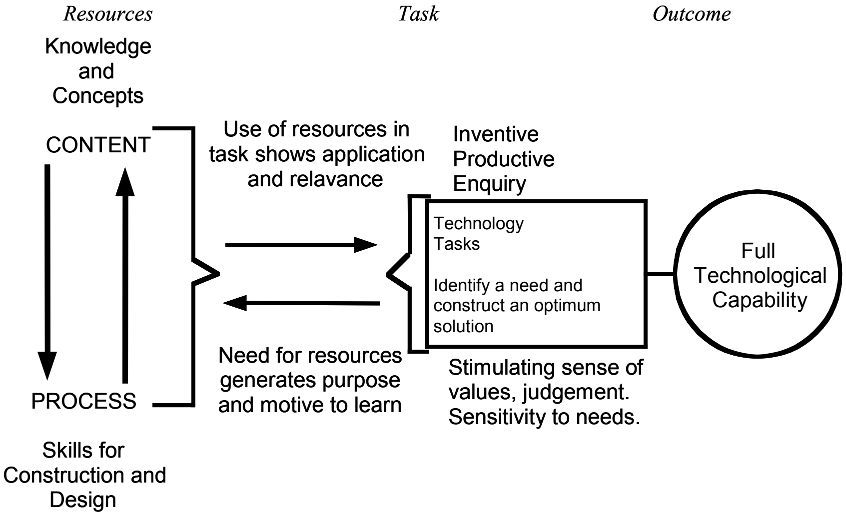

Figure 4. Black and Harrison’s model of technology education

The National Council for Curriculum and Assessment (NCCA) model in the sanctioned Leaving Certificate for Technology syllabus bases a central construct on a design-based approach in technology and society as well as health and safety, with specific content areas interconnected. This model is shown in Figure 5. The content areas, seven in total, reflect the contemporary human-made environment. The process of design is a content block within the core and an emphasis on design is evident throughout the syllabus.

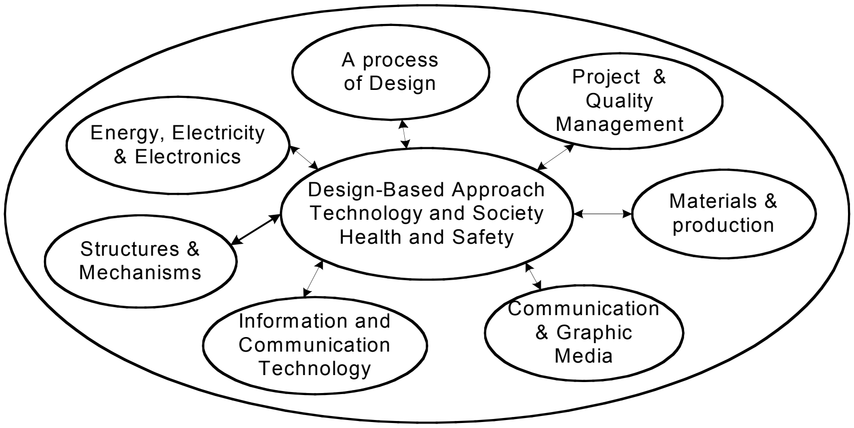

Figure 5. NCCA proposed model for Leaving Certificate in Technology

From a visual inspection of the technology education models, it can be noted that Heywood's model for an inclusive holistic approach through the integration of subjects does not reflect the current or proposed models for Technology Education. Comparing the current model (Figure 2) with the proposed model (Figure 5), a shift towards content is evident. However, the emphasis on design is made explicit. The concept of "total design" is not consistent in present or proposed revised or new technology syllabi. The proposed Leaving Certificate syllabus for Engineering Technology (2006) is an example of this case where the Ordinary-Level project is assessed with the pupil undertaking a given "dimensioned project from a drawing with an element of design" (pg. 10).

Technology Teacher Education Programs

Ireland

There are currently three programs of technology teacher education in Ireland. The University of Limerick is the sole technology teacher provider in the Republic of Ireland to date. The University of Limerick offers two well-established undergraduate courses, Bachelor of Technology (Education) in Materials and Engineering Technology/Construction Technology. One course is offered with two options at postgraduate level entitled Graduate Diploma in Education (Technology). Both fulltime undergraduate courses are of four years duration inclusive of teaching practice, six weeks in the second year and ten weeks in the fourth year.

The fulltime undergraduate course is four years in duration including six weeks of teaching practice in the second year and ten weeks in fourth year. Applicants apply through the Central Applications Office (CAO) and credits obtained in the Leaving Certificate may be applied toward the degree. Mature (non-traditional) applicants apply directly through the University and are accepted based on their credentials and an interview.

The fulltime postgraduate course accepts candidates who have a primary degree in a cognate subject area and complete a skills test in material processing (wood/metal) and manual board drawing. Candidates must successfully complete both skills tests and an interview. The course lasts for 30 weeks, split between two semesters, with 100 hours of teaching practice. In both routes to completion the courses are interdisciplinary and shared across various academic departments within the University. Enrollment numbers in both programs fluctuate due to reasons beyond the scope of this paper.

England

Concurrent and consecutive models of technology teacher education are also available in England at third level institutions. Undergraduate degree study requirements vary from two to three years, depending on experience and qualifications. Degrees offered include Bachelor of Sciences/Arts/Education, with some courses guaranteeing Qualified Teacher Status (QTS). The Teacher Training Agency (TTA) funds the initial training of teachers to ensure highly trained teachers. The (*concurrent*) undergraduate teaching directed degree in England was geared principally for the primary school and the postgraduate (consecutive) model was geared towards secondary school teachers. However this has changed and undergraduate degree programs for secondary level D&T teachers are now available.

The postgraduate options vary in duration from one-year fulltime to five years part-time. A Postgraduate Certificate (PGCE) in Secondary Education is awarded upon completion. About a dozen universities provide technology teacher education in the United Kingdom (UCAS). Entry requirements to these courses vary depending on the teacher training institution. The minimum entry requirements to all programs is that candidates must have GCSE English and mathematics at grade C or higher. Mature applicants are reviewed based upon merit. The final selection involves an interview, literacy, numeracy, and information/computer technology skills test, designed by the TTA.

Finland

Technology education teachers are trained within two groups in Finland: the class teacher (minor) and the subject teacher (major). A master's degree is usually completed as a requirement of teachers in general education. Entrance to the technology teacher education program is selective and specifies a written examination, an interview, practical skills test, and a technological reasoning test (Alamäki, 2000). Four Finnish universities provide handcraft teacher education (major), two universities provide teachers for textile craft, one for technical craft, and one for technical craft in the Swedish language. The latter admits students every other year.

Technology Education in the Curriculum

The reality of technology education in Ireland is that the subjects are predominantly male dominated. The technology teacher population is over 95% male. Student statistics from 92-94 and 01-03 can be seen in Table 6 (DES, 2006).

Table 6
Gender imbalance in the technology subjects in Ireland

Program and Course	Percent of Girls Enrolled by Year			
	1992-93	**1993-94**	**2001-02**	**2002-03**
Junior Certificate				
Materials Technology (wood)	5	6	16	16
Metalwork	4	5	15	14
Technical Graphics	7	8	17	18
Technology	34	30	33	33
	1992-93	**1993-94**	**2001-02**	**2002-03**
Leaving Certificate				
Engineering	5	5	5	6
Construction Studies	7	9	7	7
Technical Drawing	7	7	7	7

Note: Directly comparisons by year are not possible since the data are note made available each year.

This gender problem has existed for a long period and to date has not being effectively resolved. The Women’s Studies Association of Ireland made a submission to the Curriculum and Examinations Board (CEB, 1985), now the NCCA, in relation to gender imbalance. The report stated that, “the predominance of boys in technical subjects and the ‘hard’ sciences and of girls in languages, art, music and home economics continue limitation and distortion of the developing potential of both sexes” (p. 17-18). Technology as a subject within the technology education curriculum has the greatest proportion of girls, with a ratio of approximately two boys to one girl. Table 1 also shows the gradual percentage shift over the ten-year period. Gender imbalance is also evident in Finland, with boys typically selecting technical craft and girls selecting textile craft. Lavonen and Autio (2003) offered reasons for this including teacher shortage and course scheduling. The issue of female participation also exists in England as highlighted by Sayers (2002) and Harding (2002). The reason for gender imbalance include the timing of subject choice, availability of information on subject content, scheduling practices, and gender stereotypes (Darmody and Smyth, 2005, p. 171).

Schools differ in the timing of subject choice; some schools require selection of subjects before entry, or pupils are enrolled in “appetizer” courses, allowing for actual course selection later. Schools that enroll only girls are the poorest providers of technology education subjects, with none of these schools providing Metalwork (DES: Statistical Reports). Scheduling is an issue in most schools. Traditionally, technology subjects were scheduled in conflict with humanities subjects and this practice continues today.

The status of the technical subjects has been problematic since their inception. The problem originates from the social class conflict between technical and classical education extending from the early 1900s. Heywood (1983) described the perception of technical subjects as “infra-dig” (p. 226). Eventually the status problem in England was eradicated by making the subject compulsorily. According to Reen (1984) the subject metalwork was perceived to have shortcomings, reducing its efficiency as an educational medium. He exclaimed that “metalwork has enjoyed a status lower than that which its potential educational value merits from erroneous notion. It is basically concerned with lower elements of the taxonomy [Bloom’s Taxonomy]” (p. 2). Darmody and Smyth (2005) found that designated disadvantaged schools are significantly more likely to provide Metalwork and Material Technology (Wood).

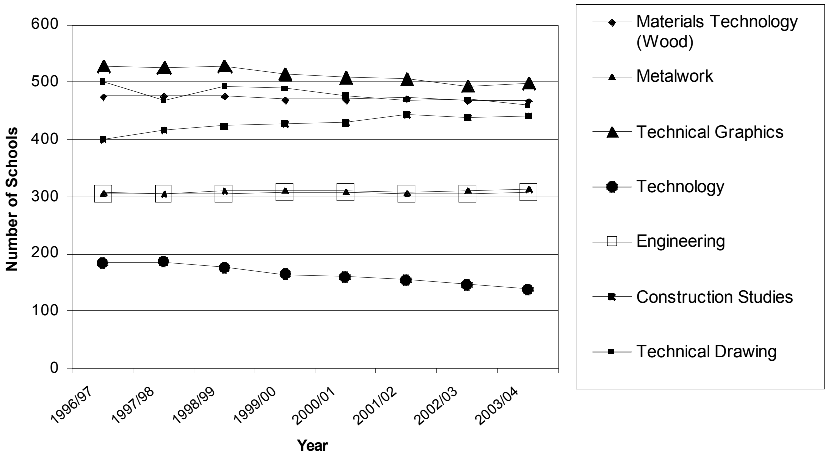

Figure 5. Current trends in technology education subject provision

The trends in subject provision can be seen in Figure 5. The largest decrease is in Technology (185 to 135) whereas Construction Studies gained (400 to 442). Metalwork and Engineering remained nearly constant over the years.

Student perceptions and misconceptions of technology subjects vary. The image problem is being currently addressed under initiatives such as the STEPS (Science, Technology and Engineering Programme for Schools), which is a partnership between the Institute of Engineers of Ireland and the DES. They aim to address misconceptions, increase participation rates of females in engineering, and provide clearer information on engineering as a career.

Technology Education Assessment

"Assessment is the tail that wags the curriculum dog" (Hargreaves, 1989). Students ask, "Does this count?" "Will I get marks for this?" Therefore the assessment procedures affect the classroom pedagogy and the orientation of subject content. Assessment is a rather poignant issue for metalwork teachers, as the syllabus was last updated in 1985 but the exam topics, content, and structure have all developed and evolved. Therefore, the exam papers have effectively become the unwritten syllabus.

The assessment of technology education may be categorized into three different areas: the project, practical skills test, and the written examination. The relative weights for each are dependent upon the particular subject. The practical skills test (Day-Exam) is conducted in the technology room. Three subjects have a skills test: Metalwork at the Higher-Level and Engineering and Construction Studies at both levels. Metalwork, Woodwork, and Engineering projects and practical skills tests (where specified) are graded in schools by SEC examiners. Construction Studies differs in that the class teacher who supervises the project work grades the completed project under close moderation by the SEC, catering for candidate equity. The written examinations for the above and Technical Graphics/Drawing are conducted by the SEC and are scheduled with all other subjects each year in June. The correction of written (theory) papers is conducted by examiners after a marking conference, with examiners correcting exams in bulk under the close scrutiny of advising examiners."

Materials Technology (Wood) is assessed through a written paper focused on theory and a practical project. One hundred points are allocated to theory and, dependent on the level the subject is taken, a different breakdown of the points is made for the project and portfolio. If a candidate is taking the subject Metalwork, a skills test will only apply if that person is a Higher-Level candidate. The skills test is worth half the points allocated to practical work (37.5%), while for a student taking the subject at Ordinary-Level the project will be worth 75%.

England

Assessment in Design and Technology subjects in England is also divided. The two modes are coursework (project) and theory. The breakdown of points applies to both levels. The course work project accounts for 60% and 40% allocated to theory. A direct comparison between the Irish and English assessment method is not possible, though a relative comparison can be seen in Figure 6. The amount of practical work is determined by the assessment procedure, comparing Ordinary-Level with Higher-Level in the Irish situation, practical work equates to 75% in both cases. However the Higher-Level element includes a practical skill examination assessed upon the completion of a device. The comparison shows a 75% practical element in Metalwork in Ireland compared to a 60% practical element in Design and Technology in England.

Figure 6. Assessment percentage weightings

The performance of pupils in the courses, as indicated by the percentage of "A" grades they earned, is reported in Table 7. The performance of students in the Resistant Materials course of the Design and Technology course in England are provided for comparison. The proportion of "A" grades appear to be about the same across subjects, with the proportion higher in Technical Graphics and Mathematics.

Table 7
Proportion of students earning "A" grades by subject.

Subject (year)	Percent "A" Grades
Metalwork (1999)	7.5%
Technology (1999)	9.1%
Technology (2002)	9.3%
Technical Graphics (1999)	13.5%
Materials Technology (wood) (02)	9.6%
Resistant Materials D&T (2002)	8.9%
English (2002)	7.1%
French (2002)	7.5%
Mathematics (2003)	12.9%

Key Features of Technology Education Assessment Ireland

Metalwork requires a skills test at Higher-Level whereas for Materials Technology (wood) a skills test is not required. Different numbers of points are allocated for the project and portfolio. The subject Technology is examined as follows, Higher-Level 50% practical and 50% theory compared to Ordinary-

Level 60% practical and 40% theory. Engineering for the Leaving Certificate requires a skills test at both levels. Construction Studies specifies a written paper worth 50% for Higher-Level and 40% for Ordinary-Level. The class teacher grades the project with external monitoring similar to Design and Technology in England.

The teaching approach to technology education is dichotomous between theory and practice. This division is more prominent in Leaving Certificate Engineering Technology due to increased complexity of subject matter. The revised syllabus caters to this division with areas of the syllabi referred to as "support theory." Williams (n.d.) argues that "Students should perceive technology as a thoroughly integrated activity, not one which can be separated into content and process, or theory and practice." This is not currently the situation in assessment nor is it anticipated to occur in the future.

Final Comments

The experience of other countries must be considered when planning and implementing new syllabi and reforms. In England, Design and Technology is compulsory and thus the perceived status of the subject is no longer a problem. The recognized importance of technological literacy in providing a broad and balanced education highlights the importance for the inclusion of technology education in the core curriculum. Technology education is provided at an early stage in Finland where pupils receive an integrated approach similar to Heywood's model. In England, Design and Technology is listed as a core foundation subject from Key Stage 1. The provision of technology education at the primary level seems logical and essential.

The technology education models of Ireland and other countries display a variety of approaches and philosophies. Two consistent features evident in the models included herein demonstrate that content and activity are inseparable. The "indissoluble alloy" of "content and activity" and "theory and practice" is needed in both the teaching and learning of technology education.

The recommendations from gender studies need to be enacted. The differences in participation rates between boys and girls need to be addressed before new and revised syllabi are implemented. In Ireland the largest loss in enrollment has occurred in the Technology course. At the same time, this course has the greatest proportion of girls enrolled. The cause of this phenomena needs to be investigated.

Entrance testing for the consecutive postgraduate model of technology teacher training in the University of Limerick is a new development in Ireland's technology teacher education. This method of entry is consistent with the highly selective nature of Finnish and English universities. The results need to be monitored for this approach over time.

Presently the universal goal of technology education appears to be technological literacy and capability. Alamaki (2000) noted how difficult it can be to achieve a balance between cognitive content and practical work in achieving this goal. Rasinen (2003) noted that the same issue of "breath versus depth" in his analysis of the curricula of six countries.

Connolly (1986) concluded his chapter in Heywood and Matthews, which focused on changes and planned changes of technology education at the time, with a quote from Nuttgens' (1978) speech in the first Stanley Lecture. "The challenge for us is to discover a more rewarding education in which thinking, and doing, and making are melted together and fused into a concept of living and learning."

Some have considered the notion of internationalizing the technology education curriculum. This is a concept that may appear to be practical in theory but not in practice. As is true in most countries, there are a lot of issues, ideologies, and philosophies that must reach compromise before progress can be made. Ireland is an example of such a country.

Abbreviations

CEB	Curriculum Examinations Board
DES	Department of Education and Science (Ireland)
DfES	Department for Education and Skills (England)
IBEC	Irish Business and Employers Confederation
NCCA	National Council for Curriculum and Assessment
QTS	Qualified Teacher Status
SEC	State Examinations Commission
TTA	Teacher Training Agency

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Integrating the Study of Technology into the Curriculum: A Consulting Teacher Model

Thomas Erekson and Steven Shumway

Over the past 40 years there have been several initiatives by leaders in the profession to make revolutionary changes in philosophy, curriculum, methods, and facilities in the transition from industrial arts to technology education. The transition to technology education has been grounded in the dramatic changes that technology and technological innovations have brought to all aspects of society. It has been postulated that to fully participate in a technologically-based society, people must be technologically literate (Pearson & Young, 2002). Thus, the need arose to assure that all students have experience in technology education in order to acquire technological literacy.

The goal of technological literacy has general acceptance in the profession, however no consistent plan has emerged for organizing and teaching technology education across states and school districts. The debate continues concerning which curriculum theory, or organizing pattern, “best” fits technology education (Zuga, 1989; Herschbach, 1992). The result has been a diverse array of plans and models for the delivery of technology education in K-12 education. The result, as indicated by Wright (1995) in a CTTE Yearbook chapter entitled “Technology Education Curriculum Development Efforts,” has been a diverse array of plans and models for the delivery of technology education in K-12 education.

While there are many of models for technology education, organizing technology education as separate and distinct courses is the most common approach at the middle and high school levels. The distinct course, or separate subject, approach is grounded in academic rationalism that identifies technology education as an academic discipline (DeVore, 1965; Erekson, 1992; Zuga, 1989). Likewise, a major purpose for the Technology for All Americans Project was to establish technology education as a core subject in the curriculum (Satchwell and Dugger, 1996).

While there are many examples of successful technology education programs that are grounded in the separate subject approach, it may take decades for technology education to gain acceptance as a new academic discipline, if it is

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possible at all (Erekson, 1992). Furthermore, Custer (2000) questions whether the profession should seek disciplinary status:

> At a time when technology educators are working hard to position the field as a new academic discipline, the questions must be asked, "Do schools need yet one more academic discipline?" or "Would students be better served if technology education was to serve as the mechanism and catalyst for blurring the boundaries among the disciplines?" (pp. 127-128)

Must the profession pursue disciplinary status or are there other educational strategies that will achieve the educational goal of technological literacy for students and co-equal status for technology teachers? Should technology education become a "catalyst for blurring the boundaries among the disciplines?" The purpose for this article is to present an alternative approach for the delivery of technological literacy education utilizing an integrative model.

An Integrative Discipline

Technology, by its very nature, touches all facets of society. It can be considered a universal that permeates culture. Gagel (1997) supported this notion, that is "there is a dimension of technology, like literacy, that is culturally universal . . the ubiquitous occurrence of technology (like language) in human cultures." (p. 20). The universal, society-permeating nature of technology makes it very difficult to focus and organize technology education curriculum. Likewise, Wiens (1995) noted that "technology cannot be studied in isolation. Technology is a social process that occurs within a social, environmental, economic, and political milieu" (p. 130).

Technology, being ubiquitous, offers a robust opportunity for connections with all areas of study in the schools. Many have suggested that technology education is, by nature, interdisciplinary (Erekson & Johnson, 1989; Herschbach, 1995; Loepp, 1991; McHaney & Barnhardt, 1989; Welty, 1989). Liao (1998) stated that "[s]ince technology education includes the study of how technology works and is designed and how it interacts with other societal systems, only an interdisciplinary approach to its study is appropriate." (p. 52). He further noted that "one of the unique features of technology studies is that it is an integrative discipline" (p. 53).

Has the time come for technology education to establish its position in the educational community by exploiting its integrative uniqueness? Hershbach (1996) noted that technology education has the potential to "fully integrate interrelated fields of study." This shows promise for our profession and for the overall improvement of education in technologically-based societies. Integrating the subjects in schools to provide a sense of connectedness is grounded in "contemporary research on cognitive theory" and many educators "have come to realize the limitations of teaching in relative isolation" (LaPorte & Sanders, 1995, p. 195). Palmer also supports the contention that curriculum integration can improve the effectiveness of education.

> We have long known that making connections between and among the disciplines provides the setting for increased understanding, retention, and application . . (Palmer, 1995, p. 55)

Models for Curriculum Integration

An array of models for curriculum integration have been developed and tried. Loepp (1991), citing Dossey, identified five basic formats for curriculum integration. The five formats include:

1. The simultaneous model – students taking courses in different disciplines with the teachers "deliberately" making "ties between the content of the courses."
2. The braided model – content from various disciplines viewed as strands to be visited on some type of "cyclical pattern to develop a spirally organized curriculum."
3. The topical model – a curriculum that focuses on a topic, or theme, throughout the year, or a major portion thereof, across multiple subjects.
4. The unified model – teachers from two or more disciplines working together to "identify a set of unifying ideas," often implemented with team-teaching techniques.
5. The full interdisciplinary model – the merging of the content from two or more disciplines. (p. 3)

In technology education there are several examples of the above listed formats for curriculum integration. For example, Maley (1989) worked with teams of math, science, and technology teachers in curriculum development that coincides with the simultaneous model. McHaney and Barnhardt (1989) promoted the central project model with a student space station simulation that is an excellent example of the topical or thematic model.

While perspectives of the effectiveness of the five models are somewhat subjective, the authors suggest that the full interdisciplinary model, in which the content from two or more disciplines are merged, has the potential to be very effective in technology education. While this model appears to show promise, it also appears to be the most elusive.

The National Standards and Curriculum Integration

A major purpose for Technology for All Americans project was to establish technology education as a core subject in the curriculum (Satchwell and Dugger, 1996). From within the profession the perspective of establishing standards is one that supports the separate subject, or unique discipline approach. Influence from key constituencies outside of the profession, however, broadened the focus of the national standards. William A. Wulf, president of the National Academy of Engineering (NAE), was an active participant in the development of the standards. He noted the broadening as follows:

> One question that emerged early in the NAE's involvement in the standards project was whether the standards were meant to serve the professional interests of technology educators or the more general goal of technological literacy. That is, were they principally to provide a framework for improving and expanding the reach of formal technology education courses, or were they instead to provide a vision for incorporating the study of technology across the curriculum?

> It is my sense that the early drafts were focused on the former objective. In contrast, the views of the NAE committee, and later, of the NRC committee, were that the broader goal should predominate. It is again to the credit of the leadership at ITEA and of staff at TfAAP that the standards evolved to favor the broader goal over the narrower one. (Wulf, 2000, p. 12)

Barriers to Curriculum Integration

If curriculum integration and interdisciplinary efforts have the potential to dramatically improve education, why has implementation lagged? Loepp (1991) identifies several barriers to curriculum integration.

> The barriers to curriculum integration are readily apparent. Turfism runs rampant throughout the educational enterprise. Teachers trained to teach a discipline become threatened when others impinge on their subject area. They also tend to feel inadequate when asked to stray from their traditional subjects. Also, teachers in elementary and secondary schools are loaded with day-to-day responsibilities and have little time to reflect on curriculum – let alone integration. Further, most readily available curriculum materials are discipline-specific and only casually refer to content from other disciplines. For many years, schools have been organized around various disciplines. Additionally, high school graduation requirements and entrance requirements to higher education institutions are discipline-specific. (Loepp, 1991, p. 4).

The barriers to curriculum integration identified by Loepp exacerbate attempts at full integration. Turfism, discipline envy, inadequacy, time constraints, lack of integrated curriculum materials, school structure, and college admission requirements are real barriers to full curriculum integration. In addition, high stakes testing is another very real barrier to curriculum integration as a study of elementary teachers involved in high stakes testing found a narrowing of the curriculum, more time spent on test review, and less time spent on instruction (Hoepfl, 2001). Can a full integration model be developed that addresses and overcomes these barriers? If this is possible, can technology education professionals exploit the integrative nature of technology and provide leadership for such an effort? Are technology teachers (and supervisors and teacher educators) willing to try something different to make full integration happen?

Custer (2000) noted that, while showing great promise, curriculum integration has not materialized to any great extent:

> Educational delivery systems tend to artificially carve schooling up into academic disciplines, separated from authentic contexts. While integration, authentic learning, and contextualized education have become popular in recent years, the reality is that little progress has been made in integrating the curriculum. (p. 127)

People view new stimuli (things) through the lens of their past experiences. The authors, with backgrounds in both technology education and in special education, have a perspective of curriculum integration that is influenced by models designed to educate exceptional children. It is the authors' belief that full curriculum integration can be achieved, exploiting the ubiquitous nature of technology, through a model that is similar to the special education model of the consulting teacher/resource room approach. The following sections provide a brief description of the special education consulting teacher/resource room approach followed by a discussion of how this model could work to fully integrate technology into the curriculum.

A Consulting Teacher Approach

The area of special education has gained standing in the schools without trying to become an academic discipline. Furthermore, special educators have used an array of service alternatives to teach exceptional students and to integrate them into the regular classroom to the extent possible. Hallahan and Kauffman (1997, p. 16) describe the special education service alternatives in which the exceptional student is most physically integrated into the regular classroom as:

Regular class only
Regular teacher meets all the needs of student; student may or may not be officially identified or labeled; student totally integrated

Special Educator Consultation
Regular teacher meets all needs of student with only occasional help from special education consultant(s); student may not be officially identified or labeled; student totally integrated

Itinerant Teacher
Regular teacher provides most or all instruction; special teacher provides intermittent instruction of student and/or consultation with regular teacher; student integrated except for brief instructional sessions

Resource Teacher
Regular teacher provides most instruction; special teacher provides instruction part of school day and advises regular teacher; student integrated most of school day

The models above present strategies for integrating the exceptional student into the regular classroom. One of the goals of these strategies is to have the regular classroom teacher assume the responsibility for teaching the exceptional student. The undergirding belief is that education of exceptional students in the regular classroom is more enriching than education in a segregated classroom.

The notion that special education teachers should provide consultation to regular teachers became popularized in the 1970’s and 1980’s. Recently, however, the approach of collaborative consultation has been advocated in special education. According to Hallahan and Kauffman (1997) the special education teacher and the general education teacher “assume equal responsibility for the student with disabilities” (p. 67). They further note that “[r]esearch suggests that collaborative consultation is a promising approach to meeting the needs of many students with disabilities in general education settings” (p. 67).

Consultation in Technology Education

Can, or should, technology education implement a special education-like model of integration that utilizes the concept of collaborative consultation and resource rooms? Does such a model show promise for increasing technological literacy? It is the thesis of the authors that not only will collaborative consultation work in delivering technology education, but it will enhance the students' understanding of technology by grounding it in the context of the various school subjects. At the same time, using this model will enhance the various subjects by providing an authentic context for learning.

How might the collaborative consulting model work in delivering technology education? In a technology education collaborative consultation model the goal would be to integrate technology into the general curriculum such that it permeates *every* school subject at all levels K-12. Palmer (1995) noted that "to be effective, integration must be both vertical and horizontal – that is, across content areas and between grade levels" (p. 58). In this model, the technology teacher will fulfill the role of a consultant who helps teachers integrate technology education content and activities into the regular curriculum, in effect, facilitating such instruction in the context of traditional subjects. Welty (1989) noted how this might work:

> . . . since technology touches almost every aspect of life, it can be used to bridge the gap between abstract concepts and concrete life-experiences. When the study of technology is integrated into the curriculum, numbers in mathematics have identities, messages composed in English class are transmitted beyond the classroom, and the laws of nature discovered in science are applied to problems in the real world. When the skills and concepts introduced in academic subjects are applied to problems in everyday life and the world of work, the curriculum intrinsically enters the realm of technology.(p.21)

Wulf (2000) supported this notion and provides a perspective in which the implementation of the new Standards for Technological Literacy is accomplished through an array of teachers. He noted:

> As the standards make clear, the goal of technological literacy requires that the content for the study of technology be delivered by a wide array of teachers – in math, science, language arts, social studies, art, history, to name some of the most obvious subject areas. Mostly, and especially in the elementary grades, this content will not be presented in stand-alone courses. Rather it will need to be infused in the lessons, lectures, and instructional materials already in place. (p. 12)

Collaborative consulting technology teachers can make a major impact by helping regular teachers integrate technology into the context of the disciplines. In such situations the technology teacher can help the regular teacher change the esoteric nature of education in the various subjects, rendering it more exciting and meaningful to students.

This approach would be similar to the way specialist teachers are used in elementary schools. Sanders (1996) noted that "[t]echnology teachers might be employed in the elementary schools the same way that art, music, and physical education teachers are currently utilized." (p. 4). This approach provides regular classroom teachers in elementary schools who are supplemented with specialist teachers who provide instruction in specialized areas like music and art. Of course, the authors propose that this model not be limited to elementary schools. Rather, it should be implemented K-12.

The collaborative consulting technology teacher model could address several of the barriers, real or perceived, to curriculum integration. For example, time constraints could be reduced or eliminated since the "time" for the technology teacher would be totally dedicated to curriculum integration (the technology teacher would not be responsible for teaching separate technology education classes). However, time could be a factor if the consulting/collaboration load is too heavy. By eliminating separate technology courses, discipline envy and "turfism" could be eliminated, or at least minimized. With supportive consulting by the technology teacher, feelings of inadequacy that regular teachers may have when asked to enhance the curriculum with technology education can be negated.

Technology Education Examples

The closest example of the collaborative consulting technology teacher model was found in a rural Wyoming school district (Wright and Miller, 1997). In this situation, technology education was integrated at each grade level K-12. The technology lab was, in many respects, used as a resource room in which classes could come for hands-on activities in support of the concepts being taught in the regular classes. Often the elementary students were in the technology lab at the same time as high school students, further evidence of its use as a technology resource room for all students. The technology teacher provided support and consultation to the regular teachers. Additional technology curriculum and activities were developed by the technology teacher for use in regular classrooms. Thus, technology education was not limited to the technology lab. Rather, technology permeated the K-12 curriculum. It should be noted that in this school separate technology education courses were offered at the middle and high school levels. Continuing to offer a few separate courses may be needed in the transition to the resource lab/consulting teacher technology education model. However, the authors suggest that there is no need for separate technology courses at the middle and high school levels.

Another example of the resource room model was found at Spanish Fork Junior High School (personal communication, November 12, 2002). The school included grade levels 7, 8, and 9. In this situation the technology teacher made the communication technology lab available to the math and English teachers in the school. These teachers would bring classes of 7th or 8th graders to the communications technology lab for instruction in English or math with learning activities that made use of the technological devices in the lab. The technology teacher used his 9th grade communication technology students as peer teachers and teacher's aides in supporting the math and English instructional hands on activities.

A third example of the resource room model was found at Hemmingway Elementary School in Ketchum, Idaho (Thode and Thode, 1997). In this setting there is a technology education teacher, Terry Thode, who operated a technology resource room available to all classes in the school. The technology teacher operates like other specialist teachers at the elementary level (e.g., art, music) in providing a specialized lab and hands-on instruction for elementary students. Terry Thode gained national recognition as an innovative technology teacher who delivers technology education to elementary students using a technology education resource room approach.

Collaborative Consulting Technology Teachers

Glen (1994) noted that collaborative consulting special education teachers have more responsibility than regular teachers and that effective consulting teachers have developed specific skills in consultation. Likewise, collaborative consulting technology teachers will be educational leaders who will have more responsibility than regular teachers. In effect they will become classroom/laboratory supervisors who work with teams of specialists. The competencies and roles of the technology teacher will be similar to those described by Stadt and Kenneke (1970) in their monograph, *Teacher Competencies for the Cybernated Age*. This approach will "require a more mature teacher than has heretofore been graduated" (Stadt and Kenneke, 1970, p. 26). Leadership, the ability to arrange and balance activities of an educational team, the fundamentals of human relations, the ability to delegate, knowledge of instructional software and hardware, superb communication skills, and the ability to work in teams are attributes that Stadt and Kenneke (1970) identified as critical to the success of future technology teachers. Collaborative consulting technology teachers will also need these attributes. Inservice technology teachers will likely need targeted professional development in collaboration, and technology teacher educators should consider including these attributes in preservice teacher education programs.

Wulf (2000) supported the notion of the technology teacher filling a different role in implementing the National Standards for Technological Literacy. He believes that the new standards will expand the influence of the technology teacher. He sees technology teachers as "resident experts" who will be "called on to advise schools and school districts" that are trying to meet the goals of technological literacy (p. 12). He further delineated the future roles for technology teachers as:

> They [technology teachers] will be expected not only to be teachers of students, but also teachers of other teachers – of their colleagues who must deliver technology content but who have little or no technical background. They will undoubtedly play other important roles. (p. 12)

Wilber (1990) reported that special education resource room teachers indicated a need for teacher trainers to provide direct instruction of specific consultation skills to better prepare them for the consulting roles. Likewise, technology teacher educators would need to design and deliver programs that develop specific skills in collaborative consulting. This will require new approaches to technology teacher education, including direct, purposeful experiences in collaboration and consultation.

Comparative Analysis

If the consulting collaborative model works in special education, will it work in technology education? Will the collaborative consulting technology teacher model as presented herein actually be implemented in the public schools? What types of educational policies, and funds, will be required to implement this model?

It must be noted that special education is implemented in public schools because of state and federal laws, and court decisions, which mandate a free, appropriate education for all individuals with disabilities in the least restrictive environment, the regular classroom where practicable (Hallahan & Kaufman, 1997). Having law and court rulings that support a collaborative consulting model has the effect of forcing it to happen in special education. In addition, special education receives significant federal and state funding, providing resources to cover the costs for the range of educational services to special students, including consulting special education teachers.

It should be noted, however, that prior to the enactment of special education laws, some school districts saw the need for special education programs and these districts funded such programs from local revenues (Hallahan & Kaufman, 1997). These early efforts were often at the request of parents of disabled students. Parents of the disabled historically have been activists in seeking specialized education legislation and funding for their children.

Unlike special education, technology education currently does not have the power of federal and state laws, and court decisions, which mandate that all students must be educated to become technologically literate. In addition, technology education is not included as part of state and national testing programs like reading, mathematics, and science, nor is technology education considered a part of college preparatory education (Erekson & Shumway, 2002). As such, technology education does *not* carry with it the mandates, or the resources to cover the costs, for collaborative consulting technology teachers.

Furthermore, the collaborative consulting technology teacher model will likely be viewed as duplication of effort by school administrators as has been the case with specialist teachers at the elementary level (e.g., art, music) when budget challenges arise. Elementary specialist teachers are often viewed as something nice to do when you have the resources, but in times of funding shortages they are generally the first to be cut with their responsibilities given to the regular elementary teachers.

It appears that the collaborative consulting model is teacher specific. That is, its success depends heavily on the capabilities and dynamics of the teacher. For example, in two of the technology education collaborative efforts cited above (e.g., Ten Sleep, Wyoming and Spanish Fork, Utah), when the teacher left the school and administrators changed, the collaborative technology education classes were discontinued.

In some states federal Perkins funds for career and technical education are used to improve (fund) technology education programs, and most of the technology education state supervisors are housed in the career and technical education units. Traditional career and technical education administrators may perceive the collaborative consulting technology teacher model as a program improvement, however this is unlikely as it will be difficult to assess the impact of the model.

Faced with no legislative mandates or targeted funding, it is unlikely that the collaborative consulting technology teacher approach will have any wide spread acceptance. However, there may be some instances where school districts, based on their commitment to teaching technological literacy, will use local revenues to fund the collaborative consulting technology teacher model.

End Note

Proposing a model to deliver technology education that eliminates specific courses and has the effect of making the role of the technology teacher transparent will not be popular in the profession. The profession has gone to great efforts to establish technology as a discipline with its unique content and methods. These efforts have brought some change, but the goal of universal technological literacy continues to evade us. Can this goal be achieved with the current direction? Maybe, given time and effort. With a new paradigm of curriculum integration in which the technology teacher becomes a collaborative consultant or “resident expert” who manages a technology resource room (lab), can the goal of technological literacy be achieved sooner? Maybe. At this point the profession needs innovators who are willing to further develop and test the collaborative consulting model in technology education.

Custer (2000) noted a unique opportunity for the profession with curriculum integration:

> If the technology education profession is successful with an integration agenda, we could well find ourselves at the core of education in the 21st century. But integrated learning environments will be very different. The risks and demands will be considerable. (p. 130)

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Project-Based Technology: Instructional Strategy for Developing Technological Literacy

Moti Frank and Abigail Barzilai

We live in a society that increasingly depends upon technology. Citizens who understand and are comfortable with the concepts and workings of modern technology are better able to participate fully in society and in the global marketplace (ITEA, 2003a). It is in the interest of science education to help students develop a greater understanding and appreciation for technology and engineering (Bybee, 2000). For these reasons a growing number of voices are calling for the mandatory study of technology by school-aged children worldwide. Technological literacy is the ability to use, manage, assess, and understand technology. It involves the application of knowledge and abilities to real-world situations (ITEA, 2003a). The Israeli national curriculum for junior high school includes a subject called “Science and Technology.” One major learning goal, as determined by the Ministry of Education, is developing technological literacy. In order to prepare pre-service teachers to teach this subject in junior high school a mandatory methods course has been developed by the Department of Education in Technology and Science at the Technion, Israel Institute of Technology. The course is based on the national curriculum of science and technology in junior high school. One objective of the course is to prepare future teachers to design and manage learning environments that promote technological literacy.

Professional Development Standards for Technology Teachers

Professional development standards for staff, teachers, and educators are common. Some examples include those from the Center for Science, Mathematics, and Engineering Education (1996); National Staff Development Council (2001); Maryland Department of Education (2006); New Jersey Department of Education (2006); and Blasie & Palladino, 2005. ITEA (2003b) has developed professional standards for use in ensuring the effective and continuous in-service and pre-service education of teachers.

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Standards are written statements about what is valued that can be used for making a judgment of quality. The professional development standards for technology teachers are based on standards of technological literacy (ITEA, 2003c). *Guidelines* are specific requirements or enablers that identify what needs to be done in order to meet a standard.

The course described in this paper – Methods for Teaching Science and Technology in Junior high School – has been designed to meet the standards following the guidelines. In order to prepare students in the course to design and manage a Project-Based Technology (PBT) learning environment, the instructors set the following main learning objective: upon completion of the course, the students should be able to apply design considerations and processes to real projects. This paper presents implementation issues and processes that pre-service teachers encountered in a PBT environment and the extent to which they applied design considerations to real projects.

Project-based Learning (PBL)

To develop a broader view of technology and understand how it is both like and unlike science, students should become familiar with the nature of engineering and design (AAAS, 1989). Project-Based Learning was found to be a learning environment that may promote technological literacy (Frank, 2002). According to Buck (1999), students in PBL are engaged in active learning and gain multidisciplinary knowledge while working in a real-world context. The importance of student engagement is widely accepted and numerous researchers have provided considerable evidence to support the effectiveness of student engagement on a broad range of learning outcomes (Prince, 2004; Hake, 1998; Redish, Saul, & Steinberg, 1997; Laws, Sokoloff, & Thornton, 1999). Bonwell and Eison (1991) summarize the literature on active learning and concluded that it leads to better student attitudes and improvements in students' thinking and writing. According to Hill and Smith (1998), the project-based courses in technology education use design processes. Because design does not happen by happenstance, a design process must become part of the course curriculum and students must be guided through the process. Green (1998) noted that project learning increases motivation to study and helps students to develop long-term learning skills. Students know that they are full partners in this learning environment and share the responsibility for the learning process. Green also stated that this approach helps develop long-term learning skills. In some studies, a positive correlation was found between self-esteem and receiving a positive assessment (Battle, 1991). Hill and Smith (1998) also found that the PBL environment in their courses increased students' self-confidence, motivation to learn, creative abilities, and self-esteem.

In a study reported by Shepherd (1998), it was found that grades for the Critical Thinking Test (a 32-item, 40-minute test that measures skills in clarifying, analyzing, evaluating and extending arguments) received by students who were taught in a PBL environment were significantly higher than those of students in a comparative group, who had studied in the traditional fashion. The PBL students also demonstrated greater self-confidence and improved learning ability. Norman and Schmidt (2000) pointed out that having students work in small teams has a positive effect on academic achievement. In a review of 90 years of research, Johnson, Johnson, & Smith (1998) found that, across the board, cooperation improved learning outcomes relative to individual work. This included academic achievement, quality of interpersonal interactions, self-esteem, perceptions of greater social support, and harmony among students. *Teamwork* is a central characteristic of PBL. In most cases group decisions, expressing the various perspectives of the team members are better than individual decisions (Parker, 1990). The students in the course presented by Verner and Hershko (2003) also went through all the stages of interdisciplinary design. In order to execute their projects, the students went through six design stages: project idea, specification, concept design, detail design and creation, operation and tuning, and evaluation. In another study, students learning in a PBL environment showed significantly higher achievement than students who had been taught using traditional teaching strategies (Sabag, 2002).

Project-based Science (PBS) and Project-based Technology (PBT)

Based on the PBL principles, Krajcik, Czerniak, & Berger (1999) suggested the Project-Based Science (PBS) approach for team projects in science education. The authors suggested the following benefits for the students: first, learners develop deep, integrated understanding of content and process; second, this approach promotes responsibility and independent learning; third, this approach actively engages students in various types of tasks, thereby meeting the learning needs of many different students; and fourth, students learn to work together to solve problems. Collaboration involves sharing ideas to find solutions to problems. In order to succeed in the real world, students need to know how to work with people from different backgrounds. PBS offers multiple ways for students to participate and demonstrate their knowledge consistent with their varied learning styles. PBS promotes the development of inquiry skills, problem solving skills, and information skills. Students may acquire lab experience and gain a higher level of cognitive skills (such as asking questions) and affective outcomes (such as curiosity and skepticism).

Based on the PBS approach presented by Krajcik et al. (1999) and the systems' life cycle model (Sage, 1995), we suggest a Project-Based Technology (PBT) model for designing a learning environment that will help promote technological literacy (see Figure 1).

The PBS approach engages learners in exploring important and meaningful questions through a process of investigation and collaboration. Students ask questions, make predictions, design investigations, collect and analyze data, use technology, create products, and share ideas. According to the PBT approach, students are required to design a technological product/system based on scientific, technological, social, and environmental principles. To emphasize technological and not merely scientific literacy, a unique quality of PBT is that the starting point is that of the actual technological requirements and needs

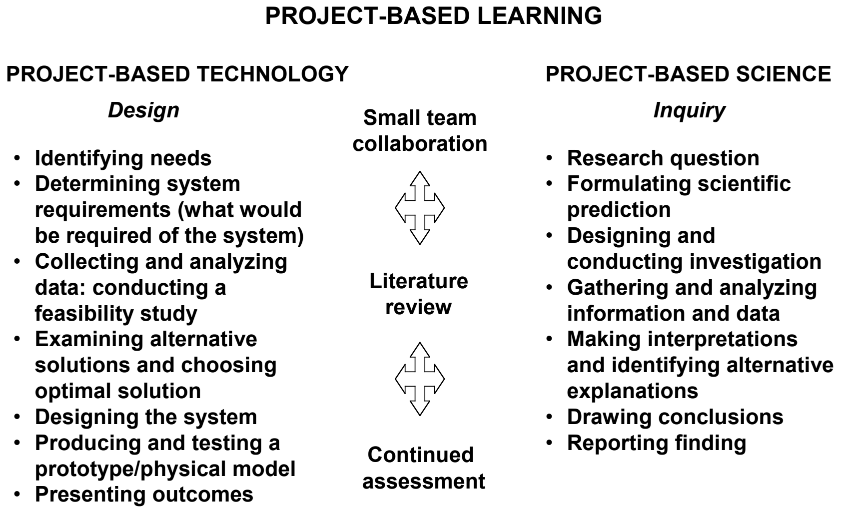

Figure 1. Project-based technology versus project-based science.

rather than a research question as in PBS. The students first identify the needs, define the system's mission and goals, and analyze the requirements. They then investigate alternatives for implementation, collect and analyze data through a process of investigation and collaboration, and conduct a trade study, after which they design the system, using a top-down approach (Frank, 2005: pp. 27-28).

The final outcomes of the project are group and individual written reports, a portfolio, a multimedia presentation in the classroom presented to the course colleagues and staff, and a physical artifact, which can assist a secondary school teacher in demonstrating a scientific and/or technological principle underlying the system.

Following are examples of students' projects: a car driven by solar energy, a water desalination system, a remote cardiologic testing system, an automated watering system, a hot air balloon system, and an automated purification system for aquarium water.

Our goals in designing a PBT learning environment were to expose the students to the synthesis processes (not just the analysis processes), and to familiarize them with technological design procedures and some engineering principles. We wanted the students to learn to apply an important technological principle - how to arrive at an *optimal* design. Our intention was to familiarize them with feedback loops, the need to make trade-offs, and the need to consider constraints while designing a product.

In PBS (Krajcik et al., 1999) as well as in PBT learning environments, learners develop deep, integrated understanding of content and processes. They learn to work together to solve problems. These approaches promote responsibility and independent learning and actively engage students in various types of tasks, thereby meeting the diverse learning needs of many different students. Students build their own knowledge by active learning and interacting with the environment as suggested by the constructivist approach, working independently or collaborating in teams, and creating a real product. Since students deal with relevant issues, their motivation increases. Students' awareness of scientific, technological, social, and environmental aspects increases and academic achievement may be improved.

The role of the teacher in both approaches differs from the traditional role. The teacher is no longer merely a provider of facts but rather a resource provider, learning environment shaper, and a tutor (Buck, 1999). The teacher may also find the work more interesting and motivating since teaching will vary every year. The teacher continually receives new ideas, thus becoming a lifelong learner.

Objectives

The objectives of the study were to: (1) investigate which implementation issues and processes pre-service teachers encounter in a PBT environment whose design is based on the guidelines and professional development standards for technology teachers, (2) learn about the students' ideas (cognitive aspects), emotions (affective aspects), difficulties, and behavior (behavioral aspects) while learning in a PBT learning environment, and (3) identify the benefits and challenges, from the perspective of the students, of the PBT learning environment.

Method

The study was based on a combination of qualitative and quantitative data analyses. Qualitative tools for collecting data included "the participant as observer," observations in the classroom, and semi-structured interviews with students. The trustworthiness of the qualitative findings was achieved by recording the interviews, cross-referencing sources, and triangulation. The latter involved omitting all findings not found in at least three interviews or at least three different data collection techniques from among observations, interviews, open questions, and students' final reports. The findings were presented to the subjects in order to assess the extent of their agreement with the interpretations (respondent validity). The data analysis strategy used was content analysis. To assure reliability, data were collected at different times and stages during the course.

The tools for collecting quantitative data were a questionnaire and analyses of students' final reports and products. The questionnaire was comprised of three parts – demographic information, closed questions, and open questions. The scale of the closed part ranged from 1 (strongly disagree) to 5 (strongly agree). To assure the questionnaire's content validity, each item was based on literature review, study objectives, and broad agreement between the three course instructors.

From the demographic part of the questionnaire, the authors learned that the course participants (i.e., the subjects of this study) were pre-service teachers studying towards a teaching certificate in the Department of Education in Science and Technology, parallel to their studies towards a B.Sc. degree in one of the faculties of Sciences or Engineering. The study was conducted in three consequent courses, fourteen weeks each. Overall 92 students, 51 females and 41 males, participated in the study. The average age of the subjects was 24 years and nine months. Every weekly class included a one-hour lecture, two hours of microteaching, and three hours dedicated to the team project.

As mentioned above, the PBT approach was the main teaching method applied in the courses. In addition, three more teaching methods were implemented: introductory lectures, textbook evaluation (using rubrics), and micro teaching. The course assessment was based on the formative assessment of students' performance in microteaching, active learning in the National Museum of Science and Technology, group assignments, and interdisciplinary team projects based on the PBT approach. The project grade was 55% of the final course grade. 10% (out of 55%) was for the physical model, 5% for a Power Point presentation, 10% for meetings with the course staff, 20% for a group report, and 10% for a personal reflection report. Several rubrics were developed for assessing the above assignments: an analytical rubric for assessing the group report and holistic rubrics (Birenbaum, 1997; CPS, 2000) for assessing the personal report, the Power Point presentation, the physical model, and the documentation of the meetings. Using the rubrics enabled both instructors and students to monitor progress and help guide them throughout the project.

An interdisciplinary team, two lecturers and one teaching assistant, carried out the course teaching as well as the research. One lecturer is an expert in technology teaching and the second is an expert in biology teaching. The teaching assistant has a M.Sc. degree in chemistry/biology teaching.

Major Findings and Discussion

This section describes how the course was designed to apply five out of seven of ITEA's professional development standards by implementing some of the guidelines. The sixth and seventh standards deal mainly with in-service teachers and were not included.

Standard PD-1: *Professional development will provide teachers with knowledge, abilities, and understanding consistent with Standards for Technological Literacy: Content for the Study of Technology (STL).*
Guideline A: *Prepare teachers to understand the nature of technology*

To expose the students to the nature of technology and to teaching methods suitable for revealing the nature of technology, the course included lectures dealing with the nature of technology, discussions, and analysis of students' work. For example, in one lecture, a comparison between science and technology was discussed (see Table 1).

As mentioned earlier, the main learning objective was the following: Upon completion of the course, students should be able to apply design considerations and processes to actual projects. After analyzing the students' final reports, it was found that 67% of the students took trade-offs and optimum considerations into account, 89% presented more than one alternative to resolve design issues and had chosen the optimal solution based on comprehensive and reliable data, and 85% began the design process with top level considerations and only afterwards went over the details. In addition, after analyzing the answers to the questionnaire, it was found that students became aware that engineering design operates within constraints (67%) and that in engineering there is always more than one possible solution (89%). The students became familiar with the nature of engineering and design, with 56% indicating that learning by PBT helped them to better understand that technology draws on science and contributes to it. In fact, 61% indicated that PBT helped them understand that science and technology are strongly connected and that engineers should use their knowledge of science and technology to solve practical problems. In addition, nearly all experienced the importance of the cooperation between the team members, with 89% indicating that it is important for them to know what other

Table 1
Comparison between Science and Technology

Dimension	Science	Technology
Analysis and Synthesis	Analysis – to explore, analyze and explain natural phenomena	Synthesis – to design, create, and build new products; to assemble parts into a system
Abstract and Concrete	Theory and theoretical aspects	Theoretical and applied aspects
Inquiry and Design	Inquiry	Design
Idealization and Optimization	Perfection	Optimum
Variables and Constraints	Variables	Constraints
First phase	Inquiry question	Need of definition and requirements analysis
Driving force	Curiosity	Human need
Precision and tolerance	Accuracy	Tolerance, trade-off
Hypotheses and alternatives	Hypotheses	Alternatives

team members do, how they progress, what difficulties they face, and what their contributions to the project are.

Guideline B: *Recognize the relationship between technology and society*

The students understood that, in addition to the scientific-engineering aspects, one must also consider the social-environmental aspect. For example, here are quotes from three interviews with students, all related to social-environment aspects:

> After extensive reviewing of dozens of Internet sites, we put a lot of effort into sorting out the data and selecting the sites that deal with scientific, technological, and social aspects related to a car that operates by means of solar energy.
>
> While building an artifact for demonstrating the pulse in the human body we decided it was very important to investigate the issue of physical fitness and its significance for keeping the heart healthy.
>
> We had to explain the chromatography method. We decided to refer also to the issues of pollution and purification of the drinking water and to explore the methods used by some countries to reduce water pollution.

Guideline D: *Prepare teachers to develop abilities for a technological world*

According to many authors, there are eight levels of ability for technological problem solving (for instance, see Mioduser 1998): (1) the knowledgeable consumer (knows what and how to check prior to purchasing), (2) the knowledgeable user (is able to operate technological systems and products by using manuals), (3) the problem solver (is able to resolve simple malfunctions and failures at home), (4) one who uses technology in order to pursue a hobby (builds, assembles and repairs technological systems and products), (5) the vocational education graduate, (6) the artisan-technician-practical engineer, (7) the engineer and (8) the scientist-engineer.

This eight-level model was introduced to the students. Since the course described in this paper was designed for junior high school pre-service teachers, the emphasis was on the first level – *the knowledgeable consumer*. The main issues discussed with the students were how to choose between commodities and products based on the Life Cycle Cost model, maintenance and operation considerations, user friendliness, environmental considerations, etc. The students were required to apply these principles to their project.

Standard PD-2: *Professional development will provide teachers with educational perspectives on students as learners of technology*

Guideline B: *Prepare teachers to provide cognitive, psychomotor, and affective learning opportunities*

Analyzing the raw data collected in the study revealed that the PBT learning environment may serve to enhance the students' self esteem. For example, one of the students attests to the following:

> At first I had many apprehensions, but the more we progressed in our work and were able to successfully accomplish more and more tasks, the more my self

> confidence increased and the more I began to believe in our ability to complete the project and meet all the course requirements.

Whereas another student stated the following about a team-mate:

> In the beginning, M. was the weakest link in the team. We demanded that she be a more active participant and the more progress we made, the more active and creative she became. Suddenly, she started to raise many new ideas … her self-esteem increased …

Researchers of the PBL method relate to the issue of self-esteem in an indirect manner. In some studies, a positive correlation was found between self-esteem and receiving positive assessment (Battle, 1991). Therefore, it is likely that in the PBT environment, which is based on formative assessment and continuous support such as the case here, an increase in certain students' self-esteem would be found.

Guideline C: *Prepare teachers to assist students in becoming effective learners*

Active learning is a principal characteristic of the PBT environment that is based on the constructivist approach to teaching. In the course presented here, students were, in fact, required to construct their knowledge by means of active experience and learning in the form of trial and error. Krajcik et al. (1999) suggested the following benefits of this approach for the students. Firstly, learners develop a deep, integrated understanding of content and process. Secondly, students learn to work together to solve problems. Collaboration involves sharing ideas to find answers to questions. In order to succeed in the real world, students need to know how to work with people from different backgrounds. Thirdly, this approach promotes responsibility and independent learning. One student articulated it very eloquently:

> While deliberating on a certain issue and searching for information sources related to this issue, I was able to come to a conclusion of my own. It was a great experience, and I am sure that I will never forget this material.

Another student emphasized the intensive activity of searching and categorizing relevant interdisciplinary information:

> After extensive reviewing of dozens of Internet sites, we put a lot of effort into categorizing the data and selecting the sites that deal with scientific, technological and social aspects related to a car that operates by means of solar energy.

Standard PD-3: *Professional development will prepare teachers to design and evaluate technology curricula and programs.*

Guideline A: *Prepare teachers to design and evaluate curricula and programs that enable all students to attain technological literacy*

One of the main assignments in the course was to evaluate the national curriculum of science and technology in junior high school. They were required to assess, according to given criteria, the learning goals, teaching strategies and methods, assessment and evaluation approaches, learning environments design and the learning materials.

The students were requested to discuss the advantages and challenges of the PBT approach in their reports based on what they had experienced in their project work. By analyzing the answers to the questionnaire, it was found that 85% of the students indicated that they would attempt to integrate this approach in their teaching and think that the process they experienced will help them design and manage PBT learning environments in the future.

Guideline B: *Design and evaluate curricula and programs across disciplines*

The national curriculum of science and technology in junior high school is characterized as an interdisciplinary subject. The learning and teaching is based on the Science/Technology/Society approach. It integrates aspects of science (biology, chemistry, physics and earth science), technology, and society.

While working on the projects, students noted that they acquired interdisciplinary knowledge. For example, one student related to the need to gain knowledge from various disciplines:

> We were required to cope with issues from various disciplines – Biology, Chemistry, and Technology. Each of us studies a specific subject and the need to perform a joint project forced us to study subjects from other disciplines. I understood that using this method helps the student acquire knowledge from other domains.

Other students indicated teamwork as a means of acquiring interdisciplinary knowledge:

> Each of us contributed his share. We were exposed to various work methods of our own … we were exposed to a variety of ideas … we learned from one another … I learned from my colleagues' unique subjects.

Or:

> There existed among us team members a readiness to share information and ideas … each team member came from a different field, and through our mutual work, a variety of ideas and scientific aspects were raised … I majored in chemistry, whereas the other members of the team majored in agricultural and civil engineering…. I helped them understand concepts in chemistry, which were totally new to them.

The students' perception of the interdisciplinary knowledge acquisition as an advantage of PBT was also manifested in their answers to the questionnaire. Based on their experience in the course, 95% of the students maintained that PBT allowed them to acquire knowledge and enhance their understanding in interdisciplinary subjects. Indeed, according to Krajcik et al. (1999), students in

PBS are engaged in active learning and gain interdisciplinary knowledge while working in a real-world context.

Standard PD-4: *Professional development will prepare teachers to use instructional strategies that enhance technology teaching, student learning and student assessment*

Guideline C: *Prepare teachers to utilize student assessment*

The formative assessment strategy that were applied in the course served, among other things, as a means of locating students' difficulties and choice of intervention in regard to assisting the students who face difficulties. The feedback we provided related mainly to the quality of the work and included advice suggesting what the students could do to improve their work (Black & William, 1998). Each group met with one of the course teachers for a formal meeting once every three weeks.

The students reported on what they had done since the previous meeting. Students' hardships were discussed, as well as coping methods for dealing with these hardships. The focus was on assessment for learning – assessment whose purpose is to enable students, through effective feedback, to fully understand their own learning processes and the goals they are trying to accomplish (Elwood & Klenowski, 2002). The interaction between the teacher and the team also included feedback and assessment regarding the degree of progress made. Each team kept the reports and the summary of the meetings with the teachers in a group portfolio.

By analyzing the students' final reports, it was found that the majority of the students maintained that continuous assessment throughout the course advanced the learning process in general. The students indicated six reasons: it helped them to understand the course goals and requirements (89%), it assisted them in evaluating the degree of progress (86%), it helped them cope with difficulties and locate the specific points that required correction or improvement (84%), it emphasized the need to examine additional aspects related to the project (82%), it assisted them in coping with conflicts among team members (77%), and it allowed the course teachers to identify the students who were experiencing difficulties (75%).

Standard PD-5: *Professional development will prepare teachers to design and manage learning environments that promote technological literacy*

Guideline B: *Prepare teachers to design and manage learning environments that encourage, motivate, and support student learning of technology*

In answering the questionnaire, 85% of the students agreed that working in a PBT environment raised their learning motivation and responsibility. 90% of the students agreed "to a large/very large extent" that PBT allowed them to be engaged in everyday relevant issues. These findings are also substantiated in the literature.

Reviewing the literature reveals that many researchers believe that in PBL the student's responsibility for learning is higher compared with traditional learning methods and that under certain conditions, the students' motivation for learning is increased (Buck, 1999). Green (1998) noted that learning by means of a project is likely to increase motivation and provide students with a sense of satisfaction. Students know that they are full partners in this learning environment and share the responsibility for the learning process.

Guideline D: *Prepare teachers to design and manage learning environments that reinforce student learning*

One advantage identified by a large number of students, is that in the PBT approach, the responsibility for the learning lies with the student. 90% of the students agreed ‘to a large/very large extent’ with this item in the questionnaire. This finding is also substantiated by some students’ responses in the interviews. For example, one of the students mentioned social pressure within the team as a factor that stimulated her to strive harder:

> During the course of the teamwork, I realized the magnitude of my responsibility. I undertook a task and my teammates expected me to perform it to the best of my ability. I realized that I could not let them down. If I “screwed up,” the quality of the teamwork could be adversely affected and we would all lose.

Another student expressed a similar idea, only in slightly different words, while mentioning the relevance as a learning motivation rising factor:

> Regarding the work allocation among us, I was in charge of a certain issue. I promptly understood that I had to master that issue so that I could later teach it to the other members of the team. The subject I had to learn was selected by me because I was interested in it. It was something I had encountered in a different course. It was really “fun” to dwell on it.

There were students who felt that participation in and responsibility for the learning processes was greater in the PBT environment than in a traditional course:

> In this course, we were the focus…it all depended on us… Whoever really wanted to learn made the effort and those who didn’t could be passive members of the team…
>
> There were no tests… grades were given according to the effort we invested, the quality of production and presentation to our colleagues…What you give is what you get…

Conclusion

The course described in this paper – Methods for Teaching Science and Technology in Junior high School – was designed to meet the professional development standards through the guidelines offered by the ITEA. While working on their projects, the students experienced the advantages and challenges of the PBT approach. The advantages and challenges are detailed herein. Most students indicated that they would attempt to integrate this approach in their teaching and think that the process they experienced will help them in the future to design and manage PBT learning environments. It was found that in the course of their active experiencing, the students acquired interdisciplinary scientific/engineering knowledge and pedagogical knowledge, and also familiarized themselves with the design process.

While working on the projects, the students were exposed to the nature of technology and to teaching methods suitable for revealing the nature of technology. The students learned how to take trade-offs and optimum considerations into account, present more than one alternative to resolve design issues, and begin the design process with top-level considerations. It was found that students became aware that engineering design operates within constraints and that, when it comes to engineering, there is always more than one possible solution. They became familiar with the nature of engineering and design and experienced the importance of cooperation among team members. The students also understood that, in addition to the scientific/engineering aspects, one must also consider the social-environmental aspects.

Applying the PBT approach and the professional development standards and guidelines may promote technological literacy and serve as a means for preparing future teachers to design and manage learning environments for developing technological literacy. The findings and implementation tips presented in this paper may serve as a basis for a follow-up empirical/quantitative study based on a random sample and inferential data analysis.

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Engineering a Poem: An Action Research Study

Janice Koch and Brooke Feingold

Overview

This study explores the use of design technology to teach a unit on poetry in a fifth grade class. The main goals of the poetry unit were to develop students' abilities to use their own creative voices to express themselves and to write descriptive poetry that creates detailed images for the reader. To reinforce the latter concept, the teacher used a design challenge that asked these fifth grade students to make a three dimensional representation of the imagery created by another student's poetry. The students' experiences of being immersed in design and construction revealed engagement and attention to detail. Their abilities to meet the design specifications and constraints of this challenge were observed and researched by the classroom teacher. The students' understanding of imagery, appreciation of poetry, and their ability to write poetry improved as the unit progressed. Design technology became a vehicle for creative expression that is not usually associated with the teaching and learning of poetry.

Introduction

This unit was implemented in a fifth grade class and the teacher's goal was to teach the poetry unit while exposing the students to engineering design and the iterative process. This process required students to think about and visualize objects in three dimensions. Their success at doing this was dependent upon the detailed imagery presented by the students' original poems. Many of the same skills that are needed for three-dimensional visualization in engineering design are also useful in representing poetic imagery in three-dimensional form.

The middle school in which the unit was implemented is situated in an affluent suburb of a major northeastern city in the United States, where parent involvement and expectations run high. In the 2002-2003 school year, there were 4874 students enrolled in the school district, with 92.6% of the student population from a white background. The district had only 10 black (not Hispanic) students, 70 Hispanic students, and 5.8% of the students were of Asian, American Indian, Alaskan, or Pacific Islander descent, reflecting a lack of diversity when compared to other districts in the state (NYSED, 2003a). In

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this particular school, only 5.2% of the students were of Asian, American Indian, Alaskan or Pacific Islander descent, 0.8% were Hispanic, and 0% were Black (not Hispanic).

Planning a poetry unit required a block of time spanning two months in order to teach the unit and collect data on the students' experiences combining learning poetry with design technology. Upon completion of the unit, the students were to:

- Understand that poems are used to express emotion and feelings, and to tell stories;
- Understand that poetry may take different forms, such as haiku, clerihew, and an acrostic poem;
- Write descriptive poetry that created descriptive images for the audience;
- Understand that a metaphor is a literary device that creates a relationship by making a comparison between two disparate ideas;
- Understand that a simile is a literary device that is a comparison between two different ideas or concepts using the word "like" or "as";
- Understand that the design process is an iterative process which could serve as a metaphor for poetry as students create and refine their concepts and constructions by testing the poem and the design product as they are being created.
  - Is the poem creating the image I am hoping for?
  - Is the design meeting the specifications and constraints of the challenge?

Teachers have used design technology to help students more fully develop concepts in a variety of subject areas, including mathematics, science, language arts, and social studies. Migdol and Chapman (2001) write about how design projects often lead to missed experiences in the classroom. Instead of fostering critical thinking and strengthening students' inquiry skills, the project becomes the ultimate goal, instead of the learning (p.14). The authors devised a design technology guide to help teachers and students become better problem solvers and more critical thinkers. The technology guide has headings that include brainstorm; plan, design and construct, and reflect; with each having their own subset of questions. Students are expected to ask themselves questions about their choices, and the authors found that when students used this model it helped them to organize their thoughts, justify their decisions, and strengthen their writing skills.

Combining a design project activity with the creative undertaking of writing a poem allows students two venues to express their original ideas. Benefits of poetry may be compared to benefits of engaging in design technology. Routman (1990) offered some benefits of poetry that include:

- Builds immediate success;
- Sets a positive tone for the class;
- Teaches a powerful way to express a personal voice;
- Teaches importance of title, ending lines, and word choice;

- Taps into interest and knowledge;
- Frees kids up to write (p.30).

Design technology can be freeing as well. It can build success and set a positive tone for the class as students are busily engaged in building. It allows students another way in which to express their personal voice without the traditional confines of paper and pencil activities. Design projects also tap into their interests and prior knowledge. For students whose abilities in standard paper and pencil activities are not as strong, design technology allows them to shine. Research shows that differently abled students can take the lead as designers and builders (Koch & Burghardt, 2002).

The Problem

In a setting of high expectations for student achievement, the researcher hypothesized that integrating Design and Technology with poetry might improve student performance in poetry writing, while simultaneously providing a context in which to practice engineering design. Furthermore, the researcher wanted to know how students who were engaged in a poetry unit would experience fulfilling the requirements of a design project.

Methodology: Teacher Research

The field of classroom research, also called action research or teacher research, is a tool for understanding the conditions of learning in the classroom. Classroom research provides insights into *how* students learn by encouraging teachers to use their classrooms as laboratories for the study of learning (Mills, 2000; Sagor, 2000; Burnaford et al, 2001; Johnson, 2005). Techniques for the assessment of student learning are an integral part of classroom research. The researcher had the opportunity to observe student interactions and experiences through an unbiased lens as a result of being a visiting teacher to the class. The following methods for data collection included:

- Analyzing the responses to pre- and post unit assessment instruments;
- Maintaining a teaching journal
- Using frequent minute papers, in which students were asked a question about the unit and given a minute to respond in writing.
- Analysis of student understanding of poetry
- Analysis of student design portfolios and products
- Student self and peer evaluations

Students were provided with a series of poetry assignments. Each assignment was an opportunity for the students to apply what they knew regarding a different type of poem. In order to improve their ability to use imagery in these poems, the students were required to represent their poetic imagery in graphical forms developed through an iterative, engineering design process.

The teacher as researcher was interested in understanding how students who were engaged in a poetry unit would experience fulfilling the requirements of a design project. The problem statement for the design challenge presented to the students read as follows: “Design and construct a three-dimensional representation of a classmate’s poem.” The specifications indicated that the students had to “Represent at least one image from the poem and that their design had to fit into a plastic storage box with the dimensions 12 x 6 x 4½ inches.” The constraints were that the students “could only use class time and materials provided in class.” Since the actual construction of the project was related to a specific form of poetry writing, the first part of the design challenge engaged students in creating a poem that had to include at least one concrete image, a simile or a metaphor, had to be between 10-15 lines in length, have a title, and could not be an acrostic poem. The reasoning behind disallowing the use of acrostic poems was that the researcher wanted the students to use other forms of poetry which would allow them to be more creative. Also, the poems were given to each other anonymously, so if a student used his own name for the acrostic poem, then he or she would be identified to a classmate.

This study describes the experiences of twenty-two fifth graders as they made sense of poetry writing in different formats and engaged in a design challenge related to their original poetry. The students represented heterogeneous abilities and functioned as an intact class. The researcher was a visiting teacher to this class. The class had no prior experience with design technology. Because photographs of the projects and some of the students were part of this study, permissions were secured in advance.

Findings

Students were asked to complete two design portfolios before they began constructing their projects. The “poem portfolio” served as a guide to help students with the planning and writing of their poems. The teacher wanted the students to brainstorm and reflect upon the specifications of the project before writing their poems. Students were given a design portfolio to help them understand how to analyze their classmates’ poems from which they were building a concrete structure. The design portfolio also helped the students to plan the construction of the design. Students made connections between designing an artifact and analyzing the poem, and all students were able to create a concrete three dimensional structure from an abstract idea. The students had a plethora of materials at their disposal, and they were allowed to bring materials from home if they justified the need. Materials included various sizes and types of cardboard, Styrofoam®, plastic containers, cardboard boxes, fabric, pipe cleaners, scissors, hot glue, paper glue, tape, and paper towel and toilet tissue rolls.

Before students began the construction of their image, they were asked to obtain approval from the teacher as indicated by a signature on their design portfolios. This was to ensure that the students had taken the time to carefully plan their designs and select materials. They were also asked to sketch two different examples of the images they were going to create. These images were part of their portfolios.

Pre- and Post Assessment Instruments

In order to assess students' understanding of poetry as a literary form, an assessment instrument was administered prior to teaching the unit. A Likert-type scale was used for the first seven items with the scale consisting of: 1=Totally Disagree 2=Slightly Disagree 3=Undecided 4=Slightly Agree 5=Totally Agree. These items are listed below:

1. I like writing poetry.
2. I feel comfortable writing poetry.
3 I have had a good experience writing poetry in the past.
4 Thinking of ideas to write poetry about is difficult.
5 Learning poetry can help me improve in other subjects in school.
6 Poetry must rhyme.
7 All poems have to be about nature.

With items 8-14, listed below, students were asked to supply short written answers.

8. When I think about poetry, I think of.. .
9. What is your favorite subject?
10. What is your favorite type of poetry?
11. Write about an experience you have had writing poetry.
12. If you were to define poetry, what would you say it is?
13. Can you name a poet? If you can write it here.
14. List some examples of different types of poetry you may know of.

Item 15 asked the students to write a poem. Once they were finished, they were asked to circle the descriptive words that they used and to underline the two rhyming sentences that were part of the specifications:

15. Write a poem about the experience of eating pizza to someone who has never had it before .The poem should have at least six lines, three descriptive words, and two rhyming sentences.

Finally, the students were asked to read five sentences and indicate whether they included a metaphor or a simile:

16. Juliet is the sun.
17. Her brain is like a marshmallow.
18. That guy is a motor-mouth.
19. I am as content as a hen on her nest.
20. River races round its bend like a pack of black cats.

The instruments indicated the identity of the students, however, they were not used as a formal assessment tool and hence, they were answered without anxiety or fear of reprisals. Since the same instrument was repeated after the completion of the unit, the final scores indicate what, if any, gains in comprehension and attitudes were made through this integrated unit. The scores on the post assessment instrument improved greatly compared to the pre-assessment (*n* = 22). The average score on the pre-assessment instrument was 71.9%, and the mode was 80. On the post assessment instrument, the average was 91.7% and the mode was 100, revealing that many students had perfect scores on the final assessment of the poetry. This represents a significant increase in student understanding of poetry.

Seventy-two percent of the students could not name a poet on the pre-assessment instrument and of the 27% who did, 18% wrote Shakespeare. The other three answers were Shel Silverstein, Theodore Roosevelt, and one student named herself. This latter student excelled in the unit due to her own sense of herself as a poet already! On the post assessment instrument, 27% of the students could *not* name a poet. The most popular answers were Jack Prelutsky and Joyce Armor, with 13% of the students naming those poets. None of the students who answered the question on the pre-assessment instrument gave the same answer on the post assessment instrument.

Another question asked the students if they liked poetry based on a Likert scale of one through five (with five being ‘strongly agree’). On the pre-assessment instrument, 9% scored either a one or a two, 50% scored a three, 18% scored a four, and 13% scored a five. On the post assessment instrument, 4% scored either a one or two, 18% scored a three, 45% scored a four, and 27% scored a five. From the pre to the post assessment instrument, students went from being undecided about liking poetry to either slightly agreeing or strongly agreeing.

The pre and post assessment instruments asked students if they felt comfortable writing poetry, which was also scored on a Likert scale. On the pre assessment instrument, 4% of the students scored a one, 12% a two, 31% a three, 29% a four, and 18% a five. On the post assessment instrument, no students scored a one, 4% scored a two, 18% scored either a three or a four, and 59% scored a five. Students felt more comfortable writing poetry after the completion of the unit than they did at the beginning of the unit.

Students were asked to define poetry on both the pre and post assessment instruments. Sixteen percent of the students on the pre-assessment did not have an answer. Another 16% said that it had to do with feelings. All of the answers were positive. On the post assessment, only 4% of the students said that they could not define poetry. Twenty-five percent said it is “about expressing feelings.” The remaining responses were varied (See Table 1).

Table 1
Definitions of Poetry

Definitions	***n***
It is about expressing feelings	5
Stories	4
It is words that do and don't have to rhyme.	3
A creative way to write	1
Words make up beautiful lines	1
A type of writing	1
Words that fit	1
It is about anything you want it to be.	1
I can't explain it.	1
A peaceful way of writing	1
Words that tell about things	1
Soothing, fun projects	1

On the pre-and post assessment, students answered the question, "List some examples of different types of poetry you may know of." On the pre assessment, eight students had no answer, six students had one answer, and five students had two answers. Three students had answers which were not types of poetry, but topics in poetry. These answers included: weather, family, feeling, blue whales, lightning, funny, romantic, loving, and fun. The examples of types of poetry the students gave were: rhyming, acrostic, Japanese, nature, spoken word, and non-rhyming. On the post assessment, the results were related to types of poetry and illustrated in Table 2.

Table 2
Responses to Types of Poetry

Type	***n***
Acrostic	11
Cinquain	8
Clerihew	2
Couplet	14
Diamante	2
Found	1
Free Verse	5
Haiku	8
Limericks	15
Quatrain	16
Rhyming	3
Shape	3

To the question "When I think about poetry I think of..." 37% of the students mentioned rhyming in their answer, while on the post assessment, only 16% mentioned rhyming, with other responses including "feelings," and other personal reflections, indicating that their thinking about poetry was more refined. A decrease in the "rhyming" responses was desired because the students' initial understanding of poetry was that it *had* to rhyme and by the end of the unit, they were able to understand forms of poems that do not have rhyming components.

The researcher was interested in comparing their attitudes toward poetry and evaluated their pre- and post assessment responses to the question, "I feel comfortable writing poetry…" and "I like poetry." Clearly, the dramatic increase in the number of students who felt comfortable with and liked writing poetry revealed an important success for this unit (see Figure 1).

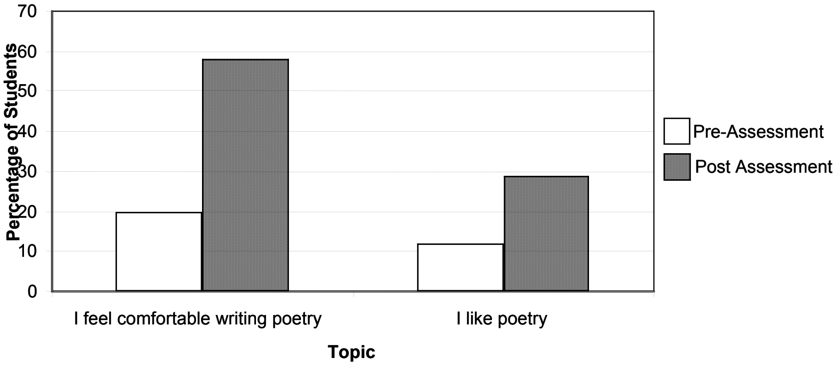


Figure 1. Students who scored a "5" in response to feelings about poetry.

Analysis of Teacher Journal

Throughout this unit, the teacher as researcher maintained copious notes recording the interactions involved in implementing the unit. As a result of analyzing this narrative data, the researcher identified three emergent themes. First, the students became more comfortable with sharing their poems orally and participating in class discussion about them. Secondly, the poetry unit gained life and excitement as the design project was introduced. Finally, the students gained expertise in manipulating the materials they needed to make the model from their drawings in their design portfolios. Clearly, the use of the portfolio was found to be an important tool for design.

Analysis of Minute Papers

At the end of various class sessions the teacher would have the students respond to prompts about their class work anonymously. These "minute papers" were a quick and informal way for the students to provide insight into what they were thinking, feeling, and learning about poetry without the pressure of censure. The final minute paper given on the last day of the unit asked the students, "How did the construction of your design project enhance your learning of poetry?" Twenty four students responded. Seventy-one percent indicated that it did improve their understanding of poetry. Their explanations varied. One student wrote, "It did because you not only get to picture your image you get to see the image and look at the details." An insightful response was, "It enhanced my learning of poetry because now I know that poetry doesn't have to just be in poem form, it can be in project form."

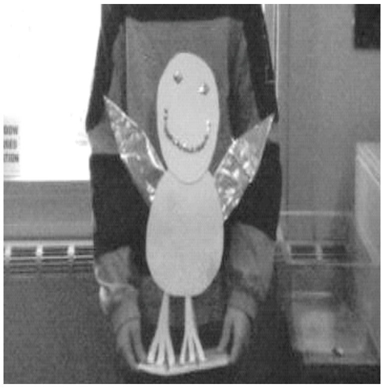
Students were also asked to respond to the prompt, "From this experience I learned..." in minute paper form. One student stated the essence of the entire unit by writing, "I learned that poetry and poems can be three dimensional." Another statement that showed that the student responding understood the importance of planning in design was, "It is easier to first think and then work, then [to] work and [then] fix." The researcher could tell that this student had difficulties tackling the design process because he wrote, "Building is a long and hard process." However, another student overcame the obstacles in her design because she wrote, "You can make anything if you just try to make it."

Analysis of Peer Evaluations

There were many different types of concrete interpretations of the students' poetry. Most students put a lot of effort into their work, which was revealed in the peer evaluations that indicated how accurately the finished projects depicted the images represented in the poem. Student peer evaluations also pointed out those projects that did not accurately reflect the designer's effort or accuracy of poetic interpretation. For example, one student had written a poem about the beach, and her peer had decided to build a sand castle, which is one of the images in the poem (see photo below). When evaluated, the designer was given a four out of a scale of five for how well she represented the poem because, "She did make a sand castle but there were also many other images to focus on." However, she was assigned a five for effort because, "She put a lot of effort in and tried her best to make it look good." Another student created a tree out of cardboard tubing and pipe cleaners as the image he was depicting from a poem about summer and swaying trees. His peer, who evaluated his work, commented, "I could not tell that it was a tree or that it went with this poem" and "I can't tell that he did a lot of work, but it looks simple and effortless." Another student depicted the image of her dog from a poem titled, "I loved Teddy". The designer took great pains to create the dog sitting on a cappuccino colored couch which is described in the poem. The evaluator gave this student a five for effort, because, "she put every minute you possibly could have into this project." There was also a poem written about a dog titled, "The Cutest Doggy." The evaluator gave the designer a five for effort because "the dog looked great and there was a lot of detail in it." However, the evaluator gave the designer a four in the category of how well the designer represented the poem because "The designer made the dog smiling and wagging her tail, but [she] didn't include anything that the dog was doing [as described in the poem]." I often found myself agreeing with the peer evaluators. The overall trend in the peer evaluations revealed that the students were able to be honest and critical while adhering to design specifications and constraints.

Waves rise up and then crash down
People laying in the sand
As children play and make sand castles
Beautiful sunsets
As the seagulls fly by
Tan, brown, and peach colored shells
Wonderful sea creatures like jellyfish and crabs
The waves are as blue as the sky
The sun beams down
So people get a tan
Beautiful things
and beautiful land

Figure 2. Completed design challenge project and poem “The Beach



Soaring Eagle
in the sky
the U.S. label
a predator
soaring
above all
the king
of the land
the top
of the chain
it’s wings
a sword
piercing
the sky
soaring eagle.

Figure 3. Completed design challenge project and poem “Soaring Eagle”

Parallels between Design Technology and Writing Poetry

As the students worked on constructing their design projects, the teacher as researcher was struck by the similarity of processes required for planning and creating an artifact such as this one, and planning and creating a poem. Both processes are iterative - that is, they begin with a plan that builds upon itself as it unfolds. The nature of poetry writing, like the nature of the design process, is also recursive as the designer goes back to re-do a design and the poet re-works an idea or an image by returning to lines in the poem that do not seem to work. As indicated by excerpts from the minute papers, students were challenged by writing the poems *and* creating the artifacts.

It became apparent that many of these students are accustomed to following explicit directions and are very good at it. However, when the directions include a challenge to be open-ended in their thinking and their designing, they become insecure and a bit unsure of themselves.

Conclusions

Based on the percentage of students improving from the pre assessment to the post assessment, it is plausible that the unit on poetry improved student achievement. However, based on the findings in the last Minute Paper, it would appear that the combination of both the design project and the poetry instruction allowed students to feel more comfortable expressing detail in their imagery and representing it through design and construction. Further, students with learning difficulties excelled when planning and constructing their designs. Their inclusion in this process was easier for them than the actual poetry writing. Hence, the use of design and construction allowed them to be more engaged. In addition, students who were not easily inclined to write and did not like the poetry unit became more invested in the unit through the design project. Through this classroom research, the discovery was made by the teacher as researcher that children's own ideas and opinions were validated through the dual creative processes of design and poetry writing.

Implications for Future Use of Design Technology

This study lends support to the idea that integrating design technology and language arts may be a way to improve student achievement. It provides some evidence that design technology can play a role in improving students' academic achievement. In another study, a researcher noted "we observed that student involvement in engineering design units led to their learning valuable and transferable problem solving skills as well as deep acquisition of [science] concepts" (Yocom de Romero, Slater, & DeCristofano, 2006). The importance of design technology for this poetry unit cannot be underestimated.

The researcher recommends that a control group be used in similar studies in the future study. The control group would receive only the poetry instruction and not the design instruction. This would allow a comparison between a traditional approach to poetry instruction and the curriculum integration approach.

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The Effectiveness of *Project Lead the Way* Curricula in Developing Pre-engineering Competencies as Perceived by Indiana Teachers

George E. Rogers

High school teachers from across the nation are realizing that their schools could provide pre-engineering programs that allow students to explore their strengths and interests in engineering and engineering technology (Thilmany, 2003). According to Dearing and Daugherty (2004), leaders from both secondary technology education and college-level engineering have called for changes in the high school curriculum to address the need to adequately prepare high school graduates related to engineering and technology. To address this need, school districts across the nation are implementing pre-engineering courses into their curriculum. As schools infuse these pre-engineering programs, leaders and teachers in technology education are debating the merits of pre-engineering education (Lewis, 2004).

Research in Indiana has indicated that "technology education teachers have embraced pre-engineering education as a very valuable component of technology education" (Rogers, 2005, p. 18). Rogers went on to note that technology education teachers from Indiana also view the pre-engineering curriculum as beneficial in developing technological literacy. Rogers and Rogers (2005) concluded that the forward provided by William A. Wulf, president of the National Academy of Engineering, in the *Standards for Technological Literacy: Content for the Study of Technology* (International Technology Education Association, 2000) provides clear evidence that pre-engineering has become a component of the technology education discipline.

During the past decade, according to Pearson (2003), engineering associations, curriculum developers, and the technology education profession have devoted numerous resources toward developing instructional materials, initiating projects, and producing media programs to revise the curriculum to include engineering concepts. Schroll (2002) noted that there was concern in the profession about whether the discipline was creating appropriate pre-engineering curricula that aligned with the knowledge base required by secondary education graduates for today's workplace. Grimsley (2002) added that the national

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educational focus is now on student accountability and student achievement, and that educators are being held accountable for their students' performance. If this is the case, how does the push for inclusion of pre-engineering curriculum affect students' development of identified competencies?

According to McVearry (2003), Project Lead The Way (PLTW) is the nation's premier program in providing high schools with pre-engineering curriculum and linkages to college-level engineering and engineering technology programs. PLTW (2005) described its curriculum as a four-year sequence of courses which, when combined with college preparatory mathematics and science courses, introduces students to the scope, rigor, and discipline of engineering and engineering technology. PLTW has grown from 11 high schools, mostly in upstate New York, in 1997 to a current total of over 1600 schools in 46 states, plus Great Britain (McVearry; PLTW). Bottoms and Anthony (2005) noted that the PLTW curriculum contains effective educational learning activities that positively affect students' learning of pre-engineering competencies. Grimsley (2002) went on to note "the primary difference in pre-engineering courses taught at most schools . . . is that students are held accountable for a more in-depth knowledge" (p. 3).

Is there evidence that school pre-engineering programs, such as PLTW, can make a difference for today's high school student? Does the claim of Bottoms and Anthony (2005) that "PLTW stresses the importance of engaging students in challenging assignments that require them to apply academic and technical knowledge and skills to complete real-world projects" (p. 12) affect the development of students' competencies in engineering and technology? Bottoms and Anthony continued by noting that the achievement of PLTW students was significantly higher than other high school students with similar backgrounds. Do classroom PLTW teachers support this claim?

Bottoms and Anthony (2005) noted that "analyses of PLTW students suggest that to improve the quality of high school career/technical studies" schools must "invest in developing high-quality instructional and curriculum guides that define course objectives, outline the content to be covered, and provide challenging, authentic projects – projects that require students to apply academic and technical knowledge" (p. 14)). Dearing and Daugherty (2004) called for the profession to carefully develop curriculum materials related to pre-engineering education. Bottoms and Anthony concluded that the PLTW curriculum provides students with quality learning experiences. Again, one must ask if there is any research to support these assertions.

Research Questions

The following research questions were addressed by this study.

1. Do high school teachers perceive PLTW learning activities as effective in developing pre-engineering competencies for their students?
2. Are there differences between high school teachers' perceptions regarding the effectiveness of various PLTW curricula in developing high school students' pre-engineering competencies?

Methodology

In order to address these research questions, this study used a survey technique to ascertain the perceptions of Indiana's technology education teachers who currently teach PLTW courses. The State of Indiana was selected to serve as the base for this research since the PLTW curriculum is included in the State's technology education curriculum, requires PLTW teachers to hold a technology education teaching license, and has the highest per capita inclusion of PLTW in the nation.

Instrument

These PLTW teachers were first asked to provide demographic data: PLTW courses taught, highest degree earned, age group, and professional association membership. A survey instrument was developed that listed 14 pre-engineering competencies addressed by the PLTW high school courses of Introduction to Engineering Design (IED), Principles of Engineering (POE), Engineering Design and Development (EDD), Civil Engineering and Architecture (CEA), Computer Integrated Manufacturing (CIM), and Digital Electronics (DE). Competencies were considered to be the general descriptions of student abilities needed to succeed in a post-secondary engineering or engineering technology program (PLTW, 2005). The competencies were selected as representative of the PLTW curriculum by a team of PLTW affiliate professors and PLTW curriculum consultants.

The IED course provides students with an application of the engineering design process based on parametric modeling techniques. POE provides high school students with a broad overview of the engineering field including statics, vector diagrams, tensile testing, and problem-solving. The DE course is focused on circuit design, logic gates, and microprocessors. CEA is concerned with developing knowledge and skills related to commercial site preparation, structure design, and building requirements. CIM is a course that allows students to develop skills in transferring design models to machining programs and then applying manufacturing automation. The PLTW capstone course, EDD, teams students with a practicing engineer to examine a real-world problem, explore design solutions, build a prototype, and conduct product testing.

PLTW teachers were asked to rate their perception of the effectiveness of PLTW course learning activities in developing pre-engineering competencies in their students. The ratings were on a five-point Likert-type scale: very effective (5), somewhat effective (4), no effect (3), somewhat ineffective (2), and very ineffective (1). The Likert-type scale was suggested for this type of study by both Zargari (1996) and McCall (2001). McCall noted that "the words of the Likert scale are converted in a meaningful way to an interval scale that gives the researcher the ability to use totals or to calculate numerical averages" (p. 2). Construct validity was determined by three pre-engineering education professionals (Borg & Gall, 2002).

Population and Sample

The population and sample for this study consisted of technology education teachers who had completed the PLTW professional development institute at Purdue University and were currently teaching PLTW courses in Indiana. The group was comprised of 76 technology education teachers. To the sample was mailed a cover letter, the survey instrument, and a postage-paid return envelope. The response was 44.7% (*n* = 34). The demographic description of the respondents can be viewed in Table 1.

A master's degree or higher had been earned by 21 teachers (61.8%); 21 respondents (61.8%) were over 40 years of age; and 24 teachers (70.6%) were members of a professional association. Professional associations noted included: the International Technology Education Association (ITEA), the Technology Education Division of the Association for Career and Technical Education (ACTE/TED), and the American Society for Engineering Education (ASEE).

As noted in Table 2, IED was taught by 26 PLTW teachers (76.5%); 12 teachers (35.3%) taught POE; and 17 teachers (50.0%) taught more than one PLTW course. DE and CEA both had six teachers (17.6%) who indicated that they taught those PLTW courses; CIM was taught by five respondents (14.7%); and EDD and GTT were taught by four of these PLTW teachers (11.8%). Teachers who taught only Gateway to Technology, PLTW's middle school course, were not utilized for this study's data analysis beyond the overall effectiveness rating.

Table 1
Demographic Descriptions of Respondents

Variable	*n*	%
Highest degree earned		
Bachelor's	13	38.2
Master's	21	61.8
Years of age		
Less than 31	6	17.6
31-40	7	20.6
41-50	9	26.5
Over 50	12	35.3
Professional association membership		
ITEA	21	61.8
ACTE/TED	2	5.9
ASEE	1	2.9

Table 2
PLTW Courses Taught

Course	*n*	%
Introduction to Engineering Design	26	76.5%
Principles of Engineering	12	35.3%
Digital Electronics	6	17.6%
Civil Engineering and Architecture	6	17.6%
Computer Integrated Manufacturing	5	14.7%
Engineering Design and Development	4	11.8%
Gateway to Technology	4	11.8%

Note: Seventeen teachers taught more than one course.

Findings

The teachers' ratings of the overall effectiveness of the PLTW curricula in developing pre-engineering competencies in students are reported in Table 3. Overall, the respondents indicated that the PLTW curriculum is effective in developing student competency in pre-engineering. The PLTW curriculum was perceived as very effective (*M* = 4.50 or higher) for developing over one half of the competencies noted. Those competencies included "construct electronic circuits (*M* = 4.67, *SD* = 0.492), "apply geometric constraints" (*M* = 4.65, *SD* = 0.485), and "apply the engineering design process" (*M* = 4.65, *SD* = 0.485). "Design logic gates" (*M* = 4.62, *SD* = 0.506), "design electronic circuits" (*M* = 4.62, *SD* = 0.506), "design automated manufacturing systems" (*M*= 4.56, *SD* = 0.512), and "perform parametric modeling" (*M* = 4.50, *SD* =0.508) were also perceived as very effective by this sample of PLTW teachers. Even the lowest perceived item, "perform CIM processes", supported the effectiveness of the PLTW curriculum (*M* = 4.00, *SD* = 1.130).

Table 3
Overall Effectiveness of the PLTW Curriculum

Competency	*M*	*SD*	*n*
Construct electronic circuits	4.67	0.492	12
Apply geometric constraints	4.65	0.485	34
Apply the engineering design process	4.65	0.485	34
Design logic gates	4.62	0.506	13
Design electronic circuits	4.62	0.506	13
Design automated manufacturing systems	4.56	0.512	16
Perform parametric modeling	4.50	0.508	32
Design and prototype solutions	4.39	0.497	28
Design CIM processes	4.33	0.492	12
Construct automated manufacturing systems	4.31	0.793	16
Conduct structural analyses	4.26	0.733	19
Perform materials testing	4.21	0.713	19
Design commercial structures	4.19	0.981	16
Perform CIM processes	4.00	1.130	15

Table 4 presents the teachers' effectiveness ratings of the PLTW curriculum divided by the PLTW courses taught. The competency ratings reported in Table 4 were calculated for only the PLTW teachers who indicated they taught that PLTW course. As previously noted, 17 teachers taught more than one PLTW course. IED teachers indicated that the IED curriculum was very effective in developing student competencies related to "applying the engineering design process" (*M* = 4.73, *SD* = 0.452), "applying geometric constraints" (*M* = 4.62, *SD* = 0.496), and "performing parametric modeling" (*M* = 4.46, *SD* = 0.647). POE teachers did not perceive the POE learning activities as effective as the IED activities, but still perceived the POE curriculum overall as effective (*M* = 4.33 to *M* = 4.00).

Table 4
Effectiveness of the PLTW Curriculum by Course

Course Competency	***M***	***SD***	***n***
Introduction to Engineering Design			
Apply the engineering design process	4.73	0.452	26
Apply geometric constraints	4.62	0.496	26
Perform parametric modeling	4.46	0.647	26
Principles of Engineering			
Design automated manufacturing systems	4.33	0.651	12
Construct automated manufacturing systems	4.33	0.651	12
Perform materials testing	4.00	0.853	12
Digital Electronics			
Design electronic circuits	4.17	0.753	6
Construct electronic circuits	4.17	0.753	6
Design logic gates	3.83	0.983	6
Civil Engineering and Architecture			
Design commercial structures	4.17	0.753	6
Conducting structural analyses	4.17	1.17	6
Computer Integrated Manufacturing			
Design CIM processes	4.40	0.548	5
Perform CIM processes	4.40	0.894	5
Engineering Design and Development			
Design and prototype solutions	4.50	0.577	4

DE teachers perceived the PLTW learning activities focused on developing students' competency to "design logic gates" as the lowest overall item (*M* = 3.83, *SD* = 0.983). DE activities related to "design" and "construct electronic circuits" were noted as effective for students (*M* = 4.17, *SD* = 0.753). The perceptions of the DE teachers related to their DE learning activities were lower than the overall perception of these activities (see Table 3) that included the input from non-DE teachers. CEA instructors indicated that their curriculum was effective for two competencies included in this survey, "design commercial structures" and "conduct structural analyses" (*M* = 4.17). CIM teachers perceived the PLTW CIM curriculum effective (*M* = 4.40) in developing skills related to "design and perform CIM processes," while EDD teachers noted that their curriculum was approaching very effective in developing students' competency to "design and prototype design solutions" (*M* = 4.50, *SD* = 0.577).

Further analysis was conducted only on the responses of the IED teachers and the POE teachers, since the IED teachers comprised 76.5% of the respondents (*n* = 26), and the next largest group was the 12 POE teachers (35.3%). Statistical analyses of the IED and POE teacher groups were conducted using the t-test to compare the teachers by highest degree earned and membership in professional associations. The one-way analysis of variance (ANOVA) was utilized to statistically compare the perceptions of these PLTW teachers related to age group.

In comparing perceptions of the IED teachers (*n* = 26) by highest educational degree earned, bachelor's degree and master's degree, no significant differences were found. However, the IED teachers with a bachelor's degree perceived the PLTW curriculum as being very effective (*M* = 4.89, *SD* = 0.333) in developing student competencies related to "applying the engineering design process" (see Table 5).

Table 5
Introduction to Engineering Design Course Effectiveness by Highest Degree Earned

	Bachelor's			**Master's**					
Competency	***M***	***SD***	***n***	***M***	***SD***	***n***	***df***	***t***	***p***
Apply the engineering design process	4.89	0.333	9	4.71	0.470	17	24	1.030	0.311
Apply geometric constraints	4.56	0.527	9	4.65	0.493	17	24	0.440	0.664
Perform parametric modeling	4.22	0.667	9	4.59	0.618	17	24	1.400	0.175

The results of examining the IED respondents' perceptions related to their membership in a professional association (ITEA, ACTE/TED, or ASEE) are presented in Table 6. There were no significant differences indicated between professional association members (*n* = 16) and non-members (*n* = 10) related to their perception of the effectiveness of the IED curriculum.

Curricular effectiveness examined by IED teachers' age group is presented in Table 7. It must be noted that younger PLTW teachers (less than 40 years of age) and older PLTW teachers (over 50 years of age) perceived the effectiveness of the IED curriculum as more effective than middle-aged teachers (41 to 50 years of age). All of the younger IED teachers (*n* = 9) perceived the IED learning activities in developing student competencies in "apply the engineering design process" as very effective (*M* = 5.00, *SD* = 0.000). An ANOVA related to this competency noted a significant difference between the IED teachers related to

Table 6
Introduction to Engineering Design Course Effectiveness by Professional Association Membership

	Member			**Non-Member**					
Competency	***M***	***SD***	***n***	***M***	***SD***	***n***	***df***	***t***	***p***
Apply the engineering design process	4.75	0.447	16	4.70	0.483	10	24	0.269	0.790
Apply geometric constraints	4.56	0.512	16	4.70	0.483	10	24	0.680	0.503
Perform parametric modeling	4.44	0.727	16	4.50	0.527	10	24	0.235	0.816

Table 7
Introduction to Engineering Design Course Effectiveness Design by Age Group

	Age Ranges					
	< 40 (*n* = 9)		**41-50 (*n* = 7)**		**> 50 (*n* = 10)**	
Competency	***M***	***SD***	***M***	***SD***	***M***	***SD***
Apply the engineering design process	5.00	0.00	4.29	0.488	4.80	0.422
Apply geometric constraints	4.67	0.50	4.43	0.535	4.70	0.483
Perform parametric modeling	4.56	0.527	4.29	0.756	4.50	0.707

Table 7a
Apply the Engineering Design Process Effectiveness by Age Group

Source of Variance	***SS***	***df***	***MS***	***F***	***p***
Between	2.087	2	1.043	7.924	0.002*
Error	3.029	23	0.1317		
Total	5.115	25			

Table 7b

Apply Geometric Constraints Effectiveness by Age Group

Source of Variance	***SS***	***df***	***MS***	***F***	***p***
Between	0.3107	2	0.1554	0.3520	0.707
Error	10.15	23	0.4413		
Total	10.46	25			

Table 7c

Perform Parametric Modeling Effectiveness by Age Group

Source of Variance	***SS***	***df***	***MS***	***F***	***p***
Between	0.3396	2	0.1698	0.6716	0.521
Error	5.814	23	0.2528		
Total	6.154	25			

age ($F = 7.924$, $p = 0.002$, $df = 25$). The ANOVA related to "apply geometric constraints" and "perform parametric modeling" did not indicate any significant differences between age groups.

The comparisons of the POE teachers ($n = 12$) in relationship to their highest degree earned are reported in Table 8. While PLTW teachers with a master's degree did perceive "design and construct automated manufacturing systems" higher ($M = 4.44$, $SD = 0.527$) than teachers with a bachelor's degree ($M = 3.67$, $SD = 1.15$), no significant difference was indicated. Both educational levels perceived activities as effective for the competency of "perform materials testing" ($M = 4.00$). POE teachers' membership in a professional association did not indicate any differences in their perception of the effectiveness of the POE curriculum (see Table 9).

Table 10 presents the POE teachers' perception of POE learning activities grouped by their age. Overall, no significant difference was indicated related to "design automated manufacturing systems" and "design and construct automated manufacturing systems." The older teachers (over 50 years of age) did perceive the POE activities higher in regard to "perform materials testing" ($M = 4.50$, $SD = 0.577$) than the middle-aged POE teachers (41 to 50 years of age) ($M = 3.60$, SD 0.894). However, the ANOVA did not indicate any significant difference between the age groups related to this activity.

Table 8

Principles of Engineering Course Effectiveness by Highest Degree Earned

	B.S. (*n* = 3)		**M.S. (*n* = 9)**				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Design auto manufacturing systems	3.67	1.15	4.44	0.527	10	1.670	0.126
Construct auto	3.67	1.15	4.44	0.527	10	1.670	0.126

manufacturing systems							
Perform materials testing	4.00	0.00	4.00	1.00	10	0.000	1.000

Table 9
Principles of Engineering Course Effectiveness by Professional Association Membership

	Member (*n* = 7)		**Non-Member** (*n* = 5)				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Design auto manufacturing systems	4.29	0.756	4.20	0.837	10	0.185	0.857
Construct auto manufacturing systems	4.29	0.756	4.20	0.837	10	0.185	0.857
Perform materials testing	4.29	0.756	3.60	0.894	10	1.440	0.181

Conclusions

The results of this study indicated that Indiana's PLTW teachers perceive the PLTW curriculum as being "effective" to "very effective" in developing pre-engineering competencies in their high school students. This positive perception was true across all PLTW courses: IED, POE, DE, CIM, CEA, and EDD. This finding concurs with an article by Bottoms and Anthony (2005) that noted the PLTW curriculum contains effective educational learning activities and that these activities have a positive effect on students' learning the PLTW pre-engineering competencies.

Data indicated that one half of the respondents were teaching more than one PLTW course and that three fourths of the PLTW teachers were teaching the IED class. Since IED is the initial high school course, this was to be expected. Demographically, the majority of these technology education teachers were over 40 years of age (61.8%), held a master's degree (61.8%), and were members of a professional association (70.6%).

These technology education teachers indicated that overall, the learning activities included in the IED, CIM, and EDD curricula were perceived as the most effective. Examination of the effectiveness of the IED curriculum by the highest degree earned and professional

Table 10
Principles of Engineering Course Effectiveness Design by Age Group

	Age Ranges

	< 40 (*n* = 3)		**41-50 (*n* = 5)**		**> 50 (*n* = 4)**	
Competency	***M***	***SD***	***M***	***SD***	***M***	***SD***
Design auto manufacturing systems	4.33	1.15	4.20	0.837	4.25	0.500
Construct auto manufacturing systems	4.33	1.15	4.20	0.837	4.25	0.500
Perform materials testing	4.00	1.00	3.60	0.894	4.50	0.577

Table 10a
Design Automated Manufacturing Systems Effectiveness by Age Group

Source of Variance	***SS***	***df***	**MS**	***F***	***p***
Between	3.333	2	1.6667	2.413	0.976
Error	6.217	9	0.6907		
Total	6.250	1			

Table 10b
Construct Automated Manufacturing Systems Effectiveness by Age Group

Source of Variance	***SS***	***df***	***MS***	***F***	***p***
Between	3.333	2	1.6667	2.413	0.976
Error	6.217	9	0.6907		
Total	6.250	11			

Table 10c
Perform Materials Testing Effectiveness by Age Group

Source of Variance	***SS***	***df***	***MS***	***F***	***p***
Between	1.800	2	0.9000	1.306	0.318
Error	6.200	9	0.6889		
Total	8.000	11			

association membership categories indicated no significant differences. However, it was noted that the middle-aged IED teachers (41 - 50 years of age) perceived the IED learning activities lower than their younger or older IED counterparts. This difference tested significant by an ANOVA ($F = 7.924$, $p = 0.002$, $df = 25$). The fact that the older IED PLTW teachers (51 years of age and older) perceived the curriculum higher may indicate that this group views the PLTW IED curriculum as meeting the needs of their students and has accepted this new pre-engineering curriculum (Rogers, 1992).

The findings of this study must not be generalized beyond the sample of Indiana teachers. Furthermore, the reader is reminded that that data are based principally on the perceptions of teachers. However, this study does support the report of Bottoms and Anthony (2005) that indicated that PLTW students were receiving effective high school instruction based on effective curriculum and engaging learning activities. As noted by Rogers (2005), Indiana technology education teachers have adopted the PLTW pre-engineering curriculum and perceive this new curriculum as effective in addressing their students' needs.

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Book Review

An Adventure Living With Simple Technology: A Review of *Better Off: Flipping the Switch on Technology*

Charles C. Linnell

Eric Brende, (2004). *Better Off: Flipping the Switch on Technology*. New York: HarperCollins. $13.95 (paperback), 234 pp. (ISBN 0-06-057004-0)

Organizations, such as the Peace Corps, Habitat for Humanity, and the Heifer Project seek to improve the quality of life for people while improving the environment. These organizations try to create a mind-set among their participants to use technology in a sustainable manner. Judging by the ever-increasing numbers who contribute time and resources to these earth-friendly, altruistic efforts, it seems that interest is growing for "doing more with less". Increased demand for organic foods, interest in creating sustainable living/working communities, and frustration with the dependence on, and prevalence of, electronic media, has created interest in living more "simply." Learning to work with basic tools, machines, and living without modern technology was Eric Brende's goal when he embarked upon an eighteen-month graduate research project in an Amish farming community.

Better Off: Flipping the Switch on Technology is an examination of how people can live a simpler, more fulfilling life without modern technology. To put this concept to the test Brende, a graduate student at M.I.T., took time off from his studies and committed to live in a remote Amish community in the Midwest with no electricity or motorized machinery. Specifically, he wanted to experience what life would be like living independent of the great American power/communication grid by using simple tools and horse/oxen-powered machinery for daily farm work. He wanted to observe the social and physical effects on himself and others that the lack of modern technology would have in a secluded, very religious, farming community. He was also interested to see how this lifestyle affected Amish family life. How were the roles of men and

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women altered compared to the families with which he was familiar? How were the children educated about life and work? What were their customs and beliefs related to the use of technology?

The author begins by questioning whether or not our 21st Century lifestyle, that includes SUVs, cell phones, cable TV, laptops, microwaves, long commutes, and sedentary electronic work environments, has made life easier or has it made it more complicated, unfulfilling, and less healthy. He hypothesized that these health and mental issues, prevalent in current society, are due to a lack of work-related exercise and stimulation gained from successfully completing a physical task. Without sounding dogmatic, he presents a convincing argument for appreciating hard work and living life at a more manageable pace. He suggests throughout the book that we should minimize our use of modern technology and focus more on community, family, exercise, and productive work with simple tools.

At M.I.T., Brende became interested in the social and environmental impacts of modern technology after taking graduate courses titled *The History of Technology* and *Science, Technology, and Society*. The more he studied, the more convinced he became that society was missing the importance of clarifying the difference between the use of basic tools for work and exercise compared to the less healthy, sedentary, and repetitive environment of automatic machines. Whereas simple tools are designed and used with physical labor to make work easier, Brende contends that complex machines are often "fuel-consuming things that deprive people of the act of thinking for themselves, physical exercise, and lack of family and community involvement" (p. 7).

On a bus trip to visit family members in the Midwest between semesters, Brende met and spoke with an Amish man and asked about his community's lifestyle. Here was an opportunity to apply his interest and research in sustainable technology in the real world. He asked if it would be possible to come to their community to live, study, observe, and work for a year. Brende soon received a letter inviting him to become a part of their settlement. However, the Amish had a few requirements – in order to preserve their privacy he had to promise not to reveal where the community was located. He and his new wife would be required to participate in daily and seasonal work and abide by the rules of the structured Amish lifestyle. The author agreed gladly. Although his wife was initially hesitant, by the end of the project she became an ardent supporter of the simpler lifestyle. His Amish landlord provided a small house with no electricity or running water and loaned him a few acres to raise crops for food and profit – he successfully grew and marketed pumpkins and sorghum, which his wife used to make and sell molasses. There was a spring with a cistern on a hill near the house. After receiving permission, Brende dug a water line to the house and installed a gravity-fed hand pump in the kitchen. One important tie to the twenty-first century that they were allowed to keep, after much discussion with the elders of the community, was their small car. Brende and his wife justified it by saying that it was to be used only for emergencies (Brende's wife was pregnant) and an occasional research-related academic trip back to Boston and M.I.T to meet with his graduate committee. They agreed to follow the rules of the community – working hard, helping neighbors, living very simply, living without electricity, and with a privy.

Needless to say, as they drove to site of their new adventure to live a life free of modern technology, the author and his wife were nervous. Living without modern technology would present challenges. How would they wash themselves, their dishes, and their clothes without a bathtub and shower, a water heater, or a washing machine? Even though they had been studying organic gardening techniques and animal husbandry, would they be able to grow, harvest, and prepare food and feed themselves with no chemical fertilizer, no herbicides, no motorized machines, and no refrigeration, using an ancient wood-fired cook stove? Would they be accepted into the Amish society? Would they be able to master the techniques required of horse/oxen-powered transportation and machinery – that included traveling to the local farmers' market, plowing, tilling, and cultivating? Would they be able to hold their own with the increased physical demands of Amish shared farm labor? As they came nearer to the settlement and the paved road turned to gravel, they noticed that the land, woods, and fields were well tended. Houses, barns, and outbuildings were very neat and structurally sound. When they arrived at the small farmhouse in which they were to live, they noticed that the inside was clean and newly painted. Their landlord had even plowed and tilled their garden area. They felt that they were ready to begin their adventure.

The author regularly compared the lifestyles of the Amish farmers with the work routines and family life of people in the technologically dependent life they had left. These observations usually ended up with an examination of the dynamics of work – how simplifying technology would impact the workers, their communities, and the environment. The farm work that the author and his Amish colleagues performed every day, except Sunday, was providing not only their living, but also a way to bond with their neighbors by shared labor. This created a sense of community that Brende had never experienced before.

In reviewing this book the reviewer's own biases for using sustainable and appropriate technology were apparent. In a perfect world, experiences like Brende's would hopefully excite and motivate students to give more thought and ask questions about how we are using technology today and the resulting impacts. How do other societies cope with technological change? Are small, self-sustaining farms and the cultures that promote them a thing of the past? Or do they hold the key for managing the sustainable use of natural and human-made resources in a responsible way. There are many problems facing the world today. If students could learn alternative ways of working and living it could lessen our dependence on non-renewable resources and we would all be better off. Just to show that Eric Brende practices what he preaches, he now has reclaimed an old house in St. Louis and is making a living driving a pedal-powered rickshaw and runs a thriving, homemade soap business from his basement.

Miscellany

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