

# The ABC's of Engineering

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## Abstract

Through a nationally funded Preparing Tomorrow's Teachers to Use Technology (PT3) grant, two cohorts of education students were established to create a learning community of skilled technology users. This community of learners was provided with many opportunities to interact with classroom instructors who modeled exemplary use of technology. The students were required to enroll in a technology rich engineering course called *Toying With Technology*<sup>SM</sup> which offered a positive, comfortable, and stimulating atmosphere in order to introduce preservice teachers to aspects of science, math, and technology in the context of engineering. As a major component of the course, students were required to research and design an Engineering ABC Book tailored to both K-12 students and classroom curriculum. A description of the *Toying With Technology*<sup>SM</sup> course, cohort, and the Engineering ABC Book Project are examined and described.

## Introduction

Today, more than ever before, technological competence has become crucial to maintaining our nation's position as a leader in global affairs and to solidifying our position in the emerging global economy (Report of the Expert Panel for the Review of Federal Education Programs in Science, 1993). Furthermore, this situation places special responsibility on American educators to guarantee that students at all levels gain exposure and encompass opportunities to pursue quality science, mathematics, engineering, and technology (SMET) education. To ensure that students are receiving quality educational experiences in the above areas, teachers must be competent and capable of providing their students exemplary learning experiences, yet many education programs are currently graduating future teachers that are unprepared to teach science, math, and technology. K-12 students are still continuing to mainstream into a more technical society and require the skills that these subjects provide to be a more productive, functioning, and educated contributing member of society. As technology is becoming an increasingly important aspect of education and our lives, the absence of

the content and processes of one subject has become increasingly evident over all others: engineering (Erwin, 2001). Erwin continues to state that engineering can be a wonderful and fascinating lens through which to look at the world around us and whether it is the rack and pinion in your ice-cream scoop or the processor in your computer, examples of engineering are abundant and everywhere. Engineering should not be viewed as a separate or new subject to be taught in the classroom but rather a context in which to teach science, math, and technology.

## **The PT3 Grant: The Cohort Students**

During the fall 2000 semester, the College of Education at Iowa State University received a Preparing Tomorrow's Teachers to Use Technology (PT3) grant. The overall goal of the grant was to educate and graduate education students who are confident and competent to assume leadership roles in the incorporation of K-12 classrooms (Thompson & Schmidt, 1999.) As stated by Gallagher & Bauerle (2003), the TechCo project, which evolved out of the overall PT3 grant, provided a technology-infused program where two cohorts of preservice teachers completed three years of technology infused coursework.

The second PT3 cohort consisted of 22 female education students: 1 secondary education major, 2 early childhood education majors, and 19 elementary education majors. The elementary education majors were obtaining endorsements in the following areas: math, Spanish, English/language arts, special education, health, social studies, art, and science. The secondary education student was majoring in biology while the early education majors were not required to seek areas of endorsement.

The cohort student participants were provided with the opportunity to enroll in courses with education instructors who were proficient in technology integration and who modeled exemplary uses of technology in the classroom. One technology rich course that the students were required to enroll in during their three years of coursework together was an engineering course called Toying With Technology<sup>SM</sup>.

## **Toying With Technology<sup>SM</sup>: The Course**

The Toying With Technology<sup>SM</sup> course was initially offered during the 1996-1997 academic year at Iowa State University by two engineering professors: Dr. Larry Genalo and the late Dr. Charles Wright. This engineering course was unique in that it was only offered to education majors. According to Genalo (1998), the course encouraged and assisted students in designing and conducting hands-on laboratory exercises, which were based upon real world problems constructed out of LEGOs<sup>®</sup>. The course expounded upon technological innovations and assisted the preservice teachers in incorporating these activities into classroom curriculum. As stated by Gallagher & Bauerle (2003), the main objective of this course is to offer a positive, comfortable, and stimulating atmosphere in order to introduce preservice teachers to aspects of engineering, science, technology, & mathematics.

The Toying With Technology<sup>SM</sup> course offered to the PT3 cohort was divided into three distinct and unique experiences. Students embarked upon the course by building robotic cars using the LEGO<sup>®</sup> Mindstorm<sup>™</sup> kits while learning and applying the Not Quite C programming language. The preservice teachers then spent the first month engaged in a highly constructionist environment where they programmed their LEGO<sup>®</sup> robotic car to perform certain pre-assigned tasks. According to Gallagher & Bauerle (2003), the Toying With Technology<sup>SM</sup> course incorporated the constructionist theory of learning by providing students with authentic activities where the students not only constructed their own knowledge but also constructed a physical object. As stated by Kafai & Resnick (1996), constructionism involves two intertwined types of construction: the construction of knowledge in the context of building personally meaningful artifacts

The second section of the course provided students with an authentic K-12 outreach experience. Local K-12 students visited the Toying With Technology<sup>SM</sup> lab that was located on campus to experience engineering through LEGO<sup>®</sup> robotics. The preservice teachers assisted students with programming LEGO<sup>®</sup> cars and various other engineering activities such as learning about simple machines using LEGO<sup>®</sup> Duplos and constructing towers and structures with spaghetti and gumdrops.

During the final section of the course, the preservice teachers learned and participated in more fundamental engineering activities and projects that could be imitated in their own future classrooms. Activities were presented to the students that included engineering design problems and critical thinking activities. Everyday children's play items such as silly putty and shrinky dinks were used to show the preservice teachers how math and science concepts could be taught to K-12 students. The students used these familiar play items to learn about math and science in the context of engineering. As a major course assignment, preservice teachers were also required to produce an authentic ABC book that lent itself to the field of engineering.

## **The Engineering ABC Book Project**

The Engineering ABC Book Project was initiated due to the lack of children's literature that lends itself to the field of engineering. Many times preservice and practicing teachers use literature to introduce difficult topics to their students. Having preservice teachers create an Engineering ABC Book would serve dual purposes. Not only would preservice teachers create an Engineering ABC book that is appropriate for a K-12 audience, they would be required to research a particular field of engineering and work with professional engineers in academia and private or public practice to learn more about specific engineering principles.

The Engineering ABC Book Project was introduced and assigned at the beginning of the semester. Through classroom activities and short lectures, students were provided with background information about the field of engineering. Students were first asked to think about a field of engineering and then choose a grade level. The preservice teachers then examined the curriculum for their target grade level(s) to see how their work would fit what students at that particular age were learning in the classroom. The preservice

teachers formed their own groups according to the particular field of engineering that they wanted to research.

Students spent the first month of the Toying With Technology<sup>SM</sup> course researching the field of engineering that their group chose. Students were encouraged to use “limited” Internet resources and examine more authentic and proven factual sources of information. The instructor met with each group of students at the end of the first month to discuss their engineering field choice, grade level, curriculum “fit” and the means to work toward the goal of a finished book product.

For the next deadline, preservice teachers were instructed to have met with the professional engineers in their field of interest, gather information for their book and to have a rough draft ready to turn into the instructor. It was interesting how the students came to find and work with engineers in their field of interest. One particular group focused on a brother of one of the group members who worked for a local food company as a chemical engineer. Another group sought the help of a DOT engineer in assisting them with their road construction story.

For the first draft deadline, students presented their work to the instructor and the rationale behind the research that contributed to the book. Students were instructed how to proceed for the next deadline. Students chose a variety of venues to prepare their final books. One group skillfully utilized PowerPoint to create their text and incorporate creative artwork by a class of 5<sup>th</sup> grade students. Another group took advantage of using a digital camera and photographed original pictures for their engineering career book. And yet another group member had her mother, who was a professional illustrator, create imaginative illustrations for their Engineering From A-Z book.

The purpose of the final draft session was for the instructor to suggest final revisions for the books. At this session, students were instructed to pilot their books for their chosen audience. Students were required to locate age appropriate students and have these children read for clarity and offer any other suggestions for improvement. After these suggestions were offered to the preservice teachers, the students then constructed the book in final form.

## **Outcomes of the Engineering ABC Book Project & Future Directions**

The project resulted in 6 original books ranging from chemical, aerospace, and civil engineering to books that combined fields or provided a general overview of engineering. The books also ranged in age appropriateness from preschool to 6<sup>th</sup> grade. The preservice teachers reported spending 50+ hours on each of the books so it was a project in which they became very involved. The instructor of the course had never anticipated this project taking on a life of its own.

After completion of the ABC book, the purpose of the project (lack of attention paid to engineering in literature) was revisited. The students were posed with the question; “Where do we go from here?” Members of the course unanimously decided that the engineering books should be presented to publishers for possible publication so that the books would reach a greater K-12 population. Currently several publishers have been

contacted regarding publication of all or some of the books and at least one of the books is under consideration for publication. Even if the books are not accepted for publication, the Engineering ABC books will be reassigned for a future Toying With Technology<sup>SM</sup> course project. The value of the project was overwhelming. Students reported having a positive and valuable learning experience during the creation of their books. The journey the students experienced and the knowledge the students acquired about the field of engineering throughout the entire semester was an invaluable educational experience. It is anticipated<sup>®</sup> that these future educators will have an impact on the lives of our K-12 students and make them more knowledgeable consumers of the field of engineering.

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