Design, Engineering, and Technological Expansion for K-12 Teachers

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Abstract

The mission for this National Science Foundation supported project is to design education programs that prepare pre-service and in-service (undergraduate and graduate) teachers to understand and incorporate Design, Engineering & Technological (DET) concepts into science and mathematics curricula in ways that meet the science and technological standards. The vision for the post-planning and implementation phase is for teachers to understand more about the designed (i.e., technological) world and how it is created. With this knowledge, we submit that teachers will be better able to engage their students through project-based learning that concurrently builds their understanding of science and mathematics, as well as engineering/technology. The object is to plan ways to ultimately institutionalize the ideas being pursued so that DET-intensive courses co-taught by both education faculty and engineering faculty are sustainable. This program is aimed at increasing the scientific and technological literacy of all students, with particular emphasis on underrepresented minorities and women.

Arizona State University has had several programs aimed at in-service training of teachers, counselors, and administrators to better understand DET and to teach to the standards, particularly those standards that involve DET concepts. However, the institution currently offers no pre-service or graduate courses for education majors that address DET concepts and processes. This project is intended to remedy that situation, using the knowledge and interest of faculty in both the College of Engineering and the College of Education. To facilitate the transition to sustainability, we have 1) conducted a needs assessment so that what is developed will meet the needs of schools, teachers, curricula, and the university, and 2) involved all of the stakeholders in the design of the DET courses so that there is acceptance by all parties involved. Success will be demonstrated through the existence and sustainability of the educational courses and modules in pre-service and graduate education programs, the numbers and knowledge of new teachers emerging from these programs, and the impact on their students' understanding of science, mathematics, and DET. A set of recommendations for a comprehensive plan for bridging engineering and education will be developed.

This paper will report on the analysis of the needs assessment, the course development, and plans for integrating DET in pre-service teacher education.

I. Introduction

The condition of K-12 science and mathematics education has gained increasing state and national, if not local, attention in recent years. The science assessment results from the 2000 National Assessment of Educational Progress (NAEP) program of the U.S. Department of Education [1] show that science scores for students in grades 4 and 8 have not improved since 1996 and scores for students in grade 12 have declined. Mathematics scores are somewhat better, showing that 4th and 8th grade scores have monotonically improved somewhat over the period from the years 1990 to 2000, but 12th grade scores, after rising from 1990 to 1996, fell between 1996 and 2000. The Third International Mathematics and Science Study (TIMSS) results show a significant difference in performance of students in affluent schools compared to students in poorer neighborhoods, showing that we have yet to democratize education.[2]

Another troubling aspect of current science and mathematics education is that too large a fraction of K-12 students are "turned off" by science sometime in the middle grades (4th through 9th). This loss of interest is particularly severe in female students and students from underrepresented segments of the population.[1] As documented by [3], the curriculum reform movement that followed Sputnik—chemistry, biology and physics—deliberately removed a focus on technology, health, agriculture, applications in industry and the home, which was present in the first half of the 20th century. This prior-Sputnik science education approach was blamed for the U.S. being beaten in launching a human into space and was labeled as poor education practice. The reforms brought about a strong focus on the primacy of the subject matter and scientific principles. Thus, much of our science education, particularly the physical sciences, in K-12 became very discipline oriented and quite abstract. We struggle with the difficult tasks of giving students a "feel" for the vast size of our planetary system, while almost simultaneously trying to help them comprehend the "smallness" of the atomic and nuclear world. We teach them the chemistry of photosynthesis, but are amazed that they don't learn that the carbon in the reaction comes from the carbon dioxide in the air .[4] This is partially a manifestation of the fact that we do not equip our classroom leaders (i.e., our teachers) with enough knowledge and understanding of science and technology to show connections between them and to correct the misconceptions that plague our students.

II. Need for Project

The project described in this paper is based on the belief that Design/Engineering/Technology (DET)—sometimes shortened to the word "technology" [5]—and its ties to science and math makes science and mathematics more interesting and lively. It gives students a "need-to-know" appeal. DET can provide the context for the traditional curriculum components of science and math, which can produce a change in student thinking from "why should I learn this material that I will probably never use?" to one of "this is really interesting or important; where can I learn more?" DET speaks to the issues that most science and mathematics curricula have yet to address.

The national model science standards [6] include DET related concepts in what students in K-12 education should know. Most of these are found in science Content Standard E that relates to "*abilities to distinguish between natural objects and objects made by humans*," "*abilities of technological design*," and "*understanding about science and technology*." Although separate technology standards did not exist at the time the science learning standards were written, there is now a model of K-12 learning standards for "technological education." [7] Indeed, the model science standards do state, these "*are not standards for technology education; rather, these standards emphasize abilities associated with the process of design and fundamental understandings about the enterprise of science and its various linkages with technology*." These "*standards call for students to develop abilities to identify and state a problem, design a solution—including a cost and risk-and-benefit analysis—implement a solution, and evaluate the solution*." In addition, under the content standards on "*Science in Personal and Social Perspectives,*" one of the standards, Content Standard F, addresses "*Science and Technology in Local, National, and Global Challenges*." This latter standard addresses issues of "*invention*;" "*the human element in science and technology*;" and "*the social, economic, political and ethical impacts of science and technology*".

Figure 1 links the standards to the process used by engineers in designing artifacts. This figure demonstrates that the "technological design process," or the process of DET, can provide a framework for teaching activities, while providing excellent opportunities for developing students' appreciation for societal, economic, and ethical issues important for civilization.

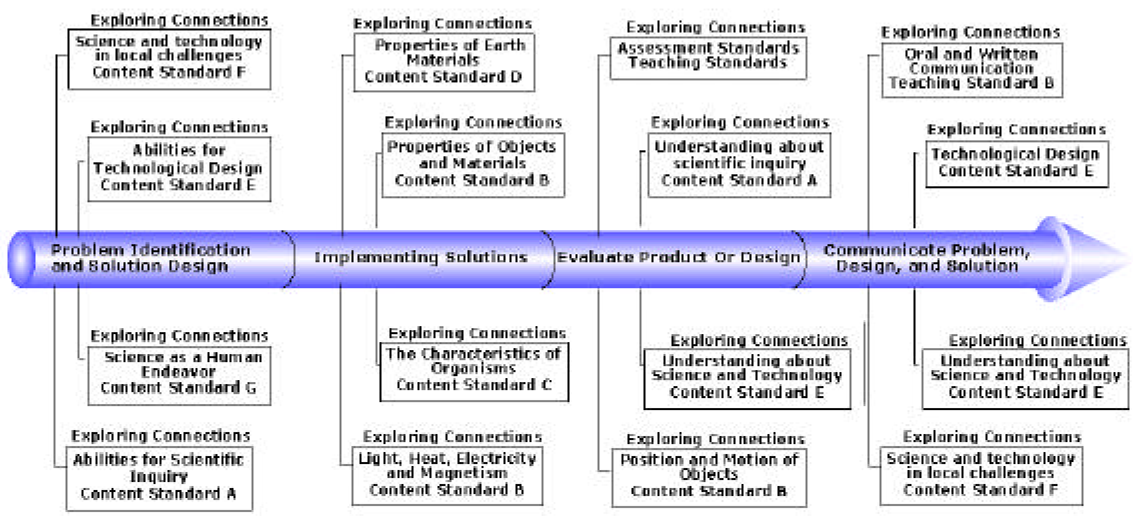

Fig. 1 The Technological Design Process will be used as a Tool for Identifying Curricular Development Opportunities across the National Science Standards

There is evidence that DET expansion in the curriculum works. The Materials Technology Institute (MTI), an NSF-sponsored project at the University of Washington and Edmunds Community College [8] begun in 1997, trains high school teachers to teach the subject of Materials Science and Technology. The goal is to provide the teachers with the background and curriculum needed to set up high school courses in this subject at their respective schools.

MTI-trained teachers found this training to be very beneficial to their teaching. Their students (221 students at 7 high schools) reported that the courses: a) made them much more interested in a science career b) increased their enjoyment of laboratory activities; and c) helped them develop their skills for working with equipment and in the laboratory setting. One of the most exciting responses to come from the student survey was that 96% would recommend, or would probably recommend, the class to their peers. Therefore, we conclude that technology introduced into the schools through teacher professional development can make a difference in students' attitudes toward, and learning of, science and mathematics. Schools in which this materials science and technology course is now taught are experiencing increased enrollments in the traditional chemistry and physics courses.

ASU has had several programs, including WISE Investments [9,10] and the MESA Program, [11] aimed at in-service training of teachers, counselors, and administrators to better understand DET and to teach to the standards, particularly those standards that involve DET concepts. However, the institution currently offers no pre-service or graduate courses for education majors that address DET concepts and processes. This project is intended to remedy that situation, using the knowledge and interest of faculty in both the College of Engineering and the College of Education.

III. Diversity Considerations

Efforts to develop K-12 curricula that prepare and motivate students to major in engineering are typically focused on mathematics and physics as the core subject matter. While these subjects form the foundation of college engineering curriculum, pedagogically they emphasize hypothesis-driven or inquiry approaches. However an important motivational tool that can also develop students' skills and confidence in engineering-related endeavors is what we term the use of "design-driven to meet societal needs" hypotheses. Our approach is aimed at developing design skills in students and facilitating students in their pursuit of designs to meet societal needs. All students can resonate with designing and building devices to meet a current need, but paradigmatically this approach better serves currently underrepresented groups such as minorities and women because the science and math are brought in contextually rather than through inquiry and because students can reflect on their role as engineers.

The notion of contextuality as an important factor in how students from different cultures describe themselves and make sense of the world around them embraces the fact that different thinking and learning styles contribute important variations of scientific knowledge and understanding. [12] In fact, role-playing and micro societies are popular with all students in K-12 and have been developed as hands-on programs in our state. For example, the Salt River Project Company program for elementary school children emphasizes design of irrigation systems and resource management of school grounds. Another important benefit of emphasizing the context of math and science to develop devices that benefit society is the recruitment of women into engineering. [13] Of the engineering disciplines offered at Arizona State University, the undergraduate Bioengineering major is essentially at gender parity in large part due to the rising popularity of medical device design, which coincidently, intimately involves the life sciences, particularly biology.

Developing a sense of oneself in a profession is another widely used method to attract students to a professional field. The lack of role models and the underlying societal baggage that underrepresented minorities carry [14] create a more acute need to identify with engineering as a worthwhile profession. Female students also can benefit from developing hands-on designing skills -- although they already succeed better than males in the classroom, they have lower self-assessment in problem solving and self-image as engineers. By emphasizing these essential design-driven aspects rather than inquiry or hypothesis creation and testing, DET is better suited to increase the number of underrepresented students that choose to pursue an engineering degree.

Of all of the major professions, engineering has among the lowest level of female workforce participation, which in 1999 stood at less than 11%. Overall, college female undergraduate enrollment has increased from 51% to 55% over the past two decades, and professional schools such as law and medicine are nearly 50% female. In contrast, female enrollment in engineering has only improved from 14% in 1985 to 18% in 1998. Closer scrutiny indicates that this 4% increase in female enrollment is due to a decline in the total number of degrees awarded during this period. [15]

Attracting women into engineering is a threefold problem. First, women must be made aware of careers in engineering, second their interest must be sustained from high school to the university, and third they must be retained in engineering majors. In Arizona, an in-house study indicated that teachers and counselors have little influence on students choosing a career in engineering. And, there is little reason to believe that this data differs greatly from that in other states. [16] Therefore, special attention needs to be paid to the way in which teachers and counselors are prepared in regard to engineering career information and pedagogy that introduce engineering concepts in a female friendly way.

However, once a young woman with good science and math skills decides that engineering is her career choice there is no guarantee that she will become an engineer. Many potential engineering majors are lost during the transition from high school to university and during the first two years in the university when students switch majors. Furthermore, the grade point averages of high school women transitioning to university who decide not to enter engineering and those leaving an engineering major for another field are good and equal to those who persist in engineering. [17] Consequently, we need to look beyond academic competence for the reasons why young women may be opting out of engineering.

The ASU Bridging Engineering and Education project addresses some of these problems by infusing engineering concepts into teacher education and university instruction with particular attention to issues of gender and ethnicity barriers that prevent well-prepared students from choosing engineering as a career and persisting in their interest in engineering studies. The goals of the project include addressing gender stereotypes and barriers to female participation in engineering by 1) identifying curricular and pedagogical needs of teachers and university faculty for implementing DET in ways that support women and underrepresented minority students, 2) developing a DET-based pilot course as a research tool for exploring DET in the curriculum in ways that support women and minority students, 3) crafting a set of recommendations for comprehensive implementation of DET in teacher education, with emphasis on supporting women and minority students, and 4) determining the effectiveness of the pilot on instructional practices, curricular choices, and student understanding of DET and engineering careers.

IV. Project Overview

Based on these issues we have set the following goals and measurable outcomes for this planning effort. The first goal is to identify and evaluate current Design/Engineering/Technology (DET) related activities and the degree of implementation in a typical K-12 system. The associated outcomes will be the completion and compilation of the surveys in K-12 schools as well as the development of needs assessment to guide the extent to which DET is both used and needed.

The second goal is, for research purposes, to develop and teach a course for in-service and graduate level teachers that can act as a vehicle and a test bed for experiments with teaching and learning approaches to DET topics that reflect insights and understanding acquired from surveys and evaluation of the first set of outcomes. The course will utilize: a) national/state teaching standards; b) national/state technology standards; c) national/state content standards; d) sensitivity to language, culture and gender; e) appropriate models of learning and teaching; f) real world application of math and science; and g) appropriate approaches to assessment of student and teacher understanding of DET. The outcomes associated with this goal are that an engineering faculty team will gain insight into what level of DET is appropriate for teachers and that education faculty will have evaluation data on the accomplishments of the course and will have begun to determine where such activities can be built into the curriculum.

The third goal is to develop a set of recommendations for a comprehensive implementation plan for DET activities and understanding in K-12 programs, based on knowledge acquired from surveys and the pilot research course evaluation. These recommendations will utilize concepts from the emerging science of learning as well as incorporate and integrate a variety of educational needs. These needs include national and state standards, cognitive factors (abilities and knowledge), and preparation and skills. The outcomes for this goal include a set of recommendations and models for insertion of DET course content at appropriate points in teacher professional development. These include 1) a DET course in general science education requirements and 2) DET content in science courses.

V. The DET Survey

The BEE team of engineering and education educators, as well as representatives from K-12, collaborated to write a questionnaire on *Technological Education for K-6 Teachers and Middle and High School Teachers of Science*. A graduate class in assessment in the COE first identified existing such surveys that were considered in the initial draft of the survey. This class then developed several drafts of the survey as one of their class projects. The survey was further refined by the BEE team, followed by a focus group of K-12 educators. To date 93 teachers have responded. The male and female respondent percentages are approximately 44% and 56%, respectively. The distribution of teachers by school sector is: 12% elementary, 47% middle school and 41% high school.

As explained to those who took the questionnaire, the results of this questionnaire will be used to develop more effective pre-service and graduate education science programs for teachers. The teachers were told that the responses will be extremely valuable to this development, but that their responses would be held in strict confidence—only aggregated results will be disseminated in any fashion. The teachers were also told that if they would like to be notified of the aggregated results, they had only to send an email of request. The survey was conducted by the Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET).

The teachers taking the survey were given a definition of Design/Engineering/Technology (DET):

The term "technology," as used in the National Science Standards, implies the design, engineering, and technological issues related to conceiving, building, maintaining, and disposing of the useful objects and/or processes in the human-built world. Sometimes this term is referred to as "technological education," but please note that it is separate from the use of computers and educational technology in the classroom. It is also distinctly different from job training or vocational education.

The survey began with the following explanation of DET:

In this questionnaire, we use the term "Design/Engineering/Technology" or DET, synonymously with what the science standards call "technology." DET encompasses a number of concepts and skills, including the ability to:

- Identify a problem or a need to improve on current technology,
- Propose a problem solution – solutions may be conceptual or physical objects,
- Identify the costs and benefits of solutions,
- Select the best solution from among several proposed choices by comparing a given solution to criteria it was designed to meet,
- Implement solutions by building a model or a simulation,
- Communicate the problem, the process and the solution in various ways.

Examples of different Design/Engineering/Technology functions include:

- Designing activities for a school outing,
- Building a paper bridge that will support a weight
- Designing the layout of a new playground,
- Inventing a new device or process,
- Designing and piloting a new device that enables paraplegics to experience a better quality of life,
- Analyzing the economics of two different types of paper towels in absorbing water,
- Building working models of devices or processes.

The teachers were reminded that DET in not a curriculum add-on:

DET materials and exercises are intended to be integrated into the teaching of science and mathematics; DET is NOT intended to be an "add-on" or extra topic to cover in the curriculum.

Block 1 (Questions 1 through 13) was about DET experience and the impact of DET training. The teachers have had little DET experience in their preservice training and indicated on the survey that they would like much more such training.

Block 2 (Questions 14 through 22) was on general perceptions of a typical engineer. Teachers think that people view engineers positively but consider them to have moderate people and verbal skills.

In Block 3 (Questions 23 through 26), the teachers were asked if they agreed with four statements. The teachers believe that people stereotype in feeling that women and minorities have lesser ability than males to do well in DET.

In Block 4 (Questions 27 through 32), teachers revealed that as they taught a science curriculum, it is important to include planning a project, developing an experiment, searching the internet, building a physical object, designing an object including the drawing, materials, and specifications (DET), and using engineering to develop technology.

The responses to Block 5 (Questions 33-37) told us that the teachers were interested in learning about DET through more DET training, mainly through in-service activities and workshops. They were not interested in learning about DET through observing a skilled teacher or, to a lesser degree through peer training and college courses.

Teachers strongly would like to teach their students to understand DET-related knowledge. The teachers wanted to teach all of the material in Block 6 (Questions 38 through 42): design process, use and impact of DET, science underlying DET, types of problems to which DET should be applied, and the process of communicating technical information.

Block 7 (Questions 43-49) inquired of the motivations of the teachers in teaching science. The teachers' motivation for teaching science is high for: work preparation, promoting the enjoyment of learning, developing an understanding of the natural and technical world and developing curiosity about scientific, engineering and technical matters.

The strength of barriers for integrating DET into the classroom was examined in Block 8 (Questions 50-59). There are many barriers, the greatest of which are equipment, money and administrative support.

In Block 9 (Questions 60-62), we learned that the teachers believe that DET will help with the AIMS mathematics test and strongly believe that DET consequences for society are positive.

Block 10 (Questions 63-64) showed that teachers have limited knowledge about how national, state, or district level standards relate to DET.

Block 11 (Questions 66-69) asked high school teachers about what counselors in their school did. High school teachers either a) don't know if their counselors discuss DET careers or b) counselors are ineffective at discussing DET career opportunities.

Questions 70-84 dealt primarily with demographics to enable additional analysis.

An interesting trend in the respondents to date is that the high school teachers do not believe as strongly as the K-8 teachers that DET is important in the science curriculum or in career considerations.

VI. The Pilot Course

A graduate level pilot course is being designed to address the research questions that must be answered before programmatic changes can be completed. Students in the pilot course, being graduate students in science education, will learn how to infuse design, engineering, and technology fundamentals into curricula by participating in the engineering design and implementation process to create artifacts or products—i.e., contextualized problems. As students gain experience in the engineering design process they will participate in transfer activities to map the DET knowledge gained to lesson plans based on the K-12 state and national standards for engineering design and technology. This is depicted in Figure 1. Students will also explore appropriate models of learning and assessment for DET as well as consider gender and equity issues within DET as they develop curricular materials and address the research questions. Assessing what skills and knowledge students learn and how well they learn them will guide follow-on programmatic changes.

The education faculty members on the course design team will learn the technological design process, scalability, applicability, and the range of DET concepts appropriate for teacher education programs—and by example, appropriate for engineering courses. Most education faculty have no training in, and little knowledge of, these concepts.

The engineering faculty members on the course design team will learn about research-based course development, teaching to standards, contextualized activities, and student-centered pedagogy. Most engineering faculty have no training in, and little knowledge of, these concepts. They also have had little training in teaching methods that support gender and diversity differences.

VII. Discussion and Future Plans

A long-term goal of the activities and research in this grant is to improve the diversity of the engineering profession since it can only best serve all segments of society by having representation from those segments of society. A good, beginning approach is in altering and improving the preparation of the educators who educate those in the K-12 system. The results of the K-12 educators' survey help reveal at least some of the issues and needs of educators in science.

One survey result showed that, while teachers have a strong interest in integrating DET activities into their classrooms, they have received little formal training in their pre-service curriculum. Possible approaches to addressing this need, such as hands-on design activities, are being developed, tested, and assessed in the new, team-taught graduate class. The knowledge and lessons learned there can be applied both for in-service activities and workshops for teachers in the field as well as courses in the curriculum for undergraduates, one of which is described below.

Survey data and the prototype course experience will be used to redesign the pre-service elementary science methods course taken by all students preparing to be elementary teachers. This course will, among other things, address the low number of women in engineering. The course will provide teachers with information, instructional strategies, and activities that will help teachers introduce girls to engineering careers and concepts and sustain interest in engineering. It will link current National Science Education standards of design technology with engineering information and help teachers infuse the current curriculum with engineering and design activities.

Another survey result revealed some diversity issues. One was the teachers' perception that people feel that minorities and females were less capable than white males in DET activities. Another was that the females in the survey felt more strongly than did males that it was important to relate DET education activities to their impact on society. This agrees with another result that shows that some female students leave the engineering field because they feel that there is little social relevance or impact to engineering activities. The graduate course is developing approaches for addressing these issues. One approach is identifying and studying female role models and legends in science and engineering. Another is developing sensitivity to diversity in the design activities in the course as well as examples of DET activities developed for K-12 classrooms.

Another need revealed by the survey was a desire by teachers to use DET activities to enhance AIMS test results. This need aligns well with the course goals, one of which is to link the DET activities to National Standards in math and science. It is intended that the course develop DET activities that enhance math and science learning by contextualizing math and science requirements in the standards.

A final interesting result of the survey was the fact the high school teachers either don't know what their counselors do regarding DET career advisement or feel that they do little DET career advisement. It is possible that there are limited materials available to high school counselors and/or that they are not aware of, or do not understand, what the engineering profession does. This topic needs to be explored further with high school counselors, possibly through focus groups, and parallel material needs to be developed from the course for counselors.

Overall, the survey results and graduate course knowledge and experience will be used to modify the undergraduate and graduate education curricula and to develop new in-service and workshop activities for science education students. These developments will be used as the basis for proposals that address diversity and DET education issues and research. Perhaps most importantly, the questionnaire and the pilot graduate course are being used as springboards to strengthen the collaboration of the CEAS and the COE.

Acknowledgement

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Mary R. Anderson-Rowland is the Associate Dean of Student Affairs in the CEAS at ASU. She earned her Ph.D. from the University of Iowa. Her research areas are in applied statistics and engineering recruitment and retention, especially for women and minority students. She was named an ASEE Fellow in 2001, one of "30 Prominent Women in Phoenix" Award in 2002, and the Society of Women Engineer's Distinguished Engineering Educator for 2002. She received the University Achievement in Gender Equity Progress Award in 1995.

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Questionnaire on Technological Education
for
K-6 Teachers and Middle and High School Teachers of Science

Why This Questionnaire-----------

The results from this questionnaire will be used to develop more effective pre-service and graduate education science programs for teachers. Your responses will be extremely valuable to this development, but your responses will be held in strict confidence—only aggregated results will be disseminated in any fashion. If you would like to be notified of the aggregated results, please send an email to *cresmet@asu.edu* with a request.

Who Is Doing This-----

Conducted by the *Center for Research on Education in Science, Mathematics, Engineering and Technology* (CRESMET), Arizona State University, Tempe, AZ 85287-5006; (480) 965-5350

What To Do When You Are Finished-------------

When finished with the questionnaire, please return the packet to ………………………………… or fax the pages directly to CRESMET at (480) 965-5993. If you would prefer to complete the questionnaire online, go to ***ceaspub.eas.asu.edu/cresmet/techquestions/login.html*** and enter a UserID of ***preservice*** and a Password of ***K12*** (all case sensitive).

Want To Do It Online? ----------

Make Sure You Know What **Design/Engineering/ Technology** (DET) Is---------

Definition of Design/Engineering/Technology (DET)

The term "technology," as used in the national science standards, implies the design, engineering, and the technological issues related to conceiving, building, maintaining, and disposing of the useful objects and/or processes in the human-built world. Sometimes this term is referred to as "technological education," but, **please note that it is separate from the use of computers and educational technology in the classroom. It is also distinctly different from job training or vocational education.**

Note: DET is distinctly different from computers and/or vo-tech

In this questionnaire, we use the term "Design/Engineering/Technology" or DET, synonymously with what the science standards call "technology." DET encompasses a number of concepts and skills, including the ability to:

- identify a problem or a need to improve on current technology,
- propose a problem solution - solutions may be conceptual or physical objects,
- identify the costs and benefits of solutions,
- select the best solution from among several proposed choices by comparing a given solution to criteria it was designed to meet,
- implement solutions by building a model or a simulation,
- communicate the problem, the process and the solution in various ways.

Examples of DET

Examples of different Design/Engineering/Technology (DET) functions include:

- Designing activities for a school outing,
- Building a paper bridge that will support a weight,
- Designing the layout of a new playground,
- Inventing a new device or process,
- Designing and piloting a new device that enables paraplegics to experience a better quality of life,
- Analyzing the economics of two different types of paper towels in absorbing water,
- Building working models of devices or processes.

DET is not a curriculum add-on

Design/Engineering/Technology (DET) materials and exercises are intended to be **integrated** into the teaching of science and mathematics; DET is NOT intended to be an "add-on" or extra topic to cover in the curriculum

Begin the Questionnaire

Please consider the definition and examples given on the previous page while answering questions on the following three (3) pages regarding Design/Engineering/Technology

Section I

Please answer the following questions circling the most appropriate answer **Use the scale of 1(Not At All) to 4(Very Much)**	Not at all			Very much
1. How familiar are you with **Design/Engineering/Technology** as typically demonstrated in the examples given on the previous page?	1	2	3	4
2. Have you had any specific courses in **Design/Engineering/Technology** outside of your preservice curriculum?	1	2	3	4
3. Did your preservice curriculum include any aspects of **Design/Engineering/Technology**?	1	2	3	4
4. Was your preservice curriculum effective in supporting your ability to teach **Design/Engineering/Technology** at the beginning of your career?	1	2	3	4
5. Did your preservice curriculum include **science content**?	1	2	3	4
6. Did your preservice curriculum include **teaching of science**?	1	2	3	4
7. Was your preservice curriculum effective in supporting your ability to teach **science** at the beginning of your career?	1	2	3	4
8. How confident do you feel about integrating more **Design/Engineering/Technology** into your curriculum?	1	2	3	4
9. How important should preservice education be for teaching **Design/Engineering/Technology**?	1	2	3	4
10. Do you use **Design/Engineering/Technology** activities in the classroom?.	1	2	3	4
11. Does your school support **Design/Engineering/Technology** activities?	1	2	3	4
12. Do you believe **Design/Engineering/Technology** education would aid all students regardless of career choice?	1	2	3	4
13. Do you believe **Design/Engineering/Technology** should be integrated into the K-12 curriculum?	1	2	3	4

To what extent do you agree that a typical engineer…. 1(Strongly Disagree) to 4(Strongly Agree)

14. Works well with people.	1	2	3	4
15. Has good verbal skills.	1	2	3	4
16. Has good math skills.	1	2	3	4
17. Has good writing skills.	1	2	3	4
18. Earns good money.	1	2	3	4
19. Is creative.	1	2	3	4
20. Is introverted.	1	2	3	4
21. Likes to fix things.	1	2	3	4
22. Does well in science.	1	2	3	4

To what extent do you agree with the following statements…? 1(Strongly Disagree) to 4(Strongly Agree)

23. Design/Engineering/Technology fields should be introduced to students as career choices.	1	2	3	4
24. Most people feel that female students can do well in Design/Engineering/Technology.	1	2	3	4
25. Most people feel that male students can do well in Design/Engineering/Technology.	1	2	3	4
26. Most people feel that minority students (African American, Hispanic / Latino, and American Indian) can do well in Design/Engineering/Technology.	1	2	3	4

As you teach a science curriculum, it is important to include… 1(Not at all Important) to 4(Very Important)

27. Planning a project.	1	2	3	4
28. Developing an experiment.	1	2	3	4
29. Searching the internet.	1	2	3	4
30. Building a physical object.	1	2	3	4
31. Designing an object including the drawing, materials, and specifications.	1	2	3	4
32. Using engineering to develop technology.	1	2	3	4

I am interested in learning more about Design/Engineering/Technology through..
1(Not At All Interested) to 4(Very Interested)

33. In-service.	1	2	3	4
34. Observing a skilled teacher.	1	2	3	4
35. Workshops.	1	2	3	4
36. Peer training.	1	2	3	4
37. College courses.	1	2	3	4

I would like to be able to teach my students to understand the… 1(Strongly Disagree) to 4(Strongly Agree)

38. Design process.	1	2	3	4
39. Use and impact of Design/Engineering/Technology.	1	2	3	4
40. Science underlying Design/Engineering/Technology.	1	2	3	4
41. Types of problems to which Design/Engineering/Technology should be applied.	1	2	3	4
42. Process of communicating technical information.	1	2	3	4

My motivation for teaching science is… 1(Strongly Disagree) to 4(Strongly Agree)

43. To enable pupils to achieve good test results.	1	2	3	4
44. To prepare young people for the world of work.	1	2	3	4
45. To promote an enjoyment of learning.	1	2	3	4
46. To develop an understanding of the natural and technical world.	1	2	3	4
47. To develop scientists, engineers, and technologists for industry.	1	2	3	4
48. To develop curiosity about scientific, engineering, and technological matters.	1	2	3	4
49. To promote an understanding of how Design/Engineering/Technology affects society.	1	2	3	4

How strong is each of the following a BARRIER in <u>integrating</u> Design/Engineering/Technology in your classroom? 1(Not Strong At All) to 4(Very Strong)

50. Lack of time to **integrate** Design/Engineering/Technology.	1	2	3	4
51. Lack of time for teachers to **learn** about Design/Engineering/Technology.	1	2	3	4
52. Lack of equipment.	1	2	3	4
53. Lack of teacher knowledge.	1	2	3	4
54. Lack of training.	1	2	3	4
55. Lack of students' reading skills.	1	2	3	4
56. Lack of students' math skills.	1	2	3	4
57. Lack of financial support.	1	2	3	4
58. Lack of emphasis on Design/Engineering/Technology concepts in district curriculum.	1	2	3	4
59. Lack of administration support.	1	2	3	4

How strongly do you agree that … 1(Strongly Disagree) to 4(Strongly Agree)

60. Design/Engineering/Technology can be integrated into a curriculum so that they will help students prepare for the AIMS tests.	1	2	3	4
61. Design/Engineering/Technology has negative consequences for society.	1	2	3	4
62. Design/Engineering/Technology has positive consequences for society.	1	2	3	4

How much do you know about the … 1(Very Little) to 4(Very Much)

63. National science standards related to Design/Engineering/Technology?	1	2	3	4
64. Arizona science standards related to Design/Engineering/Technology?	1	2	3	4
65. District science standards related to Design/Engineering/Technology?	1	2	3	4

***The following questions are only FOR <u>HIGH SCHOOL</u> SCIENCE TEACHERS.**

Counselors in my school are effective at … 1(Strongly Disagree) to 4(Strongly Agree)

66. Introducing Design/Engineering/Technology fields as career choices.	1	2	3	4	Don't Know
67. Advising **male** students in Design/Engineering/Technology career paths.	1	2	3	4	Don't Know
68. Advising **female** students in Design/Engineering/Technology career paths.	1	2	3	4	Don't Know
69. Advising **minority students** (African American, Hispanic / Latino, and American Indian) in Design/Engineering/Technology career paths.	1	2	3	4	Don't Know

Part II
Please check or answer the questions below.

70. What is your gender? ___ Male ___ Female

71. What is your age? ____

72. How many years have you been teaching full time? ________

73. How many years have you been teaching science? ________

74. Is teaching your second career? ___ Yes ___ No (skip the next question, Question 75)

75. If teaching is your second career, have you been in a science or technical field before?
___Yes. ___No
If yes, which field? ____

76. What is your ethnic group?
___African American, not Hispanic ___Asian or Pacific Islander
___American Indian or Alaskan Native ___White, Not Hispanic
___Hispanic / Latino ___Other ____________

77. Describe your educational background
___Bachelor's degree – Major __________________
___Master's degree – Major __________________
___Doctorate degree – Major __________________
___Certification achieved – Subject ______________

78. In which grade level are you currently teaching and how much time per week are you teaching science?
Grade level: ___________ Time spent on science per week: _______________Hours

79. Name the **school** where you are currently teaching?_________________________________ Title I? Yes___
No___

80. Name of the **district** for your school____

81. Have you participated in any of the ASU WISE (Women In applied Science and Engineering) Investments two-week summer institutes?
___Yes ___No

82. What familiarity do you have with engineers? Check all that apply
___I am an engineer; ___My significant other is an engineer
___I have taken some engineering courses.
___I have a friend who is an engineer.
___I have a family member who is an engineer.
___I have talked with engineers.
___I have little or no idea what an engineer does.
___Other (please explain) ________________

83. In your opinion, what grade is most appropriate for first introducing concepts related to Design/Engineering/Technology? ____________
Explain your answer____

84. Where did you become most familiar with Design/Engineering/Technology? Check all that apply:
__Preservice; __In-service; __National or State Meetings (e.g, NSTA, NCTM); __Observing another teacher;
__From another colleague; __Graduate education; __ Internet; __Books;
__Math, Engineering, and Science Achievement (MESA) Programs; __Other______________.

If you would like to be notified of the aggregated results, please send an email to *cresmet@asu.edu* with a request

Thank You For Your Help