

# **Collaborating to Build a Teaching Certification in Engineering**

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## **Abstract**

This paper contains an overview of efforts in Texas to develop grades 8-through-12 teacher certification in engineering. The need and justification for this certification is provided along with the process for developing certification standards. Draft certification standards that were developed in 2002 are described.

## **Introduction**

In 2001, the Texas State Board for Educator Certification approved adding “Engineering” to the Mathematics/Physical Science certificate approved by the Board in 2000. The board further moved to have an examination ready for this certification by fall 2005. Board members agreed that because engineering is a significant component of several high school courses and requires knowledge of both mathematics and physical science, certificate holders would be prepared to teach in all three fields.

Most are aware that there is a critical teacher shortage in math, science, and engineering and agree that the recruiting of teachers in science and engineering will bring a new population of individuals into the teaching profession. Further, colleges of engineering have the largest enrollment of students who have an interest and aptitude for mathematics and physical science. Therefore, creating this certification will advance the study of higher mathematics and science in public schools; teachers will be prepared in the content area in which they are teaching.

The recruitment of students will occur through Colleges of Engineering in collaboration with Colleges of Education. Engineering students who have completed at least one-half their engineering training, but who do not wish to pursue a career in engineering will be potential

candidates for this certificate. It is important to note that in Texas approximately 3,000 students each year depart from completing an engineering degree. These students might be viable candidates for K-12 teaching.

Given all that, the authors are collaborating to move the certification forward. They will work to develop standards, review standards, and develop tests for the new certification. Currently Dean Carroll is working with a team to develop initial standards for the proposed certification.

## **Developing Certification Standards**

Certification standards are the specifications for what teachers should know and be able to do. Standards typically contain statements describing teacher knowledge, i.e., what the teachers know, and statements describing application of the knowledge, i.e., what teachers can do. Standards guide curricula development for educator preparation programs and provide the basis for teacher certification test framework. The standards being developed in Texas are rigorous and support the Texas Essential Knowledge and Skills (TEKS) curricula.

The State Board for Educator Certification (SBEC) has retained the services of National Evaluation Systems (NES) to coordinate the development of the engineering standards. NES has organized an ad hoc committee to develop draft standards. The committee first met on July 31, 2002 and will meet again in 2003. Once the draft standards have been completed they will be given to SBEC for review and approval. Certification tests will then be developed with implementation planned for fall 2005.

Committee membership consisted of K-12 educators, engineering educators, and practicing engineers. The biggest hurdle faced by the committee was reaching a common understanding of what engineering is and is not. The committee agreed that engineering is not the same as mathematics or science, not applied mathematics and science, and not technology. A consensus was reached to use the engineering method, i.e., synthesis/design, as the basis of the standards. ABET EC2000 accreditation criteria also influence the results.

Draft standards developed by the committee for grades 8-12 are detailed in Table 1. Knowledge and application expectations for standard 2 are given in Table 2.

## **Conclusions**

Developing teacher certification standards for engineering is a positive step. However, the real challenge is attracting qualified candidates to teaching. It will be difficult for anyone not completing an undergraduate degree program in engineering to meet the draft standards. Another challenge is interpret the standards at a level appropriate and realistic for grades 8-12. The final step is for educators to find creative approaches to address these challenges.

**Table 1. Draft Standards for Engineering Certification**

1. The beginning engineering teacher possesses a working knowledge of engineering fundamentals.
2. The beginning engineering teacher integrates math, science, engineering, and other knowledge to the solution of engineering problems.
3. The beginning engineering teacher manages classroom, field, and laboratory activities to ensure the safety of all students.
4. The beginning engineering teacher adheres to ethical requirements of the profession.
5. The beginning engineering teacher identifies, evaluates, and utilizes new and emerging technology.
6. The beginning engineering teacher understands the concept of teaming.
7. The beginning engineering teacher has a knowledge of the interdisciplinary nature of math and science instruction to contextualize theory and extend knowledge to solve practical engineering problems.
8. The beginning engineering teacher understands the impacts of engineering and technology on global society.
9. The beginning engineering teacher has knowledge of specific career fields in engineering and technology including the impact of professional and student engineering organizations in career development.
10. The beginning engineering teacher has the knowledge and skills to instruct students in the use of appropriate tools, equipment, and technology used in the design and production of systems.
11. The beginning engineering teacher understands how students learn and develop engineering design and analysis skills and concepts, and uses this knowledge to plan, organize and implement classroom instruction and laboratory experiences to meet curricular goals.
12. The beginning engineering teacher is able to create, guide, and manage classroom, field, and laboratory activities to enable students to undertake quality hands-on project-based activities in a safe, creative environment.

**Table 2. Knowledge and Application Requirements for Standard 2**

*The beginning engineering teacher integrates math, science, engineering, and other knowledge to the solution of engineering problems.*

<i>Knows and understands</i> <ul style="list-style-type: none"><li>✓ Appropriate concepts in mathematics, science, and supportive technology</li><li>✓ Basic fundamentals of engineering ...</li><li>✓ The engineering design process ...</li><li>✓ Problem solving ...</li><li>✓ Appropriate and effective oral and written communication skills ...</li></ul>
<i>Is able to</i> <ul style="list-style-type: none"><li>✓ Formulate engineering problems</li><li>✓ Identify and justify a problem that needs to be solved</li><li>✓ Conceptualize possible problem solutions</li><li>✓ Identify realistic constraints</li><li>✓ Assess, test, record, organize, and evaluate information ...</li><li>✓ Choose an appropriate solution ...</li><li>✓ Implement the solution ...</li><li>✓ ...</li></ul>

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