*Discussion Paper*

# The Common Core State Standards and Teacher Preparation

## The Role of Higher Education

*Science and Mathematics Teacher Imperative (SMTI)/The Leadership Collaborative (TLC)*
*Working Group on Common Core State Standards*

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SMTI
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- Establishing and sustaining long-term partnerships with other actors and agencies in the educational system.

We consider each in turn and offer some examples of promising policies or strategies for attaining these goals.

## Aligning Higher Education Curriculum with K–12 Curriculum

> *Developed in collaboration with teachers, school administrators, and experts, these standards aim to set clear, realistic expectations for learning that are consistent from state to state and will ensure high school graduates are prepared for college and the workforce. (Kober & Rentner, 2011, p. 2)*

The central impulse for the development of Common Core State Standards (CCSS) was to create a national vision of what our children will know by high school graduation. In this sense, the CCSS are subject-specific statements of career and college readiness. Given that, there are several implications for higher education.

First, as several professional education associations have already pointed out (e.g., American Council on Education, 2011; Center on Education Policy, 2011), higher education will need to consider how to use the assessments developed to measure high school students' mastery of those content domains in college admissions and placement. Research on the predictive validity of the new assessments for college success will be needed to inform those decisions. This is especially true since universities in the states that have committed to one of the two consortia developing assessments, Partnership for Assessment of Readiness for College and Careers (PARCC) and Smarter Balanced Assessment Consortium, have made a commitment to include assessment results in making placement decisions.

Second, as we have learned, teacher preparation programs must become more active in recruiting prospective teachers. The Common Core State Standards and accompanying assessments will allow teacher preparation programs to identify individuals to recruit in middle and high school, community college teacher pipeline programs, and university-based undergraduate teacher preparation programs as freshmen. In addition to identifying students with high achievement in mathematics and science, recruitment efforts should also aim to increase the diversity of the prospective teacher pool.

Third, the content of introductory courses in higher education—both in terms of introductory discipline courses and general education courses—should be revised to ensure alignment with the content of the high school curriculum, to build on what high school students have already learned, and challenge them to learn more. Given the sequencing of many courses in mathematics and science, these revisions of introductory courses will in turn raise expectations for more advanced courses as well.

## Preparing and Educating Teachers, Both Prospective and Practicing

> *The Common Core State Standards should influence every part of every teacher preparation program for mathematics teachers. For that to happen at the secondary level, teachers themselves need to understand the standards. Teachers must have deep and appropriate content knowledge to reach that understanding; they must be adaptable, with enough mastery to teach students with a range of abilities; and they must have the ability to inspire at least some of their students to the highest levels of mathematical achievement. If the standards are to succeed in changing education, we must prepare our teachers to make them succeed. (Ewing, J. 2010)*

Another task for higher education with regard to the CCSS is to improve teacher preparation and professional development programs. In a survey of states, Kober and Rentner (2011) found that 21 state education departments saw aligning the content of teacher preparation programs with the common core standards as a challenge (either major or minor). We agree that this will be a considerable challenge, in part, due to the scope of the enterprise. As Ewing points out, teachers will need to know the standards; they will need the background content knowledge and the professional commitment to teach the standards to students; and they will need to have mastered instructional strategies that help them assist students of all abilities and ages in attaining much higher standards than have previously been in place.

In particular, there are five major changes that will need to take place in teacher preparation and professional development programs:

1. Increase selectivity and proactive recruitment to increase both the content knowledge of teachers and the diversity of the teaching force.
2. Alter the content of disciplinary courses for future and practicing teachers.
3. Alter the professional preparation courses for future and practicing teachers.

4. Identify, nurture and sustain high quality field experiences for all future teachers.
5. Design and maintain a data collection system (including both assessments and infrastructure) committed to continuous improvement.

The first change, which we have already mentioned, involves being more proactive in the recruitment of talented mathematics and science students to teaching. This recruitment must go hand-in-hand with increased selectivity and diversity in teacher preparation programs (high achieving students are attracted to programs that they perceive as challenging and high quality). Early identification of these students might involve taking advantage of the assessments that will be developed for high school graduation. Later identification of prospective teachers might entail partnerships with faculty from mathematics and science departments and advisors who could identify talented college students and help recruit them into teaching. Two examples of effective early recruitment approaches for STEM education are the UTeach model (University of Texas, 2011) and the undergraduate Learning Assistant (LA) (University of Colorado Boulder, 2011) programs. The LA program involves disciplinary faculty who are involved in the identification, recruitment and preparation of future math and science teachers.

The second change would involve altering the disciplinary preparation for prospective and practicing teachers. First, there are changes that must take place as higher education aligns curricular content with K–12 schools. In particular, an emphasis needs to be placed on the Standards for Mathematical Practice, described in the CCSS, which paint a very different view of mathematics learning than is common in many content courses for teachers. Just as the CCSS outlines the knowledge and skills that will be expected of K–12 students, we will also need standards for teachers that outline the knowledge of mathematics and sciences that teachers will need in order to effectively teach the CCSS content. When the standards for science are issued, we will need parallel efforts in the sciences as well.

Researchers have already begun documenting Mathematical Knowledge for Teaching (MKT) and Scientific Knowledge for Teaching (SKT). New research will need to investigate the MKT and SKT necessary to teach the Common Core State Standards. The Conference Board of the Mathematical Sciences (CBMS) is revising its document *The Mathematical Preparation of Teachers*, first released in 2001. It is imperative that this revision should reflect the demands of teaching the CCSS and incorporate the latest research on MKT and SKT. The report *Gearing Up for the Common Core State Standards in Mathematics* (Institute for Mathematics and Education, 2011) identifies content domains in which K–8 teachers will need particular support in implementing the CCSS.

However, it will not simply be sufficient to change the content of courses. We also will need to reconsider the opportunities to learn what prospective and practicing teachers will need to master this new, more challenging content knowledge. CBMS suggested that these opportunities—in addition to university based classes—might include:

- Immersion experiences … [in the] mathematical habits of mind, mathematical practices and mathematical disposition. Such experiences may be summer institutes, year-long professional development, on-line mathematics experiences, or incorporated in undergraduate courses.
- Greater emphasis on field and clinical experiences.
- Professional learning communities … [that include] teachers at all levels, mathematicians (at two- and four-year institutions), and mathematics educators. (CBMS, 2011, p. 15) .

Similarly, a third change will involve revising the professional preparation of teachers. These revisions would need to include the Pedagogical Content Knowledge that mathematics and science teachers would need to teach the new standards (MPCK and SPCK), as well as educating prospective and practicing teachers about the standards themselves and how to read and interpret the assessment results.

Because the CCSS expects all children to achieve much more rigorous standards, teachers will also need extensive knowledge and training in how children learn mathematics and science and in effective instructional strategies. Finn and Petrilli (2010) also note the importance of arming prospective and practicing teachers with a critical perspective on curricular choices:

> *[Teachers] are simultaneously drowning in a sea of materials (from textbooks to online lesson plan banks to modules from advocacy groups) and living in a curricular desert. What they want is a voluntary but thoroughly crafted curriculum that brings life to the standards, along with suitable textbooks, digital materials, supplemental readings, and so forth that they can use in their daily practice. They also need—and deserve—help from disinterested expert evaluators regarding which of the many instructional materials that will be described (usually by their vendors) as "aligned" with the Common Core are truly matched to its cognitive expectations and sequencing. Equally essential in the classroom are interim assessments (that break the full-year standards down into manageable but explicit chunks) and plenty of training in how to use all of this. (p. 8)*

Within professional preparation, we also will need to consider the opportunities that best equip teachers with the necessary knowledge and skills. Thus, a fourth change is reconsidering the role of field experiences. Field experiences are essential to learning to teach; one cannot escape the need to learn how to enact practices with real students in real classrooms. But field experiences are notorious for washing out the effects of any serious reform; the status quo exercises a powerful, magnetic pull away from both change and challenging content. Thus, it will be particularly important that all teachers be given opportunities to witness high quality instruction which is aligned with the CCSS, and to learn alongside masterful teachers. Developing communities of practice, including both practicing and prospective teachers, in schools focused on teaching the CCSS with fidelity provides opportunities for higher education faculty to simultaneously engage in improving practice in schools and nurturing the next generation of teachers, as has already occurred in many of the Math and Science Partnerships funded by the National Science Foundation.

One final change will require ongoing assessment of individual teacher's learning in *all* components of teacher preparation or professional development programs. Data should be analyzed regularly both for the purpose of giving individual feedback and for the purposes of nimble and ongoing program improvement.

There will be special challenges associated with the transition from the current educational system to one in which high school graduates have mastered the CCSS. In particular, we know that high school graduates entering college (and teacher education programs) are woefully underprepared in mathematics and science. We also know that, once they get to college, the disciplinary preparation of undergraduates is inadequate preparation to teach mathematics and the sciences. Thus, prospective teachers with inadequate preparation themselves will be expected to teach to high standards. If we do not address this challenge head on, it is likely that the CCSS will be "implemented" in name but not in substance.

## Conducting Relevant Research

> *Authors of the Common Core assert that students attaining these standards will be "college and career ready." But we cannot know this for certain unless actual outcomes are investigated and unless students are tracked over time. How will we know, for example, in what sorts of careers (and, for that matter, colleges) they are truly prepared to succeed? How will we know for sure that meeting the standards of grade 5 prepare you to succeed in grade 6? Or whether passing scores on the new tests are correctly set? (Finn & Petrilli, 2010, p. 9)*

A third major role for higher education in the implementation and ongoing revision of the CCSS and accompanying assessments is education research. Countless reviews of the literature suggest that we simply do not know enough about the effective instructional strategies for teaching science and mathematics to all students or the effective means for preparing high quality teachers at various points in their careers. In addition, as Finn and Petrilli note, given the financial and political investment the nation has collectively made in the CCSS, we must conduct ongoing research to help inform adjustments in the CCSS so that they might be a powerful force in reforming U.S. education.

Additional research into particular aspects of implementation also is needed. For example, the National Science Foundation is funding a project to develop a framework for large-scale professional development around the CCSS. Continuing research should be built on this framework to better understand factors related to implementing the CCSS. Broader investigations of the influence of the CCSS might follow the framework put forward by the National Research Council

(Committee on Understanding the Influence of Standards in K–12 Science, Mathematics, and Technology Education, 2001).

## Partnerships

The CCSS goals are both ambitious and crucial, given the fact that only 32–44 percent (depending on the skill assessed) of U.S. 11th graders were college and career ready in mathematics (ACT, 2011). Likewise, about one-quarter of U.S. 12th graders scored at the level of proficiency on the 2009 NAEP assessment, and in an international comparison, 15 year-olds in the U.S. scored below the average for industrialized knowledge on PISA 2009 (OECD, 2010). To embrace and respond to the CCSS in ambitious ways will take time and require setting reasonable benchmarks for making progress.

It will also require establishing and sustaining long-term partnerships with other actors and agencies in the educational system, including state education departments, state higher education agencies, and the P–12 schools. Because university-based teacher preparation programs must be accredited, there are long-standing relationships between colleges/schools of education and state education departments. The relationships between the state education departments and the disciplinary departments are less clear. Yet responding to the CCSS will require states to reform teacher certification requirements, and those requirements include the entire university community. Furthermore, work must be done to better align the mathematical preparation of students between P–12 schools and higher education. Thus, it will be important for higher education to build stable, long-term partnerships with state education departments and with P–12 schools that include and extend beyond teacher preparation.

These partnerships could serve several different functions. First, responding to the CCSS will not only require nimble and ongoing change in higher education; it will require state departments to loosen their regulations in efforts to enable and support those changes. One particular area of concern is developing a cadre of elementary teachers who have sufficient content and teaching knowledge to enact the CCSS. A position statement of the four major mathematics education associations calls for the development of certification programs for elementary mathematics specialists who can lead this charge (NCTM, NCSM, AMTE, & ASSM, 2010). Higher education institutions and state education departments should collaborate on exploring policy mechanisms for making this happen in consultation with state higher education executive officers (SHEEOs). In the case of universities that resist being responsive, the state education department can act as a catalyst for change—for example, demanding evidence that the university curriculum has been aligned with the K–12 curriculum or that teacher preparation programs require sufficient coursework in the relevant disciplines and that the content of those disciplinary courses is directly

relevant to teachers' MKT and SKT. Finally, because state education departments have a big picture view of all teacher preparation in higher education, they are well positioned, in collaboration with SHEEOs, to build higher education consortia in which universities with more capacity can help those with less capacity to enact the education vision presented in the CCSS.

Similarly, teacher preparation programs have longstanding relationships with the public P–12 schools. It is also frequently the case that mathematics and science departments have relationships with schools or with individual P–12 teachers who participate in professional development co-sponsored through disciplinary departments and often funded by federal and state grants. P–12 schools face enormous challenges as they work to respond to the CCSS: they need help educating parents to the changes, selecting new curriculum and assessments, hiring practices and policies for staff, identifying teacher learning needs and mounting effective professional development. In the meantime, teacher preparation programs in higher education depend on those schools for student teacher and intern placements.

Here too productive partnerships would enable collaboration between universities and the schools. Researchers and curriculum developers could work closely with teachers in testing out new curriculum/ assessments and tracking the implementation of the CCSS. Teacher educators could acquire new information about how schools are changing in light of the CCSS and how professional preparation needs to change in response to those changes.

Continuous improvement requires open lines of communication, shared commitments to change, a willingness to create a flexible infrastructure that can respond in a timely fashion to new information, and a streamlined way of tracking student learning over time (from K–12 schools into U.S. higher education institutions). Given the interdependence of state education departments, higher education, the K–12 schools, and teacher preparation programs, the effective implementation of the CCSS will require new collaborations among these actors and agencies.

## Action Steps

The higher education role in responding to the Common Core State Standards (CCSS) is considerable and varied. Here we have highlighted only a handful of the implications for higher education that are implied in the commitment to implement the CCSS. Given how difficult and protracted change in higher education can be, we cannot reasonably expect all of these changes will be welcomed, embraced, or immediately acted upon. Nonetheless, there are some action steps that all higher education institutions can take now. These are outlined below, along with steps that other entities should take in order to effectively engage higher education in supporting CCSS implementation.

## FOR A•P•L•U AND OTHER NATIONAL ORGANIZATIONS

- Support and encourage the engagement of the leadership (presidents and provosts) of member higher education institutions in the implementation of the CCSS within their states.
- Encourage and facilitate dialogue and collaboration among member higher education institutions in their efforts to understand their opportunities and responsibilities in response to the challenges of the CCSS.
- Convene panels of disciplinary and teacher education faculty from member higher education institutions to provide guidance to national efforts to implement the CCSS—both by higher education institutions and in collaboration with organizations of other education sectors.
- Solicit the support of the private sector and broader public to help implement the CCSS.
- Develop communication products and mechanisms that can be used to engage higher education institutions, their faculty, and other stakeholders in clearly articulating support for the CCSS and the resources necessary to ensure its effective implementation.

## FOR STATE EDUCATION DEPARTMENTS

- Form partnerships with state higher education executive officers (SHEEOs) and higher education institutions focusing on implementation of the CCSS, perhaps through P–20 councils that include representation from the business community, with particular attention to developing plans to transition to the CCSS.
- Design and maintain a data collection system that allows for P–20 data tracking.
- Revisit certification requirements to reflect the content knowledge required for effectively teaching the CCSS.
- Explore certification of elementary mathematics and science specialists to build capacity for enacting the CCSS in P–6.

## FOR HIGHER EDUCATION INSTITUTIONS

- Raise awareness of the CCSS with university presidents, provosts, deans and department chairs.
- Build a coalition of actors to engage the multiple units across disciplinary departments and teacher education departments to consider their responsibility in responding to the CCSS. In particular, provide administrative support for the creation of task forces outlined in the following sections that are needed to ensure an effective institutional response to the CCSS.
- Build coalitions with higher education institutions across the state to build support for the CCSS, to ensure a commonality of vision, and to develop shared resources for responding to the CCSS.

- Demonstrate a public commitment to be accountable to the needs faced by K–12 education by the CCSS.
- Work with Government Relations Offices to communicate institutional support for the CCSS and to garner the resources needed to provide support for implementation efforts.

## FOR DISCIPLINARY DEPARTMENTS

- Engage with the standards review and the CCSS implementation at the state level.
- Participate with university government relationships staff in advocating for CCSS and the university role in promoting their successful implementation.
- Create task forces of mathematicians and scientists to question the content of introductory courses and consider what it would take to align those courses with the CCSS in mathematics and science, paying particular attention to the Standards for Mathematical Practice and transforming introductory courses so that they are aligned with CCSS (in both content and approach).
- Create task forces of mathematicians and mathematics teacher educators, scientists and science teacher educators to question the content of disciplinary courses targeted for prospective elementary and secondary mathematics and science teachers and consider their alignment with the CCSS in mathematics.
- Create partnerships with teacher educators and K–12 educators to develop content courses that will ensure teachers have the content background needed to support students' progress in meeting the CCSS, with particular attention to the Standards for Mathematical Practice and scientific and engineering practices as described in *A Framework for K–12 Science Education*.
- Engage in collaborative efforts related to supporting K–12 education in the implementation of the CCSS, including teacher recruitment, setting standards for teacher preparation, and providing content support for practicing teachers.

## FOR TEACHER EDUCATION DEPARTMENTS

- Create task forces of mathematicians, mathematics teacher educators, mathematics K–12 teachers, scientists, science teacher educators, K–12 science teachers, assessment experts, and educational researchers to interrogate the content of the professional preparation of teachers to ensure its effectiveness in preparing teachers to teach the CCSS.
- Create partnerships with state departments of education to revisit certification requirements and measures for teacher assessment that are aligned with the CCSS.

- Create partnerships with disciplinary faculty and with K–12 schools to provide professional development as the schools work to implement the CCSS and to ensure that prospective teachers have experiences that will prepare them to teach the CCSS.
- Create partnerships with disciplinary faculty and with K–12 schools to provide technical assistance with the adoption of curriculum materials, the development of student assessments, and the development of teacher assessments in alignment with CCSS, as well as to monitor their effectiveness.
- Create research groups across departments and across institutions with a focus on understanding the implementation of the CCSS.
- Recruit strong STEM candidates into teacher preparation programs.
- Provide high quality field experiences with teachers who have mastered teaching the Standards for Mathematical Practice and forthcoming standards concerning science.
- Develop communities of practices with practicing and prospective teachers and faculty.
- Institute ongoing assessment of teacher's learning related to the standards for individual feedback and program improvement.

## FOR K–12 SCHOOLS AND DISTRICTS

- Actively seek out collaborations with higher education institutions to provide technical assistance and support in helping teachers make the changes necessary to implement the CCSS; the engagement of higher education may be of particular value in this era of constrained resources.
- Collaborate with higher education institutions to develop multidimensional plans to understand the impact of their efforts to implement the Common Core State Standards.

## FOR DEVELOPERS OF CURRICULUM AND ASSESSMENT FOR K–12

- Seek out the expertise found in higher education institutions—including both disciplinary faculty and education faculty who are actively working with K–12 schools—to ensure that the best knowledge of the field is reflected in products that are prepared.
- Ensure that K–12 representatives are included in the development, validation, and testing of products that are developed.

# Conclusion

This document sets forth an ambitious vision for the role of higher education and its collaborations with other stakeholders in working to support the effective implementation of the CCSS. It is time for us to act with equal parts vigor and prudence. While there is urgency in getting to work on the agenda put forth in this document, it is also crucial that efforts be undertaken with a sense of the long-term shared commitment among all stakeholders that will be needed to achieve these goals. Efforts aimed at providing "quick fixes"—lacking due deliberation and collaboration and failing to recognize the challenges inherent in making change—risk not only failing to achieve their desired outcomes but also undermining continued commitment to the CCSS. Higher education institutions should help to provide the leadership necessary to ensure the proper balance between immediate action and long-term collaboration needed to ensure that the CCSS become a vital force for change in the lives of our nation's children.

# References


ACT. (2010). *A First Look at the Common Core and College and Career Readiness.* http://www.act.org/research/policymakers/pdf/FirstLook.pdf

Conference Board of Mathematical Sciences. (2011). *Common Standards and The Mathematical Education of Teachers.* http://www.cbmsweb.org/Forum3/CBMS_Forum_White_Paper.pdf

Confrey, J., & Krupa, E. (2010). *Curriculum Design, Development, and Implementation in an Era of Common Core State Standards.* NC: Center for the Study of Mathematics Curriculum http://mathcurriculumcenter.org/conferences/ccss/SummaryReportCCSS

Ewing, J. (2010). *The Common Core Math Standards: Implications for Teacher Preparation.* http://opportunityequation.org/teaching-and-leadership/common-core-math-teacher-preparation

Finn, C. E., & Petrilli, M. J. (2010). *Now What? Imperatives and Options for "Common Core" Implementation and Governance.* Washington, D.C.: Thomas B. Fordham Institute. http://www.edexcellence.net/publications-issues/publications/now-what-imperatives-and.html

Institute for Mathematics & Education (2011). *Draft Report of the Policy Workshop Gearing Up for the Common Core State Standards in Mathematics.* http://commoncoretools.files.wordpress.com/2011/05/2011_05_07_gearing_up1.pdf

King, J. E. (2011). *Implementing the Common Core State Standards: An Action Agenda for Higher Education.* American Council of Education. http://www.acenet.edu/AM/Template.cfm?Section=Search&CONTENTID=39580&TEMPLATE=/CM/ContentDisplay.cfm

Kober, N., & Rentner, D. S. (2011). *States' Progress and Challenges in Implementing Common Core State Standards.* Washington, DC: Center on Education Policy. http://www.cep-dc.org/publications/index.cfm?selectedYear=2011

National Council of Teachers of Mathematics (NCTM), the National Council of Supervisors of Mathematics (NCSM), the Association of State Supervisors of Mathematics (ASSM), and the Association of Mathematics Teacher Educators (AMTE). (2010). *Mathematics Education Organizations Unite to Support Implementation of Common Core State Standards.* http://www.amte.net/sites/all/themes/amte/resources/JointStatementonCCSS.pdf

OECD. (2010). *PISA 2009 Results: Executive Summary.* http://www.oecd.org/dataoecd/34/60/46619703.pdf

University of Colorado Boulder. (2011). *LA Program: The Learning Assistant (LA) Model.* http://laprogram.colorado.edu.

University of Texas at Austin. (2011). *About UTeach Natural Sciences.* http://uteachweb.cns.utexas.edu/About

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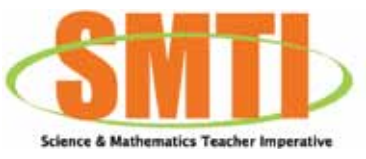




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