Curricular Coherence and Open Educational Resources in the Current Environment

An NCTM Emerging Issues Committee (EIC) Framing Paper
on issues relating to the need for high-quality instructional materials

Introduction

Since its inception, NCTM has actively promoted the use of high-quality instructional materials to support effective mathematics teaching and students' learning. In recent decades, NCTM standards publications and policy recommendations have had a profound effect on the nature of instructional materials used in schools.

Methods for delivering instructional materials have been rapidly evolving, moving from almost total reliance on print materials to a current mix of print and digital materials. Many have predicted that the trend toward digital-only delivery of instructional materials will continue to accelerate, soon making print textbooks nearly obsolete. Whether or not those predictions are accurate, the shift toward digital materials is indisputable.

Furthermore, teachers have increasing online access to a wide range of instructional materials—some of which are of high quality and some not, and many of which can be downloaded or otherwise accessed at little or no cost. Access to such "open (or open source) educational resources" has added a new set of resources for teachers' own "libraries" as they plan their instruction.[1]

The changes in the availability and delivery of instructional materials have created a new instructional-materials landscape for mathematics teachers, school administrators, mathematics education researchers, and publishers of educational materials. This evolving new landscape raises issues that merit consideration by the NCTM Board of Directors.

The Emerging Issues Committee (EIC) suggests that through a coordinated strategy that involves publications, position statements, online communications and other public statements, and conference planning, NCTM can and should play a leading role in helping states, districts, schools, teachers, and teacher educators better understand the features of high-quality mathematics curricula, the processes needed to develop them, and best practices for integrating rich tasks into any adopted curriculum. This would better position math educators to make informed decisions about their instructional materials—whether the materials are purchased, locally developed, or adapted. We believe this would provide an important service to the mathematics education community.

[1] Open educational resources, or OERs, come in a variety of formats. Some are adaptable (including materials that can be modified online in a wiki-like manner) and others are downloadable PDFs, such as the Engage^{NY} materials that are available from the New York State Education Department.

A Dilemma with Curriculum Development

Based on EIC discussions, one important issue is the growing practice of teachers, schools, districts, and states of developing their own mathematics instructional materials by gathering and sequencing resources discovered online. This practice is, of course, not news to NCTM or to the members of the Board, nor is it inherently a bad idea.

NCTM has, for decades, published materials that encouraged teachers to integrate high-quality mathematical tasks and problems into their mathematics instruction, particularly in cases where the core instructional materials being used are devoid of interesting, high-cognitive-demand lessons. The excitement of being able to easily integrate a collection of mathematical tasks and activities into a curricular sequence is attractive to many, if not most mathematics teachers. Today, some of the most vibrant discussions about mathematics teaching and learning currently take place within online communities that are built around sharing instructional resources and ideas. NCTM's current partnership with the Math Forum exemplifies a strong, positive commitment to encourage more of these kinds of activities.

In an ideal situation, teachers with a well-developed understanding of mathematics, student learning trajectories, and the learning goals of their curriculum are adopting and sharing high-quality tasks that fit within their curricular goals and that students experience as valuable and coherent. Sharing such tasks online allows teachers to form "virtual PLCs" to compare implementation and share student work on the tasks and engage in forms of lesson-study with teachers and even researchers, in ways they may not be able to do in their own school setting. NCTM would like to support and encourage this kind of sharing of tasks. On the other hand, such sharing can devolve into isolated teachers who don't have a strong curriculum with clear learning goals and well-developed descriptions of student learning trajectories, and selecting tasks on their own that they find through Internet searches and use because they seem engaging. But they may not have a clear idea of a) how to make the task feel valuable and coherent to the students, and b) how to engage with other teachers around the shared task to question how it is implemented, anticipate student work, and plan to support student learning toward clear goals.

In these kinds of cases, it is clear that one tool that supports teachers in making effective use of rich tasks, including those that they found through online sharing communities, is having a well-developed sense of learning goals and trajectories—in other words, a strong curriculum. In many ways, the widespread availability of online tasks makes having a coherent curriculum at the school and district level even more important because it is the curriculum that establishes the learning goals in a coherent progression and helps teachers see and understand the multiple pathways that students take through the progression.

The dilemma is that while districts, schools, teachers have greater access than ever to tools and resources for developing their instructional materials, the skill required to develop high-quality curriculum materials is both vast and complex, but neither widely understood nor appreciated. As a result, locally developed materials—or even those developed by state departments of education—typically do not incorporate the many factors that characterize coherent, well-

developed materials. Furthermore, developing coherent, high-quality materials is a non-trivial activity that almost always involves multiple rounds of iterative development and field-testing to accomplish. It is a feature of curriculum development that is difficult to replicate in most local settings.

Seeking Coherence across Multiple Dimensions

NCTM has long recognized the importance of coherence in a well-developed mathematics curriculum. Broadly stated, coherence means that connections are made from one year to the next, from one idea to another, from one representation to another, and from one statement p to many others that are implied by p. There is coherence pedagogically, logically, conceptually, and with the real world.

The Curriculum Principle in *Principles and Standards for School Mathematics* (NCTM, 2000) states, "A curriculum is more than a collection of activities." The Curriculum chapter in *Principles to Actions: Ensuring Mathematical Success for All* (2014) states: "An excellent mathematics program includes a curriculum that develops important mathematics along coherent learning progressions and develops connections among areas of mathematical study and between mathematics and the real world."

As access and use of online resources increase, there has been renewed attention to the importance of curricular coherence. The importance of making visible to mathematics educators the coherent learning progressions and connections around which the curriculum is designed, as well as other aspects of high-quality mathematics curricula is timely and needed.

Stimulated by the 1989 NCTM *Curriculum and Evaluation Standards* and by the work of leading mathematics educators, new models for the development of instructional materials emerged. Rather than serving largely as a resource for sequencing lessons, assigning practice problems and introducing content around which teachers designed daily lessons (primarily explanations and example problems), these newer curriculum models seek to integrate mathematical content with mathematical practices. Moreover, research about how students learn, access and equity, the effective use of technology, and effective pedagogical practices are interwoven into the materials. Varied and more robust assessment programs are integral tools for teachers and students. Rather than isolating topics, the newer models make more mathematical connections and link topics within and across grades.

The resulting materials are coherent across several dimensions. First, the content grows and builds upon itself in ways that align with research on how students develop and retain mathematical understanding. This includes, but is not limited to, attention to the hierarchical structure of the discipline. Coherent mathematics programs also help students make sense of mathematics by situating the mathematics in problem solving contexts, so that students learn the mathematics in order to answer meaningful questions in real-world or mathematical contexts. Explicit attention is paid to promoting students' conceptual understanding of mathematics so that

the mathematics itself makes sense to students. By linking mathematical topics within and among mathematical domains, mathematics appears as a unified discipline rather than as a collection of topics. This is emphasized further through careful attention to cross-grade articulation of mathematical ideas and skills. Additionally, consistent approaches in the use of tools (technological and other), instructional strategies, assessment, and accessibility, as well as careful attention to lesson design creates programs that seamlessly integrate a wide array of components into a coherent whole and facilitate the development and maintenance of a classroom culture with consistent student expectations.

Curricular Coherence in Any Standards Environment

The authors of the Common Core State Standards for Mathematics (CCSS-M) identified coherence as one of its guiding principles (p.3)[2]. From the beginning, the CCSS-M authors were concerned that practitioners and developers would examine the individual standards and overlook how "the standards document fits them together, presenting a coherent whole where the connections within grades and the flows of ideas across grades are (visible)." (Daro, McCallum, and Zimba, 2012)[3]. To make some connections more apparent, the primary authors of the CCSS-M organized the content standards into clusters and domains.

An Emerging Issue for NCTM

The trend toward increased use of open educational resources and locally developed instructional materials is likely to continue and expand. The lure of low-cost materials at a time when many districts, schools, and states are facing significant budget pressures is significant. A new group of technologically oriented teachers and school leaders sees exciting opportunities in the development and sharing of next-generation curriculum materials using open educational resources.

But while the movement toward more locally developed materials may be increasing, it is not without significant pitfalls. This includes the amount of time taken on curriculum development that might be more productively spent addressing other aspects of high-quality mathematics programs, such as supporting teachers to better understand learning trajectories through the study of student thinking, increasing their pedagogical content knowledge, and engaging in lesson study with an eye toward the Mathematical Teaching Practices. And it includes the question of whether locally developed models can maintain the type of coherence that is characteristic of well-developed instructional materials.

Teachers and district personnel need high-quality curriculum materials that require minimal supplementation (and tools to help identify and select them). Given a strong, coherent set of

[2] National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics.* Washington, DC: Authors.
[3] http://commoncoretools.me/2012/02/16/the-structure-is-the-standards/

curriculum materials teachers can focus their attention on developing and implementing lesson plans that incorporate the Mathematical Teaching Practices highlighted in *Principles to Actions* and that reflect their students and their communities.

As the materials development landscape changes, NCTM can serve districts, teachers, and schools by highlighting the elements of high-quality instructional materials and effective practices for developing them. NCTM has already attempted to focus some attention on the importance of developing a coherent mathematical program. As stated on p. 71 of *Principles to Actions,* "Grade-level mathematics content standards are too often treated as checklists of topics. When they are regarded in this light, mathematics content becomes nothing more than a set of isolated skills, often without a mathematical or real-world context and disconnected from related topics." Diane Briars's November 2014 President's Message highlighted other important elements of high-quality, coherent instructional materials that promote students' mathematics learning and good instruction by teachers.

However, these and other messages from NCTM about high-quality curriculum are scattered and embedded in different publications and sources. Given the critical role that instructional materials play in defining what happens in mathematics classes, a more direct approach may be warranted. The EIC has heard from the field that individual teachers look to NCTM, in particular, for guidance about instructional materials. As indicated above, the EIC suggests that the Board consider an *aggressive, coordinated, and comprehensive approach* to focus attention on a broad range of fundamental issues related to instructional materials and their implementation.

For example, NCTM institutes and new Problem of Practice (PoP) model for professional development could include explicit conversations about how teams of educators can make choices about implementing and adapting individual tasks into their curriculum. The ARCs that NCTM is developing through the new Curriculum Resources Committee could include online discussions either within NCTM's website or on social media to encourage lesson-study type conversations that focus on how teachers make good choices in adopting and adapting rich tasks. Tasks published by NCTM could include in their templates suggestions about fitting the task coherently into local learning goals and trajectories and adapting tasks for technological considerations, instructional strategies, taking into account the diverse needs and cultures of learners. NCTM is already planning to repackage and rebrand a tool, developed jointly with NCSM, for evaluating curricula—the re-release of those tools is another opportunity to emphasize the need for curricula that emphasize coherent learning pathways and require minimal supplementation.

Whether providing guidance for teachers about selecting and using instructional materials is integrated within existing programs or plans or as a new initiative, with thoughtful planning and clear direction NCTM can play an important, valuable role that is undoubtedly needed to help districts, schools, and states make smart, informed decisions regarding instructional materials.

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