Math and Science Education Focus Groups: Summary

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INTRODUCTION

Over two days in November, 2004, the Kauffman Foundation brought various stakeholders together to participate in a series of focus groups to discuss continuing and emerging challenges in math and science education and share ideas about possible solutions. There were five focus groups, comprised of district administrators, out-of-school educational providers, teachers, organizations that work with parents, and universities.

Despite different roles and perspectives, the focus group participants proved to be united in the belief that math and science education must be improved significantly to prepare students to live and work in a changing economy that is increasingly reliant on expertise and skills in math and science.

When queried on why student achievement in both subjects is so low, and so few students pursue advanced coursework in either, focus group participants described an array of issues. Most of the challenges cited were raised in all of the focus groups. The issues included:

- Lack of student interest in or motivation to pursue math and science education
- Ineffective instructional strategies
- Curriculum that is disconnected from students' real world experiences and future educational/job opportunities
- Inadequate teacher preparation
- Insufficient support for new teachers
- Poor professional development for educators
- Lack of awareness of the importance of high-quality math and science instruction
- Acceptance of limited achievement or even failure in math and science
- Lack of resources
- Limited collaboration among stakeholders

These issues are discussed more fully below. Participants' ideas about possible responses to these challenges are described in the subsequent sections.

CHALLENGES IN MATH AND SCIENCE EDUCATION

At the top of the list of challenges cited was a lack of student interest in math and science, which becomes pronounced by middle school. Participants noted repeatedly that students are bored in math and science classes and, as they age, they disengage from the study of both subjects. Taking calculus or physics is something the few “super smart” students do—not “regular” students. A key factor in this lack of interest is poor instructional strategies in math and science that are, unfortunately, the status quo in the majority of schools and districts. With few exceptions, math and science instruction relies primarily on lecture and recitation—teachers dictate facts and students regurgitate them. Rarely do students engage in hands-on or experiential learning that would enable them to actively discover scientific or mathematical knowledge, and lead to deeper understanding.

Not surprisingly, the curriculum students are taught rarely seems relevant to them. It has no apparent connection to their daily lives nor does it seem to be linked to their future. Students have little if any awareness of the broad array of jobs that require some level of math and science knowledge, ranging from web and software designers , to technical writers to wildlife biologists, and many others. Students may not be aware some of these jobs exist, much less which math and science courses they need to complete to pursue them. Given this, mastering a boring curriculum seems of little value to students.

Poor instruction and tedious curriculum is closely tied to a host of issues surrounding the quality of teaching. Participants in every focus group named inadequate teacher preparation as a significant contributor to poor quality of instruction. Participants in several focus groups noted that, at the elementary level, teachers may have had only one or possibly two classes in math and science each as part of their training. They have little content knowledge or experience in effective instructional strategies in math and science. As a result, few are comfortable teaching either subject and, as district administrators discussed, teachers teach to their strengths, not their weaknesses. Teachers who are uncomfortable teaching math and science tend to devote little attention to either, preferring instead to focus on other areas such as literacy, where they feel more confident.

Many teachers of the upper grades, who are much more likely to have majored in a math or science field, struggle in the classroom. Their content knowledge is deeper yet they teach the way they were taught—lecturing to students. They have little knowledge of, or experience with, scientific inquiry through hands-on learning activities that engage students and spark their interest in math and science.

Inadequate Professional Development

Compounding the deficiencies of teacher preparation programs are the poor professional development opportunities typically offered to math and science teachers. Induction programs for new teachers are usually inadequate. Like most new teachers, those in math and science receive little support and are left to figure things out on their own, muddling along as best they can.

For new and experienced math and science teachers alike, professional development rarely leads to improvements in instruction. Often, professional development is provided through workshops that pull teachers out of the classroom for a day and rely on lecturing and the review of printed materials. Yet math and science teachers are like the students they teach—they learn best through hands-on experiences and they need time to fully master new ideas and skills. When teachers have the opportunity to conduct an experiment themselves, they are more likely to incorporate the experiment into their curriculum than if they simply receive a hand-out that describes the experiment.

Math and science teachers often have fewer on-site resources for guidance than their colleagues. Most teachers, including those teaching math and science, would like to have on-site mentors or coaches who can provide immediate and intensive guidance and feedback on instruction. However, this model remains uncommon in schools, especially in math and science. The roles of principals and assistant principals are evolving to emphasize instructional leadership, so they can provide support for many teachers, but rarely to math and science teachers. Few principals have substantive knowledge of math or science or are skilled in how to teach either subject effectively. Most math and science teachers grapple with isolation and lack of information on best practices and face a combination of unique challenges.

Recognizing the Value of Math and Science

Surrounding and contributing to the poor instruction and tedious curriculum that permeate math and science education is a context that does not value either subject. Both inside and outside the education community, there is a lack of awareness of the importance of mastering math and science, especially at advanced levels. Many parents know as little about the myriad of job opportunities that are available to those with strong math and science backgrounds as their children do; and, they do not fully understand how closely their children's future economic success and stability is tied to math and science. If parents do see this link and have concerns about the quality of math and science instruction provided to their children, they rarely know how to address these concerns. How should they measure the quality of instruction? What knowledge and skills in math and science should their children have mastered, and when? If there appear to be problems with

math and science instruction, what might be the solutions? Parents with little math and science knowledge themselves are intimidated by both subjects. They are not the only ones who feel this way.

Improving literacy has been the focus of most educators and policymakers alike for several years. Proficiency in reading and writing are essential for success in all other subject areas, including math and science, and no one in the focus groups disputed its importance. Led by Reading First, part of the federal No Child Left Behind Act, the federal government, states and districts have devoted considerable resources to improving literacy, particularly among young students. Unfortunately, the intense focus on literacy appears to have come at the exclusion of efforts to improve achievement in other subjects. Many participants from across the focus groups spoke of how this emphasis on literacy has overshadowed math and science. Several participants noted that funding for initiatives to improve math and science has fallen and that, particularly in science, student achievement only seems to be visible to school, district and state education leaders in years when "it counts"—when achievement scores in science are being factored into state assessments.

While math and science are not the only subject areas struggling to gain attention and funding, the consequence of diminishing emphasis and funding for both is perhaps greater than for other subjects. Several teachers, district administrators and out-of-school providers noted that effective math and science instruction requires more materials and equipment than necessary to teach other subjects, such as history or economics. Math and science classes cost more money than other classes and recent budget cuts have hit both hard—current funding for them is simply not enough.

Underpinning many of these challenges in math and science education is a lack of collaboration, even communication, among stakeholders. When asked about how they work with each other, participants cited a few examples—coming together occasionally for projects, participating in annual networking meetings—but did not point to ongoing, substantive collaborations to improve math and science education. According to out-of-school providers, many school and district staff, as well as university faculty,question how out-of-school programs contribute to student achievement. Out-of-school providers, school and district staff and university representatives spoke of each having different cultures, languages, goals and modes of operation and how these differences shape and limit joint efforts. Several district administrators and teachers recognized that, to their detriment, they have few connections to community resources such as science museums.

Out-of-school providers expressed frustration at the seeming impenetrability of schools and especially districts. They described fruitless attempts to identify the

appropriate person in the district with whom they could coordinate various activities and programs.

Few participants spoke of the cost that they, and ultimately students, may pay for this lack of communication and collaboration but several referenced a lack of connection between the content of out-of-school programs and district curriculum. Several out-of-school providers have aligned their programs with state curriculum standards, but not all have been able to do so; these participants described their program content as complementary to curriculum standards but expressed some frustration at the disconnect.

STRATEGIES TO IMPROVE MATH AND SCIENCE EDUCATION

As they identified many of the same challenges in math and science education, participants across the focus groups also suggested many of the same broad strategies to address them; however, they had different ideas regarding implementation. These strategies fall into five main categories:

- Raising awareness of the importance of math and science education and the need to improve it
- Improving teacher quality
- Strengthening math and science curriculum
- Instituting inquiry-based, hands-on instructional strategies
- Fostering collaboration among stakeholders

Raising Awareness

Focus group participants were united in the belief that building a greater awareness of the need to improve math and science education, within and outside of the education community, is essential. This could be done in part through a multi-faceted public awareness campaign that would target various audiences—teachers, parents, community members and more—using multiple methods. Representatives of groups that work with parents indicated that messages about the importance of math and science education should come from individuals or organizations that parents, especially low-income and minority parents, trust. Several participants also suggested engaging business leaders and other key community stakeholders who would advocate for improvements.

Across the focus groups, many participants felt that it was important to lconvey, in very clear terms, what the economic cost of failing to improve math and science education would be for individual students and the community as a whole. Parents, teachers and other educators, business leaders, even students themselves, understand well the economic and social penalties for not knowing how to read—but, few understand the price of not knowing how to solve a linear equation, or even how to do long division.

Participants from most of the focus groups, including teachers and representatives of math and science organizations, spoke of the need to engage parents regarding math and science education. Those representing organizations that work with

parents were most concerned about the role of parents, particularly low-income and/or non-English-speaking parents, and the need to involve them in their children's education. School staff members have explored various strategies to engage parents, such as Family Nights in which parents join their children in hands-on, inquiry-based activities, and have experienced some success. However, educators need to be more pro-active. Most parents, regardless of their background, are committed to their children's academic success—those who are poor or non-English speakers often simply do not know how to support it, or what specific things they need to do to help their children be successful in school. Several participants suggested that teachers should ask parents what they would like to know, as often the information parents get from schools is not the information they want. It was also suggested that parents be encouraged to provide practical ideas about how they might become more involved in their children's education.

Representatives of out-of-school providers and of the groups that work with parents as well as several teachers called for efforts to raise awareness among students of future opportunities relating to math and science. They spoke of the need for programs and other experiences that would expose students, particularly low-income and minority students, to various career options available to those with math and science knowledge. Many out-of-school providers already offer such programs, but they have encountered several persistent barriers—the rising cost of transporting children to and from off-school-site programs; a lack of awareness about their programs among educators at the school and district level; and, among educators who do know about their programs, skepticism about how participation in the programs will improve student achievement.

Suggested solutions to the problem of transportation rested on garnering additional funding. A few out-of-school providers have successfully connected with school and district people and built positive relationships with them by having staff who work specifically on those collaborative opportunities. One out-of-school provider explained that asking school and district staff what they need to meet their goals, and working within the organization's capacities to do so, has helped build productive relationships with schools and districts. This may be a model for other out-of-school providers or organizations that seek to work with schools or districts on a variety of issues.

Participants from universities suggested that representatives of higher education might be well suited to engaging policymakers around math and science education. They may generate, or have access and can disseminate, research that describes both the costs of not improving math and science education and the potential benefits for doing so.

Improving Teacher Quality

There was widespread agreement that improving teacher quality is absolutely vital; math and science instruction will not change if teachers' knowledge and skills are not greatly expanded.

Discussions of ways to improve teacher quality centered on teacher preparation programs and on professional development. Participants in every focus group, including several from universities, held that teacher preparation programs do not adequately prepare math and science teachers. Teachers and district administrators advocated for increased coursework in math and science content as well as more time in classrooms, working with students. They also called for far greater exploration of the use of scientific-inquiry-based, hands-on instructional strategies and suggested that faculty in schools of education should teach their students in the same way that they hope these future teachers will instruct children. Finally, several participants indicated that all would benefit if faculty from schools of education spent much more time in K–12 classrooms, as most seem to be disconnected from the daily demands of life in a school.

District administrators, teachers and university faculty discussed professional development at length. The broad consensus among them was that current professional development practices are ineffective. Nurturing master teachers or mentor teachers in math and science who could then provide on-site guidance and immediate feedback and support to teachers was suggested several times in these focus groups.

Participants also indicated that teachers need opportunities to deepen their content knowledge, though few cared for the workshop formats that are commonly used to do so now. Teachers called instead for multi-day institutes, held during the summer, in which they could work with university faculty or other science and math professionals to deepen their content knowledge and practice various hands-on instructional strategies. By holding them during the summer, teachers would have time to reflect on what they are learning and consider how best to incorporate it into their curriculum.

Teachers were also in agreement that schools or districts should cover the cost of professional development and, perhaps, graduate study as well. Young teachers, those most in need of additional training and support, have very limited resources. While recognizing that many professional development experiences are expensive, teachers believed the programs should be covered by schools and districts. Teachers wrestled with the question of whether they should be paid to participate in professional development. Many teachers, they believed, are eager for high-quality professional development and would not need the incentive of payment to participate in it—assuming it was of high quality. They thought the same was true for many of their colleagues but wondered if, in taking a reform initiative to scale

across a district, it might be necessary to offer payment to ensure participation from all teachers.

Teachers and administrators spoke of their desire to nurture greater communication and collaboration among teachers. They hope for “vertical” communication and cooperation—math and science teachers from first grade through twelfth meeting regularly so that the needs and goals of every grade, as well as the instructional links between grades, are clearly understood by all. In addition, they discussed the value of engaging teachers in other subject areas who have little awareness of the challenges of math and science education, or, about how math and science are connected to other subject areas and how instruction across subjects could be enhanced by exploring these connections.

Several teachers and administrators expressed hope that schools would cultivate professional learning communities, in which teachers would have time to work together around various issues and would encourage each other to test without penalty and provide feedback on new ideas and new strategies.

Participants in the administrators, teachers and university focus groups also noted that teachers are not the only ones in need of high-quality professional development—principals and other school leaders should be included as well. As described above, few principals have much knowledge about the content of or effective instruction in math and science fields. Some participants wondered whether principals typically have enough knowledge to even evaluate math and science teachers, much less provide effective guidance to help them improve.

Strengthening Math and Science Curriculums

Over and over, participants in all of the focus groups spoke of the seeming irrelevance of math and science curriculum to students, because it has little connection to their lives. Some students will push through a tedious curriculum because they have parental encouragement or some other incentive to do so, but many students will simply choose not to take math and science courses or to take less rigorous ones.

Getting students engaged and enthusiastic about succeeding in math and science requires curriculum that relates to their experiences. Exposing students to different career options will help them see how they may reap future benefits from studying math and science, but most young people need more than a distant promise—math and science needs to be interesting and relevant to them today.

Instituting Inquiry-Based Instructional Strategies

As frequently as they called for curriculums that are connected to students' lives, participants in all of the focus groups spoke of the need to make inquiry-based instructional strategies the norm across math and science education. Doing so is largely dependent on faculty at schools of education incorporating it into their own curriculum, and using it in their own teaching. School and district leaders must also make it a core element of professional development.

Beyond this, numerous participants also said there should be a continued effort to conduct research, and, test emerging strategies to enhance math and science instruction, which should then be disseminated to practitioners. While universities may be best positioned to take the lead in such efforts, others could also have a role. University faculty may partner with districts and schools to undertake such research—and, in the process, build the capacity of teachers to pursue their own active research. Out-of-school providers may also be valuable collaborators, as they may have greater flexibility to test innovations than is available in traditional school settings.

Fostering Collaboration

Many of the strategies to improve math and science education described above offer natural opportunities for various stakeholders to collaborate. A partnership, for example, between a university and a school could provide university faculty the chance to be immersed in the realities of daily life in a school,l so that they would have a better understanding of what teachers need to be successful. Accordingly, they could adapt teacher education curriculum and activities. Such a partnership may also enable teachers to gain access to math and science faculty who could assist them in deepening their content knowledge. University faculty could also be a conduit for information on best practices. Tutoring or mentoring programs connecting college students with K–12 students, and providing them with additional academic support, could be another valuable component of such partnerships.

Representatives of the out-of-school group providers and organizations that work with parent groups advocated for greater communication about best practices, and about identifying the "go-to" people on various issues within central office. They also suggested that they might be well suited, given their community ties, to collaborate on a coordinated campaign to raise awareness of math and science education.

Clearly, there is no shortage of opportunities to collaborate. What then do stakeholders need to do to facilitate successful collaboration? What do stakeholders need to do to build a positive relationship with one another? Comments from out-of-school providers, described above, touched on one aspect of relationship building—

partners should not dictate to each other, they should share insights. This approach reflects a broader need highlighted by several participants from universities—partners have to respect each other and acknowledge each other's skills and expertise. No one person and no single organization can provide the solution to every problem.

Out-of-school providers and university faculty agreed that respecting school staff is critical. School and district staff are the target of considerable criticism that, fair or not, often makes them defensive. In addition, the offer of assistance from an outside organization can appear to imply to school staff that they are not capable educators. Outside organizations must present themselves carefully, particularly at the outset of a relationship, when people are still getting to know and learning to trust each other.

University faculty identified additional elements they believe are essential to developing productive relationships with other organizations. These include:

- Clear and frequent communication
- Articulating a shared goal for which all partners assume responsibility
- Agreement to assess, and on methods to assess, math and science programs
- Delivering on what was promised

CONCLUSION

Despite their different roles and perspectives, focus group participants were unanimous in viewing math and science education as being in critical need of reform and that this reform should not be put off. They were similarly united in identifying the problems of math and science education and in outlining strategies for responding effectively to them.

No one suggested that reforming math and science education would be easy or fast. Over a decade of standards-based reforms and signal that comprehensive reform around any aspect of education is arduous and time-consuming. There are no quick fixes.Yet, the unanimity in the views of participants, and their willingness to turn a critical eye on themselves and their colleagues in similar roles, reveals not only their sense of urgency but it suggests that they have learned from watching other reform efforts. They may be more interested in finding common ground, more open to communication if not collaboration, and more willing to hold themselves and to be held accountable for resolving the challenges of math and science education than was often the case in earlier reform movements. If this is the case, reforming math and science education may not be quicker than other reform initiatives but it may be less contentious.