HIGH SCHOOL MATHEMATICS CURRICULAR DECISION-MAKING:

A NATIONAL STUDY OF HOW SCHOOLS AND DISTRICTS SELECT AND IMPLEMENT NEW CURRICULA

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INTRODUCTION

The following monograph presents findings from a nation-wide study of the decision-making processes that schools and districts engage in when choosing a high school mathematics curriculum. During the past decade, secondary mathematics educators have confronted increasing pressures, as well as conflicting messages, when faced with the task of choosing a new mathematics program. On the one hand, the prevalence of high stakes testing in many states and districts encourages a traditional approach to mathematics – one that emphasizes basic skills and traditional algorithms. National Standards[1], on the other hand, advocate for a complete overhaul of high school mathematics that better reflects the needs of citizens in the new millennium – one that integrates the use of technology and includes many new topics, such as probability and Boolean algebra. In response to the challenges of achieving high standards, and in response to a persistent sense of student disenchantment with high school mathematics courses, a number of schools and districts across the country are seeking alternatives to the traditional sequence of mathematics courses that has defined secondary mathematics education for more than 80 years. They recognize that the traditional series of courses – Algebra I, Geometry, Algebra II – fails to meet the mathematical needs of many students. While eager to reform their high school mathematics programs, many districts and

[1] Professional Standards for Teaching Mathematics, *National Council of Teachers of Mathematics (Reston, VA: 1991).*

schools find that the task of re-organizing an entire secondary mathematics curriculum to be daunting.

The study described here arose out of a desire to better understand what we call “the high school mathematics curricular decision-making landscape" – that is, the people, the ideas, and the contextual forces that figure most prominently in shaping the curricular decisions that districts and schools make when putting together their high school mathematics programs. Our interest in conducting the study grew out of our work with COMPASS, the secondary mathematics dissemination and implementation center funded by the National Science Foundation. COMPASS contracted Inverness Research Associates to document and evaluate the work of their center. In trying to fully comprehend the issues of disseminating, implementing, and supporting non-traditional mathematics programs, it became to clear to us that we needed to know much more about the existing national landscape of curricular decision-making as it pertains to high school mathematics. By better understanding the existing realities of high school mathematics programs, and by exploring both the demand for reform, and the constraints that limit it, this study presents data about a “market niche” that is served by five new NSF-funded integrated secondary mathematics curricula. These curricula represent radically new visions of high school mathematics education, and they are also the curricula that are disseminated through the work of the COMPASS Center.

What We Mean by Curriculum and Curricular Decision-Making

In all grades K-12, the teaching of mathematics and science is largely determined by “the curriculum” that is taught. And yet, the notion of curriculum is ambiguous, or at least multi-faceted, encompassing a range of meanings. The root meaning of “curriculum” is derived from the Latin verb “currere” and its broad literal meaning is “the course to be run.” Curriculum lay out a course of study. It is how this course of study gets laid out that makes the difference in the way that states, districts and schools think about and make decisions about curriculum. For some, curriculum is defined by standards that specify what students should know and be able to do. Others interpret curriculum as a specific instructional program with its associated materials. For others it is a kind of “scope and sequence” of topics to cover. And for some it is simply a textbook.

Although national, state and district standards are ever-present, the day-to-day teaching of high school mathematics is still shaped strongly by the specific curricular materials – namely the textbooks – that districts adopt, schools purchase, and teachers use. While it is clear that curricular choices are critical in determining the nature and quality of instruction, the particular nature of the selection process – how these decisions are made, who makes them, what criteria shapes them, and what implications those decisions have for reform efforts – is not well known. The forces that determine the use of one curriculum over another, exactly how and why educators specify the exact “course to be run by their students,” remains largely unstudied. The collective practice across the nation of how curricula are selected and implemented is what we call the “curricular decision-making landscape”.

What are the major landmarks of this landscape? When people make choices about curriculum for their students, what does that decision-making process look like? What factors most influence people's decisions? And who are the people most centrally involved? In this monograph, we set out to examine the curricular decision-making landscape of one discipline at a single level – high school mathematics[2]. We have chosen to do so at a particularly interesting time in its history.

The Development of Innovative Curriculum

A little more than a decade ago, in concert with broader educational reforms, ideas about effective mathematics teaching and learning began to shift. Through its 1989 publication of *Curriculum and Evaluation Standards for School Mathematics*, the National Council of Teachers of Mathematics (NCTM) offered a vision of K-12 mathematics education that departed markedly from what most Americans had ever experienced as students. The NCTM Standards offered a broad framework for what the K-12 mathematics curriculum should include in terms of content priority and emphasis, building on five general goals for all students: 1) that they learn to value mathematics, 2) that they become confident in their ability to do mathematics, 3) that they become mathematical problem solvers, 4) that they learn to communicate mathematically, and 5) that they learn to reason mathematically. In short, the overarching goal of the standards was the mathematical empowerment of *all* students – a significant change in vision given common perceptions of mathematics as an elite and abstract discipline that is difficult to master and largely disconnected from everyday human experience.

The implications for secondary mathematics were substantial. The standards recommended that many topics in the traditional curriculum be de-emphasized or even eliminated – topics like conic sections and polynomial factoring. The authors discouraged teaching calculus in high school and encouraged schools to instead offer more courses for students in other areas of mathematics, such as statistics. Given its entrenched history, envisioning what the standards might look like in reality at the high school level proved difficult. While many teachers agreed that the traditional series of courses might not provide the best conditions for the majority of students to learn mathematics, they could not imagine how to teach mathematics any other way. They could see the value of the standards, but had difficulty envisioning how to implement them in their own classrooms.

Other research indicates that if the curriculum and materials go unchanged, the majority of teachers are highly unlikely to implement any new standards or to dramatically alter what they teach or how they teach it. (For years we have known that no curriculum is "teacher proof"; now it is also becoming clear that no teacher is "curriculum proof"). Teachers are willing to infuse incremental changes into their practice and curriculum. However, the kind of mathematics reform put forth in the NCTM Standards – that is, a significant shift in the conceptualization of the high school mathematics program –

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[2] *We have conducted similar studies in high school science, and K-8 mathematics. See www.inverness-research.org for more details.*

necessitate real changes on the part of teachers and students. New and innovative curricula are a necessary, if not sufficient, component of the reform that is required if classrooms are to reflect the kind of instruction envisioned in the National Standards.

Recognizing this need for alternative curricula, in 1992 the National Science Foundation (NSF) funded the development of five new secondary mathematics programs. Developers were instructed to design new curricula that would provide students with a richer and deeper high school mathematics experience than that afforded by the traditional sequence. All five of the programs[3] that resulted from this effort are multi-year series of comprehensive courses that incorporate the NCTM Standards and integrate topics from many different areas of mathematics, including algebra, geometry, statistics, and so on. As the development phase came to a close, NSF funded the COMPASS Center to support the dissemination[4] of these five new high school mathematics curricula. The expectation has been, as these new curricula become part of the nation's secondary mathematics curricular landscape, that they will facilitate a shift in thinking about high school mathematics – as well as a shift in the teaching and learning of this discipline so bound by tradition.

The Importance of Understanding the Curricular Decision-Making Landscape

The influence of the NCTM Standards on how educators think about mathematics teaching and learning is an example of how trends in education can also shape the curricular terrain. Ideas about what students need to know or be able to do are ever evolving. Local priorities and national politics also play a role – not to mention market forces, such as economics of textbook publishing and the cycles of supply and demand. Indeed, the very nature of a particular discipline -- whether that discipline is perceived as dynamic or static – is yet one more factor affecting the course of curricular decision-making.

It follows that when curriculum designers prepare their products for the educational marketplace, they differ in their motives and starting points. The National Science Foundation and others have invested millions of dollars funding curriculum development projects to create a "supply" of curricula that reflect national standards and an inquiry-based approach. At the same time, educational publishers have historically been in the business of producing mass quantities of curricular materials aimed at capturing large percentages of "marketshare" – meaning their interests are not in promoting a new vision, but in producing curricula that appeal to their "mainstream" clients. In the case of

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[3] *The five high school mathematics curriculum series are: Interactive Mathematics Program (IMP); MATH Connections: A Secondary Mathematics Core Curriculum; Contemporary Mathematics in Context (Core-Plus); Mathematics: Modeling Our World (ARISE); SIMMS Integrated Mathematics: A Modeling Approach Using Technology.*

[4] *For more information on these implementation and dissemination centers, see the report "The NSF Implementation and Dissemination Centers: An Analytic Framework," published on www.inverness-resesearch.org/reports.html.*

secondary mathematics, publishers of the most widely-used secondary mathematics materials have produced texts that reinforce well-established and traditional ideas about high school mathematics teaching and learning. Four years of sequential mathematics courses have required four distinct sequential textbooks.

Therefore, when new curricula like the NSF-funded mathematics programs are developed, they do not enter the world in a neutral fashion. Rather they are thrown into a marketplace that reflects the current curricular priorities and thinking. The new programs must compete within and be judged within the broader dominant landscape of considering, selecting, and implementing curricula.

Under these conditions, if NSF or any another funding agent wants its curricula to contribute to the quality of mathematics education, then it must manage a delicate balance between being "new and different" and remaining palatable to a significant number of schools and educators. Clearly, NSF-funded curricula must reflect the national standards and meet high mathematical standards. But it is also important that curriculum developers and disseminators understand well the most prominent features of the current curricular decision-making landscape for their discipline. Ultimately, it is the fit between the characteristics of the new curricula and the existing landscape that will determine who adopts the new curricula and how they use it. And it is both the quality and quantity of this usage which, in turn, will determine the ultimate return on the investment that NSF and others have made in the new programs.

This Study

During the academic year 1998-1999, a team from Inverness Research Associates began evaluating the work of the COMPASS Center. At the time, the five NSF-funded high school mathematics curricula had completed the curriculum development phase of their work and were in the midst of the early stages of implementation. As our work with COMPASS began, it quickly became clear that both we and the COMPASS staff needed to better understand the processes and criteria that schools and districts used to choose their secondary mathematics curricula. Thus, as the first step in our evaluation work, we conducted a national survey (sent to district mathematics specialists and mathematics department chairs across the country) which asked about the curricular decision-making processes used in high school mathematics. These surveys were followed up with interviews of key curricular decision makers. In what follows, we describe what we learned from these surveys and interviews.

The Data

In the Fall of 1999, Inverness Research sent out approximately 3600 surveys to district mathematics specialists and high school mathematics department chairs across the country. Our goal was to get a sampling of people who would be concerned about and have an influence over secondary mathematics curricula nation-wide. Therefore, we developed our recipient list using a variety of sources, including the NCSM membership

list, a national listing of high school mathematics department chairs, and the COMPASS website visit list. There were six versions of the survey, each one with a slightly different focus. (The six survey versions appear in Appendix A of this report.)

We received responses from 571 respondents, representing 460 districts and 48 states. Many of the respondents had overlapping professional responsibilities, such as high school chairs who are also district coordinators or instructors at the local college. We asked people to answer the survey from the perspective of their highest level of responsibility (classroom, school, or district). For example, a district coordinator who also chairs at a high school was directed to respond from the perspective of the status of his or her district rather than from his or her school. We received about twice as many surveys from high school chairs (57% of respondents) as we did from district-level people (29%). The remaining group of respondents (14%) included university instructors, consultants and others who were concerned with and knowledgeable about high school mathematics but were not currently affiliated with a high school or district.

The question of whether our sample is representative of the nation is an important one. From the results of the survey, and from our comparison with other reports, we conclude that in many ways our sample is typical. On the other hand it also appears that our sample is slightly biased toward respondents who are interested in and knowledgeable about mathematics reform. In that sense then, these results represent an upper limit, or a best case scenario, when viewed from the perspective of COMPASS and the five high school mathematics programs disseminated by COMPASS.

At the end of the survey, we asked respondents if they would be willing to talk to us further by phone about their experiences. A number of those surveyed agreed to such a follow-up interview. We then contacted a small group of these respondent volunteers with whom we discussed the state of curricular decision-making in more depth. (The interview protocol is included here as Appendix B.) We also conducted a small set of interviews with a similar group, referred to us from COMPASS leaders, that we knew was currently engaged in curriculum decision-making involving integrated mathematics curricula.

This Monograph

We believe the findings based on our surveys and interviews will be of value to anyone interested in learning more about decisions related to high school mathematics, the current mathematics reform movement, and curriculum implementation in general. The current monograph draws most heavily from our survey results. We have used the interview data primarily to complement and ground the survey piece by providing details that were not readily attainable via questionnaire. We have integrated the data to present a more complete picture, but when our sources disagreed, we have noted so.

We have organized the monograph around four key questions that have helped us think more clearly about how schools and districts choose and implement their high school mathematics curricula. Our goal was to document who actually makes the mathematics

decisions at the high school level and to learn what influences their choices. We also wanted to examine current curricular patterns and the extent to which decision makers seem positioned to make a change. The specific questions we address are as follows:

- ***Who chooses the mathematics curriculum at the high school level?***
- ***What factors influence the choice of a new curriculum?***
- ***What is the nature of secondary mathematics curricula that are currently adopted and in use?***
- ***What is the level of interest in changing the high school mathematics curriculum and what is the vision for that change?***

In the final section of this report, we discuss the implications of the answers to these questions – not only for NSF and the curriculum developers it supports – but also for those involved in similar efforts to improve the teaching and learning of high school mathematics.

MAJOR FINDINGS

Because this was a general study about curricular decision-making practices and influences, our surveys posed many questions about a variety of topics. However, for the purposes of this monograph, we have limited the scope of our findings to the four areas that best illuminate the major factors involved in choosing and implementing mathematics curricula at the high school level.

➢ *Who chooses the mathematics curriculum at the high school level?*

The decision about which curriculum to adopt and implement can be a weighty one; it determines much about what is actually taught as well as the quality of the learning experiences students will have in mathematics classes, often for a number of years. Given the implications, we wanted to know who in districts and schools is in the position, and has the power, to actually make this kind of curricular selection.

We found that there is not a singular profile of a mathematics curriculum decision-maker. Across the nation, the kinds of people who select high school mathematics programs runs the gamut. Different configurations of teachers, parents, administrators and others help choose curricula, depending on the district context. Some interesting findings follow:

- The size of the district plays a significant role in determining who chooses high school mathematics curricula.

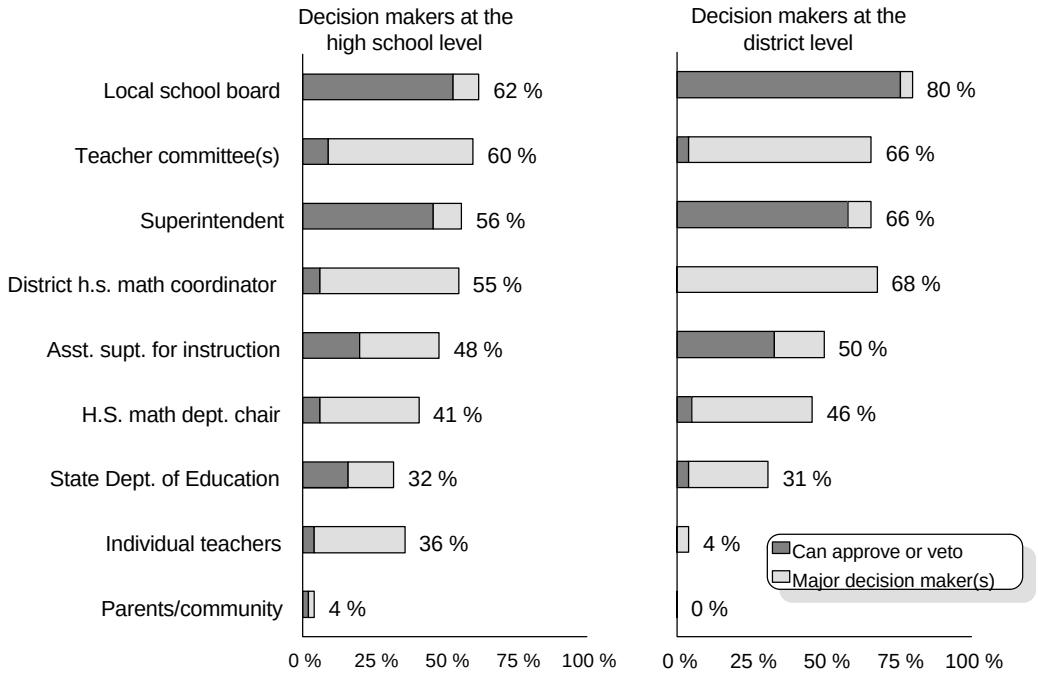
The larger the district the more influence discipline-specific district-level administrators are likely to have. Larger districts are likely to have a mathematics coordinator, and larger districts are likely to take a stronger role in the defining of curriculum and the choice of curricular materials. In medium-sized districts, where a district specialist tends to have responsibility for a number of curricular areas, mathematics department chairs become more involved in the process and consequently teachers also have more opportunity to influence the decisions that are made. In very small districts it is very often teachers alone who tend to make most decisions.

- There is often a distinction between the "initiators" and the "approvers" in the curriculum selection process.

In many instances, those who initiate and guide the curricular selection process are department chairs or actively involved teachers and administrators. According to our interviews, it is often the enthusiastic reform-minded teachers who take the lead in directing their departments to research various alternative mathematics programs. The mathematics department then works to narrow the field, piloting programs and winnowing the list down to one or two options that are informally endorsed by the teachers and department chair. Staff at the district level then sign-off on those choices, but ultimately the superintendent and school board must give their final approval for the district to purchase and implement the curriculum. This stamp of approval is often simply a pro forma nod to the program which has been recommended by the mathematics department and district mathematics specialist. Thus, those who have a grounded knowledge of the discipline propose a curriculum, but they are not necessarily those who approve it. In fact, as is clear in Figure 1, frequently one group has little to do with the other.

Figure 1. Major Decision Makers About High School Mathematics Curricula

"WHAT ROLE, IF ANY, WOULD THE FOLLOWING GROUPS HAVE IN MAKING CHANGES IN YOUR SCHOOL'S/DISTRICT'S HIGH SCHOOL MATHEMATICS CURRICULUM?" (N=93)



Ratings were made of a 5 point scale where 1 = "involved very little if at all' and 5 = "can approve or veto". Total percentages represent combined ratings of 4 and 5.

- High school mathematics teachers play a significant role in determining the curricula their students will use.

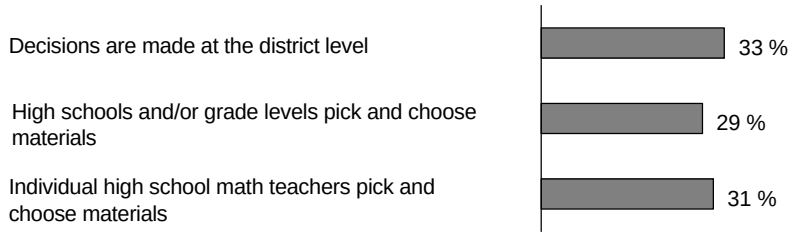
The real process of choosing high school mathematics curricula is, often in subtle ways, more teacher-dependent than we expected; the survey shows that almost two-thirds of these decisions are made by teachers.

According to our survey respondents, 33% of high school mathematics curriculum selection decisions are made at the district level – while 29% of these decisions are made by grade level or school staff and 31% are made by individual teachers (see Figure 2). This means that teachers participate in 60% of the decisions. Either as individuals or in groups (e.g., on committees), teachers are highly involved in the selection process. Even in places where they do not have final say, their desires and opinions about the curricula seem to carry substantial weight. Our interview data also highlighted the extent to which mathematics department chairs and district administrators listen carefully to their teachers' views about teaching materials. Even school boards ultimately seem to pay careful attention to teacher recommendations. As one department chair in the midst of

choosing a new program noted, "If we have a recommendation that has the support of both high school departments, I don't see any problem with the board accepting [that choice]."

Figure 2. Who Selects The High School Mathematics Curricula

"WHICH OF THE FOLLOWING DESCRIBE YOUR DISTRICT'S HIGH SCHOOL MATHEMATICS CURRICULUM AS IS IT TAUGHT CURRENTLY?" (N =118)



➢ *What factors influence the choice of a new curriculum?*

Just as important as the people making the curricular decisions are the factors that influence their choices. One portion of our survey asked respondents to rate a range of possible factors – from state and district standards to teacher beliefs – that might play a role in the selection of a high school mathematics curriculum.

- State standards were mentioned most often as having a major influence on people's choice of curricula.

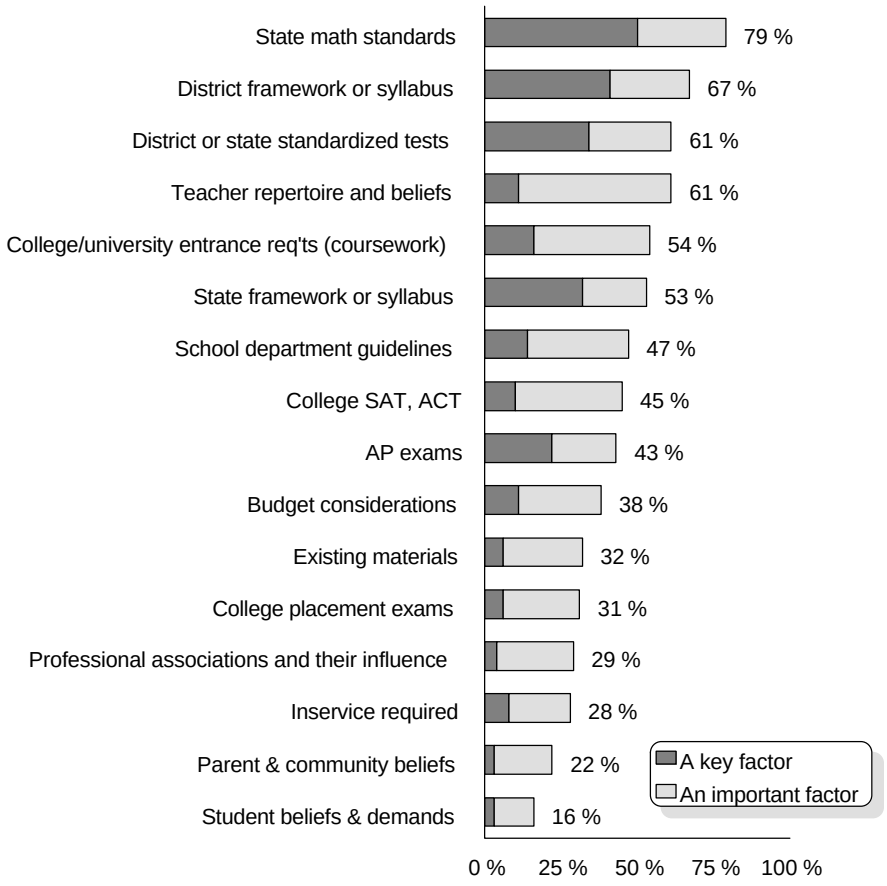
79% of the survey respondents indicated that they paid close attention to state standards when making curricular decisions (see Figure 3). Those we interviewed also reported that members of mathematics departments examined the state standards and then researched texts to find a program that would "meet" those standards. In some cases, after reviewing a program under consideration, teachers were asked to complete a "textbook adoption proposal form" to indicate the ways in which their choice aligned with the designated standards.

Interestingly, some survey respondents reported that their states actually mandate a particular course structure and sequence when it comes to high school mathematics. Almost always this mandate precludes, or at least makes very difficult, a new approach such as the integrated curricula represented in the COMPASS Center. It is also true that in many other states, the state department of education will specify content to be covered and exit standards to be met. They also may create and administer a range of assessments. But in these states, the reality is that state requirements do not completely dictate course structure nor do they prescribe specific teaching approaches. Hence, we heard from some respondents that, while it may not have been easy, it was possible to pursue the adoption and use of alternative curricula. As one respondent told us, "the state can set the bar, but it is up to districts and schools to determine how to get over that bar".

It is important to note that about half the states have state adoption processes. When a state provides significant funds for the choice of those texts that are on the state list, it is very difficult for a district to adopt non-listed materials. Clearly in these cases the state plays a very key role in the selection process.

Figure 3. Factors Influencing The Selection Of High School Mathematics Curricula

"WHAT DO YOU SEE AS THE MAJOR FACTORS THAT INFLUENCE STRONGLY THE SELECTION AND ACTUAL USE OF HIGH SCHOOL MATHEMATICS CURRICULA IN YOUR SCHOOL/DISTRICT?"(N=117)



Ratings were made on a 5 point scale where 1 = "Not a factor," 3 = "Somewhat of a factor", and 5 = "A central or key factor." Totals for this graph represent combined ratings of 5 (dark gray) and 4 (light gray).

- District frameworks can also play an important, but not determinant, role in curricular decision-making.

District frameworks are often somewhat diluted versions of the state standards, with district-specific modifications. While our survey respondents strongly agreed about the centrality of state standards and district frameworks, we found that both state and district standards served as constraining parameters, as opposed to strict criteria that completely defined the selection process. The mathematics educators we spoke to did not see district frameworks completely determining the choice of curricula. In fact, there was often a mismatch between formal district policy and the reality of the classroom decision-making process. And there may only be a loosely coupled connection between formally adopted texts and actual instructional practice. As one department chair said when asked about a district framework or syllabus, "Yes, I'm sure there is one…," but in her district, teachers use the standards and adopted texts primarily as guides, deciding as a department which material they will use, skip, or supplement.

- Tests and testing performance (including college entrance exams and state exit standards for high school courses) are another significant factor that influence curricular choices.

In this era of high stakes testing, states, districts and schools are focused on student assessments. Curricular decision-making cannot help but be affected by the current testing climate. Overall, testing tends to support the curricular status quo. Similarly, university entrance requirements also tend to play an important role in supporting the status quo. In the early 1990's, following the publication of the NCTM Standards, many American state universities and colleges created a nationwide trend by collectively increasing the amount of mathematics required for undergraduate admissions. These institutions set a new standard by insisting on the completion of Algebra II or its equivalent as a prerequisite for post-secondary study. Although this mandate received a mixed reception overall, it served to reinforce the value of the traditional secondary mathematics curriculum at a time when mathematics reformers were attempting to fashion new options for students.

Teachers clearly pay attention to what is on state tests and college entrance exams when selecting their programs. "The standards have always been there," said one department chair, but now that the state has placed so much emphasis on accountability, "it's at a new level. And if that's what they're holding us accountable for, we feel like we should at least make an effort to give our kids a chance to pass those tests, so within reason we will do all we can." In districts where there are large numbers of students who do not do well on tests, there can be two different reactions. One is to simply try and do more of the traditional curriculum. Another is to try an alternative approach. Indeed, one of the main motivations we heard from respondents for seeking alternative curricula was the presence of a group of students who seemed poorly served by current programs and courses.

The opposite is true as well; that is, in districts where students are faring well on assessments and are successful in their college applications, there is often little motivation to change the current program. We heard this sentiment expressed during interviews, "We have kids that get perfects on the SATs and do well in college mathematics courses…[so we don't need to change]." Such views are quite pervasive among certain districts, primarily affluent suburban ones.

- Teacher beliefs figure prominently in the curricular decision-making process.

Both surveys and interviews point out the fact that individual high school teachers have a great deal of influence in the curriculum selection process. Naturally, their beliefs about what is important and their past experiences as educators will impact the choices they make. Indeed, 61% of our survey respondents viewed "teacher repertoire and beliefs" as a major factor influencing the selection process (see Figure 3 above). The beliefs and teaching repertoires of teachers are often a strong indicator of district and/or school culture. At least to some extent, the ideas and beliefs that teachers hold dear generally reflects the larger district's past and current priorities. Teacher beliefs also bear a connection to their professional associations and professional development activities – both of which offer teachers a broader national vision of mathematics education. Thus, the experience and sophistication of teachers, even if it is only a few individuals, can play a very large role in shaping the vision for, and interest in, curricular change at the school and district level.

- Decision-makers rely heavily on "word of mouth" and personal communications.

"Word of mouth" is the most commonly used and trusted source of information about high school mathematics curricula. Among our survey respondents, 70% said that they often used this "resource", and 51% said they found it to be of great value. Most often, this kind of informal sharing takes place at professional associations and conferences as well as showcases, curriculum seminars and state-level meetings. Less structured environments offer even more opportunities to discuss and form opinions about curricula; peers share information in the lunchroom and during casual after-school meetings. In many places the high school mathematics faculty are a small and tight group. Sometimes, word that a colleague from another school has had a bad experience with a particular program can decide the fate of that program instantly. Or, conversely, the visible success of a teacher using a new curriculum, can attract broader interest and a willingness to consider a new curriculum. Informal communications thus play a major role in influencing educators' perceptions about different curricula, and therefore, what they ultimately adopt and implement.

➢ *What is the nature of secondary mathematics curricula that are currently adopted and in use?*

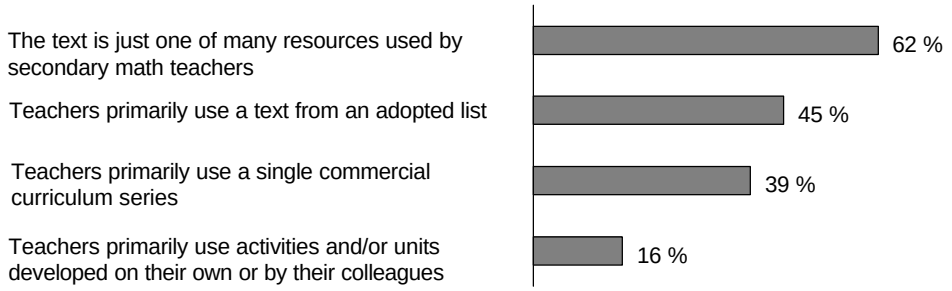
Despite reform efforts of the last decade, there has been little change in the secondary mathematics curricula that most high schools use across the country. According to the people we surveyed and interviewed, the mathematics program in a given school or district remains largely determined by the adopted (usually traditional) textbook. Our national data set indicates that there is indeed some exception to this rule – such as the limited infusion of the NSF-funded curricula and other integrated programs. Still, most districts continue to offer the traditional four-year sequence for the majority of their students.

- Currently, most high school mathematics teachers rely primarily on the use of a traditional textbook.

According to our survey results, almost all teachers rely heavily on commercial materials as the core of their mathematics curriculum. Respondents from nearly half of the districts represented (45%) told us that teachers primarily use a text from an adopted list of curricula. Thirty-nine percent of the districts told us that teachers most often use a single adopted commercial curriculum series (e.g., Houghton Mifflin, Harcourt-Brace). However, we find that schools do not usually adopt one series for all courses. Instead, they choose one publisher's text for algebra, and another for geometry. Also, people often opt for books that provide supplementary support materials for teachers and some form of "technology integration." How (and to what extent) teachers make use of the additional materials is typically left to their individual discretion.

Figure 4. Teachers' Current Use of High School Mathematics Curricula

TEACHERS' CURRENT USE OF HIGH SCHOOL MATHEMATICS CURRICULA (N=118)



In our interviews, people from larger districts reported that most teachers were likely to be using a mainstream traditional text – in part, because that is what they have always used, and also because adopting innovative programs tends to be a greater challenge for very large school districts. However, at the same time, if the motivation and momentum to alter curricular choices exist, larger districts tend to offer more room for curricular variance across schools. Typically in this setting, a high school can make its own decisions within a broad array of state- and district-determined parameters.

Further, many mathematics curriculum decision-makers, when reviewing a textbook or series, tend to categorize topics according to the structure provided by the traditional sequence of courses. The selection process tends to consider the coverage of topics; rarely, do mathematics departments think holistically about "the four-year high school mathematics program" or the composite four-year mathematics experience of a student. Very practical guidelines such as reading level and topics covered dominant the choice. One mathematics department chair described the process by which he chooses curricula this way, "I look for things that we have to teach. I look for support material. I look for the way certain things are said – for students to be able to read it. I try to pick the [texts] that aren't too difficult and aren't too elementary – a middle of the road kind of thing."

- A number of districts and school have opted to adopt and implement multiple, parallel curricular tracks – one more traditional, and one more innovative – largely in an effort to address variable student needs and interests.

High school mathematics has a long tradition of offering students a range of course options; the notion of multiple track mathematics programs is quite common. Although the practice aims to help schools meet the learning needs of a variety of students, it often leads to achievement-based tracking. Those who choose NSF-funded programs for use in parallel track situations typically do so because they want a curricular option for those students who historically have not done well in mathematics. They want something that maintains academic rigor while also presenting mathematics in a new light. They also seek an opportunity for students to learn mathematics differently – namely, through a process of investigation and discovery. One department chair's comment sheds light on what people are looking for in their non-traditional track: "We don't want anything that is 'straightforward' – and by that I mean a topic is introduced, the kids work a few problems around it and then move on to the next topic. Instead we look closely at the situation the student is put in to learn; we look for materials that ask students to learn through discovery."

In another district that uses parallel tracks, the mathematics specialist told us that their experience with one of NSF-funded curricula has helped them see how mathematics can be more attainable for a wider range of learners. Across our interviews, we encountered a perception that the NSF-funded programs were largely designed to provide an approach to mathematics that was good for the lower achieving students – for those who struggle to learn mathematics the traditional way. Mathematics educators told us they wanted "non-traditional students" who learn "in other ways" to have the option of non-traditional curricula.

➢ *What is the level of interest in changing the high school mathematics curricula and what is the vision for that change?*

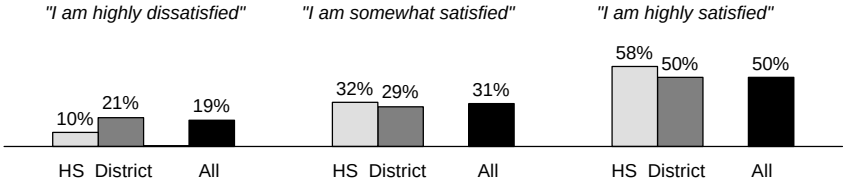
As a group, our survey respondents and interview participants expressed only limited interest in significantly changing their secondary mathematics curriculum.

Satisfaction

The lack of widespread interest in changing the curriculum is explained, at least in part, by the widely shared sense of satisfaction that mathematics educators expressed in their existing program. Among of those who completed the survey, 50% said they were fully satisfied with their current curricula (see Figure 5). However, it is important to note that another 19% of our survey respondents reported being highly dissatisfied with their present programs. Looking at this group in more detail, twice as many district representatives (21%) as high school department chairs (10%) report being highly dissatisfied with the mathematics curricula they now use.

Figure 5. Satisfaction With Current High School Mathematics Curricula

"OVERALL, TO WHAT EXTENT ARE YOU PERSONALLY SATISFIED WITH YOUR CURRENT SCHOOL/DISTRICT HIGH SCHOOL MATHEMATICS PROGRAM?"[5] (N=87)



Ratings for this question and the following three graphs were made on a 5 point scale where 1 = a very low rating and 5 = a very high rating. Ratings of 1 and 2 were combined, as were ratings of 4 and 5.

[5] *Respondents were instructed to think about their school or district in answering this question and all others on the survey, depending on whether they have a school-level or a district-level position. When findings are of interest, we break out responses by professional role. All three types of respondents – high school chairs, district coordinators and other interested people (consultants, university faculty, etc.) – are included in total percentages.*

- In districts where there is the presence of mathematics reform, especially at the lower grades, there is a greater likelihood that teachers and administrators will be dissatisfied with the traditional secondary mathematics curriculum.

Clearly, changes occurring in one part of the educational system can impact another. Shifts in pedagogical approach in one discipline often permeate into other areas. Because of the cumulative nature of mathematics, improvement efforts targeting younger students can ultimately influence the experience of their counterparts at the high school.

For example, in one medium-sized suburban district, the lower grades have shifted their emphases by adopting *Everyday Math* for grades K-5 and *Math in Context* for grades 6-8, while the high school remains unchanged. The secondary Director for Curriculum and Instruction in this district predicts that high school students and parents will soon "not stand for" traditional mathematics books and teaching. She expects that, amidst growing pressure, the high school teachers will begin to make changes on their own. If not, she is fully prepared, with the support of the school board, to make an executive decision that forces their hand. "We will adopt one of the five NSF curricula, there's no doubt in my mind. We're having too much success at the K-8 level."

- When districts and schools had earlier unsuccessful experiences with a non-traditional program, there is more unwillingness to consider alternative curricula.

A small of group department chairs and administrators reported that some of their teachers had encountered earlier difficulty implementing non-traditional curricula. A number of these respondents also indicated that in these earlier efforts the teacher supports, particularly professional development, had not been as comprehensive as they might have been. Additionally, if a school or district had not thoroughly "bought into" the shift in thinking that accompanies the use of an alternative program, it was often too overwhelming for a teacher to successfully teach the new curriculum.

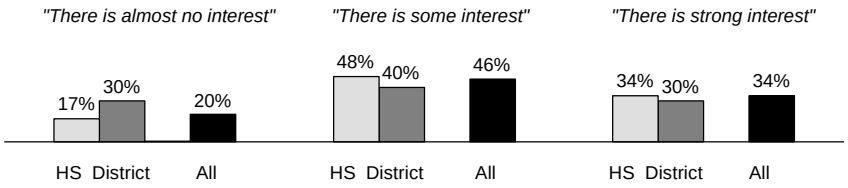
Interest in Change

Given the state of satisfaction with current high school mathematics instruction, we wondered about the level of interest in revising or replacing current curricula. Overall, it appears that people are intrigued by the possibility of improving their current mathematics program, but they also anticipate that any significant curricular changes will come about slowly.

- Our survey results suggest that approximately one-third of schools and districts are quite interested in changing their secondary curricula.

Figure 6. Interest In Changing High School Mathematics Curriculum

"OVERALL, TO WHAT EXTENT WOULD YOU SAY THAT THERE IS INTEREST IN CHANGING THE HIGH SCHOOL LEVEL MATHEMATICS CURRICULUM IN YOUR SCHOOL/DISTRICT AT THIS TIME?" (N=41)

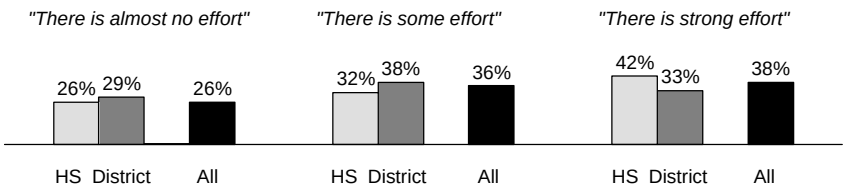


- The survey results suggest that the majority of schools and districts nation-wide are engaged in some sort of effort to improve high school mathematics in their setting.

According to our survey participants, in three out of four schools and districts there is at least some effort currently underway to improve high school mathematics curriculum (see Figure 7). In a surprising 42% of high schools and 33% of districts represented in our survey sample, respondents reported that there is currently a strong and active effort to change.

Figure 7. Current Efforts To Change High School Mathematics Curriculum

"OVERALL, TO WHAT EXTENT WOULD YOU SAY THAT THERE IS AN EFFORT TO CHANGE THE HIGH SCHOOL LEVEL MATHEMATICS CURRICULUM IN YOUR SCHOOL/DISTRICT AT THIS TIME? (N=199)

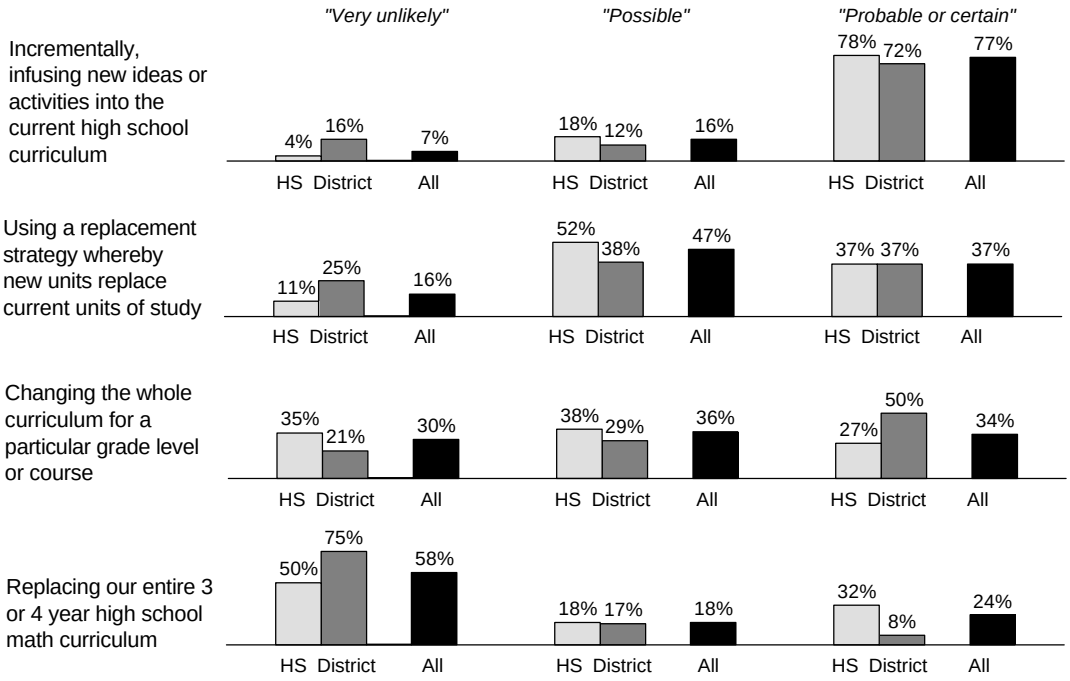


- Those interested in changing their mathematics curricula anticipate making gradual changes.

Even among those who expect change, few people think that sweeping reform will happen any time soon. They predict that change will come about incrementally, with the infusion of new ideas into the existing curriculum (see Figure 8). It is more than twice (77% vs 37%) as likely that change will come about through the infusion of a few new ideas than even the use of replacement units. Only a quarter of all respondents (24%) felt there was any probability of replacing the whole high school mathematics program.

Figure 8. How High School Mathematics Curricular Change Might Happen

"IF YOU PICTURE CURRICULAR CHANGE IN HIGH SCHOOL MATHEMATICS IN YOUR SCHOOL/DISTRICT (WHETHER OR NOT IT IS PLANNED AT THIS TIME) HOW MIGHT IT HAPPEN?" (N=85)



Ratings were made on a 4 point scale where 1 = "Very unlikely," 2 = "Possible," 3 = "Probable," and 4 = "A certainty." For this graph, ratings for "possible" and "probable" are combined.

In our interviews we found most teachers remain inclined toward curricula with which they feel comfortable – a natural and understandable tendency. As one department chair who had used the same curriculum for many years reported, "I chose [my current curriculum] because it was more like what I was used to doing."

Additionally, there was a recognition that the innovative curricula put higher demands on the teachers. Some of people we interviewed pointed out that traditional materials – those with which many teachers feel more familiar and at ease – actually allow teachers to do their job without truly knowing the mathematics. The non-traditional curricula, this

reasoning continued, require teachers to more carefully consider student thinking which in turn demands a much deeper understanding of mathematics. One mathematics coordinator explained: "Traditional materials permit teachers not to know their mathematics. When you do a non-traditional curriculum, you have to know the mathematics to pull it out of the kids." Many districts simply felt they were not ready to meet these demands.

- Those who believe they have a strong traditional high school mathematics program in place, where the majority of students are enjoying success, feel quite content with their current curriculum and see little need for radical reforms.

Understandably, when people perceive that all is well, there is little motivation to change – as is the case for many suburban, upper middle-class and high income districts. Students generally do well on state tests and meet college entrance requirements. While district leaders might want to make modest changes (i.e., introducing some new replacement units or adding a few things by infusion), massive curricular overhaul simply does not interest them.

One mathematics educator in a small western district stated a view expressed by many. In response to our question about the interest in change, he explained, "Our kids are going to college. We're all set here." To varying degrees, "we're all set" was a sentiment that echoed across our interviews. In addition, those who indicated interest in some sort of change, offered fairly murky or mixed visions of what that change might mean. For the most part, curricular decision-makers in high school mathematics were neither seeking nor particularly open to innovative approaches that would involve a radical departure from the status quo.

- While there is growing interest in the five NSF-funded secondary mathematics curricula, their marketshare is small and they have not yet been widely implemented.

Interestingly, most of our respondents said that they were aware of the five innovative curricula disseminated by the COMPASS project. But most of the people we interviewed indicated that they find the curricula a bit "too far to the left of center" or "too big a change" for their school or district. As is to be expected, teachers and administrators are looking for some degree of familiarity as they examine new curricular options. They want to compare their existing programs with the potential successors. However, the "non-traditional" curricula are currently viewed as being a marked departure from what and how the majority of teachers presently teach. In a high stakes testing environment, they represent for many too large a risk. So it is not surprising that many educators still lean towards what they know best – traditionally-based textbooks. Even in our positively biased sample, we found relatively few districts "implementing or using" these curricula.

Figure 9. Awareness Of Each Of The Five High School Mathematics Programs

TO WHAT EXTENT HAVE YOU HEARD ABOUT OR ARE FAMILIAR WITH EACH OF THE FIVE HIGH SCHOOL MATHEMATICS CURRICULUM SERIES?

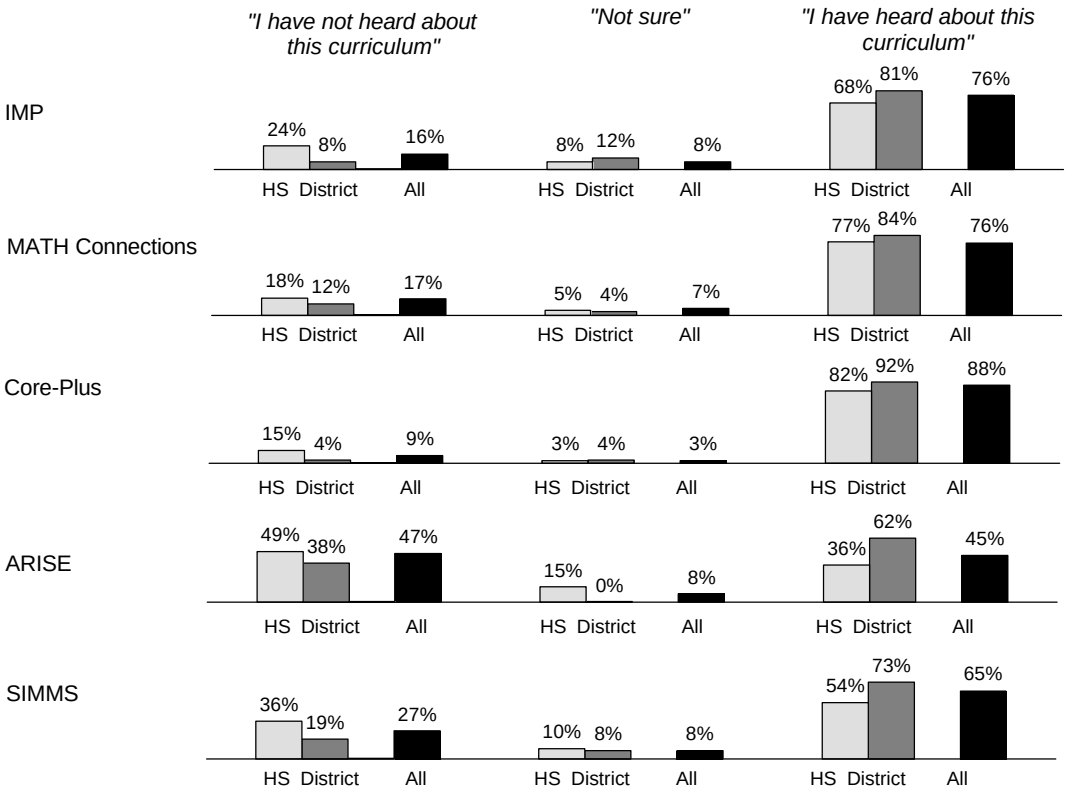
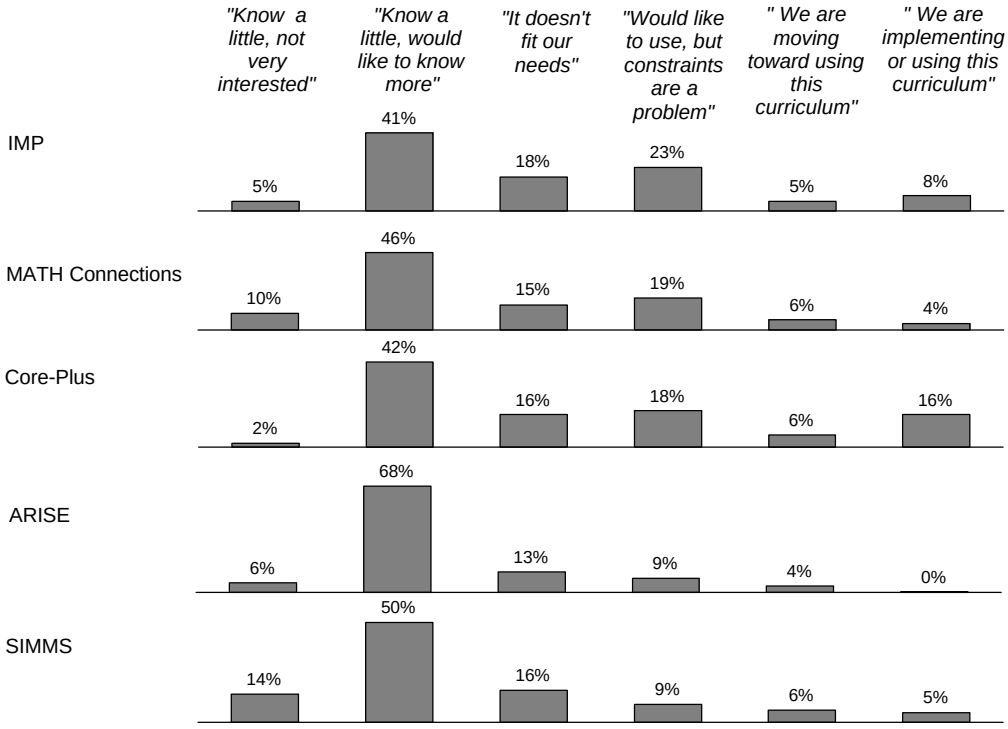


Figure 10. Impression Of And Interest In The Five High School Mathematics Programs

WHAT IS YOUR IMPRESSION OF EACH OF THE FIVE HIGH SCHOOL MATHEMATICS CURRICULUM SERIES AND YOUR INTEREST IN THEM AT THE MOMENT?



IMPLICATIONS FOR NSF AND OTHERS INVOLVED IN CURRICULUM DEVELOPMENT

In the previous sections we have described the "landscape" of high school mathematics curriculum decision-making. In this section we offer our ideas about the implications of this landscape for the work of NSF, curriculum developers, and implementation and dissemination Centers.

- The effort to disseminate these curricula must center heavily on the education of individual teachers.

Although district personnel oversee the formal adoption process and present new curricula to school boards, the real impetus and energy for curricular reform continues to come through teachers and their professional connections. Teachers are the ones who regularly attend conferences, workshops, and institutes; they are the ones who bring ideas and enthusiasm back to their departments, schools, and districts. In many districts and schools the expertise of high school mathematics teachers is valued – there is a strong operating assumption that it is high school mathematics teachers that know their discipline best and tend to be more knowledgeable about their field than most district leaders, board members, or state legislators. It follows that high school mathematics teachers are given considerable freedom in making curricular decisions, a pattern that is quite different from what we see at the elementary level.

Also, it is to be remembered that leadership development and curriculum innovation often go hand-in-hand. Teachers who become involved in professional associations eventually assume leadership roles in their schools and districts. It is the most involved teachers who become department chairs and even district mathematics coordinators. Hence, it is important to have an ongoing effort to help leading teachers across the country become aware of and interested in the NSF-funded innovative curricula.

Finally, it should be remembered that high school mathematics teachers not only play an important role in initiating the curricular selection process, but they also have considerable autonomy in implementing whatever curriculum is adopted. As one interview respondent told us, "even though the topics for any given course are laid out by the state, it is the department that makes choices about what to cover – and when you close the door, it comes down to the philosophy of the individual teacher."

The important idea here is that teachers will advocate for the curricular programs that reflect their aspirations and beliefs. Given the small size of most mathematics departments, and the autonomy generally afforded to high school teachers, the power of the individual teacher to affect curricular decision-making should not be underestimated. One of the major implications of this study for those who develop and disseminate

curriculum is the power of professional associations and all forms of informal professional communications. It follows then that all curriculum developers and disseminators would be wise to maintain a strong relationship with NCTM – both at the state and national levels – as well as NSF-funded projects and other professional development initiatives.

- The existing curricular decision-making landscape is primarily focused on the process of textbook adoption for isolated courses. The COMPASS-related curriculum projects have a different conceptualization – and a more programmatic perspective – of curriculum adoption and implementation. Therefore, the dissemination process must help districts and schools rethink the whole idea of adoption and implementation.

The COMPASS curricula are designed to be complete 3 or 4 year integrated high school mathematics programs, with the expectation that students will participate in the full three or four year cycle of coursework. Choosing to adopt one of these programs means that a district commits to implementing the entire curriculum as a coherent programmatic whole, a prospect that most educators find overwhelming, if not downright foreign. In contrast, the traditional practice of adopting a textbook requires much less of an investment. Even choosing a new textbook series does not demand the restructuring necessary for a multi-year integrated program. Therefore, curriculum developers and disseminators need to make clear to districts and schools the substantial difference between building a new program and adopting a new textbook. Both the benefits and the costs of the new integrated curricula must be carefully laid out if local school and district officials are going to succeed in making the right curricular choices.

- With innovative curricula comes a need for supports that were not necessary when teaching traditional courses using traditional texts.

Many schools and districts have grown accustomed to simply ordering new textbooks, distributing them to teachers, and expecting that teachers can successfully use the new texts without any additional training. Some teachers also believe that knowing their subject area well means that they will be able to teach from any book. However, the reality of the newer, non-traditional programs is that they demand a great deal more from teachers – in terms of both pedagogy and content – creating a substantial need for teacher professional development as part of the implementation process. New curricula also demand more from students and from the system as a whole. Providing professional development is expensive for institutions and time-consuming for teachers. Not surprisingly, some interviewees told us that the more traditional curricula were simply easier to use and more “fail safe”. Innovative curricula, for many, represent a high gain, high risk choice. Dissemination efforts must help people assess their “risk tolerance” and clearly understand the work that will be needed to succeed in implementing one of these new programs.

- To exist in the real world, new programs must be credible and marketable to a range of audiences – in education circles and beyond. Curriculum development remains a political as well as an educational endeavor.

The pressure that high school teachers, parents and even college advisors face to ensure that their students are adequately prepared to pursue the next level of study is palpable. Standards, testing and admissions requirements weigh heavily on the minds of these groups when considering new curricula. Thus, we believe that there is a heavy burden of responsibility on the developers and disseminators of innovative curriculum to educate (and then support) school staffs and parents, and to provide opportunities for them all to participate in the decision-making process. Districts and schools that consider the new curricula need help in understanding some of the political issues that are involved and be prepared to do the groundwork that is necessary to avoid serious conflicts.

- Schools and districts can use multiple strategies for replacing old curricula with new curricula – and each strategy has its advantages and disadvantages.

Replacing the entire four year high school mathematics curriculum wholesale is one option, although many schools fear that full-scale implementation of a new program will be viewed as being too much change at once. Our experience, however, is that when done well, with ample preparation and the full backing of the faculty and administration, this strategy is likely to be successful.

A second option involves a strategy of "phasing in" a new curricula over several years. The development of "stand-alone" modules in some programs enables teachers and schools to try a "replacement unit" prior to committing to full curriculum implementation. And it is not unusual for high school teachers to supplement their adopted curriculum with favorite activities or units from other sources. Indeed, much incremental curricular change happens through this process of partial replacement. Some of the COMPASS programs we work with have produced a handful of stand-alone modules. The question remains whether or not this is an effective way of getting teachers interested in the full curricula. Many fear that teachers will simply pull bits and pieces from the integrated programs to augment their courses rather than committing to the kind of curricular and pedagogical change associated with implementing a standards-based curriculum. Thus, this replacement strategy has the advantage of helping people incrementally prepare themselves, but the transition between a traditional set of course offerings and a whole integrated program is often not straightforward.

Finally, there is the strategy of offering parallel curricular tracks – one traditional, one "innovative". In the minds of many, this helps reduce the risk associated with implementing a standards-based curriculum as the sole mathematics program for the district or school. A positive feature of the parallel track option is that it provides an opportunity for the community (teachers, students, parents) to see the new curriculum at work—and in a number of cases, the success of the program sells itself. However, under these conditions, it is also easy for the new curriculum to become "ghettoized" and seen

as useful only for "those other kids". Parallel tracks is a long term successful strategy when it leads to the new curricula being labeled and perceived as academically equivalent to the college-track program.

- Districts and schools need to know that the implementation of a new curriculum system-wide requires multiple years of sustained effort — a challenge given even the best of circumstances.

The timeline for implementing one of the COMPASS curricula is on the same order as the timeline for state and district adoptions – five to seven years. Given this reality, a new integrated curriculum is likely to be abandoned and replaced before it is fully implemented, let alone taught well. Curriculum developers would be wise to prepare for the likelihood of schools systems to assume a short-term view and help their clients devise strategies to sustain the work at multiple levels of the system for the multiple years required. Savvy public relations activity – within the school and throughout the community – can help sustain an implementation effort long enough for it to reach a critical mass.

- Overall there is a small – but significant – market niche for innovative new secondary curricula that truly embody and embrace the NCTM Standards. The return on the NSF investment made in innovative curricula will come from significant improvements in quality of instruction, and not from quantity of usage.

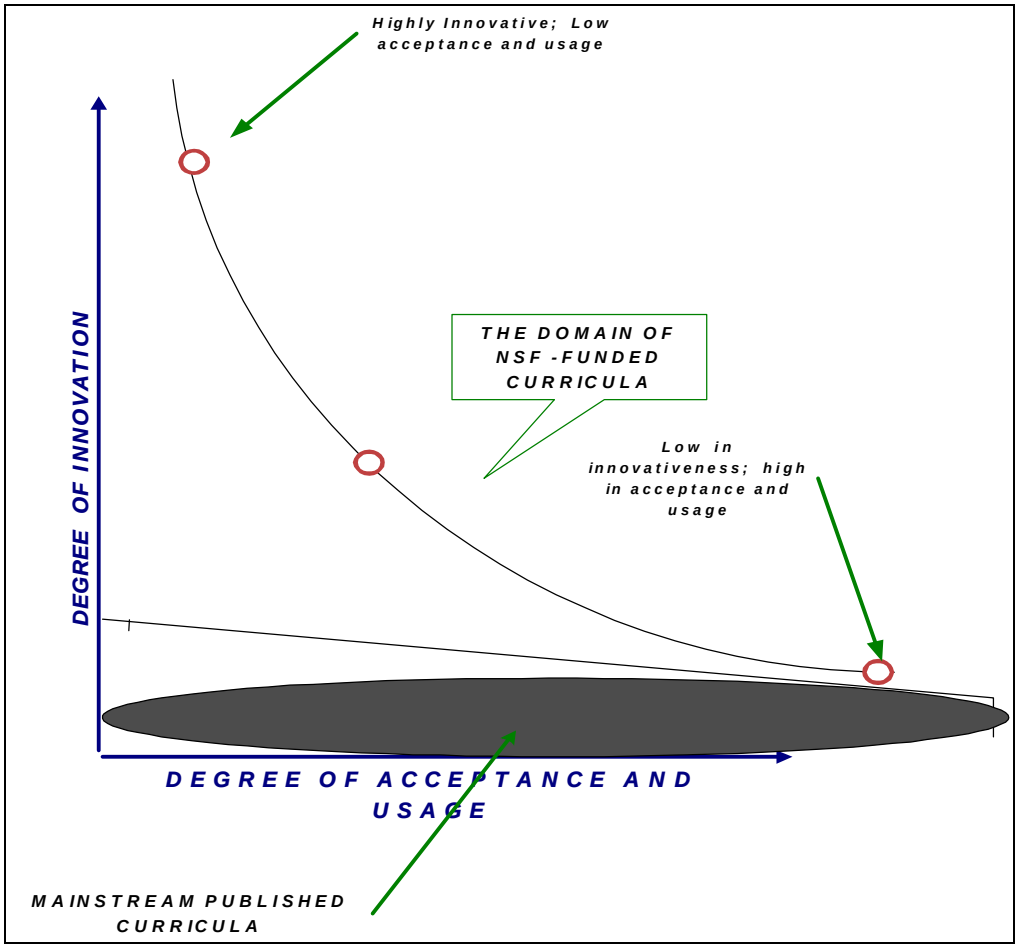
The newest addition to the NCTM Standards documents was unveiled in April of this year[6], *Principles and Standards for School Mathematics* (PSSM). Like the publications that preceded it, the NCTM Standards lay out a vision for mathematics education K-12, establishing a new floor for what should be standard practice and raising the ceiling for what is attainable. High quality, rigorous and engaging materials, like the COMPASS-disseminated curricula, are a key component of that vision. However, the reality, as indicated by our study, is that most schools and districts are not sufficiently interested in – or prepared for – changing their curriculum and pedagogy to the extent that these integrated curricula require. Nonetheless, there is indeed a small but significant number of teachers, schools and districts who are unequivocally dissatisfied with the status quo and working to find a viable alternative. Even though the national market-share may be small, we think there is nonetheless a strong argument for focusing secondary level mathematics reform efforts on those schools and districts who are on the leading edge of reform – that is, actively targeting those who are already interested in making a change and are willing to promote a substantially different vision of high school mathematics instruction.

In light of our study's findings, NSF's entire effort to develop and implement high quality curricula raises questions of purpose and goals. As the Figure 11 below shows, there is an inevitable trade-off between the degree of innovation of a curriculum and the breadth

[6] Principles and Standards for School Mathematics, *National Council of Teachers of Mathematics (Reston, VA: 2000)*.

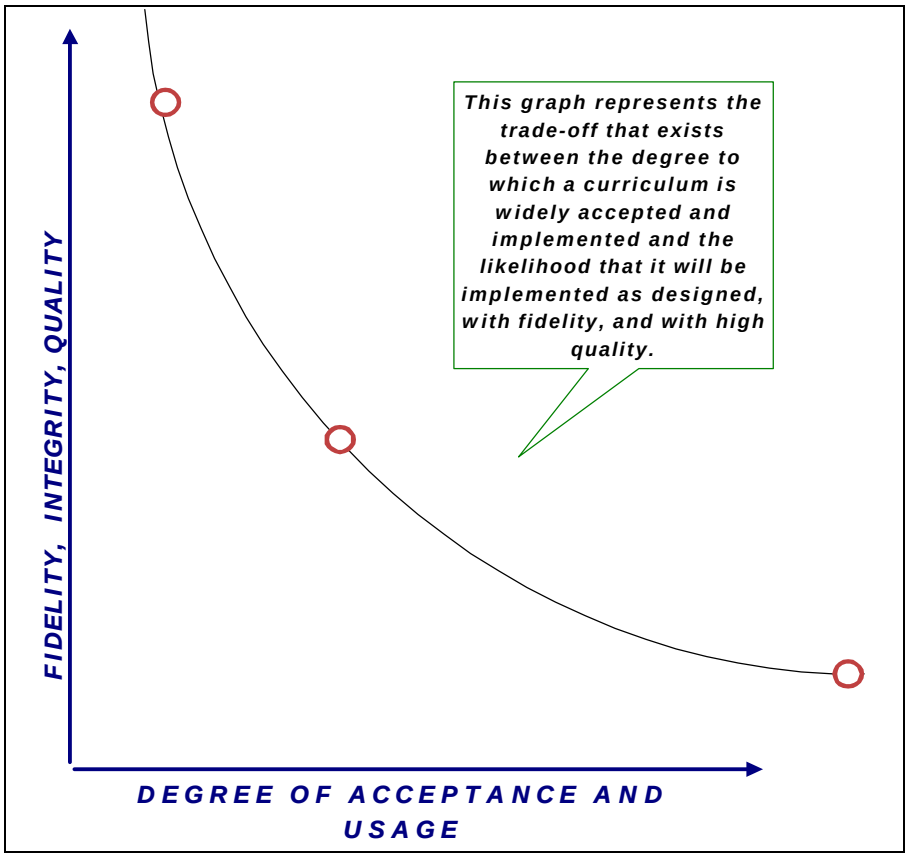
of its acceptance by the market. The integrated multi-year, inquiry-based mathematics curricula are highly innovative – they require a great deal of effort and support and they result in a very different kind of mathematics teaching. Consequently, their appeal will not be to the mass market.

Figure 11. The Trade-off Between The Degree Of Innovation Of A Curriculum And The Breadth Of Its Acceptance By The Market



Second, as Figure 12 below shows, there is also a trade-off between the quality of implementation and the scale of implementation. Having an innovative curriculum taught by many of teachers in a way that maintains the quality and integrity of that curriculum is not easy to do. Hence, NSF as well as the curriculum projects themselves must be aware of the realities of this marketplace and be clear about the trade-offs that they make when pursuing a particular dissemination or implementation strategy.

Figure 12. The Trade-off Between The Quality Of Implementation And The Scale Of Implementation



If a funders' primary intention is to reach a large audience, implementation will likely be more superficial and less successful across the board. If, on the other hand, maintaining high quality is important, then working in fewer schools and districts seems well worth the trade-off. It appears clear that the COMPASS curricula fall on the highly innovative end of the spectrum. Consequently, the return on the NSF investment will come from quality and not quantity. That is, if implementation efforts can be restricted to and concentrated in those places where the readiness is highest and the impact is likely to be the greatest, the curricula should lead to substantially different high school mathematical programs. While the marketshare for these new curricula will not be large, the differences in the kind of instruction and the quality of the learning experiences offered students should be clearly evident.

CONCLUSION

Thoughtfully choosing and implementing a new high school mathematics curriculum presents significant challenge for mathematics educators at all levels of the system, particularly given the complexities of the curricular decision-making landscape as laid out here. Decision makers occupy all positions – although many of the most influential are teachers – and they hold a wide range of beliefs about what should take priority in the selection of a secondary mathematics program. Contextual factors, including school and district culture, shape a great majority of these beliefs, as do externally imposed measures, such as standards, assessments and college requirements.

We have encountered some evidence that the complacency or satisfaction level of our nations high schools is lessening, at least to a small degree. Increasingly, many high school mathematics educators feel that they can and must do better for their students. In a small percentage of districts and schools there is a willingness to go beyond a kind of infusion strategy and consider instead the option of developing whole new programs. These schools and districts, dissatisfied with the evident failure of their mathematics programs to serve all their students, and led by advocates who share a vision that corresponds with the NCTM Standards, are clearly pursuing more profound change. New programs do not come easily; they demand new pedagogy, in some cases new content, and even a new understanding of mathematics education. Still, the path is not an impossible one. Innovative and rich curriculum accompanied by necessary supports, can be the "lever" which pushes the system toward the kind of education that is envisioned in the national standards.