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Utah Mathematics Teacher
Spring/Summer 2011
Volume 4, Issue 2

Visual Cues

Rule	Visual Cue	Language	Initial example or linked idea
Multiplication with same base	$a^m a^n = a^{m+n}$	"together"	$a^{a_a a_a}$
Power to a power	$\left(a^m\right)^n = a^{m \cdot n}$	"by"	$a\ a\ a\ a$ / $a\ a\ a\ a$
Product or quotient to a power	$(a \cdot b)^n = a^n \cdot b^n$ $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$	"distribute"	$5(x+2) = 5x+10$
Negative exponent	$a^{-n} = \frac{1}{a^n}$	"move to the other side"	$x+3=5$ -3
Division with the same base	$\frac{a^m}{a^n} = a^{m-n}$	"subtract" or "cancel"	$\frac{a\,a\,a\,a\,a}{a\,a}$

Exponent Rules

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Call for Articles

The ***Utah Mathematics Teacher*** seeks articles on issues of interest to mathematics educators, especially K-12 classroom teachers in Utah. All are encouraged to contribute articles and opinions for any section of the journal. Some of the features are: UCTM Leader Spotlight; Letter from the NCTM President; Letter from the UCTM President; Voices from the Classroom; Mathematics for English Language Learners; Puzzle Corner; Recommended Readings and Resources; the Utah Elementary Mathematics Curriculum and Implementation; College and University Research; and others.

Teachers are especially encouraged to submit articles for ***Voices From the Classroom***, including inspirational stories, exemplary lessons, beginning teacher ideas; or managements tools. Sample ideas are (but not limited to) focused on the CMI framework, teachers or districts who have successfully implemented the CMI, Inquiry based calculus, new math programs K-12, the U of U/ Jordan District partnership master's degree program, Cross-district Algebra assessments, and many others.

Manuscripts, including tables and figures, should be typed in Microsoft Word and submitted electronically as an e-mail attachment to Christine Walker (Christine.Walker@uvu.edu). A cover letter containing author's name, address, affiliations, phone, e-mail address and the article's intended audience should be included. Items for ***Beehive Math News*** include, but are not limited to, NCTM affiliated group announcements, advertisements of upcoming professional meetings, and member updates.

Don Clark Award

Lifetime Contributions to Mathematics Education

This award is for the educator who has impacted mathematics education in Utah over the course of several years.

Karl Jones Award

Excellence in Elementary Mathematics Education

I. Encourage student achievement by:

- Providing activities, which enhance understanding of math concepts.
- Generating enthusiasm for math among students.
- Providing opportunities to apply and extend mathematics skills.

II. Serve as a role model for other teachers and for students by:

- Demonstrating interest in acquiring and maintaining skills in mathematics, including instructional skills.
- Implementing effective teaching techniques.
- Demonstrating a willingness to share skills and ideas with other teachers..

George Shell Award

Excellence in Secondary Mathematics Education

I. Encourage student achievement by:

- Providing activities, which enhance understanding of math concepts.
- Generating enthusiasm for math among students.
- Providing opportunities to apply and extend mathematics skills.

II. Serve as a role model for other teachers and for students by:

- Demonstrating interest in acquiring and maintaining skills in mathematics, including instructional skills.
- Implementing effective teaching techniques.
- Demonstrating a willingness to share skills and ideas with other teachers..

Muffet Reeves Award

Excellence in Teaching of Teachers

This award is for the teacher who has shown outstanding work in the area of professional development related to mathematics and is a great motivator of teachers.

Notes:

Utah Mathematics Teacher

Table of Contents

Spring/Summer 2011 **Volume 4, Issue 2**

3 *UCTM Presidents Message*
We Change...
Logan Toone, President, Utah Council of Teachers of Mathematics

4 *NCTM President's Message*
An Opportune Time to Consider Integrated Mathematics
J. Michael Shaughnessy, President, National Council of Teachers of Mathematics

7 *Utah Council of Teachers of Mathematics* ***News***
Membership & Opportunities

8 *Cue Up Procedural Skills*
Jim Brandt & Gretchen Rimmasch, Southern Utah University

14 *Involving Immigrant Parents in the Mathematics Education of Their Children*
Vessela Ilieva, Ph.D., Utah Valley University

29 **Utah Council of Teachers of Mathematics Membership Form**

30 **Call For Awards**

NOTES:

Utah Council of Teachers of Mathematics
Membership Form & Registration

Step 1: Log onto http://www.utahctm.org

Step 2: Link to Membership

Step 3: Link to "Join UCTM"

Step 4: Fill out the Registration form (sample below) and click "Register"

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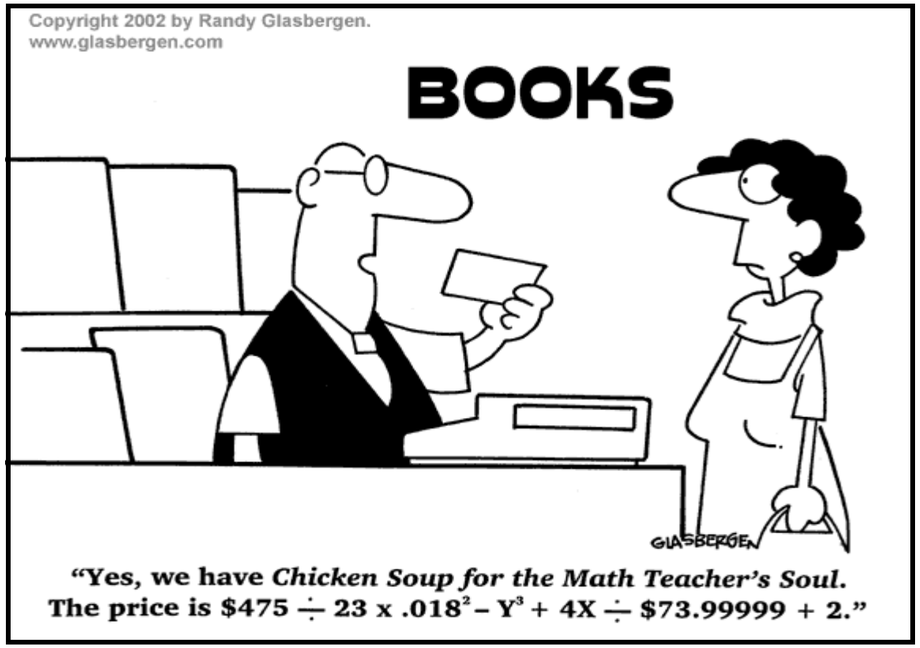

Presidents Message

We Change …

Logan T. Toone, UCTM President

The math education community is swimming in a cocktail of information regarding the Common Core State Standards Initiative. Some of the information is true; some is not. We have known about the Common Core for a long time, but it still seems that with every new memo, meeting, or training comes some element we haven't seen before. Some aspects of the Common Core are mandatory; some are optional. Across the country, each state has its own plan for implementation, and within each state, districts and charter schools have their own plans as well. Amid the barrage of new information, it can be difficult to sort the facts from the quasi-truthful rumors (which, considering the recent political dialogue on math curriculum could be either well-intentioned or malicious). Coupled with this cocktail of information, the trepidation inherently accompanying such wholesale change grows exponentially. As math educators, we truly face some challenging transition years ahead.

But the Common Core State Standards Initiative is not some adversarial beast to be feared, avoided, or even overcome. The increased depth and rigor of the new standards truly do have potential to change the way we teach mathematics ... for the better. Prominent math professionals from around the country have come out in strong support for the initiative, and although there are still some critical unanswered questions that deserve our attention, most math educators see merit in undertaking the challenge of implementation.

We know that the transition won't be easy and that most of the responsibility for change will fall on classroom teachers, but the prospect of better instruction with a stronger, more comprehensive, and rigorous curriculum makes it worth the challenge. We have a lot to tackle in coming years, and the forthcoming change is indeed daunting. My hope is that as we undertake the changes that lie ahead, we will remember our own personal responsibility to make the Common Core work. On the banks of Massachusetts' Walden Pond, the great American philosopher Henry David Thoreau captured the essence of my message and hope for what lies ahead in the transition to the Common Core. He wisely said, "Things do not change; we change."

Good luck to all who undertake this great effort!

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

An Opportune Time to Consider Integrated Mathematics

by NCTM President J. Michael Shaughnessy
NCTM Summing Up, March 2011

In the February President's message, I addressed the issue of alternative pathways for our secondary mathematics students as they make the transition from high school mathematics into post-secondary mathematics in colleges, community colleges, and universities. In that column, I posed several questions that catalyzed my reflections on the need for alternatives to the current predominant pathway available to our secondary students—the pathway that leads to college calculus. Among the questions that I posed were the following: "What can we do to provide students with relevant, coherent mathematical options on their pathway through high school and as they move into college in the 21st century?" and "Is the 'layer cake' of algebra-dominated mathematics that pervades U.S. secondary schools still relevant?"

These questions have subsequently prompted me to reflect not just on transition issues, but on the entire secondary mathematics experience that many, if not most, of our high school students undergo in this country. I received a large number of responses to that column, and that input has provided some added motivation for this message. In this new column, I want to make a case for integrating the mathematical content areas throughout our students' secondary mathematics experience.

In my view, the "layer cake" approach to high school mathematics that currently dominates so many secondary school mathematics programs—built on course sequences such as algebra I, geometry, algebra II, or algebra I, algebra II, geometry—is an outmoded approach in a 21st-century educational system. There are a number of reasons why I believe that at this point in our history an integrated approach would be an improvement over the "layer cake" approach. Among them are some important interconnected challenges that we face: we need to (1) lay the groundwork for more mathematics options in the transition from high school to college; (2) understand the vision and approach of the Common Core State Standards for Mathematics, which have been adopted by so many states of and (3) reflect on what it means to be internationally benchmarked. Let's consider each of these in turn.

If we are truly going to build viable options for our high school students to make the transition into college mathematics by a path that is different from the path to calculus, we need to lay the foundations for those alternative transition paths throughout high school mathematics. We must not reduce other possible paths to just an add-on course in

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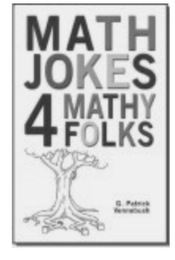

Q: What's the sine of 40? A: Saying things like, "When I was your age..."

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the fourth year of a high school experience. Students can—and should—have opportunities to learn content in both geometry and data analysis and statistics while they are learning algebraic skills and algebraic representations of mathematical concepts. Statistics relies on both symbolic algebra and functional algebra to represent measures of center, spread, and association. The geometry of graphic arts depends on linear algebra and matrices in computer representations. Exposure to relevant applications of algebra integrated with statistics and geometry *throughout* a high school student's learning of mathematics will help instill more meaning and sense making in his or her algebra experience and lay a foundation for transition options to college mathematics.

The Common Core State Standards for Mathematics (CCSSM) can be thought of as an unprecedented opportunity for rethinking potential pathways through K–12 mathematics, particularly pathways through secondary mathematics. The secondary level standards in the Common Core are presented in a way that actually invites the integration and interweaving of algebra, geometry, and data/statistics throughout the first three years of high school. In fact, the two sample pathways through secondary mathematics that the appendixes to CCSSM present provide approaches involving an integration of mathematical content, with one of those sample pathways offering an approach that is more heavily integrated than the other.

In recent years, a hot topic in the news has been the mathematics performance of students in the United States as compared with that of students in other countries. With U.S. students placing below the middle on many of these international comparisons, we have heard continual calls from policymakers and in the media for mathematics learning in the United States to be internationally benchmarked. However, it's not clear just what people mean when they use the term "internationally benchmarked." One possible approach to benchmarking is to focus on the mathematics pathways through which students learn and experience mathematics. If we take this approach, it is currently impossible to benchmark mathematics learning in the United States in international comparisons because it makes no sense to internationally benchmark a country that takes a "layer cake" approach to its mathematics while 90 percent of the rest of the world teaches mathematics by using an integrated approach. Our country's approach to mathematics is the exception when compared with most of the rest of the world. If we want to be accurately benchmarked internationally, we will need to take an integrated approach, especially in our secondary mathematics curriculum.

I can already hear the arguments against taking an integrated approach to secondary mathematics. I've heard the excuses many times throughout my career: "But we've just adopted a new curriculum—we can't change again now!" "We can't do that—the colleges won't accept our students coming in with an integrated curriculum—the colleges won't know what to do with them!" "We can't switch—we have no money to buy new books." And so on.

The states that have adopted the Common Core State Standards have three years to implement them. The two Assessment Consortia are now beginning their work in developing and piloting the assessment instruments that will be put in place in 2014.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

Students need to see mathematics as an integrated whole, with connections across the content domains, and they need to experience some of the applications and uses of mathematics *before* they transition to college. And the United States will never show well in international comparisons of mathematics performance as long as other countries have an integrated mathematics, and we take a "layer cake" approach. In this country, we have an unprecedented opportunity over the next few years to integrate the content of our secondary mathematics, and we should do everything we can to make the most of that opportunity.

About NCTM President J. Michael Shaughnessy

Mike Shaughnessy has taught mathematics content courses and directed professional development experiences for mathematics teachers at all levels, K–12, as well as community college and university. He has authored or coauthored more than 60 articles, books, and book chapters on issues in the teaching and learning of mathematics. From 1996 to 2008 Shaughnessy served as the director of the doctoral program in mathematics education at Portland State University, Portland, Oregon. Throughout his career, his principal research interests in mathematics education have been the teaching and learning of statistics and probability and the teaching and learning of geometry.

A principal focus of Shaughnessy's research has been students' understanding of chance and data, and he has attempted to explore, synthesize, and build on the contributions of psychologists and mathematics and statistics educators alike to strengthen knowledge related to students' learning about data and chance. Syntheses developed by Shaughnessy of research into how students think and learn about probability and statistics have appeared in the chapters "Probability and Statistics: Reflections and Directions" and "Research on Statistics Learning and Reasoning" in the first and second editions, respectively, of the *Handbook of Research on Mathematics Teaching and Learning,* a project of the National Council of Teachers of Mathematics (1992, 2007).

From 2004 to 2008, Shaughnessy directed a four-year NSF ROLE (Research on Learning and Education) project to investigate middle and secondary students' conceptions of variability and distribution in statistics.

Shaughnessy served as a member of the Board of Directors of the National Council of Teachers of Mathematics (NCTM) from 2001 to 2004, and in April 2010, he began a two -year term as NCTM President.

Shaughnessy received his Ph.D. in mathematics education from the Department of Mathematics at Michigan State University in 1976. He taught in the Department of Mathematics at Oregon State University from 1976 until 1991, and at Portland State University in the Department of Mathematics and Statistics from 1991 to 2008.

Taken from www.nctm.org (President's Corner)

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Use activities that reinforce the development and use of mathematical language and overcome potential linguistic barriers.	Incorporate mathematical dictionaries as part of students' daily learning of mathematics – and ask for parent participation in the development (either through contribution or to sign completed ones on a regular basis). Teacher and students who speak a language different from English will be able to identify cognates or patterns in vocabulary, and the dictionaries may help with vocabulary recall and use and with the formation of mathematical connections across languages. Parents may also find similar connections for themselves. Include mathematical notation as part of the dictionary. Ask students to inquire about the ways their parents learned to denote operations, decimals, fractions, etc. and to include a sample problem in the dictionary.

Conclusion

Research and practice agree: when schools and parents work together, students' mathematical progress and achievement improve. However, the relationship between schools and immigrant parents is not always established and developed effectively, as there are a number of disconnects that prevent it from being as fruitful as possible. Some activities that could reform and improve the relationship have been identified and proposed in the literature, but there is a lack of specific teacher-led actions that teachers of mathematics can immediately use to involve immigrant parents. The activities offered in this article are geared toward building an ongoing relationship between mathematics teachers and immigrant parents. They can be immediately incorporated in the daily instruction and offer opportunities for further extensions in order to establish broader immigrant parent participation. Action research studies in classrooms where these strategies are applied could provide needed details on their effect on students' achievements as well as parents' response to their use.

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Table Two: *Activities*

General parental involvement steps	Mathematics-related activities
Approach parents with an invitation to take part in the learning process. Start with smaller, doable actions or activities that add to the daily mathematical activities – and gradually keep expanding their scope.	Have students write a (bi-weekly or monthly) note to their parents where they explain what they have learned in their math class, and how this knowledge is applicable. Ask for students to return the notes with a comment or signature from the parent. Implement a weekly "tracking" folder with a sheet listing the mathematics homework for every week or two. Request that parents sign to acknowledge homework completion. Then, include these sheets in students' portfolios and use at parent-teacher conferences when discussing students' progress. Send home regular updates on students' progress – and ask for some type of parental acknowledgement that they have seen them. Again, use them when you meet with parents to show that keeping parents informed and involved is part important for your class.
Inquire about and incorporate parents' funds of knowledge	Think "out-of-the textbook" and have students rewrite textbook problems in the context of their family – using their names and relationships, and to find out if these problems make sense to their parents – and in what way they would formulate a similar problem if they don't? Assign students to interview a parent on how they use or used mathematics in their daily activities and/or past and present occupations. Provide a short set of interview questions for students to use. The results on how and how much we use mathematics may be surprising for students and parents alike. You may find out stronger mathematical backgrounds than you expected for many immigrant parents. These stories will also provide you with information on possible connections with parents' mathematical experiences in the future. Ask students to include their parents when solving problems and to inquire about ones that exemplify mathematical concepts and originate in their home, traditions, or culture. What kinds of coins and bill denominations are used in the native country? What are some ways to work effectively with the metric system? How do you go from Fahrenheit to Celsius and vice versa? What games use mathematics? These parental contributions will have an illuminating effect on how we use Bishop's six universal mathematical behaviors (measure, design, count, locate, play, or explain) when using mathematics (Bishop, 1988).

UCTM News

What Is the Purpose of the Journal and Your Membership in UCTM?

As the 2010-2011 school year closes, it is time to reflect back to discover what experiences and opportunities have influenced you. We realize that the pressure of CRT tests, AP exams, Concurrent Enrollment, and other end-of-year tasks are first and foremost in your minds. We also realize that many of you face serious challenges that seem to defy the odds. Yet you have the right to be proud of what you've done, the achievement gap you've closed and the amazing progress you've made with your students. We at UCTM, have an unshakeable belief that every student can succeed, and that you have the power to tap into the amazing learner in every child. We want to help in this success by offering our journal and other opportunities in your quest and in your path to success as you plan for the 2011-2012 school year.

We'd like to offer the following suggestions:

- Learn more about the organization at http://utahctm.org
- Plan for and attend the Fall 2011 Conference and invite a new member
- Volunteer to serve on the UCTM Board
- Submit an article, exemplary lesson, best teaching idea, or favorite cartoon to the Fall 2011 Journal
- Send thoughts, ideas and suggestions to any of the many board members.

Any questions or concerns, please don't hesitate to contact any board member and have a wonderful summer!!

Cue Up Procedural Skills

Jim Brandt & Gretchen Rimmasch
Southern Utah University

In this article, we present the results of a classroom teaching experiment involving the use of visual cues in teaching exponent rules. The cues are a simple classroom teaching strategy that yielded statistically significant positive gains in student performance. Although our visual cues were designed for exponent rules, we argue that similar strategies could be used in teaching almost any procedural skill. We think it would be useful and of interest to mathematics teachers across the K-12 curriculum.

Developing students' computational skills is one of the goals of teaching many mathematical topics, ranging from operational algorithms in elementary school to derivative rules in calculus. While many articles in mathematics education focus on conceptual understanding (see Star, 2005), the National Research Council (2001) called for equal focus on conceptual understanding and procedural skills. Greater computational fluency allows students to approach routine exercises with more flexibility and also gives them the skills to engage in later problem solving activities. Further, many authors have argued that mathematical processes and procedures form the conceptual basis for new mathematical objects (for an overview, see Gilmore and Inglis, 2008). For instance, the procedure of plugging into algebraic expression underlies the concept of a function. At a later stage, this function process/concept becomes an object of study in itself. Thus, while we sometimes talk about mathematical concepts and procedures separately, the two are intimately related. In fact, research indicates that procedural and conceptual knowledge develop in an iterative process, with enhanced procedural understanding leading to greater conceptual understanding and vice versa (Rittle-Johnson, 2001). In terms of classroom teaching, what can mathematics educators do to help their students in attaining greater computational skill? In this paper, we report the results of a classroom teaching experiment involving the use of visual cues to help students recognize and apply the correct exponent rules when simplifying exponential expressions. More generally, we argue that visual cues can help students improve their procedural skills in a wide variety of mathematical settings.

Methods

Our classroom teaching experiment involved two sections of an undergraduate Intermediate

a sign of academic trouble rather than an invitation to be involved in the day-to-day learning of mathematics.

5. Recognize that immigrant parents who are in the process of learning how to navigate the educational system do advance in their learning of language and culture – and with this change, your relationship will also grow and be open to new forms of parental engagement. The parent who needed a translator during your first meeting may not need one next time you meet. Similarly, by providing opportunities to become engaged with, share, and learn about the mathematical experiences of their children, you are putting down building blocks for other forms of participation.

6. One starting point to including immigrant parents in mathematics education that is often overlooked is engaging them in learning what content is taught and learned at different grade levels in elementary schools, and for middle and high school age children – understanding each course content, course sequencing, and tracks. Especially at times when changes are occurring – as with the starting implementation of the Common Core – parents need to be informed in order to be included. Again, they may not have previous experiences to build on – for example, if they as learners were exposed to a national curriculum - and schools need to reach out.

Activities for Engaging Immigrant Parents in Mathematics

The National Council of Teachers of Mathematics (NCTM) has recently set forth a number of recommendations for involving Latino/a parents in mathematics based school partnerships (NCTM, 2010). The suggested activities summarize most recent research and closely tie it with some of the traditionally strong values of Latino families. The NCTM document further supports the strategies just discussed in that considerations of culturally specific beliefs and expectations need to be an integral part of the efforts for successful immigrant parent involvement in mathematics education. They need to be taken in consideration if schools are seeking to engage immigrant parent in ways that are truly committed to the students' success.

The set of suggestions below are geared toward teachers who want to initiate activities where parents and students work together and use mathematics in context in order to provide opportunities for parental involvement. These activities as suggested as a way of building a bridge between parents' previous mathematical knowledge and ways of learning mathematics and their applications in relation to mathematics curriculum and pedagogy in American schools. As already suggested, this process takes time and mutual understanding to develop. A critical component here is the effort to sustain and expand the parent-teacher connections that are being built – as students' mathematical knowledge advances, the need to continue cooperation with parents in order to provide solid support at home becomes even more important.

Table Two includes a starting set of activities for engaging immigrant parents in the mathematical learning of their children in order to initiate and maintain involvement. The relationship sought here is a sustained, mutually beneficial communication that emphasizes parents' funds of knowledge and relates them to the mathematics curriculum. In addition, these teacher-initiated actions engage students in involving their parents are a resource for important mathematical knowledge recognized by the school and the teacher. They are appropriate for the elementary as well as the middle and secondary level.

> Most notably parental expectations and style each demonstrated a strong relationship with scholastic outcomes. Thus, it was not particular actions such as attending school functions, establishing household rules, and checking student homework that yielded the statistically significant effect sizes. Rather, variables that reflected a general atmosphere of involvement produced the strongest results. Parental expectations and style may create an educationally oriented ambience, which establishes an understanding of a certain level of support and standards in the child's mind." (p. 262),

This view is further supported by Shah (2009) who claimed: "It is not the types of literature available to parents or the number of opportunities provided to be part of school activities that matter but, rather, how the social context makes parents feel about being involved." (p. 213). Shah extended the boundaries for parental involvement when she found that Latino parents " who have traditionally been seen as not interested in school activities, are more likely to be engaged in their child's school when they see themselves represented in governance and decision-making bodies." (p. 225). One way to translate these findings in the realm of mathematics education is to take a personalized approach that excludes any deficit assumptions and stereotypes and at the same time acknowledges and welcomes immigrant parent's previous experiences and knowledge. Initial steps toward achieving such atmosphere include the following:

1. Introduce immigrant parents to the forms of school-parent relationship established in your classroom and school, but also inquire about their experiences and expectations. As humans, our values are deeply and intrinsically embedded in our ways of making sense of the world, and their change is a process that involves learning and changing behaviors that are source of internal conflicts about remaining truthful to one's self. Demonstrating understanding and not devaluing the original parental beliefs on education instead of insisting on immediate and quick change is critical for one's willingness to embrace the new experiences.

2. Recognize and acknowledge that immigrant parents often hesitate to visit your classroom and get engaged in the ways you expect as a natural consequence of their previous ways of communicating with schools. Teachers' authority and autonomy characterize many school systems around the world, and immigrant parents may need time to understand the new role they are expected to have in their new environment. To ensure transition and parent buy-in, consistently use activities that welcome parents' participation through indirect involvement – through mathematics homework or written communication that requires some form of parental response, and build inquiries about parents' previous mathematical experiences into the class work. This approach will supportive of the process of parents' gradual experiential learning about American education.

3. Change the tone and the content of conversations on immigrant parent participation. Is it really lack of parental involvement, or is it that we have not provided the opportunity and the knowledge for the immigrant parents to get involved? Do we expect them to know intrinsically the expectations and traditions with respect to parental engagement in education without presenting them with opportunities- and the time - to learn about them?

4. Choose communication forms that allow for best understanding. While communication with parents is important and valuable, contacting parents over the phone may not be the best option at first, due to a possible language barrier. Listening in the absence of body language and other visual cues is one of the most challenging language skills to develop. The inclusion of academic mathematical content in this mode of communication further complicates the challenges for parents. Unless there is an interpreter available to help, do not make a first contact over the phone if possible. A form of written communication would work better if a face-to-face meeting is not an option. Even with an available translator, using the phone to establish connection with parents immediately depersonalizes it. In addition, parents who have not experienced this type of teacher and school communication may consider your call

Algebra course. Each section had approximately 45 students and was taught using a modified lecture format, with questions and discussion mixed throughout the class. The content of Intermediate Algebra is similar to a high school Algebra II course; college students are placed in the course based on the math ACT scores or their performance on a math placement test. The course is focused on strengthening students' computational skills so they can be successful in a general education mathematics course such as College Algebra. Although most students have seen much of the material previously, they are placed into the course because of weak computational skills. In terms of exponent rules, in particular, while all students in our study reported studying them previously, they had difficulty applying the rules correctly (on an initial survey, students only answered 44.78% of the questions correctly). Since the students had seen these rules before but had difficulty applying them correctly, we needed some other tool to help students improve their skills. Rasmussen and Marrongelle define a pedagogical content tool as "a device, such as a graph, diagram, equation, or verbal statement, that a teacher intentionally uses to connect to student thinking while moving the mathematical agenda forward" (2006, p. 309). In our case, our agenda was increased computational skill, and we chose consistent classroom use of visual cues to aid in classroom discussion.

The visual cues used in teaching exponent rules are illustrated in the figure below.

Rule	Visual Cue	Language	Initial example or linked idea
Multiplication with same base	$a^m a^n = a^{m+n}$	"together"	$a^{a_{a_a}}\ a^{a_a}$
Power to a power	$\left(a^m\right)^n = a^{m \cdot n}$	"by"	$a\ a\ a\ a$ $a\ a\ a\ a$
Product or quotient to a power	$(a \cdot b)^n = a^n \cdot b^n$ $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$	"distribute"	$5(x+2) = 5x+10$
Negative exponent	$a^{-n} = \frac{1}{a^n}$	"move to the other side"	$x+3=5$ -3
Division with the same base	$\frac{a^m}{a^n} = a^{m-n}$	"subtract" or "cancel"	$\frac{a\,a\,a\,a\,a}{a\,a}$

In creating these visual cues, we tried to use prompts that would focus student attention on the appropriate rule while also making connections to previous mathematical knowledge that might help in remembering the rule. For instance, in the case of a power to a power, we can think of the number of instances of the base in a rectangular array. Then the appropriate power comes naturally from taking the product of the two powers. Making this connection explicit, we drew a rectangle around the powers when taking a power to a power to suggest multiplying the length times the width. Further, alternate language, such as "*m by n*," was used by the instructor to reinforce the connection to a rectangle. Similarly, since division with the same base can be accomplished using cancellation, we used a symbol that reminds us of cancelling but in the shape of a "*S*" to suggest *S*ubtraction. To see if consistent classroom use of these visual cues was effective, one section of Intermediate Algebra was taught without any visual cues using standard language (control group), while another section was taught with visual cues using modified language (treatment group). For example, in the control group, to simplify $a^5 \cdot a^2$ we would say "multiplying with the same base, we add the exponents to get a^7 " without any extra prompts or cues on the board. On the other hand, in the treatment group, we would circle the exponents 5 and 2 and say "together we have a^7 ". In both sections, exponent rules were discussed during two class periods. Students' computational skills were assessed using pretest and posttest surveys involving simplification of exponential expressions, and the gains made by students in the control group versus the treatment group were compared.

Results

The pretest and posttest scores of the students in the control group and the treatment group that completed both surveys appear in the table below.

	Pretest score (% correct out of 9)	Posttest score (% correct out of 9)	Gain (posttest-pretest)
Control group (n=21)	50.22%	75.67%	25.45%
Treatment group (n=29)	41%	79.33%	38.33%

Focusing on the gains (posttest-pretest), the students in the visual cues section showed greater improvement. Further, using a *t*-test on the gain, the difference between the sections was statistically significant ($p<0.034$). We also assessed whether students used some type of visual cue – either ours or their own – while working on the pretest and posttest exercises. Students in the treatment group were more likely to use some type of cue to help in simplifying the expressions. Again, the difference was statistically significant ($p<0.026$). The problems that caused the most difficulty involved fractional powers and negative exponents.

Lopez and Donovan (2009) suggested *Family Math Nights* as one form of creating parent-school connections that stimulated parental involvement in the mathematics learning of their children. They suggested using this type of community events as a culminating activity of a school-wide mathematics initiative, or as a separate venue for introducing parents to the mathematics curriculum. Lopez and Donovan promoted math nights as a community-building event that became the stimulus needed to stronger connect mathematical experiences at home and at school, and it resulted in positive attitudes of all involved. The authors further suggested that this type of partnerships provide a variety of involvement opportunities for parents, which could be a critical for involving immigrant parents. According to Lopez and Donovan, these nights "are leading the way in developing partnerships that respect language and culture while acquiring the language of mathematics and learning mathematics, effectively communicating to parents, and making school systems and resources accessible to parents and students."(p. 228)

Another contributing factor that affects immigrant parental involvement is the parents' existing level of anxiety about mathematics that could be further alleviated by the different ways in which mathematics is taught and explored in the U.S. compared to the native country of the parents. Anhal, Allexsaht-Snider, and Civil (2002) worked with three Latina parents who were able to observe the mathematics lessons in their children classrooms and then shared their reflections on the processes. Issues of different approaches to learning and teaching mathematics became apparent to parents, as well as their different levels of mathematical proficiency – and both should be carefully considered when initiating and planning immigrant parent involvement in the mathematical experiences of their children. A critical point of this study was the departure from a deficit view of immigrant parents by seeking their contributions as valuable resource on the educational process with their children's best interest in mind. Important points raised by the parents included the influence of previous mathematical learning experience in a different educational tradition on their perception of the teaching process, the role of mathematics teacher's enthusiasm about the content they were teaching for learner's engagement, and the influence of teachers' bilingualism on their ability to teach mathematics to non-native speakers. These observations signal parents' strong potential as contributors to the parent-school dialogue in improving the mathematics education of immigrant students.

Strategies for Immigrant Parent Involvement

Research suggests multiple forms of parental involvement in mathematics education that may be successful with immigrant parents. The strategies suggested below target the development of a solid parent-teacher relationship in general and the engagement of immigrant parents in mathematics learning in particular. These two areas are mutually supportive as they recognize the role of immigrant parents for the educational process and engage them as valuable contributors in a content area. This approach to parent involvement also reflects the approach suggested by Jeynes (2005). After performing a meta analysis of the relation between parental involvement and student achievement, he found that

Civil and Bernier (2006) described a school-parent partnership where teachers and parents took the lead in teaching workshops on solving mathematical problems. Using a dialogical approach, the researchers engaged ethnically and linguistically diverse parents from a working class Latino neighborhood in leading mathematical discussions with teachers and other parents, where they were able to demonstrate their ways of knowing mathematics. During the project, parents and teachers engaged in heated conversations about the "right" ways of knowing mathematics as well as questioned each other's authority. Teachers insisted on the role of appropriate education training, while parents put more emphasis on exploring different ways of approaching mathematical content. Civil and Bernier concluded that while bringing parents as equal participants was an important and needed step to their involvement in their children mathematics education, there was also the need for further exploring how parents' intellectual contributions could be better utilized for the benefit of the teacher-parent collaboration. On a similar note, Menendez and Civil (2008) suggested informal parent workshops as one approach to involving parents more closely with mathematical content – and thus provide them with the tools and knowledge to engage in mathematical learning with their children. Important characteristics of the workshops were their voluntary attendance, flexible scheduling, and alignment of the workshops' themes with the content studies by the children of the attendees.

Ginsburg, Rashid, and English-Clarke (2008) found that engaging parents in the mathematics learning activities has the potential to also benefit their children. Adults who worked on improving their mathematical knowledge in order to help their children, began also learning from their children and as a result, were in a position to learn together with their children and thus to support them in a naturally occurring mathematical conversations. These reported advantages of the reciprocal parent-student relationship that occurred as a result of the focused parent learning should be considered by teachers when establishing activities to engage immigrant parents as participants in their children mathematical learning. I recall how surprised my children were to find out that the way I wrote and worked through mathematical problems was different from their teacher's and from their textbooks. I did not write the division sign the way they did in school, I did ask more questions than I gave "right" answers to the problems when they needed help, and occasionally mispronounced the mathematical vocabulary words. These were perhaps signs that "my" mathematics was not equally important and correct – and experience similar to what Civil (2009) described as "different forms of mathematics" (p. 1443) for immigrant parents. In working together we discovered that "my" mathematics worked as well as the school one, and they were relieved when I began also writing and solving mathematical tasks in the way they were learning.

Sheldon and Epstein (2005) examined the effectiveness of 14 forms of parent-school mathematics partnerships, and found that all schools in their sample engaged in three of them: providing mathematics teachers' contact information to parents, individual parent-teacher conferences for struggling students, and regular submission of report cards to inform parents of students' progress. None of the schools in the sample organized activities for parents on Saturdays. Other activities included workshops for parents during daytime school hours or in the evening, awarding mathematics achievement certificates to students, inviting parents to school award ceremonies where mathematics achievement was recognized, making videotapes, game packets, and library materials on mathematics available to families, asking parents to volunteer as tutors, assigning homework to be completed with the participation of a family member, and developing and implementing assignments that incorporate real-life applications of mathematics in different occupations. The authors concluded that

> If schools hope to increase student test performance in mathematics, for example, they need to strategically plan family-involvement activities that encourage and enable interactions between students and family members relevant to the mathematics curriculum. Activities that engage many families and children in discussing and conducting mathematics at home are more likely than are other involvement activities to contribute to students increasing and maintaining their mathematics skills. (p. 204)

For instance, the most common mistake in simplifying $a^2 \cdot a^{1/2}$ was to incorrectly multiply the exponents while the most common error in simplifying $(-2)^{-3}$ was to cancel the negatives. Both these errors involve applying a rule students have used in the past in a new and inappropriate context.

Using our visual cues, we would circle the powers 2 and ½ to indicate addition and would the move negative power to the denominator, placing these calculations in the appropriate context. In fact, students who used some type of visual cues were more successful in simplifying these exponential expressions correctly.

Discussion

The use of visual cues in teaching exponent rules required very little change on the part of the instructor. The teacher could simply insert the cues into their normal practice (lecture, talking with small groups, discussing student presented solutions, etc.). With this minor change, however, we observed improvement in students' procedural skills. We attempted to link the cues with other familiar ideas, such as the area of a rectangle, and used modified language such as "*m by n*" rather than "*multiply the exponents*." However, in a preliminary study, no difference was found between using the visual cues with suggestive language versus using the visual cues with standard language. Differences were only observed between using the visual cues and not using the cues. We did find that a fairly large number of students (23.5%) in the control group used some type of visual prompt or extraneous mark to help them in applying exponent rules. This would suggest that many students already use some type of visual cues in procedural exercises, and making explicit classroom use of standardized, well-designed cues may help these students in learning the desired computational skills.

Although very few students made explicit use of our visual cues in simplifying exponential expressions, we both feel that use of these visual cues improved classroom discussion. We had fewer questions about why we combined exponents in a certain way, and when students asked questions about their own work, a simple mark on the page communicated the correct process fairly efficiently. Further, during the rest of the course, when other problems involving exponents came up, the cues made it easy to remind students of the correct procedure. In the end, even if we had found no improvement in student work, we would both continue using these visual cues in our classes. The cues made it easier to focus student attention on a particular portion of an algebraic expression and also made it clear why you were using one rule rather than another.

Conclusions

The consistent use of visual cues by the instructor improved student performance in simplifying exponential expressions. Rearranging and rewriting algebraic expressions involves procedural skills that are essential in performing a variety of tasks, such as communicating mathematical ideas, looking for patterns, solving algebraic problems, etc. In teaching mathematics, "a teacher has the obligation of enculturating the students into the discourse and conventional representational forms of the broader community" (Rasmussen & Marrongelle, 2006, p.395). Computational fluency is part of the culture of mathematics. Thus, along with conceptual understanding, teachers need to help students develop their procedural skills. Visual cues can play a role in teaching a wide variety of these skills. We are not arguing that we should use cues in teaching every mathematical topic – adding a second layer of inscriptions on top of existing mathematical symbols is not the goal. However, by drawing attention to specific portions of an expression, visual cues can aid classroom discussion and help students attain greater computational fluency. Reflecting on our own experiences, creating these visual cues and using them in the classroom was a lot of fun. We would urge you to identify a skill your students are having difficulty performing, and to think creatively with a colleague about pedagogical content tools you could use to help your students in improving their procedural skills.

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> The tense relationship a bicultural (Latino, Asian, African, etc.) parent has with the U.S. public school system is negatively affected by the cultural biases and economic interests inherent within the institution of public education as demonstrated by its historic role of using its power to impose the values and wishes of the dominant culture onto bicultural student and parent populations. (p. 29)

In sum, it has been established that parental involvement matters for the education of immigrant students – and it is also of importance to the parents themselves. If immigrant parents appear hesitant to get involved, it is for reasons different from lack of interest in or passion for education. A small sample of the contributing factors include a possible language barrier, including and especially in the specialized academic vocabulary; previously internalized cultural and educational traditions that are different from the ones in the dominant culture; and inability to attend school functions based on employment or other responsibilities. All of these factors are of importance when exploring ways to engage more immigrant parents in mathematics education and should be considered when building a comprehensive parental inclusion model.

Immigrant Parent Involvement in Mathematics

Research and practice strongly support immigrant parent involvement in the mathematics learning of their children (Lopez and Donovan, 2009; Sheldon and Epstein, 2005). Inclusion of immigrant parents not only positively influences the success of the individual student, but may have an effect on the educational system as a whole, as "parental involvement may be one means of reducing the achievement gap that exists between White students and some racial minority groups" (Jeynes, 2005, p. 263).

Strayhorn (2010) found that several forms of parental involvement affected positively student achievement in mathematics of Black high school children. Parental attendance of school gatherings and parent-teacher conferences, parent checks of mathematics homework, and visits of the mathematics classes were all related to higher student achievement. Strayhorn suggested that the information parents receive from attending school activities provided them with needed connections to what was needed for their children to succeed. In a study that examined the role of teacher-parent communication for student achievement in mathematics in a highly ethnically diverse school, Sirvani (2007) found that students who took home monitoring sheets of their mathematics work two times per week significantly outperformed their peers in the control group. The results were statistically significant on both testing and homework assignments, and lower performing students in the experimental group did significantly better than the lower performing students from the control group. These findings suggest that regular parent-teacher communication on mathematical content affects positively students' achievement, and that such practice may be one way to involve immigrant parents in the mathematics education of their children.

Lopez and Donovan (2009) also maintained that strong parent-school partnerships are in the heart of successful parental involvement, and "effective family–school mathematics partnerships consider the cultures in their community and develop appropriate mathematics content activities for parents as teachers." (p. 228). One role these partnerships play is to prove perspectives on mathematics education together with opportunities for parents to become familiar with the mathematical traditions, notations, and context of mathematics taught in the U.S. This is a needed step as in terms of parental involvement in the mathematical learning of their children, since the ways in which parents have learned mathematics is one of the important factors that determine the ways in which immigrant parents engage in helping their children with mathematical tasks (De Abreu & Cline, 2005).

school day. I gradually learned that this type of participation was determined by the history and nature of the educational system. This initial lack of knowledge and understanding of the educational tradition could be interpreted as unwillingness to be involved – and I made a conscious effort to find time, visit the classroom, and contribute similarly to the other parents. Still, I felt uneasy as I was not socialized in the form of parents-school relationship, and being present and participating in what has culturally been strictly teacher-dominated environment felt unnatural to me – a phenomenon recognized in the literature as related to cultural and ethnic identity (Civil, Planas, & Quintos, 2005). For similar reasons, I also hesitated to be the initiator of my involvement, a phenomenon well described by Wong and Hughes (2007): "although ethnic minority parents express a strong desire to be actively involved in their children's education, they are more likely than are majority parents to believe the school is responsible for initiating efforts and creating opportunities for parent involvement in school." (p. 646). When expecting involvement of immigrant parents, educators need to recognize that not proactively seeking opportunities to volunteer in the classroom does not equal lack of interest, as parents may be coming from an educational system where the teacher is the one and only authority in the classroom. The lack of socially bound knowledge about the norms of parental participation while in the classroom, combined with a resulting sense of inadequacy not knowing what is expected from them, and the potential interference with the authority of the teacher should also be considered. In addition, immigrant parents may be sensitive about their level of English language fluency and their pronunciation and how it is going to be accepted by both teacher and students (Lopez and Donovan, 2009; Tinkler, 2002).

Other analyses of parental involvement of racially, ethnically, and linguistically diverse students confirm that the conflicts between what is valued by immigrant parents and is expected by U.S. schools and society are grounded in different cultural norms and beliefs about education. In an exploration of the mathematical practices of parents of African American students, Martin (2006) described the contradiction as rooted the commonly described images of these parents in education: "One of the limitations of the literature on African American parental practices and school involvement is that these parents are often portrayed as passive, lacking the kind of agency and advocacy that is accepted and expected as the norm for White, middle-class parents." (p. 25). Similarly, in the review of parental practices of immigrants, Olivos (2004) observed that

> Conflicts between Latino parents and the public schools often lay in their differing views and values about education, particularly since these are the most "tangible" differences. Expanding this concept, I also believe that the tense relationship a bicultural (Latino, Asian, African, etc.) parent has with the U.S. public school system is negatively affected by the cultural biases and economic interests inherent within the institution of public education as demonstrated by its historic role of using its power to impose the values and wishes of the dominant culture onto bicultural student and parent populations. (p. 29).

Martin further explained that the pre-established norms often act as restrictions to appreciating the value of immigrant parental involvement: "The practices and behaviors that are idealized—for example, volunteering in schools and classrooms, helping students with homework, fund raising—are those against which all parents are judged." (p. 25). Olivos added to this discussion by suggesting that Latino/a parents "lack the necessary appropriate avenues with which to access information concerning the education of their children and their rights as parents." (p. 33) – and this lack results in misinterpreted expectations on both sides between schools and immigrant parents. The resulting gap and its interpretations by schools and parents may be the critical divide that needs to be address in order to effectively involve immigrants parents in education. Olivos (2004) summarized this conflict:

Involving Immigrant Parents in the Mathematics Education of Their Children

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Parental involvement has been recognized as a contributing factor to students' academic success and to their progress in mathematics. Schools across the United States are welcoming a growing population of immigrant children, and their parents are often not engaged as expected by schools. To provide immigrant parents with opportunities to be involved in mathematics education, schools and teachers need to be knowledgeable of effective approaches to do so. This paper explores important findings and recommendations on immigrant parent involvement and suggests specific activities for mathematics teachers willing to initiate, maintain, and expand the participation of immigrant parents in the mathematics learning of their children.

Introduction

Parental involvement has been recognized as a contributor to students' educational progress and their greater success in schools (Fan & Chen, 2007; Olivos, 2004, Epstein, 2001). Parental support has been noted as a factor in students' progress specifically in mathematics (Sheldon & Epstein, 2005). At the same time, the lack of parental interest in and engagement with the school work of children has been suggested as a reason for immigrant students to lag behind in mathematics achievement compared to their peers (Civil, 2009). Critics maintain that immigrant do not provide sufficient support for mathematics learning at home and at school. In this paper, we first review the roots of this erroneous assumption about parental involvement of immigrant students. Then, an examination of the literature on immigrant parent involvement in mathematics education will provide the theoretical background for practical suggestions on what schools and teachers could do in order to involve effectively immigrant parents as contributors and participants in the mathematics education of children. Lastly, the paper offers a set of action steps and activities that teachers of mathematics across grade levels can use to invite and engage

Table One. Expected parent involvement in the U.S.

Type of parental activity	Description
Communicating	Designing and conducting effective forms of communication about school programs and children's progress
Volunteering	Recruiting and organizing help and support for school functions and activities
Learning at home	Providing information and ideas to families about how to help students with schoolwork and school-related activities
Parenting	Helping all families establish home environments that support children as students
Decision-making	Including parents in school decisions
Collaborating with the community	Identifying and integrating resources and services from the community to strengthen and support schools, students and their families.

Adapted from Epstein, 1995

Involvement of Immigrant Parents

Researchers have been exploring parental involvement as one potential contributor to the success of immigrant children in U.S. schools. Studies have found that racially and ethnically diverse parents value highly involvement in their children's education, and express strong interest in being involved in an active way (Hwang & Vrongistinos, 2010; Chavkin & Williams, 1993, as cited in Lopez & Donovan, 2009). At the same time, scholars report that parents of ethnically and linguistically diverse students are less likely to communicate regularly with their children schools, and are perceived by both teachers and administrators to be less involved and willing to be involved (Wong & Hughes, 2006). These parental behaviors are strongly attributed to lack of interest, lack of motivation, and lack of value associated with education (Lopez and Donovan). These conflicting findings force an exploration of the discrepancy between the professed willingness and interest for involvement of immigrant parents and the perceived absence such interest according to school faculty and officials.

Reports in the literature shed some light on the reasons behind such discrepancy. According to Chavkin and Williams (1993, as cited in Lopez & Donovan, 2009), immigrant parents may have expectations for parental involvement reflective of norms that are quite different from the ones established in the U.S. As a result, these parents expect different dynamics of the parent-school relationship since "what we learn through our culture becomes our reality, and to see beyond that is often difficult" (Chamberlain, 2005, p. 199). As an immigrant parent myself, I had to learn through experience the societal values and the corresponding expectations with respect to the role of parents in school in the U.S. Parents were expected to contribute in quite different ways in Bulgarian schools. For example, the established practice of having parents regularly present as volunteers in elementary classroom was completely foreign to me. I was not familiar with the unwritten rules on parent volunteering, and struggled to understand why it was acceptable to put children in the classroom in unequal position by having some parents present on a regular basis while other were understandably not able to be there during the

change. Our society and schools need to adequately address these changes by preparing the largely single race, monolingual teaching force to work effectively with children and parents from a variety of ethnic, cultural, and linguistic backgrounds. Administrators and teachers are in need to identify and adopt approaches that are in tune with the population changes, as the future of the nation will depend on the strong educational preparation of all of our students.

Parental Involvement in Schools

A spectrum of empirical studies shed light on aspects of parental involvement in schools that specifically affect student achievement. One obstacle to comparing their results has been the different ways to operationalize both parental involvement and student achievement (Fan & Chen, 2001). In studies that also considered racial or ethnic membership, the ways in which minority status has been labeled and represented have also been problematic. Claimed group membership according to official standard grouping is accompanied by a great within-group diversity in terms of nationality, ethnicity, languages, and traditions (including different educational traditions). While the broad racial and ethnic categories are needed for mostly statistical purposes, nowadays they fail to encompass the variety of characteristics within the larger groups while some are strongly associated with stereotypes and assumptions originating in the way the categories are constructed and used. This paper provides a summative review of the literature and the resulting set of strategies for initiating and maintaining for parental involvement that address within-group and between–group differences by looking for patterns that can provide a wide baseline on parental involvement trends that are common across the differences.

Parent Involvement in the U.S.

The first step in developing a comprehensive approach to involving immigrant parents in education is to establish what constitutes "parental involvement" in U.S. schools, as values and beliefs about the ways parents participate in education differ across countries and cultures. The expectations for parental involvement in schools across United States include a range of activities, from help with homework to volunteering at school activities. One of the most comprehensive frameworks (Epstein, 1995; Epstein, Coates, Salinas, Sanders & Simon, 1997; Sheldon & Epstein, 2005) organized these activities in six general groups. They include communicating with the school, volunteering at school, participating in school decision making, parenting, learning at home, and collaborating with the community. These types of involvement and their short descriptions are presented in Table 1.

immigrant parents in the classroom. Throughout the paper, the reader will find the personal narrative of the author as an immigrant parent who has experienced firsthand the discussed issues.

Why focus on immigrants?

The popular definition of "immigrant" available in most dictionaries states is "a person who comes to a country where they were not born in order to settle there." (Wordnet, 2011). Arzubiaga, Nogueron, and Sullivan (2009) noted that this summative term includes voluntary immigrants, migrants, and refugees, and they suggest the term im/migrant to emphasize the nature of resettlement (voluntary, work-related, or involuntary). In this paper, "immigrant" will be used summatively in reference to all individuals who were not born in the United States and relocated here with the intentions of permanent residence.

In the last decades, immigration has become the greatest demographic change factor in United States. The general trend of the resulting influx on the population throughout the nation is well documented and expected to continue. According to the U.S. Census Bureau (2008),

> The nation will be more racially and ethnically diverse, as well as much older, by midcentury, according to projections released today by the U.S. Census Bureau. Minorities, now roughly one -third of the U.S. population, are expected to become the majority in 2042, with the nation projected to be 54 percent minority in 2050. By 2023, minorities will comprise more than half of all children – and by 2050, the non-Hispanic Whites will be less that half of the total U.S. population. In 2050, the nation's population of children is expected to be 62 percent minority, up from 44 percent today. Thirty-nine percent are projected to be Hispanic (up from 22 percent in 2008), and 38 percent are projected to be single-race, non-Hispanic white (down from 56 percent in 2008).

These demographic changes are largely influenced by international immigration to the United States – and to Utah in particular. Current Census data shows that in the last ten years, the state of Utah welcomed about 530,000 new residents (U.S. Census Bureau, 2011). Of these, close to 157,000 reported Hispanic/Latino(a) as their ethnicity. In the last decade only, this greatly diverse ethnic group grew to 13% of the total Utah population (358,340 people). To compare, in 1990, the whole Hispanic population of Utah was less than 85,000. Previous Census predictions have Utah reaching a population of 210,000 people claiming Hispanic heritage in 2015; a sign that the change is happening significantly faster than ever expected.

57% of the last decade population increase in Utah for children who are under 18 years of age consisted of individuals considered a racial or ethnic minority. Currently, one of every four children in Utah schools is classified as a "minority." In public discourse, statements regarding low academic achievement and needs for special programs often accompany this label. Research and practice have been working on identifying actions that support the learning of the racially, culturally, and linguistically diverse students, and yet the educational response is not corresponding to the rate of demographic