

PLAY AND BUILDING HISTORIES/IDENTITIES OF MATH COMPETENCIES FOR LATINOS/AS*

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The purpose of this paper is to reconfigure the functions and effects of 'play' as a developmental tool. We describe how researchers can apply sociocultural theory in order to better understand, and ultimately address issues related to Latinos' development in mathematics. The discussion draws on work conducted in an after-school, non-remedial mathematics club and focuses on the nature and role of 'play' in understanding the cultural and linguistic resources Latino students utilize as they do mathematics. One purpose of this work is to create an alternative pedagogical model that challenges today's dominant perspective of learning environments, which have proven ineffective for minority populations in the U.S. In framing our research, we maintain that students develop most efficiently through dialogues and interactions with others (Vygotsky, 1978; Cole, 2006) in order to make meaning of mathematics.

“Some persons have contended that mathematics ought to be taught by making the illustrations obvious to the senses. Nothing can be more absurd or injurious: it ought to be our never-ceasing effort to make people think, not feel.” – Coleridge

“The moving power of mathematical invention is not reasoning but imagination.” – De Morgan

INTRODUCTION

“Who cares? It’s only a game,” said one Latina third-grade student when asked whether she had formulated a strategy for winning the Counters Game, an activity designed to expose concepts of probability. At the conclusion of the game, the same student tries to peek at the undergraduate (UG) facilitator’s strategy. The UG playfully moves away, withholding the piece of paper that outlines a winning strategy. This is a snapshot of one example highlighting some key aspects of the importance of play in our studies of the *Los Rayos de CEMELA* (The Center for Mathematics Education of Latinos/as) after-school club, an informal, non-remedial activity system that is rich in mathematical concepts atypical of third and fourth grade elementary school curricula.

We too often think of play as insignificant. This is reflected in how teachers largely keep children from playing within the classroom. Play is an activity that is restricted to the playground during recess or to hours outside of the school schedule. It is typically considered distracting, unproductive, and unrelated to learning. Within the context of increasing pressure on teachers to raise students’ test scores on standardized exams, play is perceived as an inefficient use of time; it also can serve as a conditional reward for good behaviour, or to fill time. However, we maintain

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that play serves an important role in teaching and learning because it can reveal students' knowledge and repertoires of practice. Additionally, results of standardized assessments suggest, mistakenly in our opinion, that Latinas/os have little knowledge, especially in mathematics (NCES, 2002). In light of this, we need to have a better grasp of what Latinas/os know and what resources they draw upon for learning. Play can be one way to perform this function.

The purpose of this paper is to challenge and expand our perceptions of 'play,' to recharacterize it as a functional tool for child development in mathematics, and to suggest how it can be integrated into teacher education programs. In the discussion that follows, we will present sociocultural theory as the basis of our understanding of the role of play in development, as well as how it can be utilized to address issues related to improving Latinas/os' learning of mathematics. Specifically, we will show how play can facilitate the creation of desired learning environments (physically, socially, and emotionally), restructure power relations, serve as a tool for improving teacher education, and enrich learning activities in order to capitalize on the child's zone of proximal development (Vygotsky, 1978).

POINT OF VIEW

Play is an important part of human interaction and development. As Vygotsky (1978) states, "... in play, things lose their determining force. The child sees one thing but acts differently in relation to what he sees. Thus, a condition is reached in which the child begins to act independently of what he sees ...(pp. 96-97)," and "...from the point of view of development, creating an imaginary situation can be regarded as a means of developing abstract thought (p. 103)." When mathematicians and teachers of mathematics use the phrase "play with the numbers", what does this mean? We can consider this a call to experiment with the situation at hand. In the process of "playing with the numbers", the child has to critically interpret the numbers in order to imagine new possibilities with them. This is the first step in the development of abstract thought to which Vygotsky refers. Games involving numbers, or even playful interactions with numbers, satisfy Vygotsky's conditions as noted above and facilitate children's thinking. Traditionally, however, this particular role of play has not been given sufficient attention in the mathematical context.

At the heart of sociocultural theory is the impact of interaction on learning, and interactions are largely dependent on dialogue (Bakhtin, 1981). As children engage in conversations with others, they problem solve collaboratively, negotiate meanings, and develop facility with words (Wells, 1999; Bakhtin, 1981). This is relevant in the mathematical context, as there are increasing expectations for students to formulate questions, communicate understandings, and articulate strategies (NCTM, 1995). As a result, it is no longer sufficient for teachers to emphasize children working by themselves in silence. Given the current, poor status of Latinas/os' education and the fact that much of their school time is spent as passive learners (Brenner, 1994), talk and interactions become critical factors in their learning (Moschkovich, 2002). Moreover, children's talk provides a vehicle for teachers to know how they think mathematically. This helps teachers make appropriate instructional decisions. Play provides an important context to highlight children's talk and includes instances where participants transcend their immediate situation through references to other contexts by means of language, language play, jokes, imaginary situations, role-play, gestures, and 'horse-play' (Vygotsky, 1978). Consequently, play in

mathematics does not only develop abstract thought as mentioned above, but is where the child freely engages with others, imagines new mathematical contexts, role-plays mathematically, and experiments with numbers and mathematical language.

Play occurs not only when the participants “play” a game, but also in the interactions between elementary school students, parents, undergraduates, graduate students, and university faculty, who make up the after-school participants. Usually play is characterized as something that children give up after Kindergarten and is thereafter reserved for recess, sports, and other activities not usually associated with learning and development. In our study, we rely on the assertion that “play contains all developmental tendencies in a condensed form and is itself a major source of development (Vygotsky, 1978, p. 102).” In addition, learning, development, and play transpire through the use of language as a mediating tool. By studying discourse between participants, we hope to uncover developmental processes in participants’ talk in Spanish, English, and in their shifts between these languages as they engage in mathematical activities. So far, we have found that play occurs in many forms and is inextricably intertwined with communication, identity, learning, and development.

CONTEXT AND METHODOLOGIES

A frequently asked question to our research group is: Why study Latinas/os? Do they learn differently than other populations? As it turns out, Latinas/os now comprise the largest “minority group” in the United States. They also have the most persistent and disturbing pattern of educational underachievement among all racial and cultural groups in the country. This includes the poorest achievement in mathematics (NCES, 2002). Additionally, it is no exaggeration to claim that most teachers in the U.S. will be teaching Latina/o children (Young, 2002). Yet, there is a paucity of knowledge on the language and cultural factors that mediate Latinas/os’ learning of mathematics, knowledge that can inform research and practice.

We assert that an appropriate response to Latinas/os’ underachievement is not the “back-to-the-basics” initiatives that currently dominates urban school policy (Lipman, 2004), but rather it is more beneficial to immerse students in an environment where they are able to utilize multiple levels of psychological functions – not just recollection (Khisty & Chval, 2002).

Our research is conducted in a large, urban school district in the Midwestern United States. Within this school system, there are approximately 421,000 students enrolled in the more than 620 schools. Of these students, nearly half (48.6%) are African-American and nearly an additional two-fifths (37.6%) are Latina/o. This leaves only 8.1% White, 3.2% Asian/Pacific Islander, 2.4% Multi-Racial, and 0.1% Native American students. Furthermore, 85.6% of students are classified as coming from low-income families, and 13.7% are categorized as “Limited English Proficient” (School District Data, 2007).

In the middle of this huge school bureaucracy lays Wilson Dual Language Academy, our research site. Wilson is made up of approximately 425 students in Pre-Kindergarten through 6th grade. The racial breakdown is 97.4% Latina/o and the next largest percentage is White students (1%). The school has a relatively large transient population reflected by the 25.6% mobility rating. Additionally, 98.3% of students are eligible for the government’s free or reduced lunch program, and 68% are categorized as English language learners (ELLs) (School District Data, 2007). Wilson

advertises itself as a “World Language Magnet Cluster School, offering a Dual Language Program in Spanish and English. The school’s goal is for all students to be bilinguals by the end of 6th grade (School District Data, 2007).”

The research we report here is based on data gathered in an after-school project loosely modelled after the work of *The Fifth Dimension* (Cole, 2006) and *La Clase Mágica* (Vasquez, 2003). The after-school is designed to give Latinas/os experiences doing non-remedial mathematics in curriculum topics beyond the students’ grade level (4th). Such topics include probability, algebraic thinking/patterns, and complex problem solving. Students are encouraged to be self-directed, to work collaboratively, to verbalize their thinking, and to ask questions. Playfulness between adults and children is a critical part of interactions in the after-school. Specifically, our discussion revolves around students’ playing the Counters Game. It is one of several planned activities in the after-school project and largely focuses on probability concepts.

To play, each player creates their own game board, consisting of a rectangular strip of colored construction paper with hand drawn boxes spread from left to right, with one of each of the numbers from 2 through 12 written in each space. Each player receives 12 "counters" (small plastic cubes or chips) and places them on their own game board, arranging them according to their own preference. For example, a player may put several counters on the numbers 5, 6, and 7 while leaving other numbered spaces unoccupied. All other arrangements of the counters are allowed as long as all of them are placed on a numbered space on the game board. A pair of dice is passed between each player, who then rolls them to get a number between 2 and 12. Upon summing the quantities of the two dice, each player then checks their game board to see if any of their counters are on that total. If so, one piece is removed and discarded. If there is no counter on the total, the player does nothing. Next, another player takes a turn rolling the dice. Players take turns rolling the dice until one person has removed all of his or her counters to win the game.

After there is a “winner”, players begin another round and once again arrange their counters. Based on their success or challenges in the initial round, players are likely to make modifications to their original counter arrangement. In this activity, we are interested in observing how each student arranges his or her counters. Specifically, we ask, "Do students place their counters using strategies formulated by observing the frequency of particular numbers appearing during random throws of dice?" For example, a student may notice that the numbers 6, 7, and 8 appear more frequently than the others between 2 and 12. As a result, the student's rearrangement of game board counters may indicate strategies that the student uses to figure out how to maximize chances of winning the game.

Fourteen to twenty third- and fourth- grade students have been voluntarily attending *Los Rayos de CEMELA* for nearly two years. They meet twice a week for one and a half hour sessions. Within the sessions, students are allowed many freedoms to choose their activities and to dictate the course a project will follow. This design is deliberately chosen by researchers to create a drastically different environment than what is typically found in the traditional classroom. The activities are designed to foster high-order thinking and reasoning skills. All sessions of *Los Rayos* are captured by multiple video cameras and are later analysed both by individual researchers and through collective group analysis.

In general, our research goal is to find intersections between mathematics learning, language, and culture. More specifically, CEMELA seeks to describe patterns that emerge regarding how Latino children use Spanish and English in mathematics, the cultural resources they draw on, and how social networks develop because of and around language and culture. This is part of understanding the processes in which students develop identities as mathematics learners through their interactions with university students and researchers and participation in the after-school mathematics program. We wish to better understand and map how networks (learning communities, for example) form around language, culture, and mathematics activities, and influence children's identity as having math competency. In other words, we recognize language and cultural resources and redefine them as learning capital. The focus is on the nature of learning as one of interdependence between social networks, resources, and contexts.

DISCUSSION AND ANALYSIS

The connection between language and mathematics can be summarized by Vygotsky's (1978) observation that "speech...requires sequential processing. Each element is separately labeled and then connected in a sentence structure, *making speech essentially analytical* (p. 33)." Further, "from the point of view of development, creating an imaginary situation can be regarded as a means of developing abstract thought (Vygotsky, 1978, p. 103)." In this sense, we are interested in the participants' development of mathematical thinking, which is characterized by analysis and abstraction, which, in turn, is facilitated through play. The participants guide each other through a constellation of mathematically rich activities in a context that allows them to use Spanish, English, or both, in any combination, while developing a mathematical literacy identity not constrained by the language of the dominant culture. This informal, hybrid space provides a safe, non-threatening, and thus encouraging environment for bilingual students as they negotiate the complexities of learning a second language, English, and a third language, academic mathematical talk. It is through play, experimentation, language, social interactions, and meaningful mathematical activities that *Los Rayos* participants reveal clues about their developmental processes. Like Vygotsky, we find that "play provides a much wider background for changes in needs and consciousness (1978, p. 102)."

In order to illustrate these points, we will describe three different scenarios. The first case was mentioned in the opening of this paper. At the start of the Counters Game, Guillermo (all names are pseudonyms), a graduate student, introduces the activity to two students, Sara and Natalia, with the assistance of an undergraduate student, Jessica. After several minutes spent going over the procedures for playing the game and preparing a game board, the group is ready to begin the process of playing. Before starting to play, however, Jessica asks the girls if they know a way to win the game. To this question, Natalia replies, "Who cares?" Jessica responds: "You are not going to win if you do not know a way to win." Natalia ends the dialogue with the argument, "It is just a game."

This exchange reveals the relaxed attitude of the student, Natalia and the kind of relationship she has with the undergraduate student, who is also Latina, but older. Natalia does not seem to feel the restraints or pressures of formality typically associated with the classroom. Instead, she is playing with a "friend", someone she can "talk to." Additionally, the student is not interested

in analyzing the possible trajectories of the game at this point. Rather, she is merely excited to begin the experience and commit herself to the uncertain outcomes of the activity.

It is also interesting to note the tendencies of the undergraduate pre-service teacher, Jessica. She acts similarly to many other pre-service teachers in that she is anxious to have students formally analyze the problem situation and reach an answer, regardless of the difficulty of the task or that this is not a “school” context. In this way, the pre-service teacher seems preconditioned to interpret this environment as an opportunity to teach students as if this were a regular classroom. Contrarily, Guillermo demonstrates patience as he encourages the students to play the game before he requests any student thoughts about strategies for the game. By interacting with the student in various ways (i.e. playing the game, answering questions), he is effectively and consciously creating space for the child to make sense of the activity.

Also prior to the start of the game, Sara, the other student, thought Guillermo had misplaced his counters and rearranged them for him. This action highlights two important characteristics of ‘play’. First, through a participatory and somewhat collaborative activity, the power relations have noticeably shifted. For example, in many of the classrooms we have visited, the teacher maintains a clear tone and appearance of authority. In the situation at hand, however, the adult does not have the same authoritative position. Instead, in this context of play, adults and children can interact more freely and equally. The child can alter the adult’s materials without asking permission to do so, as in this case, and thus, asserts a sense of initiative and independence. The child contributes to the overall quality of the “play”. Certainly, this changes the dynamics of the group and the interactions that occur around the activity. The shift in power relations should not be so surprising of an incident, however. Most children delight in attention from adults, individual time that is rarely afforded to them in the classroom.

Furthermore, this incident demonstrates the active mind of the student. That is, by noticing and altering Guillermo’s counters, Sara is not mindlessly going through directions given by the undergraduate facilitator, Jessica. Rather, she is evaluating the information given to her (the structure and procedure of the game), interpreting this information based on past experiences, and acting according to her interpretations. Her attention to Guillermo’s arrangement should not be construed as an inability to comprehend the activity. Instead, Sara is externalizing her current understandings of probability concepts.

It is important to note that Guillermo does not ask about strategy, but models it. He did not reprimand Sara when she rearranged his counters. Instead, he moved them back without comment, but was clearly smiling or smirking as if to acknowledge her maneuver, but challenge her at the same time. Once again, the student shows that she is comfortable entering in a conflict situation and essentially challenging a perceived authority figure. From our perspective, this is a significant demonstration and development of agency within the student.

As the game continues, Guillermo introduces humor. He begins to call out, “*Cinco* (Five)!” after each roll of the dice even though the dice reflect a sum other than five. What is the purpose of making this deliberate mistake? First, Guillermo is guiding students to a deeper engagement with the activity by challenging them to analyse participants’ responses – they could be incorrect. He is implicitly conveying to the students that this is not a passive activity. Furthermore, he seems as

though he is more clearly defining the desired environment, one that is safe and non-restrictive. This space is significantly different from the formal classroom, because it shows students that it is acceptable to be wrong or to contest the situation.

The above case can be sharply contrasted with another group playing the same game. In this other situation, the actions of the leader point to ideologies that undervalue play as a tool for development and learning. This group consists of a university student (Pamela), four female students (Lidia, Mariana, Graciela, and Leti), and Lidia's mother. Despite the students' willingness to assist each other, Pamela definitively assumes the lead of the group. She stalls student-to-student interactions so that she can attempt to make certain points clear to the students. Her style replicates the Direct Instruction style that one may commonly find in classrooms, especially with poor children. Pamela dominates the discourse space, only interrupting the flow of her monologue with questions that require minimal responses. These questions are largely characterized as having "Yes" or "No" answers. Additionally, very few opportunities are given to the students to share their thoughts, either with each other or with the adult figure, or to be inventive and assertive. Consequently, after as little as three minutes of Pamela's mini-lesson, the students' attention noticeably drifts. No eye contact is made with Pamela. The end of the students' patience is marked when Graciela asks, "Can we start?" But, her request went unacknowledged.

The pedagogical methods that Pamela practices are an indication of her ideologies, most notable among them being what the students should gain from this experience, which has little to do with play. She steadfastly clings to her conception of the grounding principles of the game, essentially depriving the students from discovering them themselves. Furthermore, Pamela is not capitalizing on the resources or cultural capital of the group. For example, Lidia's mother quietly works on her counters board and allows Pamela to select the direction and pace by which the group will progress. While the mother may be revealing that her culture/social practice privileges teacher authorities, she is nonetheless marginalized from the interactions surrounding the activity. Here lies implication for the classroom, as it shows that Direct Instruction & Instruction-Response-Evaluation formats can change the participatory nature of activities – particularly 'play' activities (Khisty & Chval, 2002; Valdés, G., Bunch, G. C., Snow, C. E., & Lee, C., 2005).

The third case is a collage of interactions ignited by 'play'. As mentioned earlier, the benefits of play do not dissipate with age (Goncu & Perone, 2005). In this particular situation, three mothers joined an undergraduate, Alejandro, and three students, Rodrigo, Judit, and Mateo, to play the Counters Game on a different day. Many notable interactions occurred within this atypical group formation. For example, Rodrigo, a consistently timid student, became increasingly animated as the game progressed. Whether this change in behavior can be attributed to the activity or the presence of his mother is interesting to consider. In either case, however, the interactions were playful with joking and spirited language exchanged between participants, especially involving Rodrigo, and with shifting positions of "power" among all the participants. An environment was created where children and mothers established themselves as knowledgeable and capable persons.

Additionally, the participation of the mothers allowed the game to move in an unforeseen direction. After two rounds of the game, the participants began noticing that seven was the most

likely sum to be rolled. Certainly, this was a primary objective of the game. However, once the group made this observation, it became clear that participants would concentrate their chips on seven. The group agreed that this was an “unfair” advantage. Consequently, the mathematics learning was raised to a new level: one mother proposed to change a rule of the game. She suggested that players not be allowed to place their counters on seven. This proposal has both practical and mathematical effects, while illuminating a significant characteristic of ‘play’ - the means by which to bridge the generational gap between children and adults. Structurally, the game now changed slightly; it no longer exists in its original form where the goal is to get “seven”. Since the parent changed the rule of the game, each player must adjust their winning strategy. In other words, the participants must extend their thinking past the original game’s rules and parameters. The Counters Game had certain structures that dictated what can be done, and under which circumstances, in order to reach the desired end result. When a particular structure or rule is changed, or in this case when one is added, then participants are forced to rethink the effects of each rule, and consequently, they must rethink their strategies as well. The rethinking activity requires higher-level cognitive skills, and a cognitively demanding problem solving situation like this can be intimidating or even discouraging. In this play situation, however, the challenge is met by enjoyment and strong motivation to succeed in the game.

This modification of the structures can be paralleled in mathematical terms as well. For example, in a linear equation involving positive numbers only, one particular input produces one particular output. That is, the equation has built-in structures that determine what a certain action (input) will consequentially produce (output). The coefficient of the equation, for example, serves as one of these structures. And, if it is changed, a particular input will result in a different output. In short, changing certain mathematical conditions affects the outcome, just like in the game. Most importantly, however, is the fact that by making this proposal, the mother has instantly raised the level of mathematical conceptualization. Determining the sum that is most likely to occur is one level; mentally ordering the sums in order of likelihood is a much more advanced problem-solving situation.

Moreover, these interactions point to the importance of play as a means to bridge generational differences. It is no secret that the majority of pre-teen and teenagers feel some degree of distance from adults, because they perceive them as unlike themselves. Play is an opportunity to discover common ground through an enjoyable experience. Our research agenda calls for further evaluation of the specific supports and resources the more experienced person provides to the youth.

Finally, student responses to others’ questions cannot be characterized as a simple answer. Rather, the responses were longer and reflected more complex psychological functioning than mere recollection. For example, at the end of the session, students eagerly offered explanations of their winning strategies. The fact that they are conceptualizing new knowledge is unknown to them, but this is very apparent to us. These explanations are great avenues through which researchers can analyze their thinking.

CONCLUDING REMARKS

Play does not necessarily have to equate to time-off-task. It can serve as vehicle for understanding how learners experiment with the confluence of mediating experiences as they negotiate mathematics concepts, language practices, shifting roles, and identities. From a macro level, we ask: What would it look like if more university teacher education and research programs integrate teacher education, parent involvement, activity development, and research methods in a way that allows more possibilities for collaboration and interaction in more varied contexts? Something like this should allow for flexible purposing (Dewey, 1934) and culturally relevant education (Ladson-Billings, 1995). We hypothesize that teacher candidates would be better equipped with the knowledge of child development and the invaluable experiences of intimate interaction with children, both of which can come about through play—if play is recognized as a means of opening children’s minds. Hence, we argue that these sociocultural experiences could more efficiently prepare pre-service teachers than the often-sterile preparatory routines that have been in place for decades with very few modifications. Through play with children, pre-service teachers could learn to listen to them, to map their cognitive abilities that are often suppressed in classrooms, and could learn to ask students questions with the purpose of engaging them in critical higher-level thinking or problem-solving.

The interactions between CEMELA researchers, Latina/o students, their parents, and university undergraduates represent the interventionist nature of our research, and “activity theory is interventionist in its methodological approach (Kuutti, 1999, p. 373).” At the heart of this intervention is our goal to demonstrate the extensive resources Latinas/os have for learning mathematics. In this learning process, play and playful interactions serve a critical role for changing the dynamics and power relations between Latinas/os and the dominating attributes of school. Furthermore, play actually extends children’s thinking to broader dimensions of mathematics. The objective of *Los Rayos de CEMELA* after-school project is informed by Vasquez’s charge to “imagine possibilities” as well as to foster imagination (Personal Communication, April 2007).

The most opportune space for our type of intervention is in an after-school setting since *No Child Left Behind* testing and accountability mandates have resulted in more classroom time devoted to test preparation rather than to innovation (Lipman, 2004). While the NCTM and the state mathematics learning standards emphasize deeper understanding of concepts, students (and consequently their schools and teachers) are assessed mostly by tests that can only tell us whether the student is right or wrong, but not how s/he thinks. Furthermore, these tests do not reveal any insights as to why students’ correct or incorrect responses occur. Studies show that there is still a long way to go as far as eliminating the “noise” variables, factors that contribute to inaccurate interpretations of test results, in mathematics tests for English language learners (Abedi, 2006; Abedi & Gándara, 2006; Abedi & Lord, 2001). While we are facilitating students as they construct math identities by providing meaningful after-school experiences, we are also looking for the sources of “noise” as we mine their experiences for clues to developmental processes.

Current school policies for assessment result in an overemphasis on simplistic “time-on-task” approaches to instruction. This means that the most frequently prescribed intervention for “failing” students tends to emphasize “tutoring” of basic skills and remedial drills. On the contrary,

results from the after-school and program and an examination of the role of play in mathematics suggests that one way to address the improvement of learning among Latinos/as is to promote more collaboration between students, parents, teachers, pre-service teachers, and educational researchers. By increasing the number of cross-site (i.e. school, street, home) interactions and bridging the generation gap that can be accomplished through a recognition of play, it seems inevitable that conceptual meaning making and retention of skills and facts will correspondingly increase as well.

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