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Productive Peer Culture: Algebra Project Students' View

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Introduction & Purpose

The purpose of this study was to determine students' perspectives about productive peer culture for mathematics learning. The participating students were attending an annual residential summer institute and have been participating in Algebra Project activities for at least one year. Of the 26 high school students attending the institute, they all participate in mathematics literacy work[1] through their local Young People's Project (YPP) groups, while 20 of those students also receive their regular school-based mathematics instruction within an Algebra Project Cohort Model (APCM) structured classroom[2].

The Algebra Project targeted persistently underserved mathematics students who typically scored in the lowest quartile of state mathematics achievement tests. Additionally, Algebra Project students' friends who were interested were invited to participate. The goal of the Algebra Project Cohort Model (APCM) is to develop sufficient mathematical understanding so that at the end of four years of high school mathematics, students are able to take college mathematics for credit, for those who choose that path. The APCM structure does not seek to remediate the students, but to accelerate their mathematical understanding through several approaches, such as high school and university partnerships, supporting teachers for developing effective mathematics instruction, and exposing students to experiences that support mathematics learning and success. The approach of interest and the focus for this study is the transformation of student culture related to mathematics learning. I call this transformational classroom culture productive peer culture.

Theoretical Perspective

Many high school mathematics classrooms have disproportionate numbers of at risk students who have been and continue to be underserved by high schools in the United States, especially in urban centers or rural communities (Hardy, 2005). An underlying assumption is that underserved students are often subjected to interventions that manifest as some form of remediation (i.e., reteaching what was not learned). One must wonder about the influence of perpetual remediation on sociocultural elements that plague mathematics classrooms comprised of high numbers of at risk students. For example, how connected are intervention practices to boredom-inspired misbehaviors such as perceived inattention, off-task conversations, or texting? The APCM approach does not include remediation as an intervention strategy. Instead mathematics acceleration and pedagogy focused on engaging students in mathematics are used. Mathematics acceleration for at risk students is an innovation and rarely attempted approach for creating mathematics success for this population.

Cultural change within mathematics classrooms is a common theme within recent standards, foundational works, and related publications by the National Council of Teachers of Mathematics

[1] High school students are mentored by college students to facilitate mathematics related games and activities with middle and elementary grade students for the purpose of developing younger people's mathematics literacy.
[2] An APCM (funded by an NSF DRK12 award #0822175) cohort is made up of no more than 24 high school students who commit to taking at least 90 minutes of mathematics instruction each day for all four years of high school.

(NCTM), the National Governors Association Center for Best Practices (NGA Center), the Council of Chief State School Officers (CCSSO), and the National Research Council (NRC). The Common Core Standards for School Mathematics describe sociocultural elements of mathematics classrooms and learning in terms of standards for mathematical practice ("CCSSM," 2010). The NCTM standards and related texts describe sociocultural elements as mathematical processes (e.g., NCTM, 2000; Porter, McMaken, Hwang, & Yang, 2011; Reys, Reys, Rubenstein, & National Council of Teachers of, 2010). “Adding It Up” discusses strands of mathematical proficiency to describe sociocultural aspects of mathematics classrooms (Kilpatrick, Swafford, Findell, ., & . 2001). What is missing from these publications are pathways for transforming existing high school mathematics classroom cultures to the environments described. I argue that such environments are aligned with what I refer to as productive peer culture. I further argue that the APCM structure serves as a viable structural and/or process pathway for transforming today’s high school mathematics classrooms, including those that are full of at risk students, to productive peer cultures for mathematics learning.

Research identifies several sociocultural elements of mathematics classrooms that support effective development of mathematics understanding and learning. Related to the foundational TIMMS study, Hiebert and colleagues (1997) identified critical features of mathematics classrooms for developing mathematical understanding. Sfard’s (Sfard, 2001, 2007; Sfard & Kieran, 2001) work around Discourse as an approach for developing mathematics understanding also suggests the need for a transformed classroom cultures that support Discourse for learning. Grant (2009) suggests that mathematics learning is not solely dependent on teaching, tasks, and pedagogy, but can be significantly enhanced or hindered by sociocultural contexts or culture.

This research report is the first of several to share findings that emerge from a five-year investigation funded by the National Science Foundation to investigate how the Algebra Project Cohort Model influences student achievement and the mathematics classroom environment. As the project continues, I plan to investigate these relationships from multiple perspectives. In this research report, student perceptions about productive peer culture are interpreted through the following questions. What is productive peer culture? How does productive peer culture relate to mathematics learning?

Participants & Site

The 2010 two-week residential Algebra Project Mathematics Summer Institute included students from two different Algebra Project sites from the mid-western United States. The students are affiliated with the Algebra Project through one or two ways, either they participate in an Algebra Project Cohort Model (APCM) classroom for daily mathematics instruction or they work as a mathematics literacy worker in the Young People’s Project (YPP[3]). There were students from four different Algebra Project cohorts from the two Algebra Project sites. All of the students from APCM classrooms and YPP from both sites were invited to attend the summer institute at no cost to their families.

At the time of the summer institute, one site is from a small urban school district with one APCM cohort in its second year and an active YPP group in its third year. From this site, 15 students attended the

[3] More information about YPP can be found at http://www.typp.org/

institute and of those students 9 participated in both APCM and YPP and 6 participated in YPP only. The second site is from a rural school district with three APCM cohorts, one second-year cohort and two first-year cohorts. From this site, 11 students attended the institute and of those 4 students were from the two first-year cohorts and 7 students were from the one second-year cohort. This is the second year that the two Algebra Project sites held a shared residential summer institute. The first year's institute was held at a university near the rural school district in a small town and the second year's institute was held at a university closer to the small urban district in a large urban city.

The students from the two sites are very similar their communities have high poverty, low graduation rates, and academic apathetic parents[4]. The primary differences are race and gender ratios. For the small urban cohort, all 15 students identify as Black or bi-racial (1). For the rural cohorts, all students identify as White or multi-racial (2). Of the 26 students attending the summer institute, there were 12 males and 14 females. The number of males and females from the small urban cohort are almost equal (8 males and 7 females) and there are almost twice as many females as males from the rural cohort (4 males and 7 females).

Modes of Inquiry

The research questions that drove this investigation are: (a) What is productive peer culture? and (b) How does productive peer culture relate to mathematics learning? These questions were asked of students affiliated with the Algebra Project in the ways described above. Qualitative methods were used to interpret students' verbal utterances and written responses to these questions and report Algebra Project connected students' perspectives (Denzin, 1997). The data used for interpretation was collected during the 2011 two-week residential Algebra Project Mathematics Summer Institute. The data included three different types of data: a) video recordings of the two working sessions using two video cameras (approximately 420 minutes of video); b) audio recordings of student group reflections using two digital audio recorders placed randomly by the workshop facilitator and students; and c) collaborative student summaries about productive peer culture.

Working session 1 (150 minutes)

The students were told nothing about productive peer culture (PPC) prior to coming to the summer institute. Then they were asked to work collaboratively within their self-selected groups of three to four students to define characteristics of PPC. Students were reminded that there were no wrong answers as PPC has not been defined. After collaboratively generating written characteristics or features of PPC, we watched several video clips from the Disney Pixar film, Monster's Inc. (Disney Enterprises Inc./Pixar Animation Studios, 2001). A movie selected for several reasons: a) this session was scheduled for the first event of the morning; b) most students would be familiar with the characters and plot; and c) most adolescents would likely enjoy watching an animated movie more than listening to an adult talk about anything.

[4] Academic apathetic parents include those parents who are more likely to support their students by attending a sporting event or buy a new dress for a dance than attend an academic event, such as a parent math night.

As the session designer video clips were selected that included a variety of peer collaborations, some that from my perspective were examples and others were non-examples or perhaps leave space for dispute among the student participants. Table 1 lists the scenes (or partial scenes) used during the session and captures my reflective thinking related to the clips prior to implementation. Specifically, listed in this table are my perspectives of whether or not each scene exemplified PPC, peer groups or characters one might identify as a peer group within the scene, and characteristics of PPC that students were anticipated to identify during the working session. We watched only a small part of the video for this session, and naturally the students wanted to finish watching the movie during their free time, which we accommodated.

Table 1: Scenes used to depict examples and non-examples of Productive Peer Culture during Working Session 1

Scene # - Title	PPC (Y|N)	Peer Group	Potential Characteristics of PPC
2 - Monsters in the Closet	N	Scare recruits	No communication or teamwork
4 - Morning Workout	Y	Sam & Sully	Teamwork, shared goal
8 - Scare Floor	Y|N	Multiple Scaring teams	Collaborative, argumentative, supportive, competitive
12 - Harryhausen's	N	Restaurant monsters	Uncooperative, every monster for itself, chaotic
14 - Bedtime	Y	Sam & Sully	Making sense of problems to solve, planning, teamwork with common goal

After each video clip, students were asked to decide if the scene showed an example of productive peer culture (PPC) and explain their thinking. For each clip, group decisions were made and explained, and when groups did not agree comparisons were made arguments ensued and students were asked if their decisions were changed. Then the students were asked to revisit their initial characteristics or features of PPC in terms of mathematics learning and to record their thinking on chart paper. Before leaving the working session, students were informed that we would meet at the end of the two-week summer institute to take this topic up again, and they were encouraged to insight PPC and to keep an eye out for instances of PPC during the institute as they engaged in mathematics learning.

Working session 2 (60 minutes)

Students were asked to reflect on the summer institute and to recount instances of PPC related to their own or others mathematics learning that they could recall over the last two weeks. They were asked to describe any examples either verbally or in writing in a page or less. Few students opted to create written descriptions, but several students were willing to share their accounts using the audio recording devices we had on hand. The audio recorders were passed around by students to capture their thoughts. They were then given time to share their recollections within their groups and then tasked with creating a concept map that depicted their group's current thinking about PPC for mathematics learning.

Results

Interpretation

This study is about making sense of students' perspectives about productive peer culture (PPC). Qualitative interpretation methods were used for this purpose (Wolcott, 2001). Specifically, by carefully examining artifacts (i.e., PPC characteristics and concept maps) produced by the students working in small groups of three or four during the working sessions, several themes about PPC emerged and were used for coding. A general sense of students' perspectives about PPC in relation to mathematics learning was developed from this analysis and then the videotaped working sessions and audiotaped small student group reflections were reviewed to find supporting (or contesting) evidence from the students in situ. Qualitative analysis software, NVivo v9 (QSR International, 2011) was used to support this interpretive analysis.

Careful review of the student artifacts collected during the two working sessions yielded 12 emergent themes overall related to PPC. The number of themes coded across the artifacts are presented and discussed in Table 4 in the next section, because it gives a sense of the students perspectives with respect to the groups of students shared perspective about PPC from the two working sessions. The students did not choose to write verbose prose to summarize their thinking from either working session, but instead opted to use bulleted phrases or single words in many instances. The directions did not require sentences and there were few written. This writing style was expected given that the working sessions were part to a two-week residential mathematics summer institute.

Several of the emergent themes came from actual language found within the student artifacts, such as collaboration, communication, outcome, common goal, and leadership. Other emergent codes were interpreted using the actual student language from the artifacts. Several examples of the student language used and the interpreted themes are shown in Table 2.

Another theme emerged that was implied from the student language, cognitive demand, which was interpreted as thinking or knowledge. The artifacts evidenced this theme both implicitly and explicitly. For example, one student group wrote, "things you know and can share" which was interpreted as an implied example of cognitive demand. Something that is known requires some level of cognitive demand if it is to be shared. Examples of student group's statements of cognitive demand that were explicit included, "critical thinking," "challenge," and "knowledge."

Table 2: Examples of student language selected to explain interpretations

Emergent Theme	Examples of Student Language from Artifacts
Commitment (to task)	• Getting stuff done; work hard • Pay attention, work hard, never give up • The work they have to do • Working through different conflicts

Emergent Theme	Examples of Student Language from Artifacts
Support	• Help each other out • Constructive criticism • Assisting other people when needed • Helpfulness
Engagement	• All fun and active • We as peer have to show and give. . . • Turning them into actions • Take it in and explain to others
Structure	• Make a plan • Everyone has a role to play • Understanding your role

Upon repetitive review, one of the emergent themes (sociocultural) was split into two new themes (positive personal dispositions and group norms). See Table 3 for examples of the student language from the artifacts. The last found emergent theme during the analysis, but perhaps one of the most interesting was ownership. One of the student group's wrote "We're the ones who make up the PPC. Without 'us' there's nothing. . ." on their concept map. After recognizing this as ownership, all other artifacts were revisited in search of this theme, ownership. Several examples were found, including "taking control" and "able to take it [knowledge or understanding] in."

Table 3: Two new emergent themes from one original theme - Sociocultural

New Emergent Themes	Examples of Student Language from Artifacts
Positive Personal Dispositions	• Patience • Cooperation • Honest; trustworthy • Positive thinking
Group Norms	• Positive interactions • Work with people we don't like • talking to one another about roles, activities, and/or the work • help create; help keep focus

Findings

The coding summary shown in Table 4 represents students shared meanings and perspectives about productive peer culture (PPC). Specifically, the larger the number of sources coded (column 2) shows that a particular theme was found on more artifacts. The number of times coded (column 3) shows the number of times a particular theme was found among all artifacts. Some themes were found multiple times on the same artifact. Therefore, the top two themes related to PPC shared among all student groups were collaboration (13) and communication (12), followed by a three-way tie (8) among support, cognitive demand, and structure. Collectively, across all student groups, the top five themes that emerged in descending order included collaboration (22), positive personal dispositions (16), communication (14), cognitive demand (13), and support (12). These written artifacts were used to interpret students' perspectives about PPC, specifically that critical elements of PPC include collaboration and communication, along with positive personal dispositions, support, cognitive demand, and structure.

Table 4: Themes used to interpret student perspectives related to PPC

Emergent Theme (Code)	Number of Sources Coded	Number of Times Coded
Collaboration	13	22
Sociocultural[5]	10	24
Positive Personal Dispositions	7	16
Group Norms	5	11
Communication	12	14
Support	8	12
Cognitive Demand	8	13
Structure	8	11
Outcome	6	6
Leadership	6	9
Commitment	5	7
Engagement	5	7
Common Goal	3	3
Ownership	3	5

These interpretations of student perspectives related to productive peer culture (PPC) are further supported by comments made during working sessions. For example, during working session 2, one student recounted the following as an example of PPC during the summer institute:

> The hard work showed off. Everybody got stuff done, everybody who was slackin' picked up the slack and that's all it is, they worked hard in different groups and some of the people they didn't even like but they got over those foes and worked hard and worked together.

This brief account is focused on both collaboration and cognitive demand; multiple instances of "hard work" and references to groups and togetherness support this claim. Collaboration appears to be a key element of this story as the student describes how groups worked together, even in spite of having to work with those they did not like to get stuff done. Within this brief account, the student speaks of at

[5] This theme was split into two, positive personal dispositions and group norms, and once it was split, the original theme was no longer used directly with respect to interpretation.

least two positive personal dispositions (i.e., pick up the slack and got over those foes) or perhaps group norms based on one's perspective, and clearly there is an undercurrent of a common goal and outcome.

Another example of PPC was recounted by a different student that exemplified peer support and cognitive demand and is in the context of mathematics learning.

> Another way was when Ts theorem was being done. Uh, J went up to the front and helped them out without actually taking over their theorem. He like was squatted down at the board and helped them work through it, and helped them push the theorem forward. And when people talk about Ts theorem they talk about T and A and they forget that J was even up there.

In addition to this account exemplifying cognitive demand and support, a very relevant part of this story was the inclusion of J's positive personal disposition, humility. In the story, T and A are girls and J is a boy. The boys in this group are often not so humble, they like to take credit for the things they have done. J was listening to this tale as it was being recounted, which I thought was an interesting dynamic among peers and was shared in part to give kudos to J; however, saying more about that is beyond the scope of this paper. Worth mentioning, is that in each of these stories, communication is an underlying element that was not mentioned explicitly by the students. Perhaps they are so used to talking about mathematics within the Algebra Project that it is taken for granted and the students do not feel the need to mention communication or the mathematics talk explicitly in their accounts. However, communication was mentioned on almost all artifacts produced by the students.

One small group of students' wrote a definition for productive peer culture as part of their summary at the end of the first working session:

> We're the ones who make up the P.P.C without 'us' then there's nothing. We're the ones who have to give the support to each other. We as peers have to show and give communication to each other. We as young adults must take on leadership to overcome different obstacles in life. Us as leaders, have the knowledge to make a change of production that we do.

During the second working session, a student was asked to bring another student up to speed who arrived at the summer institute after the first working session and he offered the following verbal definition to the student:

> Productive peer culture is pretty much like you and your peers getting together and tryin' to make something good of the situation. Like if yall tryin' to do a math problem, you and your whole group are trying to figure it out. Not just a few people, but everybody is trying to do the one thing to figure it out.

If we consider these two definitions, each of the 13 themes listed in Table 4 are included either explicitly or implicitly within these definitions. These two concise utterances in the students' voices offer the best responses to the questions asked in this study: a) What is productive peer culture? and b) How does productive peer culture relate to mathematics learning?

Discussion

Scholarly Significance for Future

Defining productive peer culture for mathematics learning is an initial step in determining if the Algebra Project Cohort Model (APCM) is a pathway for transforming high school mathematics classroom cultures for mathematics learning. If productive peer culture (PPC) proves to be aligned with the envisioned environment as articulated by NCTM, NRC, and related publications that articulated transformed mathematics learning environment for success in the 21st Century, and APCM is found to be a pathway for developing PPC, then perhaps APCM can serve as a viable structure for transforming high school cultures for improved mathematics learning. Ultimately structures and processes that encourage and/or support cultural transformations within mathematics classrooms will support efforts in preparing students for the knowledge work required for the future.

References

Common Core State Standards for Mathematics. (2010). Retrieved May 10, 2011, from http://www.corestandards.org/the-standards/mathematics/introduction/standards-for-mathematical-practice/

Creswell, J. W. (2009). *Research design : qualitative, quantitative, and mixed methods approaches / John W. Creswell* (3rd ed. ed.).

Denzin, N. K. (1997). *Interpretive Ethnography: Ethnographic Practices for the 21st Century*. Thousand Oaks, CA: Sage Publications.

Disney Enterprises Inc./Pixar Animation Studios. (2001). Monster's Inc. Burbank, CA: Buena Vista Home Entertainment, Inc.

Erickson, F. (1986). Qualitative Methods in Research on Teaching. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (3rd ed., pp. 119-161). New York: Macmillan.

Grant, M. R. (2009). *Examining classroom interactions and mathematical Discourses.* Unpublished Ph.D., The Ohio State University, United States -- Ohio.

Hardy, L. (2005). How Rural Schools are Tackling the Twin Problems of Isolation and Poverty: A place Apart. *American School Board Journal, 192*, 18-23.

Hiebert, J., Carpenter, T. P., Fennema, E., Fuson, K. C., Wearne, D., Murray, H., et al. (1997). *Making Sense: Teaching and Learning Mathematics with Understanding*. Portsmouth, NH: Heinemann.

Kilpatrick, J., Swafford, J., Findell, B., ., N. R. C., & ., M. L. S. C. (2001). *Adding it up : helping children learn mathematics*. Washington, DC: National Academy Press.

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

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common Core Standards: The New U.S. Intended Curriculum. *Educational Researcher, 40*(3), 103-116.

QSR International. (2011). NVivo 9. Doncaster, Victoria, Australia

Reys, B., Reys, R. E., Rubenstein, R. N., & National Council of Teachers of, M. (2010). *Mathematics curriculum : issues, trends, and future directions*. Reston, VA: National Council of Teachers of Mathematics.

Sfard, A. (2001). Learning Mathematics as Developing a Discourse. In R. Speiser, C. Maher & C. Walter (Eds.), *Proceedings of 21st Conference of PME-NA* (pp. 23-44). Columbus, OH: Clearing House for Science, Mathematics, and Environmental Education.

Sfard, A. (2007). When the rules of discourse change, but nobody tells you: Making sense of mathematics learning from a commognitive standpoint. *Journal of the Learning Sciences, 16*(4), 565-613.

Sfard, A., & Kieran, C. (2001). Cognition as Communication: Rethinking Learning-by-Talking Through Multi-Faceted Analysis of Students' Mathematical Interactions. *Mind, Culture & Activity, 8*(1), 42-76.

Wolcott, H. F. (2001). *Writing up Qualitative Research*. Thousand Oaks, CA: Sage.