Ben Ostermeier (BO): Hello everyone, so I am here talking with Bill Crombie today. Today is October 10, 2018, and he'll be talking today about his experiences with the Algebra Project. So hi Bill, how are you doing?

Bill Crombie (BC): I'm good.

BO: Good, so my first question is, tell me about how you became part of the Chicago Algebra Project?

BC: Oh, okay, so let me say, I think the Chicago Algebra Project began, if I remember correctly, in January, the activities from the project began in January of 1991.

BO: Okay

BC: Chicago was unique because that project was actually put together by a number of community-based organization that were involved in Chicago school reform, right, so I guess over the previous decade. And it was, that group, there was a member of that group, professor Charles Payne, who talked to them about the Algebra Project, I think in a conference which they held on community-based learning, if I can remember correctly. And it was really these community-based groups, with the collaboration of Chicago Public Schools, Dorothy Strong, Dr. Dorothy Strong, was the director of, I think K-6 mathematics at the time, that talked to Bob and the Algebra Project in Cambridge and really started that initiative. So I went out to Chicago that January of 1991 as one of the trainers, Bob and myself did the training at DePaul University, and I think within that first year, Nell Cobb became the first director of the Chicago Algebra Project, and so I was basically between '91 and '94 really going to Chicago, almost on a monthly basis and for a couple of weeks during the summer, to work with the project under Nell's leadership.

BO: Okay, and were you, did you work with the Algebra Project prior to working in Chicago, like were you working in the Cambridge area.

BC: Yes, well I started with Bob's organization, the Algebra Project in January of 1990, I was, this is the previous year.

BO: Right

BC: During the spring I was working with Bob on some curriculum development around the transition curriculum. That summer he was giving two trainings, one in San Francisco in Oakland, and another one down in Spelman in Atlanta. He asked if I would be interested in, really, attending those trainings to get a sense of what the Algebra Project work with teachers really looked like. We had done curriculum together, but I hadn't actually seen the material come alive with teachers or students. I attended, it was amazing, and so in the fall of 1990, I came on full time with the Algebra Project, we call it AP Inc., in Cambridge, Mass.

BO: Okay, and then you just progressed to moving to the new Chicago Algebra Project shortly thereafter.

BC: Yes, well, not exactly shortly.

BO: Okay sorry.

BC: For four years I worked with Dr. Cobb, as I said she was director of the Chicago Algebra Project. In 1994, she moved from CAP, Chicago Algebra Project, to a position in math education in DePaul University, and it was really in the fall of 1994, that I came on as director of the Chicago Algebra Project.

BO: Got it.

BC: I was in Chicago as the director of the project basically from '95 to, it was probably, 1999.

BO: Okay.

BC: You know about, four and a half to five years.

BO: Can you talk a little bit about your experiences as director of the Chicago Algebra Project?

BC: It was interesting and different. At the time, let's see, when I came in, the project in Chicago was pretty large. At the time, the focus of the project for those first five years I was in the project had been on middle schools. We had a middle school curriculum. And at that point in Chicago, there were 20 middle schools we were working with, and we had four implementation specialists who were supporting those schools. And by implementation specialists, I mean these were basically teachers who had been through the teacher training, had worked with us for a number of years and had attended the Algebra Project Train-the-Trainer Program. And we managed to set up a kind of cooperative agreement with Chicago Public Schools, so these, really teachers, were still employees of Chicago Public Schools, but they came out of the classroom and worked basically full-time with the Chicago Algebra Project for, something on the order of two to three years. And the Algebra Project covered the cost of their replacement teacher, so the implementation specialist within CPS. As I said they came out of the classroom for a number of years. I think they gained from the experience of doing professional development with other teachers, and then they would return to the classroom. It was also at that time that in Chicago we started working with a few high schools, and really I think by the late 90s, Chicago Public Schools was dealing with some issues around improving mathematics instruction, not just in the middle schools but in the high schools. And the Chicago Algebra Project started working closely with the Chicago Teacher center, which if I remember correctly, this center was a part of NEIU, which was a state university at the time. So it really provided me with an opportunity, not just to work with the middle schools, which is where we started, but to look at some of the issues that we faced as those middle school students went on to

high school. And even beyond we had a couple of collaborations, collaborative efforts that we made with Chicago, what were they called, city colleges, so those are the two-year colleges that are connected with Chicago, and where a number of our students of ours past high school would go. It was an interesting time.

BO: Yeah, sounds exciting. So how did you change from working with the Chicago Algebra Project to transitioning later to becoming the primary professional development person essentially for the Algebra Project?

BC: Oh, well that was relatively easy, because it was in a sense going home. Before I left to become director of the Chicago Algebra Project, that was my primary focus in Cambridge with the Algebra Project, teacher professional development. And in particular, at that time, what we referred to as the Algebra Project Train-the-Trainer Program. Really within, by 1991 and 1992, it became absolutely clear that, with the national expansion of the project, Bob and myself could not possibly visit the sites which support after the initial Algebra Project training. So I think at that time, while Bob had a focus curriculum development, my focus became, not just professional development, but really developing a national cohort of Algebra Project trainers. And these were middle school teachers, high school teachers, and even some university professors, who had been through the initial teacher training, and had either worked through the material or worked with students, minimally for a year, and had an interest in providing local support to their project, in addition to other sites around the country. This effort around ToT, training of trainers, was really the, what would you call it, the brainchild behind it, was Jim Burruss, who worked with us in the first instance for, I think on the order of six or seven years, to establish the Train-the-Trainer program. Bob met Jim in a Train-the-Trainer session, and this was, is, a competency-based program that really looks at developing a small-set of targeted competencies to, as a trainer, to really do two things. In order to handle whatever the conceptual material is effectively, in terms of adult learning, but also to manage the group dynamics, which we quickly learned is very important in any training session, and actually in the classroom. So it was really Jim Burruss who helped us during those, probably up through 1996, 97, who helped us establish the ToT program at the middle school. So actually when I moved to Chicago, that work around ToT that I had been doing in the context of the Algebra Project, kind of followed me to Chicago. We had a small facilitation team for the ToT intensive workshops during the summer that consisted of Jim Burruss, myself, Maisha Moses was with the team, Lynne Godfrey, who Bob originally worked with, at the King open program, was part of that facilitation team. So while I may have moved from AP Inc. to the Chicago Algebra Project as director, the work with the ToT was continuous and without interruption. In the early 2000s, the ToT program with the Algebra Project, Jim helped us reconstruction of this program to develop local capacity under the acronym PDPD: Professional Development for Professional Developers, instead of a similar competency-based developmental program, but the focus was now, under PDPD, was now on the high school mathematics curriculum, and the development of professional developers who could work with high schools as opposed to middle schools.

BO: Okay, cool. So could you also talk about your effort to develop an accessible calculus, known as Polynomial Calculus, and how that relates to work within the alliance to students in key math education transitions, such as elementary to middle school, middle to high school, and so on?

BC: Oh, sure, well let me back up before I get to polynomial calculus, to tell you where I think we are, with respect to curriculum that's used both in the Algebra Project and in the Young People's Project, and it has to do with those transitions that you mentioned. I think it's generally recognized that there are some critical transitions that students make, but first from elementary to middle school, then from middle school to high school, and then from high school to college, or career and whatever special training may be necessary for the careers that a graduating high school seniors are going into. And the position of the project is that really, especially for that last transition, you know, math should not act as a barrier or impediment to the choice of college or career that graduating seniors make. So in a sense, one way in which you can look at the curriculum which the Algebra Project works with, and has been working with, as a way to really support students, and in particular, the students that are having problems, troubles with the mathematics, you know, we kind of designate that as students who perform in the lowest quartile, right, in state exams. The curriculum is really trying, particularly for those students in the transitions that they make. So for example, you know, one of the things that's different between now and when I was growing up, I distinctly remember the time I spent memorizing multiplication tables, it was mostly through repetition. Luckily I didn't find it as boring as I think as a lot of kids do today, for whatever reason. But having that mental database of just the multiplication tables, has implications in middle school with respect to the kind of multiplicative thinking that acts as a foundation for a number of topics as kids go into Algebra, right, in terms of linear functions, functional thinking, and the like. So in that first transition, from elementary to middle school, YPP actually has been developing a curriculum that they first used outside of school, but is increasingly being used in school also called the Flagway Game. This game related to the idea of prime factorization, and because it's a game, and what we have seen time and time again is, students from high school all the way down to elementary school love playing this game, it invokes a lot of emotion, and I think cognitive scientists frame it as one of the things that drive knowledge items into long-term memory is that kind of affective component, that goes along with the basic cognition. So what ends up happening with the game Flagway, is the children learn basically the prime factorization of numbers from 2 to 40 to 50 to 100, and they can go beyond, in the context of playing this game. So the game actually provides a broader scope than what we did 50 or 60 years ago in memorizing time tables. So that transition really from foundation for algebra in terms of multiplicative thinking and that transition from elementary to middle school, is facilitated through Flagway. When we're looking at the transition from middle school to high school, and really Algebra, we have a number of, what we call foundational units, from pie charts to trip lines, that provide a different kind of conceptual foundation for students who have found the more canonical standard presentation of the mathematics unsatisfactory. So in the Algebra Project, we actually, we're not trying to remediate in the sense of, well let's tell

the kids one more time, and maybe a little slower, what the mathematics is, we are looking for a small set of experiences which allow them to really construct certain mathematical concepts through the exploration of those experiences. And that targets this middle school, kind of 8th grade to 9th grade transition, where the kids need a foundation in order to do well in algebra. The last transition is where the idea of an accessible calculus, or polynomial calculus, comes in. And just, well let me tell you what had happened. Before, during the Algebra Project, this is in, what was it, late 1989, I was reading an article in a book that was edited by Struik, a mathematician/historian from MIT, which had a number of old papers in it. One paper in particular was by a student of Galileo Galilei, this fellow was Bonaventura Cavalieri. And Cavalieri had figured out, using certain infinitesimal arguments, how to find the area under the parabola, the cubic, and I think he found the area under a curve going all the way up to x^9. So this is, you know, before Leibniz and Newton had really formalized and figured out the conceptual framework behind the calculus. In particular, this was pre-integral calculus. And Cavalieri did this, as I said, an infinitesimal argument around adding up all the lines under the graph. I read this in around, I was reading around 1989, and Struik had annotated this article by Cavalieri and really translated Cavalieri's geometric argument into an algebraic argument using a summation over all lines. And I noticed at the time that if, the only property of the summation that was used in Struik's rendition was linearity. And I noticed that if you replaced the summation over all lines, which comes, which makes direct connection with this idea of adding infinitesimals if you replace that summation with just an area function, the kind of derivation that Struik wrote in this annotation goes through, it doesn't involve limits, and it looks like you could actually find the area under a parabola with straight algebra. Now the trick was though, if you, you know, there were Cavalieri's derivation cross terms, and you need to get these algebraic identities, develop algebraic identities, to get rid of these cross terms. So the algebra was even more intractable for high school students or college students, than the concept of limits. So when I joined the Algebra Project, that interesting factoid went on the shelf. In 2000, my family moved from Chicago, we went down to San Benito(??) [26:10], and I received an email from a student I worked with in Chicago asking about the Leibniz-Newton controversy, and you could tell I was bored because I must have written back with a two or three page response to that question. But it also reminded me of this problem that Cavalieri had set about. So I decided to look at it again, and luckily I did not have Struik's texts or his annotations with me, so I looked kind of *ab initio,* and it turns out that if you don't follow Cavalieri's patterns, that is you try to solve that problem of the area under the parabola, using just algebra and basic geometry, it's tractable, you can do it. And I looked at the cubic, and that one using the same set set of concepts worked out, and then I said, "I wonder if this can work x^n." And it turns out that it does, I wrote this up and sent it to a teacher I worked with in Chicago, I got a response back saying, "I have no idea what you're talking about Bill." So what I did was, I translated the algebraic argument into a geometric argument, a series of pictures, and that series of pictures was clear enough, right, so that it turns out not just high school students, well not just high school teachers, but high school students at the level of a geometry class could understand it. I think the following

summer I shared this with Staffas Broussard, who's a mathematician, who was a mathematician at the University of New Orleans, he's since retired from the mathematics department. But we then set out over the next three years to see if, "Well if you can bring the beginning of the integral calculus down to the level of a high school geometry course, can you bring the beginnings of the differential calculus, which is easy enough to crack to the integral calculus, can you bring that down to the level of an Algebra I course?" And it turns out that indeed you can., and we kind of, you know, worked that out over the next couple of years. I get the opportunity to actually develop some lessons around this with students in the summer program in Princeton University called PUPP, Princeton University Preparatory Program. We've been able to, actually in the early 2000s we've used the material closely in professional development settings, because we talk about how teachers need to provide experiences for students that are based, inquiry based exploratory, right, where they can play with ideas. Well for teachers to do that effectively, they also need those experiences, and what we've seen is that, you know, high school math teachers who've gone through calculus, they may not have taught it for awhile. But they went through calculus, the standard calculus with limits. So by giving them problems in the polynomial calculus, this accessible calculus, this is a path to the concept of derivative and integral, which they have not taken, but they are well versed in the tools that you use to construct that path. So it gives them an opportunity not to repeat things that they already know, right, but to use things that they know very well to explore some new approaches and new ideas. So in a sense, they know where they're going, right, cause they've done calculus as part of their undergraduate career, but they have a real, an authentic exploratory, because they have never gotten to the calculus through the tools of elementary algebra and geometry. Working with the Southern Initiative Algebra Project over the past six or seven year, we've also had an opportunity to introduce this accessible calculus, this polynomial calculus to a number of mathematicians from, at this point, maybe a dozen HBCUs that we've worked with around the country. And you know, once again, the issue there, is whether we can create more paths into the calculus, and consequently, more paths into STEM careers, by making the calculus accessible, really at the level of college algebra, has been the focus. So that has also been a lot of fun.

BO: Very exciting. So what has been, what have you found most rewarding in working with the Algebra Project?

BC: Uh, well, well, one of, I'm thinking up the ladder to the most rewarding.

BO: Yeah sure.

BC: So one of the rewarding pieces about it is, I'm in this funny job where, you know, I get to do actually a lot of nice mathematics and physics, and actually the approach that the Algebra Project takes the mathematics is much more like the route that a physicist takes, at least from my perspective, than the kind of traditional mathematician. We start simple concrete experiences and attempt to explore them, right? That's what a physicist is concerned with. Trip lines is basically an exercise in kinematics, and as a

matter of fact, you know, the way that this accessible calculus, this polynomial calculus is developed is, you know, really akin to a Newtonian development of the calculus, through motion, so I think on the conceptual side, I've, over the past 27 years, I've been, I've had an opportunity in the Algebra Project to think deeply about some basic concepts and issues in both physics and mathematics. With the ToT program and PDPD program, they involve kind of this interesting combination of group dynamics, cognitive psychology, have both the kind of cognitive, affective, and social interact. I've really since college had an interest in the social-psychological sciences, less than the mathematical and physical sciences, but that's been there. The Algebra Project has been a place where, kind of that has been an active and important piece of my work also. The, now I'm getting closest to the top. The work with mathematics teachers has also been rewarding, but I think probably the best thing about this work is what we see students are able to accomplish, and these are students who know that the school, you know, the kind of school superstructure does not think that they know math, does not think they can do math, and where these kids end up realize that they can do math, and can be good at it. I mean that is one of the most amazing transformations that you could possibly. And so probably that's what's been most profound about this. And it's really, it's supported by the initial work that, you know, YPP does with kids. You know, kind of all the way up through that middle school transition, elementary to middle, middle to high school, and we're just beginning to look at the high school to college transition. So I think that process of student transformation and how that these students are able, you know, to remake the alliance, right. So the fact that they're academic and non-academic is, that I think is probably the most exciting thing about the work.

BO: Yeah, and conversely, what has been your greatest challenge in working with the algebra project, and how did you deal with that challenge?

BC: Oh, that's interesting. One of the, at the first ToT, I was talking to one of the participants, and I guess at the first ToT, I had been working with the Algebra Project for two years. And I remember she told me, she liked the Algebra Project and the idea behind it, but, you know what, she said, "You know what, I really can't stand is, every year, just when I think I'm getting good at something, my job description changes, and I'm back at the start again, as opposed to, you know, where I thought I was," and I remember kind of telling her, "Really?" Because, that's what I found most fun and engaging about the project, that, you know, the group, the Algebra Project is a small enough group that every couple of years, your job description is going to change in some fundamental way, professionally, you know have to learn how to engage a whole new set of challenges. So, you know, I really started out, as I mentioned before, coming into the Algebra Project doing some curriculum development with Bob. That first, fall of 1990 when I started with the Algebra Project, I went to a teacher PD in Louisville, Kentucky. Bob wasn't able to make it, I went there on my own, and I'm still not sure what I did or did not do, but I certainly got some teachers upset and angry. Actually, before I got back to Boston, the director of mathematics in Louisville, Kentucky had already talked to the folks in the AP office. It was absolutely clear. I may have known a lot of math and physics, but I did not know how to work with teachers,

right, around these materials, and we actually started putting in place, right, this Train the Trainer program. We talked to Jim Burruss, as I said, and ended up working with him for seven years, to really get ToT in place during the 90s. So I mean, that was kind of, my first example of, you know, walking into a job that I was completely incompetent. All the competencies that I had were in another domain. And I quickly had to figure out how to at least do no harm, right, in the context of teacher professional development. I think I presently do no harm, and you know, we actually had some good things coming out of it. So, basically every couple of years, as I said, the nature of the job description changes. I think also the past couple of years, one of the things that particularly difficult that we're still trying to figure out is, you know, when administrations change at the top, it sends tremors down through the system. So if a new superintendent, for example, comes into a district, not always, but often enough, that new superintendent needs to make his or her mark, a distinctive mark on the entire system. So if the Algebra Project is in the district with a new superintendent coming, the Algebra Project may not be in the district, you know, come the following year. There's a countervailing force around teachers who are committed, teachers and administrators at the school level that are committed to the project, parents and community activities that are committed to the project, but you know, that side has to be developed withstand the aftershocks of a changing administration at the superintendent level or just below, at the academic officer level. So that, so before, a whole new set of competencies and skills that I think the project is facing. This idea, just to jump ahead, of developing local alliances that are part of a national alliance, you know, that idea of a local alliance is really a community-organizing notion. But it's really local community organizing. So really over the past year, year-and-a-half, I think, for me, right my principle learning in the project has been how we, not just the professional development, right, how in the course of spending time in the district, we support this idea developing a local alliance, right, with university partners, partners in the schools system, the teachers that we work with. This local alliance that we'll be learning for the next few years. Probably more than two. But that, I think that probably the biggest challenge on my plate right now.

BC: Yeah, well that transitions well to the last question I had prepared, which is, how do you see the national alliance and its member organizations challenging educational inequity and living up to the promise of "We the People"?

BC: Oh, good, we're right there. You know it's, it's interesting. I was at a meeting, I was at Broward County all last week, and they had a meeting of local alliance at Broward College, so there were representatives from SIU and the Miami project and from Broward County public schools. They invited some administrative from Broward College itself, right, and Bob was in town, so he came to the meeting, and you know, spoke to the group. And I've seen this a couple times before, I mean the way Bob opens the meeting was, he asked everyone to follow him and recite the preamble to the constitution, right, and there were some students, it was a pretty diverse group of about 25 to 30 people in this auditorium. And we went through, right, the preamble to the constitution. Bob talked a little bit about what it means and its relationship to building local and national alliances that support the learning of students, particularly

in math, right, performing in the lowest quartile. And, you know, what I find really interesting about this, about that meeting, and this recitation of the preamble, is that I, you know, what I've seen, and I saw at that meeting, that, my guess would be everybody there had heard the preamble before, but it also looked like the recitation of that, together, struck a deep chord, right, with the folks at that meeting. And it was a chord that resonates with this idea of our collective responsibilities to students performing in the lowest quartile. That is I guess, one of the most, I don't know what you'd call it, at the same time, beautiful and effective, kind of, community meetings that I've seen, that I've been to. And I, you know, I in the sense that this, we've all heard the preamble, but the work around math literacy for students performing in the bottom quartile, right, when you go through the preamble in that context, I think it's transformative for people. I don't know if I've answered your question...

BO: No, that's great

BC: ...it's what your question invoked in my mind, because I was just there last Friday.

BO: Yeah.

BC: Everytime I see that, it's absolutely amazing.

BO: No I mean, I think that's a great story, and I hope I get to see that someday. So you've answered all the questions I had prepared, was there anything else you wanted to address related to your work with the Algebra Project or the growing of the National Alliance or anything else?

BC: Uh, no, I think that's pretty good. You know, actually, let's see, when was it, three weeks ago? Three weeks ago, I was in Broward County, oh, two weeks ago, I'm sorry, in Broward County, in one of the classrooms there. And in the particular classroom the Algebra Project teacher is also the football coach. And I mean, you know, what's really interesting, is that the kind of team development that he does with his football players, making those football players into a family, a close-knit family. He and the teacher team that he's working with a total of three teachers are kind of working on developing that same cohesiveness, right, that same feeling of closeness and support in their math classroom. So one day I walked in there, they were watching this motivational video, right, and I forget the name of the guy who was doing it, but he was talking about a football team, the team that won, he asked this audience of kids he was talking to, he asked them when they won. When did they win the game? You know, the kids looked at him, they said, you know, the last quarter, right, when they made the final point. And this coach who brought in this video turned around and said, "Well no, that's when they won the game. They won the game in the first quarter." Right, kind of preparation and attitude and he went through a thing. But it reminded me, what it reminded me of, is, in another ten years, I'm moving into my last quarter, and I think increasingly, hitting 75 right. Increasingly, I have an interest in who in their first or second quarter is going to pick up this work, right, and continue it.

BO: Yeah.

BC: So, if anybody's listening, we need you! To pick up this work, because I'm moving into my last quarter. That random though it was comes to mind often now.

BO: Yeah, sure, that was very well put Bill, and I want to thank you so much for taking the time to talk to me today.

BC: Oh you're welcome, it was fun.

BO: Yeah so, I'm signing off now.