

2016

An Investigation into the Accessibility of AP Calculus

Brian Austin Dodge
University of Southern Maine

Follow this and additional works at: <https://digitalcommons.usm.maine.edu/teacher-education-capstones>



Part of the [Educational Assessment, Evaluation, and Research Commons](#), [Educational Leadership Commons](#), [Educational Methods Commons](#), [Educational Psychology Commons](#), [Science and Mathematics Education Commons](#), and the [Secondary Education Commons](#)

Recommended Citation

Dodge, Brian Austin, "An Investigation into the Accessibility of AP Calculus" (2016). *Capstone Research Projects*. 1.

<https://digitalcommons.usm.maine.edu/teacher-education-capstones/1>

This Capstone is brought to you for free and open access by the Teacher Education at USM Digital Commons. It has been accepted for inclusion in Capstone Research Projects by an authorized administrator of USM Digital Commons. For more information, please contact jessica.c.hovey@maine.edu.

An Investigation into the Accessibility of AP Calculus

Brian Dodge

University of Southern Maine

EDU 643

2 Barriers to AP Calculus

Abstract

This is a mixed methods ethnographic study conducted to determine what obstacles students face when approaching AP Calculus. I focused my study on home economics, peer pressure, ELL status and home support. Overall, I found that being a student who is ELL (hereafter defined as a student who was or currently is required to take ACCESS testing) had the most negative effect of the previously listed factors. Home economics and peer pressure were inconclusive or often had no effect. Finally, having a supportive home life in the form of parents who value education, encourage goal-setting, and set high expectations had a positive effect in accessing AP Calculus. These findings allow me to focus my future work to mitigate the negative and foster the positive influences.

Introduction

I teach AP Calculus at a large high school in northern New England. We have the most culturally and linguistically diverse student body north of Boston. I have taught all manner of students from year-long Algebra 1 all the way up to Calculus. It is impossible for me to ignore the fact that race, gender, household wealth, and socio-economic factors in general all seem to affect the students that end up in AP Calculus. The problem I see is that the racial and linguistic representation of students in AP Calculus is not proportional to the total school population. Most of my AP students are white and come from upper-middle class households. My informal preliminary investigation found that some of my preconceptions may be inaccurate: the gender disparity is not what I would have

3 Barriers to AP Calculus

originally thought (my current class is 65% female to 45% male.) However, I still had questions about the cause(s) of the disparities between the general Deering student population and the population in my AP Calculus classes and how they have changed throughout the years. I wanted to know the causes of the barriers students face when accessing AP Calculus and what I might be able to do to make my courses more accessible to all students. I also wanted to know what I could do to encourage these students to take AP Calculus.

My research helped me illuminate these barriers and helped me to better understand the situation of the “typical” student at my school and why they choose to or not to take AP Calculus. Due to the time limits of my study, I was not able to implement sweeping changes this year, but as I move forward in my career I can enact change in my department based on the findings of my research. I conducted a mixed-methods ethnographic study to answer these questions. I needed to know the measurable trends in demographics of these students as well as the impressions of future, current, and past AP students to determine the nature and cause of the trends. For quantitative data and to help eliminate subjectivity I will contact the guidance office, retrieve College Board reports, access the maine DOE, obtain demographic data from my district’s multilingual office, and access Office of Civil Rights data. I also plan on conducting multiple interviews for more qualitative information. Having been an AP Calculus teacher for one year already I was able to contact some Deering alumni who took AP Calculus to determine why they chose to take the course and the steps that they took to get there. I had hoped to also interview 8th grade teachers about criteria for recommendation to certain 9th grade math tracks but I was unable to make those interviews happen.

4 Barriers to AP Calculus

Literature Review

The focus of my literature review is to give me a foundation of understanding to help guide me as I conduct my research. It is important for me to understand the current (and former) realities of access to AP courses as I moved forward with my research. I had never had the time to sit down and do actual quantitative analysis of my high school, its population, and trends around AP access. With that in mind, I tried to find studies that will give me some structure, hard data, methods, qualitative information, and quantitative data for comparison. A study that incorporates the history of the AP program seemed like an obvious place to start. This led to me to Broad's study: *Road to Equity: Expanding AP access and success for African-American Students* (2013).

The study is fantastic for providing an overall history of the AP program in general and how it has changed over the years. It is a very interesting history that shows the AP started as a program for "superior boys and girls" in the northeast in the '50s. At the time, the schools in the northeast were hoping to prepare a very small portion of students for the academic rigor of college. After the early years of these driving paradigms, schools moved towards a broader goal of preparing *all* students for success in college. The AP program grew significantly over the years but the major racial and economic inequities persisted.

In general, districts across the country have made great strides in providing access to AP testing for students. At the same time access has improved, test scores have gone down. This report investigates a few schools that serve minority students where the participation *and* test scores have improved. The study was done in conjunction with the Broad Prize for Urban Education that awards \$1 million annually to an urban school

5 Barriers to AP Calculus

district with the greatest overall performance and improvement in student education. While many of the strategies pointed to in this study are out of reach for myself (e.g. 6-week AP camps for students) some are within the realm of feasibility. For instance, we could offer an elective class on analytical skills. In general, all schools that are successful with their AP program exhibit: “casting a wider net for academic potential by expanding access to gifted programs, applying gifted strategies to all children, and analyzing student results on precursors to college entrance exams to identify students.”

The second study I investigated was Walker’s: *Why Aren't More Minorities Taking Advanced Math?*(2007) Walker investigates the disparity seen in rates of students who represent a minority (particularly Black and Hispanic) that take higher level math classes. Walker found that teachers’ preconceived notions about motivation and aspiration of minority students are often untrue. This is not a case of lack of desire. In addition, she found greater parity for lower level classes like algebra and geometry but it becomes more exaggerated for classes that are often prerequisites for college. Walker provides a list of six suggestions for how we can improve access for these students: expand our thinking about who can do mathematics; build on underrepresented students' existing academic communities; learn from institutions that promote math excellence, such as historically black colleges and universities that graduate many minorities with math-related degrees; expand the options in school math courses; expand enrichment opportunities by providing more out-of-classroom mathematics experiences; make minority students less isolated in advanced mathematics courses.

By giving recommendations about how we can make these courses more accessible to students who are in a minority the author gives me a basis for my

6 Barriers to AP Calculus

inquiry. In other words, the solutions given by Walker illuminate the problems, policies, and practices that I might expect to encounter while conducting my research.

My research so far had really missed an important population of my high school: students who are English Language Learners. Luckily I was able to find a study that very closely mirrors my intentions for my own study: *“I’m Not Going to Be, Like, for the AP” English Language Learners’ Limited Access to Advanced College-Preparatory Courses in High School (2014)*. This was a qualitative case study done at a large public high school where the authors examined the educational policies in place that restricted curriculum access to students who are ELLs. The study found that districts typically set goals for ELLs of just graduating high school. Anything beyond that was seen as unrealistic. In the 2014-2015 school year 29% of the population of the high school I work in were ELLs. This is an increase of almost 300% from just 15 years ago; but their numbers are not rising in my AP classes.

This study points to offering quality, high level rigor while at the same time offering language scaffolding to support the students. Among their findings were that there is rigid tracking in place for ELL students. Once placed in the “ELL track” there is almost no way of getting out of it to access higher level courses. Each ELL class feeds into the next and offers little hope of launching out to “regular” education classes. The study found that this tracking is so prevalent and entrenched that the parents of ELL students and the students themselves are not aware that they have the ability to move out of this track.

Another major barrier were standardized tests. For my students this includes, but is not limited to: MEA, NWEA, SAT, and Smarter Balanced Assessment. These tests

7 Barriers to AP Calculus

were often gateways to accessing AP or honors classes. Since these tests are not written with language supports in place, they don't accurately reflect the drive, ability, or knowledge of the ELL student who is taking them, thereby preventing the student from entering a higher level course. Finally, this study found that there is a general sense of acquiescence from parents and staff that this is the way it has to be. People felt like any meaningful change was out of reach. I feel like this is something that I encounter in my high school every day. The research points to other studies that show the population of ELL students in US schools should approach 25% by the year 2025. As my school has been around that figure for the past few years I feel as though this study gave me a great window into my own school. Since the US already lags behind many other nations in terms of producing college graduates, we can't afford to leave such a significant portion of our population behind.

I found this study to be perfectly connected to my own research goals. Their findings mirror my own anecdotal findings in my high school. Most of what the authors describe I see every day. I approached my research using this study as a rough guide to see if my initial thoughts and observations are as similar to the authors' as they appear on the surface. For additional summaries the authors have their own summary of their research on youtube:

https://www.youtube.com/watch?v=ZNf_gKhy30g&feature=youtu.be

My final investigation looked to "race theory" (an explanation of which can be found at: <http://www.odec.umd.edu/CD/RACE/CRT.PDF>) as a framework for understanding achievement gaps in different student populations in high school: *A critical race analysis of Latina/o and African American advanced placement enrollment*

8 Barriers to AP Calculus

in public high schools (2004). The authors seek to analyze the availability of Advanced Placement courses and how that impacts educational outcomes. They use the following questions to guide their research: How do school structures, practices, and discourses help maintain racial and ethnic discrimination in access to AP courses? How do Latina/o and African American students and parents respond to the educational structures, practices, and discourses that help maintain racial and ethnic discrimination in access to AP courses? How can school reforms help end racial and ethnic discrimination in access to AP courses? To address these questions, the authors looked at a few different districts in California as well as a few charter and magnet schools. They found three different patterns at the district level: Latina/o and African American students are disproportionately underrepresented in AP enrollment in the top AP high schools in the state and the Los Angeles Unified School District. Schools that serve urban, low-income Latina/o and African American communities have low student enrollment in AP courses. Even when Latina/o and African American students attend high schools with high numbers of students enrolled in AP courses, they are not proportionately represented in AP enrollment. This last finding is exactly what I'm seeing at my high school and what I hope to continue investigating further.

While their recommendations are not in my opinion groundbreaking in any way (promote supportive advanced study and college- going culture, access to qualified teachers, intensive academic support, etc.) I feel that the study provided excellent comparative data for me and my research.

9 Barriers to AP Calculus

Research Question and Sub Questions

Guiding Question:

What barriers deter students from taking AP Calculus?

Sub-Question 1: *What are the specific factors in a student's home life that affect access to AP Calculus?*

Sub-Question 2: *What is the role of peer pressure in a student choosing whether or not to take AP Calculus?*

Constructs: Barriers, Access to AP Calculus

Variables: Race, socioeconomic status, standardized test scores, demographics

Research Design

I have chose to do a mixed methods ethnographic study. It is my desire to focus on the cultural and social aspects of my high school's population and the effects they have on student class selection and educational goals. As the only AP Calculus teacher at my school, I am already immersed in the group that is the subject of my study. I am entering my fourth year as a teacher in this building and have been surrounded by the group about whom I will be researching. I have come to know these students quite well during this time. Even though I have come to know these students well I feel that there are many decisions they make (or are forced to make) that I was having difficulty understanding.

10 Barriers to AP Calculus

I chose a mixed methods study because I don't believe that a qualitative or quantitative study alone will make a complete picture of the situation. To that end I used an integrated research approach. The qualitative research was conducted in the forms of interviews with current and former students and the quantitative data will come in the form of demographic data about the AP student population in its current state and throughout the years.

Sample and Setting

I looked to select a sample for my research that ensured feasibility as well as productivity. To that end I selected a representative purposive sample of the aforementioned students. It was my goal to select only students who exhibit the qualities I was looking to analyze: ELL and free and reduced lunch for example. However I found finding the students and the time to interview them difficult to obtain. Also, free and reduced lunch status was unobtainable as that is confidential information. As a current teacher, the students I saw every day were my best resource. I interviewed two of my current students who both used to take the ACCESS test. Having taught AP Calculus last year as well I was able to get in touch with a former student through email

In addition to these samples of students I am interested in a convenience sample of as many freshmen as I could get to take my questionnaire. I wanted to see what students think of themselves, their families' mathematical tendencies, and how they saw their own ability to access AP Calculus.

Procedures

I will conduct several interviews of current and former. These interviews gave me the qualitative experiences of students in order to paint a picture of what factors have

11 Barriers to AP Calculus

affected a student's choice (or perhaps perceived inability to choose) in high school courses. I also used these interviews as a tool to help me answer both of my sub-questions. I also conducted an interview with another math teacher to find out who they nominate for AP Calculus and what specifically leads a student to sign up or not sign up for AP Calculus.

I used a questionnaire to also help give me a broader understanding of my school's population: current and future. I gave the questionnaire to a convenience sample of 72 students currently in freshmen math courses at my school. It gave me broad motivations, barriers, and positive factors as perceived by the students themselves. The questionnaire helped me answer my two sub-questions. The results from the questionnaires also helped me understand the current state of motivation and a more "mathematical biography" of students. I had to know more about incoming students' perceptions around requirements for accessing AP Calculus and their perceived ability to access the class.

Finally I accessed quantitative demographic data to complete my mixed methods study. I looked at data provided by the College Board about what type of student is taking the AP Calculus exam and how that typical student has changed over time. I should also point out that not all students who take AP Calculus choose to take the exam at the end of the course. I will speak with the guidance department in my school about the demographics that are specific to my school's AP population. I also looked into the Office of Civil Rights and the Maine DOE to see overall demographic information about the general student population in Maine and how it has changed over the years. Finally,

12 Barriers to AP Calculus

the multilingual office in my district was very helpful providing trend data for the percentage of students in my district whom they classify as ELL.

Data Collection Tools

- Current and former student interview protocols.
- Questionnaire

Findings

Sub-question 1: What are the specific factors in a student's home life that affect access to AP Calculus?

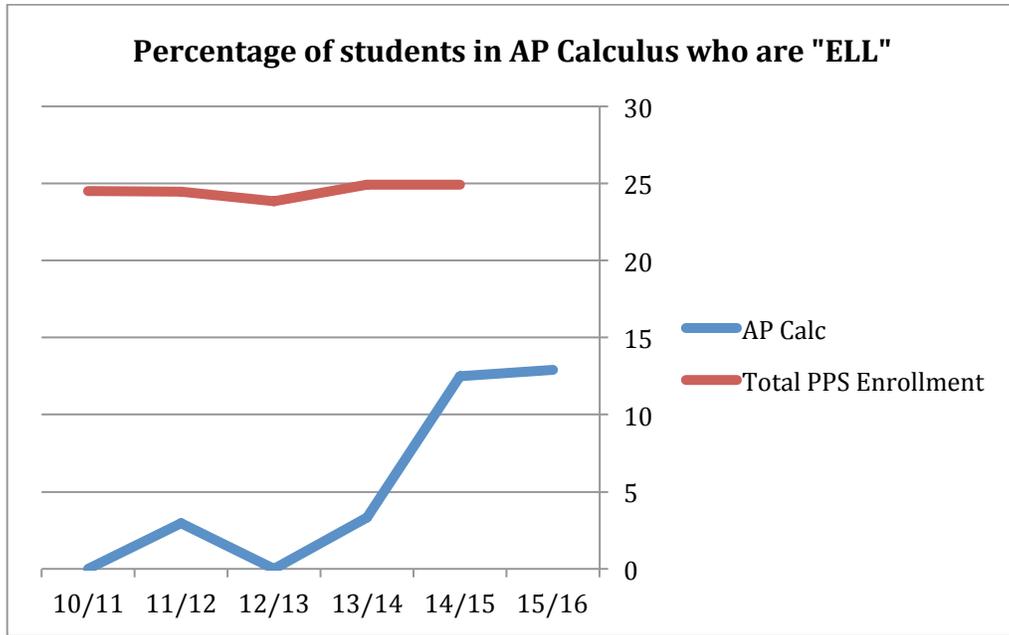
Home Economics (inconclusive):

Due to confidentiality reasons, I was unable to obtain specific data about individual students' free and reduced lunch status. I was left to work with the information I obtained from the College Board. The most interesting thing I found was that 56% of AP Calculus test-takers have a family income level of \$60,000 or more. The average household income of a home in the county in which I teach is approximately \$47,000. This clearly indicated that the majority of AP Calculus test-takers have significantly above-average incomes; 27% higher to be specific. However, this was the only data I had available to me in the time I was given and I don't feel as though this is enough information to make any real claim for the impact that income has on access.

English Language Learner Status (Slight negative effect):

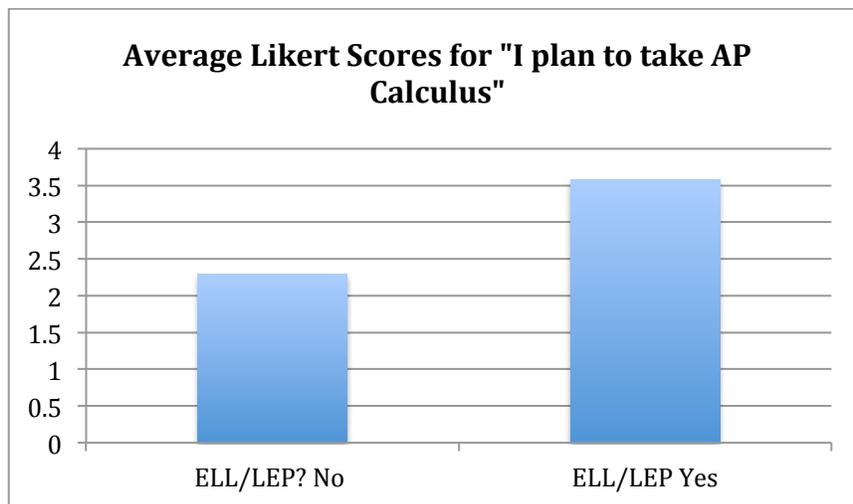
As mentioned previously, I am defining an "English Language Learner" to be a student who has at any time been required to take the ACCESS test for English language development. The graph below shows the percentage of total students in the district and students in AP Calculus who are "ELL".

13 Barriers to AP Calculus



As you can see, ELL enrollment in AP Calculus has spiked in this last couple of years, which is a great sign of improving access. However, it still remains well below the district percent.

This general lack of alignment with district norms was what lead me to conduct this study in the first place but I was surprised when I turned to analyze the results of the questionnaire. Contrary to what I expected to see, I found that students who qualified themselves as “ELL/LEP” were much more likely to “plan to take AP Calculus.”



14 Barriers to AP Calculus

So students who are ELL are more likely to see themselves in AP Calculus but are less likely to get there. I had to turn to the interviews to find some kind of a window into a cause.

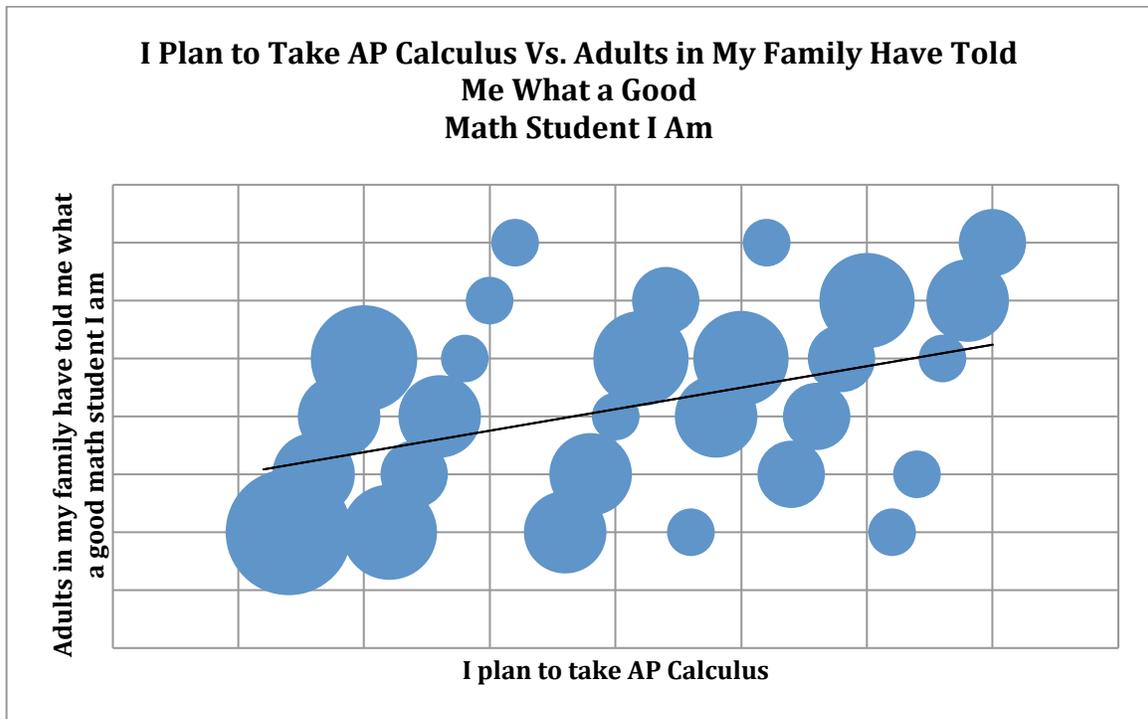
The interview I did with another math teacher in my high school shed some light on the issue:

Students who come to (our district) as newcomers often get placed in the ELL Foundations math class. When students pass this class, they usually move to year-long Algebra 1. When they pass that class they will usually take Algebra 2 CP which feeds into Geometry CP. At this point, they are a junior – assuming they were taking math quite frequently – and even if they wanted to there wouldn't be enough time before graduation for them to take Accelerated pre-calculus and AP Calculus.

This is a classic case of tracking and is very unfortunate. Through no fault of their own, students with very high math ability (students will have often already taken Algebra 2 or pre-calculus) will be placed in ELL Foundations in Math because of their language skills. They can usually do the arithmetic, algorithms, and mechanics that constitute these classes but have a tough time working through word problems because of lack of understanding of cultural references (playing cards, baseball, etc.) and not understanding the language in general. Getting out of this class is entirely contingent on their mastering the English language.

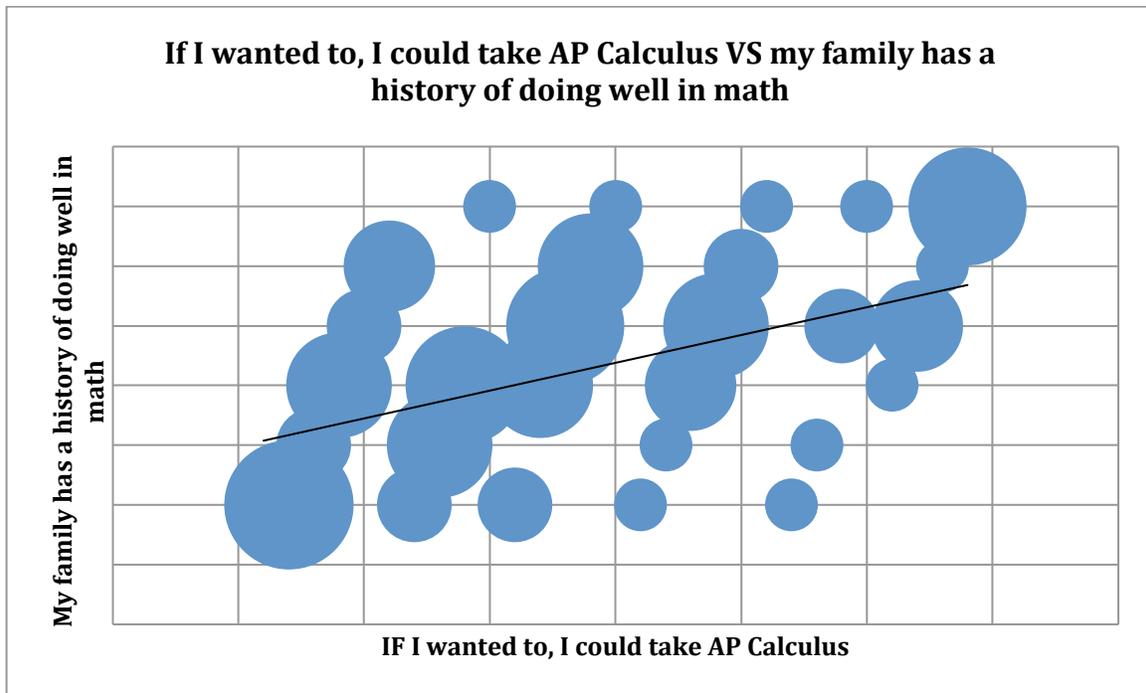
Home Goals/Support (positive effect):

I found multiple pieces of evidence to indicate that having a strong, supportive, goal-oriented family supports a student's ability to access AP Calculus. In addition to having a strong income (see pg 12) students showed a positive correlation when I compared the likert scores of their responses to the questions: "I plan to take AP Calculus" and "adults in my family have told me what a good math student I am." This can be seen in the graph below.



The size of the bubble is proportional to the number of responses for that specific combination of values. The scores range from 1 to 6 with 1 being “very false” and 6 being “very true.” I plotted the trend line of this data and it has a positive correlation coefficient of 0.1612.

Using the same data from the questionnaire, I compared the responses to the questions: “If I wanted to, I could take AP Calculus” and “my family has a history of doing well in math.” I found similar results.



This time the correlation coefficient was 0.2128.

My interviews supported the idea as well. Student “A” who is an 18 year old Somali girl currently enrolled in one of my AP Calculus courses said: “My parents really want me to be a pharmacist. I need a lot of math to be a pharmacist.” This shows me that she has parents who have set high goals for her and showed her what is required of her to meet these goals. Student “B” who is a 17 year old Iraqi boy currently enrolled in my AP Calculus class said, “My mom was a Bio teacher in Iraq. My family feels very strongly that education is important. I want to make them proud.” Again, this student tells me that his family has a history of valuing education and has instilled a sense of duty and obligation to meet their goals. Finally the 3rd student I interviewed, student “C”, is another student from Somalia who graduated from the high school in which I teach last year. He said, “My mother was mathematically inclined so I had a good support system there, but there was a language barrier that prevented full support. In high school there

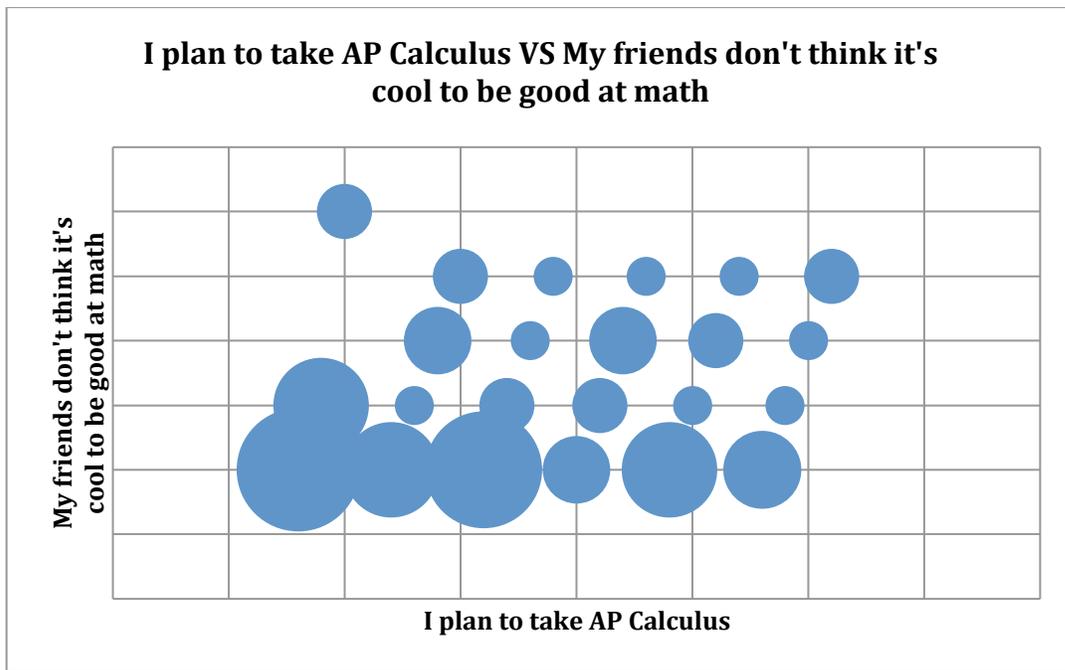
17 Barriers to AP Calculus

was the obvious goal for me of going to college and being successful.” All three of these students attributed (at least in part) their ability and desire to take AP Calculus to their parents.

Sub-Question 2: What is the role of peer pressure in a student choosing whether or not to take AP Calculus?

Peer Pressure (often no effect):

Most of my research found that a student’s perception of their peer’s thoughts and feelings had little or no effect on what classes they wanted to take. One example of this is visualized in the chart below.



While there was almost no positive correlation here, we can see that most of the responses for students who “plan to take AP Calculus” are clustered in the False side of the answers to “my friends don’t think it’s cool to be good at math.” I like the idea that even if we didn’t compare the results from “my friends don’t think it’s cool to be good at

18 Barriers to AP Calculus

math” to planning on taking AP Calculus, we still see the same result: students generally don’t care what their friends think about what classes they take.

Two out of the three students I interviewed agreed with the questionnaire results. Student A actually laughed at the question about peer pressure and heartily disagreed that her friends thought it wasn’t cool to be good at math. Student B said, “No. My social network pushed me to be in these clubs and be a part of the school. Once I did that I felt more comfortable and confident to be more involved.” However, Student C said passionately:

From my perspective (peer pressure) played a negative role; students come from middle school wanting to stick with their same groups and not fleeing the mentality of the group. In my case, the group believed that it is more beneficial to take CP classes, graduate, and look for local college opportunities. I'm not saying that is a bad plan for a singular person, but when it becomes the systematic fate of an entire section of the school (mainly low-income students and immigrants), it becomes dangerous.

These results lead me to believe that the effect peer pressure has on a student is dependent on their specific group of friends.

Limitations

In discussing the findings of my research, it’s important to note the obstacles and barriers I faced *myself* when conducting this study. The biggest of these was the difficulty in finding people able and willing to be interviewed. I had a limited timeframe in which to work and busy schedules combined with a certain amount of apathy on the part of the potential interviewees made for a smaller pool. I was never able to meet with an 8th grade teacher about the transition to high school and therefore couldn’t include the

19 Barriers to AP Calculus

method that 8th grade teachers, guidance counselors, and students use to select placement of a 9th grade math class.

In addition to the interviewees I had an overwhelming amount of quantitative data to sort through. Guidance provided an enormous amount of data for demographics and I worry that I would have been able to make more findings if I had more time and skill to sort through it.

I was also faced with the fact that data on ELL is often unreliable. This is primarily because families who are new to the district often specifically say that English is the primary language spoken at home to avoid being labeled as ELL and be placed into the aforementioned classes. At both times, this strengthens my findings by showing that the ELL families themselves see the limiting nature of these classes and weakens my findings by not having entirely reliable figures.

Recommendations and Implications:

I've thought about the implications for my findings as belonging in two categories: implications for my own practice and implications for future research. I'll start with my recommendations for my own practice.

All of my results were not entirely conclusive. However, I feel like there are some things I can do right now to mitigate some of these barriers. The first comes from the observation that family supports in the form of goals and pressure to meet those goals have a very positive effect on a student's education. It is very important to work to build supportive math communities, tutoring groups, and college information support for families whose first language is not English. I'm already working with a student who put

20 Barriers to AP Calculus

forth the idea for ELL tutoring groups where students who speak the same language get paired up to support each other with their studies.

I also think it should be a primary focus of the math department to avoid placing students in the ELL Math Foundations course whenever possible and to transition students out of that class as quickly as possible. Not only do the data support the limiting nature of this class but the interview I conducted with the other math teacher reinforces that theory.

Finally, we should continue to do the work of helping students set high goals for themselves. Students in high school should be working to push themselves to constantly be better than they were. We need to set an expectation of high standards and ensure that students have the scaffolding in place to meet these goals. These goals should come from the school *and* from home. This was the single most important factor I uncovered in my research and it's necessary to promote this.

Since my findings were not entirely conclusive I must also recommend further research. Some of my findings were conflicting and some were inconclusive. I would recommend further narrowing of focus to eliminate more variables in the study. A study on the effect of home economics (where feasible) would be my first place to start. While I would narrow the focus of the guiding question I would broaden the scope of the research to include other successful and not so successful districts in the surrounding area. This would increase the variety of data and add further strength to the findings.

Summary and Reflection

Throughout this journey/investigation I have learned a tremendous amount about myself, my practice, my students, and the factors for success in reaching AP Calculus. I

21 Barriers to AP Calculus

have been struck by the honesty of the participants and the effect of these analyzed factors on their choice to access or not to access AP Calculus. I never imagined that there would be a clear “answer” to my guiding question, but I did hope that it would have been slightly more definitive.

I am happy to have developed and used the skill of action research. It gives me great power over influencing decisions at the district level. Very often teachers with whom I work will have ideas for how to make things better but all too often we don't have the research to back those statements up. I know feel comfortable conducting my own research on which I can base pedagogical decisions. Through continued iteration I will refine my practice in a effort to better meet a more diverse student body's needs.

As a Calculus teacher, I can't help but think of a mathematical analogy for this process. I think of my growth through using this process as a limit problem. A simple of example of which is that I walk halfway to the wall, then half the remaining distance, then half the remaining distance, and so on forever. I never stop getting closer to the wall, but I never get to the wall either. The wall would be pedagogical perfection. It's simply unobtainable. However, I will never stop trying to improve myself through the iterative process and therefore I will never stop getting closer to that wall.

Sources

- * Portland Public Schools, (2015). Multilingual intake history: Fourteen-year ELL enrolment. Retrieved from http://mlc.portlandschools.org/about/demographic_data Oct. 16, 2015.
- * Walker, E. (n.d.). Why aren't more minorities taking advanced math? *Educational Leadership*, 65(3), 48-53. doi:November 2007
- * Broad, E. (2013, August 1). Road to equity: expanding AP access and success for african-american students. Retrieved September 21, 2015.
- * Kanno, Y., & Kangas, S. E. (2014). "I'm Not Going to Be, Like, for the AP" english language learners' limited access to advanced college-preparatory courses in high school. *American Educational Research Journal*, 0002831214544716.
- * Solorzano, D. G., & Ornelas, A. (2004). A critical race analysis of Latina/o and African American advanced placement enrollment in public high schools. *The High School Journal*, 87(3), 15-26.
- * Matthews, M., & Farmer, J. (n.d.). Factors affecting the academic achievement of academically talented learners. *Journal of Advanced Academics*, 19(3), 472-501. doi:spring 2008
- * 2013 college bound seniors total group profile report. (2013). Retrieved December 1, 2015, from <http://media.collegeboard.com/digitalServices/pdf/research/2013/TotalGroup-2013.pdf>