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Brianna Louvier
bml14a@acu.edu

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Exceptional Mathematics Teachers: What the Learners Think

Brianna Louvier

Abilene Christian University

Abstract

The purpose of this study was to determine high school learners' perceptions of what makes an exceptional mathematics teacher. The author was a pre-service teacher serving her clinical teaching internship in a high school mathematics classroom in which Precalculus, Pre-AP Precalculus, and AP Calculus were taught. For this study, data was collected through a student survey, one-on-one interviews, and focus group interviews with students. The data was analyzed using the constant comparative method. Four major themes emerged from the data, including the significance of a teacher's attitude, the importance of a teacher's desire to help and teach learners, whether or not a teacher teaches well, and how well teachers know their learners and have relationships with them.

Exceptional Mathematics Teachers: What the Learners Think

“He was a terrible teacher!” exclaimed Mallory (all names have been replaced with pseudonyms). “We barely took notes, he was the worst at explaining things, and he was just flat out rude to us!” This conversation occurred on a typical morning during mine and my co-teacher’s second period planning time, in which we had four learners in the room. The learners were discussing one of their previous mathematics teachers, whom they all agreed was not a good teacher. They were quick to discuss why they thought he was so bad, but what about their good teachers? What qualities does an individual have to possess in order to be an exceptional mathematics teacher?

Purpose

The purpose of this study was to determine learners’ perceptions of what makes an exceptional mathematics teacher. In other words, I wanted to know what learners think in regards to exceptionality, mathematics teachers, and the intersection of the two. This study expands on the research on this topic, as it focuses specifically on high school learners’ perceptions of mathematics teachers in the United States. This study aimed to answer the following research question:

What are the perceptions of the learners in Ms. Anderson’s classes at Victory High School in regards to what makes an exceptional mathematics teacher?

At the time of the research, I was a student in a graduate program and had a year-long co-teaching placement in a high school mathematics classroom at Victory High School. The classes my co-teacher and I taught included Precalculus, Pre-AP Precalculus, and AP Calculus. Our learners were in eleventh and twelfth grade, and we had approximately 80 learners total in

our classes. Victory High School is located on the north side of a small west Texas town, with a population of around 123,000 people. Victory High School is one of four high schools located in the town, and is the only Science, Technology, Engineering, and Mathematics (STEM) focused school. There were about 400 learners enrolled at Victory High School, making it the smallest high school in the town. The student body of Victory High School is represented by 0.6% American Indian or Alaskan Native, 3.8% Asian American, 5% African American, 35.6% Hispanic/Latino, 52.1% Caucasian, and 2.8% two or more races. About 44.2% of the Victory High School population is economically disadvantaged, and the school itself has claimed to be a Title I school. Additionally, 3.8% are English Learners (EL), and 3.5% are considered special education. For the purpose of this study, only six classes total, covering three subject areas, served as participants.

Literature Review

After a child's close family, teachers are often the most influential adults in their lives (Ernest, 2019). Everyone in the world has had a teacher of some sort at various points in their lives, whether that be a parent, public school educator, or a mentor. As a result, teachers play a major role in the lives of children. Teachers of children who attend public schools play an especially important role in their lives, as they can spend up to 40 hours a week with the children in their classrooms. In other words, teachers matter. Ripley (2010) stated teachers mattering is, "...[the] most stunning finding to come out of education research in the past decade: more than any other variable in education-more than schools or curriculum..." (p. 2). Furthermore, the majority of individuals who have attended school have a favorite teacher. Very rarely, however, do individuals, especially at the secondary level, say that mathematics is their favorite subject, or

that mathematics teachers are their favorite teachers (Farooq & Shah, 2008; Midgley, Feldlaufer, & Eccles, 1989).

Even so, both the presence and the importance of mathematics is growing in high schools in America (Zinth, 2008). As a result, learners are required to take a greater number of mathematics courses throughout their education than in years past. Not only is mathematics growing more prominent in high schools, but it is also growing throughout the world. More and more learners are required to take mathematics courses in order to better prepare them for the world as it becomes more outwardly mathematical; thus, not only do teachers matter, but more specifically, mathematics teachers matter. It is because of this that it is imperative that mathematics educators strive for exceptionality in the classroom.

How educators, especially mathematics educators, reach and maintain exceptionality varies according to different researchers; however, most researchers agree that educators must take some action in order to be exceptional at what they do. In a study conducted by Akbas, Cancan, and Kiliç (2019), they found that content knowledge alone is not enough to make mathematics teachers exceptional at what they do. Exceptional mathematics teachers are so much more than experts in their field, but what exactly is it that differentiates between bad, average, and exceptional teachers of mathematics? In their study, Wilson, Cooney, and Stinson (2005) stated, "...mathematics teachers needed to have an extensive knowledge of both mathematics and their students in order to teach well" (p. 91). In other words, content knowledge combined with a relationship with the learners in the classroom leads to good teaching. Additionally, Wilson, et al. (2005) discussed how experience and the ability to make connections between mathematics and the world are vital aspects of what makes up a great teacher.

A lack of teaching experience, however, does not necessarily mean that novice teachers cannot reach exceptionality. Paape (2018) argued that the implementation of the National Council of Teachers of Mathematics' (NCTM) Eight Effective Practices (National Council of Teachers of Mathematics, 2014) (see Appendix A) is what makes a mathematics educator a good teacher. Others (Wilkinson, 2018; Mhakure, 2019; Wilson, et al., 2005; Liang, Mira, Prasad, & Patterson, 2019) have argued that educators conducting research is what makes them better at what they do. The specific types of research that these authors discussed in their studies came in the form of action research (Wilkinson, 2018), Lesson Studies (Mhakure, 2019), reflecting on their own practice and observing other educators (Wilson, et al., 2005), and teaching research to others (Liang, et al., 2019). On another side of the spectrum, Ernest (2019) argued that it is an educator's code of ethics that sets apart an exceptional mathematics teacher. In other words, the way that educators treat and think about learners has a big impact on their effectiveness in the classroom.

Research has been conducted on the perceptions of other educators and practitioners regarding what makes an exceptional mathematics teacher (Even, 2011; Wilson, et al., 2005). While the thoughts of these individuals is important, it is the learners' perceptions that I am striving to determine. Although minimal, there has been some research conducted on learners' perceptions of what makes an exceptional mathematics teacher. Akbas, et al. (2019) studied what 40 fifth through eighth graders in Turkey thought were qualifications of effective mathematics educators. They found that personal traits such as fairness and mercy, respectful attitudes toward learners, the ways in which lessons are taught, and providing feedback are the main qualifications of what makes an effective mathematics teacher. Similarly, Williams, Sullivan,

and Kohn (2012) found that secondary students in Texas believed that a friendly and caring attitude, enjoyment and knowledge of the subject and how to teach it, and good classroom management skills were characteristics of outstanding teachers in any field. Unfortunately, however, there has been little research conducted on this topic in secondary schools in the United States. Additionally, there is little research highlighting high school learners' perceptions of this topic, even though learners' perceptions help determine how schools do business (Bernhardt, 2004).

Methods

The following describes the qualitative action research study I conducted in the context of a high school mathematics classroom. Specifically, the classes included Precalculus, Pre-AP Precalculus, and AP Calculus, and the learners were in either the eleventh or twelfth grade. I studied what the learners' in my year-long clinical teaching placement thought makes an exceptional mathematics teacher.

Participant Selection

The participants of this study included students at Victory High School who were taking Ms. Anderson's Pre-Calculus (39), Pre-AP Pre-Calculus (22), or AP Calculus (19) classes. The classes consisted of 50 boys and 30 girls. Six of the learners were African American, five were Asian American, 44 were Caucasian, and 25 were Hispanic. I sent home a parent information letter and consent form, and the students were asked to sign an assent form. Of the 80 students total, all who received parent permission and assent to the study participated. This was a total of 53 learners.

Data Collection

All student participants who provided consent and assent were given a survey (see Appendix B) about what makes an exceptional mathematics teacher. The survey consisted of five questions given on a Likert scale, and three open-ended questions. A random sample of learners who provided consent and assent were selected for interviews. The interviews were conducted both through focus groups and one-on-one interviews. The random sample was selected by numbering each participant, and using the random integer generator on a graphing calculator to select the 18 learners who would be interviewed. If a number was selected twice by the calculator, that number was disregarded the second time. The first six unique integers generated by the calculator were the six learners who were interviewed one-on-one, while the following 12 learners participated in the two focus group interviews. The one-on-one interviews (see Appendix C) lasted approximately ten to fifteen minutes. Upon completion of the one-on-one interviews, two focus group interviews (see Appendix D) lasting 20 to 30 minutes each were conducted, each with a different random sample of six learners from Ms. Anderson's classes. The interviews were semi-structured, with pre-planned but open-ended questions (Hendricks, 2017). The interviews were also audio-recorded and transcribed. Additional questions were asked depending on the responses of the participants.

Data Analysis

All of the qualitative data was analyzed using the constant comparative method, with initial coding followed by creating hierarchies of categories and supporting codes (Hubbard & Power, 2003). I began by analyzing 20% of all collected data, and created a list of 15 to 20 codes, known as level 1 codes (Tracy, 2013). Next, I used the 15 to 20 level 1 codes to code the remaining 80% of data. Then, I took the level 1 codes and synthesized them in order to create

level 2 codes that represented major themes from my findings within the data. After all of my data was coded, I created a codebook (see Appendix E) in order to define, organize, and analyze the created codes (Hendricks, 2017). In order to further reflect on my findings and the main themes that emerged from my data, I also wrote research memos for each of the level 2 codes (Tracy, 2013). The quantitative data from the learners' survey responses was analyzed using descriptive statistics. The data from the surveys, excluding the open-ended questions, was graphed on a series of scatter plots, one for each class period, as well as a summative scatter plot (Hendricks, 2017) (see Appendix F).

Findings

Upon completion of my data collection and analysis, the following four major themes emerged: the significance of a teacher's attitude, the importance of a teacher's desire to help and teach learners, whether or not a teacher teaches well, and how well teachers know their learners and have relationships with them. These major themes developed based on student survey responses, as well as individual and focus group interview responses.

Teacher Attitude

A teacher's attitude is something that directly shapes the classroom from the very first moment teachers and students come into contact with each other. The research participants reported that what a teacher says and how they behave at "Meet the Teacher" events and on the first day of school shows learners what to expect from the classroom. If teachers seem like they have better things to do than talk to a child and their family, the child is more likely to regret going to that class every day. In other words, first impressions matter. But, they are not the only thing that matters. As the year goes on and teachers and learners get to know each other, attitude

and behavior continue to be a vital aspect of the classroom. How teachers react when learners do not understand a concept, which students they spend most of their time looking at and talking to, and tone of voice can affect what learners think of their teachers and how they in turn will respond to both the teachers and the content in the classroom.

In regards to what makes an exceptional mathematics teacher, attitude is a defining factor between good and bad mathematics teachers. This topic appeared in the surveys countless times, and was discussed in the interviews over 30 times. The research participants reported that bad mathematics teachers are often rude to their learners, impatient when the learners struggle and have questions, have a dull or bland personality, radiate negative energy, and clearly show their biases against other students or groups of students. One participant stated in their survey that a bad mathematics teacher, "...laughs at students problems, or they are mean, rude, or very boring..." Data from other learners showed similar thoughts on bad mathematics educators, adding that they simply show that they "do not care" about the content or the learners and their ability to understand the content.

On the other hand, good mathematics teachers are kind to their learners and patient with them when they struggle and have questions. When asked what sets apart exceptional mathematics teachers from good mathematics teachers, learners stated that exceptional mathematics teachers are enthusiastic about being at school and show that they care about their learners and their ability to learn in the classroom. Other words used to describe exceptional mathematics teachers included compassionate, understanding, and encouraging. Additionally, exceptional mathematics teachers are able to cultivate a comfortable and welcoming learning environment in their classrooms. One learner described the best teacher he ever had stating, "The

way he talked to you was just...you feel comfortable, [you] feel at ease.” Everyone should feel comfortable and at ease in the classroom in order to ensure a safe and productive learning environment. One of the best ways to ensure that learners feel safe and comfortable in the classroom is to have a good attitude. Exceptional mathematics teachers excel at this due to their ability to remain compassionate, patient, enthusiastic, and encouraging. Learners also reported that the physical environment of an educator’s classroom can help make learners feel more comfortable and welcomed. According to the research participants’ responses to the surveys, 44 out of 53 learners stated that they could quickly tell the difference between good and bad mathematics teachers. This was also discussed in both the one-on-one and focus group interviews, in which a majority of the learners stated that a teacher’s attitude and the environment they cultivate in the classroom are ways in which learners can quickly tell what kind of experience they will have in the classroom with that particular teacher. Exceptional mathematics teachers are not only compassionate, patient, enthusiastic, and encouraging, but they also ensure that their environment aligns with their words and actions.

Desire to Help and Teach

As a pre-service teacher, I want to be a teacher partially due to my deep desire to help others love learning and love mathematics. I am always happy to help my learners when they have questions, are struggling to understand content, or have a deep understanding of the content and need to be extended. For some educators, however, this does not seem to be the case. The learners who participated in this research stated that they believed that many teachers may have come into teaching because they had nothing else that they wanted to do, or because they are experts in their field of content. While knowledge of content is important, learners reported that

exceptional mathematics teachers have a desire to teach and help their learners. In fact, a teacher's desire to help and teach appeared over 30 times in both the surveys and the interviews. During the first focus group interview, Connor commented on what makes an exceptional mathematics teacher. He stated, "...the willingness to help students, because if the teacher isn't necessarily willing to help the students understand the concepts, they aren't really teaching them anything." In other words, if teachers are not willing to sit down and help their learners with their content, then the students are not really learning and retaining it.

Exceptional mathematics teachers are not just willing to help their learners, but they are willing to do so at any and all times. They are happy to help outside of a learners' designated class time, such as before school, after school, during planning periods, during lunch, or during other class periods in which the same content is being taught. In his one-on-one interview, Knox described one of his exceptional mathematics teachers as follows: "...[the] teacher's like so helpful, she stays with me after school...or helps me out with all that stuff..." He continued, stating that exceptional mathematics teachers will also, "sit with you so you fully understand anything, everything." Taking time out of the day to help learners shows them that their teacher truly cares about what they are learning, and that the teachers, as a result, also care about their teaching.

Enthusiasm to teach is also a vital characteristic of exceptional teachers. The learners reported that exceptional mathematics teachers are passionate and enthusiastic not only about mathematics, but also about teaching and learning in general. This enthusiasm is often then transported over to the learners in the classroom. One learner reported the following in regards to exceptional mathematics teachers:

They have to be passionate about their subject in order for the students to be passionate about that subject, because they're not going to follow someone who's just going over it and doesn't have any passion for it. If you have passion, others will follow your path.

Not only is a passion for a specific content area important, but if a teacher is not enthusiastic about being at school in general, then the learners are less likely to be enthusiastic about being there as well. Similarly, if it is obvious that a teacher is not happy to be teaching that day, then the students will not be happy about learning content from them. As a result, it is vital that educators remain encouraged and passionate about their jobs as educators, as well as their content fields.

The desire to help and teach is a key element of what makes an exceptional mathematics teacher. If a teacher does not want to help their learners understand content, then the learners will not be receptive to listening to what the teacher has to say, nor will they be willing to learn the content themselves. In other words, if a teacher does not want to help their learners understand the content they are teaching them, then it is highly unlikely that the learners will put forth the effort to try to learn the content.

Teaches Well

“Teaches well” was a phrase that appeared a number of times throughout my research. Over and over again in the learners' surveys, they stated that exceptional mathematics teachers teach well, or that certain teachers are exceptional because of the manner in which they teach. “Teaches well” was such a broad term; therefore, it was necessary that it receive a more in depth exploration during the one-on-one and focus group interviews. While a number of themes recurred throughout the surveys that I believed to be qualities of someone who teaches well, I

wanted to know what the learners thought about this. Throughout the interviews, the learners gave an overall definition of a teacher that teaches well as someone who is able to help learners understand and retain the content. In the second focus group interview, Cece stated the following:

I think all the teachers that I've had at Victory are exceptional because I've actually like learned and like it sounds weird, but I have actually been able to retain information and regurgitate it or recreate what I've learned, and that's not a first for me, but that just proves to me that I know I'm learning things.

In other words, Cece knew that her teachers were exceptional at what they do and that they taught her well because she was able to retain information and later relay it to others in multiple different ways.

The research also showed that learners believed that teachers who teach well have certain attributes and behave in certain ways. Specifically, the learners discussed that their teachers expressed the following attributes and behaviors: a knowledge and love of their content, deep and thorough explanations, constantly checking for understanding and not moving on too quickly, teaching engaging and fun lessons, relating the content to both the learners themselves as well as to the real-world as a whole, able to teach and explain concepts in multiple different ways, providing their learners with individual help and attention, being flexible and adaptable, balancing strong and weak learners, and consistency, organization, and preparedness. Some of these characteristics and behaviors are a part of most educators; however, the presence of each of these characteristics and behaviors is part of what makes an exceptional educator. In mathematics specifically, it is vital that teachers are able to provide thorough, step-by-step

explanations about mathematical processes. It is also important that educators check for understanding and explain those processes and concepts in a variety of ways in order to ensure that all learners understand the material.

The learners' use of the term "teaches well" is significant to what makes an exceptional mathematics teacher as it defines what is seemingly obvious. Exceptional mathematics teachers should be expected to teach well, but what that means was not entirely clear prior to conducting this research. "Teaches well" and the topics that define this term appeared over 150 times in the surveys and interviews, providing a better image of what this term means and its significance to exceptional mathematics education. Especially through the six individual and two focus group interviews, what the learners described as teaching well in their surveys became clear. To be an exceptional mathematics teacher, ensuring that the learners understand and retain information is vital. In order to do so, exceptional mathematics teachers must know their content well, and be able to explain it in multiple different ways through relevant, engaging, steady-paced lessons and activities, all while also checking for understanding, asking questions, and in turn also answering the learners' questions. If a mathematics teacher does not have all, or is not working on obtaining all of these qualities, they may not qualify as an exceptional mathematics teacher in the eyes of their learners.

Knows the Learners (Relationships)

One of the key defining factors that set apart exceptional mathematics teachers (and exceptional teachers in any content, really) from other teachers is the relationship that they have with their learners. This topic appeared 45 times throughout the interview process, and throughout a number of the learners' surveys. Exceptional mathematics teachers start off the

school year by getting to know their learners and establishing a relationship with them, rather than jumping right into direct instruction mathematics notes on the first day. They care about their students' lives, including what they do outside of school and in other classrooms, and they make an active effort to get to know their students outside of their individual classrooms. One learner, Tyler, stated the following:

Like we can have conversations with the majority of our teachers at Victory about things besides academics, like laughing and having a good time, playing games, things that are outside of school. It just helps make things more, uh, lively.

In other words, the educators Tyler mentioned are able to connect with their learners on both an academic and a personal level. In doing so, they are also able to learn about the needs of their learners both academically and personally.

Exceptional mathematics teachers always have the learners' academic needs in mind, and are able to meet those needs in whatever way necessary. Identifying learners' needs can be done through simply asking the learners, assessment, and observations. A number of the research participants stated that an exceptional mathematics teacher really pays attention to their learners. As a result, they see the little things about their learners. For example, they can identify what two learners may need to sit next to each other in class, or a specific area of struggle that a learner has from past mathematics classes. Not only are exceptional mathematics teachers able to identify their learners' needs and struggles, but they can also identify their strengths, and when to extend them or give them specific jobs.

Exceptional mathematics teachers also consistently work to improve their practice. In order to do so, it is imperative that teachers listen to their learners' needs, interests, and feedback.

In a focus group interview, the learners discussed how engaging in activities like the interview were ways in which educators could get to know their learners better and thus know how to best teach them. During this interview, Seth stated that being an exceptional mathematics teacher, “also could mean knowing each individual student and knowing each way they learn, and adapting to that so you can make one lesson including all these different kinds of learning techniques into one good lesson that everybody can understand.” Seth, along with a number of the other research participants, knew the importance of having an educator who keeps the needs of their learners in mind, rather than only thinking about what is most convenient or easiest for themselves. In order to do so, however, teachers have to take the time to get to know each of their learners.

Knowing learners is a significant part of being an exceptional teacher. Not only was it brought up a number of times by the learners, but they specifically described this quality as a key defining factor between good and exceptional mathematics educators. A teacher showing that they care and that they are interested in the lives of their learners is one of the first steps towards an appropriate student/teacher relationship in the classroom. That relationship can play a major role in how educators respond to their learners’ needs and interests, as well as how the learners respond to their teachers and their teaching. Having that relationship allows for more room for respect, grace, and hard work on both parties’ parts. Exceptional mathematics teachers, specifically, are able to cultivate these relationships with a variety of learners on campus, even those who are not in their classes and those who do not like mathematics. While a good mathematics teacher may have a good attitude, a desire to teach, and teach well, if they do not

have a good relationship with and know their learners well, they are not quite at the exceptional level.

Implications for Teachers

Individuals are often quick to point out the bad qualities and struggles that others face or possess. That is why it was so quick for my learners to discuss and describe the bad mathematics educators they have had. When they were asked to think about the good qualities of their teachers, specifically exceptional mathematics teachers, the learners often struggled to find the words they wanted to say—at least at first. After the first few minutes of the interviews, however, the participants often had a hard time refraining from naming quality after quality of exceptional teachers of mathematics. As a result of this study, the research participants benefited in a deeper understanding of the performance of their previous and current mathematics teachers. They also gained a better understanding of themselves as learners of mathematics, and the qualities that they think make up exceptional mathematics teachers.

By conducting this study, I am now able to better my practice as a mathematics educator. The findings of this study provide me with specific examples of how I can better my practice in order to ensure more efficient and effective student learning occurs in my classroom. This study is also important in the context of the high school mathematics classroom because teaching and learning is a vital part of life. Most of the research participants have been in a classroom for many years, and a number of them will continue to be learners either in college, as teachers themselves, or in other career fields. As a result, it was useful to them to analyze what makes an exceptional mathematics teacher. Furthermore, a teacher's job is to prepare students for successful futures. The results of this study may impact the way teachers go about teaching,

especially mathematics, in their classrooms. This study adds to the knowledge base of teachers by providing insight into the perceptions of secondary learners relating to what makes an exceptional mathematics teacher.

This study is also beneficial to the education community at large, as the findings showed qualities of exceptional educators in general, not only those with a focus in mathematics. In other words, all educators can have a good attitude, have a desire to help and teach, teach their content well, and truly know their learners. Out of the 53 research participants, 34 said that they strongly agreed to having an exceptional mathematics teacher, and 18 agreed. Only one learner disagreed with this statement. On the other hand, 10 learners strongly agreed, 24 agreed, 12 disagreed, and seven strongly disagreed with having a bad mathematics teacher throughout their time as learners. By pursuing exceptionality as educators, we can flip this spectrum and shrink the number of learners reporting that they have had bad mathematics teachers.

Although this study showed a number of valuable findings, there are still a variety of unanswered questions in need of addressing in future studies. In particular, I wonder how the age of the research participants affected the results. All of the participants were either juniors or seniors, meaning they ranged from 16 to 18 years old. As a result, they all have had a number of mathematics teachers throughout their time in school. Had the research participants been in elementary or middle school, I wonder how the results may have been different. I am also curious about whether the age of an educator and the years of experience teaching affects their effectiveness as an educator in the eyes of their learners. All of the mathematics teachers at Victory High School were either in their 20s or 30s, so all of the mathematics teachers that the research participants have had at the high school level were fairly young. Does being an older

teacher have an impact on how well an educator teaches? What about an older teacher who also has 15 or more years of experience? Further studies should be conducted on groups of learners from younger, and possibly older age groups, and their thoughts on the exceptionality of mathematics teachers who are both older (40 years old and older) and have 15 or more years of experience teaching mathematics.

While this study was conducted in a fairly typical public high school in America, it did not come without its limitations. Due to the fact that the school was one of four high schools in the district, had significantly fewer learners than the other schools, and the STEM nature of the school, the variety of potential research participants was smaller than if it had been conducted elsewhere. Every learner that wanted to attend that school had to meet a certain set of criteria, and if those criteria were not met then they were either not allowed to attend or continue attending the school. Specifically, learners had to apply to the school, while they could attend the other schools in the district without having to do so. In order to be accepted, the learners had to have a certain grade point average (GPA) and limited behavior referrals. Upon acceptance to the school, each student had to choose one of the two focus tracks offered; therefore, each learner who attended the school had a focus in either Information Technology (IT) or engineering, and each year they had to take a number of classes that corresponded to their chosen track. As a result, the school was stereotyped as the “nerd school,” by individuals in the town, including those who attended the school.

Even with this label, not everyone who attended the school considered themselves to be “nerds.” Another requirement of the school was that all learners at the school were required to take Precalculus in order to graduate. Because of this, even with the fact that the school had a

STEM focus, a number of the learners in my co-teacher's and my Precalculus classes struggled with mathematics. Had they not been at Victory, they probably would have never taken Precalculus. According to the survey data, when responding to the statement "I like mathematics", nine learners strongly disagreed, eight disagreed, 22 agreed, and 14 strongly agreed. In other words, while most of the research participants reported that they liked mathematics, 17 of them reported that they did not like it. Interview data also showed that even some learners who are good at mathematics do not like it, and vice versa. Additionally, a majority of the mathematics teachers at the school had either been nominated or won the district's "Mathematics Teacher of the Year" award at some point in their careers. Taking these three characteristics of the school (the STEM focus, Precalculus requirement, and district recognized mathematics teachers), the potential pool of research participants was limited, especially in regards to my topic of what makes an exceptional mathematics teacher. As a result, I cannot help but wonder how the results of this research would be different had it been conducted in a larger school with lower achieving learners. I would be interested to see how the results of a similar study conducted in a larger, inner-city public high school would differ from this study. Further studies should be conducted on this topic in order to determine whether the characteristics of what makes an exceptional mathematics teacher that were determined in this study are conducive to other studies in other locations as well.

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Appendix A

Effective Mathematics Teaching Practices

Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.

Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.

Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.

Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.

Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.

Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Appendix B

Mathematics Teachers Survey

Circle or shade the answer you think best describes you.

1. I have had an exceptional mathematics teacher.

Strongly Disagree	Disagree	Agree	Strongly Agree
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2. I have had a bad mathematics teacher.

Strongly Disagree	Disagree	Agree	Strongly Agree
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3. I can quickly tell the difference between good and bad mathematics teachers.

Strongly Disagree	Disagree	Agree	Strongly Agree
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4. My favorite teachers are typically mathematics teachers.

Strongly Disagree	Disagree	Agree	Strongly Agree
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5. I like mathematics.

Strongly Disagree	Disagree	Agree	Strongly Agree
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Write your response to the following:

6. Describe the best mathematics teacher you have ever had.

7. What makes an exceptional mathematics teacher?

8. What makes a bad mathematics teacher?

Appendix C
One-on-one Student Protocol

1. How would you define the word “best”?
2. Describe the best teacher that you have ever had.
3. Tell me about mathematics teachers (in general).
4. Describe the best mathematics teacher you have ever had.
5. What is the difference between good and bad mathematics teachers?
6. What do good and bad mathematics teachers have in common?
7. How can you quickly tell the difference between good and bad mathematics teachers?
8. How do you prefer to learn? (i.e., visual examples, projects, etc.)
9. How have teaching methods like Project Based Learning and Problem Based Learning played a part in your mathematics classes and your ability to learn mathematics?
10. Does having a good or bad mathematics teacher impact how much you learn in the classroom?
11. What sets apart good and great mathematics teachers?
12. What makes a great mathematics teacher?

Questions may vary, and additional questions may be asked depending on the answers of the participants.

Appendix D
Focus Group Student Protocol

1. How would you define the word “best”?
2. Describe the best teachers that you have ever had. What makes them the best?
3. Tell me about mathematics teachers (in general).
4. Describe the best mathematics teacher you have ever had. What makes them the best?
5. Compare and contrast good and bad mathematics teachers. What makes them different?
What do they have in common?
6. How can you quickly tell the difference between good and bad mathematics teachers?
7. Does having a good or bad mathematics teacher impact how much you learn in the classroom?
8. How have teaching methods like Project Based Learning and Problem Based Learning played a part in your mathematics classes and your ability to learn mathematics?
9. What sets apart good and great mathematics teachers?
10. What makes a great mathematics teacher?

Questions may vary, and additional questions may be asked depending on the answers of the participants.

Appendix E

Codebook

Color	Name	Level	Definition	Example
Dark purple	Engaging and fun lessons	I	The teacher creates lessons that keep the learners engaged and enjoying their learning.	“The best mathematics teacher makes learning engaging by combining it with games.”
Plum	Knows the learners (relationships)	II	The teacher knows their learners and works to have a relationship with them.	“Makes relationships with students.”
Violet-brown	Teacher attitude	II	The teacher has a positive, welcoming attitude. They are patient with and kind to their learners.	“She taught class enthusiastically and with joy. She was kind and understanding.”
Brown	Knowledge and love of content	I	Teachers are not only knowledgeable of their content, but they are also passionate about it.	“What makes an exceptional math teacher is if s/he knows the material well...”
Yellow	Desire to help and teach	II	Teachers want to teach their learners and have a desire to help them learn.	“...are always willing to work with them to help them better understand.”
Peach	Teaches well	II	The teacher is able to teach concepts in a way that the learners can remember the content.	“...is able to teach concepts in a way that makes them ‘click’ and stick.”
Grey	Deep explanations	I	The teacher provides thorough explanations of the content, sometimes explaining step by step processes.	“Explains in good detail by step.”

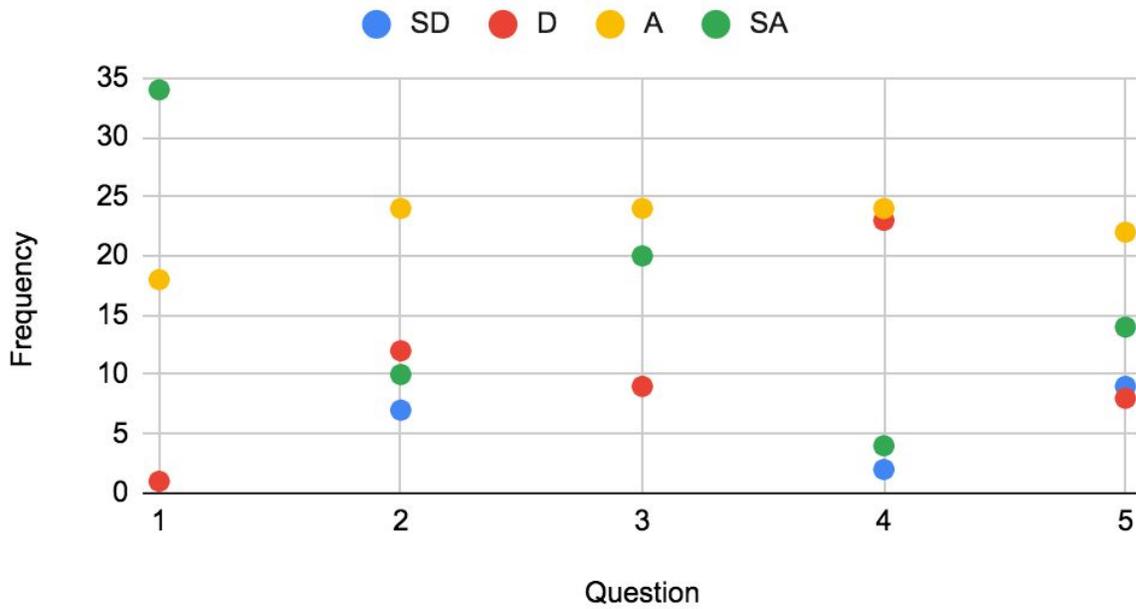
Pink	Checks for understanding and does not move on too quickly	I	The teacher assesses the learners' understanding. Pacing of the class is appropriate for the learners.	"...made sure I understood the process."
Red	Multiple ways of teaching	I	Teaching and learning are not shown in only one way. Teachers are able to teach and explain the same concept in a variety of ways.	"An exceptional math teacher is one who can explain things in more than one way."
Blue	Relevance and real-world content	I	Teachers are able to relate concepts to the real world. Content is relevant to the learners' lives.	"Exceptional math teachers make their class applicable to the real world."
Light blue	Individual help and attention	I	Teachers provide one-on-one help and attention.	"She would sit next to me and show me what to do, even sometimes reteach me the whole lesson."
Blue-green	Comfortable, welcoming environment	I	The teacher cultivates an environment in which the learners feel comfortable and welcome.	"...providing a space that is non-hostile."
Green	Flexible and adaptable	I	Teachers are flexible with the schedules, willing to change plans to best suit the learners' needs. They also adapt to those needs as appropriate.	"...adapt to the learning behavior of the class."
Green-yellow	Listens to feedback	I	Teachers listen to their learners and take their thoughts into	"My best mathematics teacher...listened to

			consideration.	her students so that she could adjust the class to improve it.”
Pink-violet	Consistency and organization	I	Teachers and their classrooms are consistent and organized. They typically follow a routine every day.	“She was very organized and funny.”
Purple	Pays attention	I	Teachers pay attention to their learners and see the little things that they may need help with.	“I believe an exceptional math teacher knows the student’s strong suits and weaknesses in math.”
Lavender	Balances strong and weak learners	I	Teachers are able to teach all of the learners in their classroom at the same time. They can balance the learners who are strong in math, as well as those who struggle with it.	“My best math teachers are able to balance both the kids who are strong in math, and those who are not.”

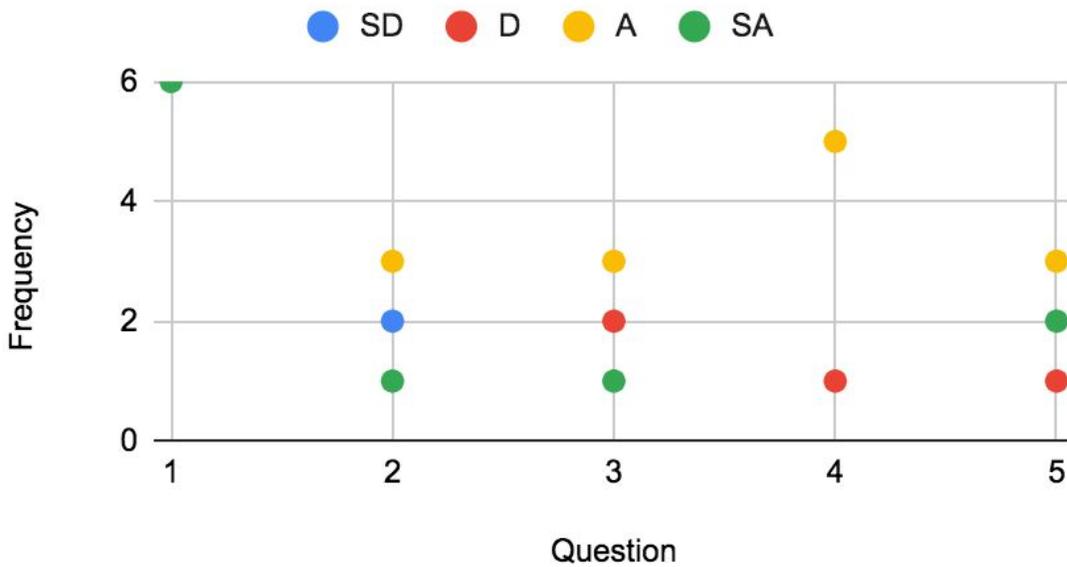
Appendix F

Scatter Plots

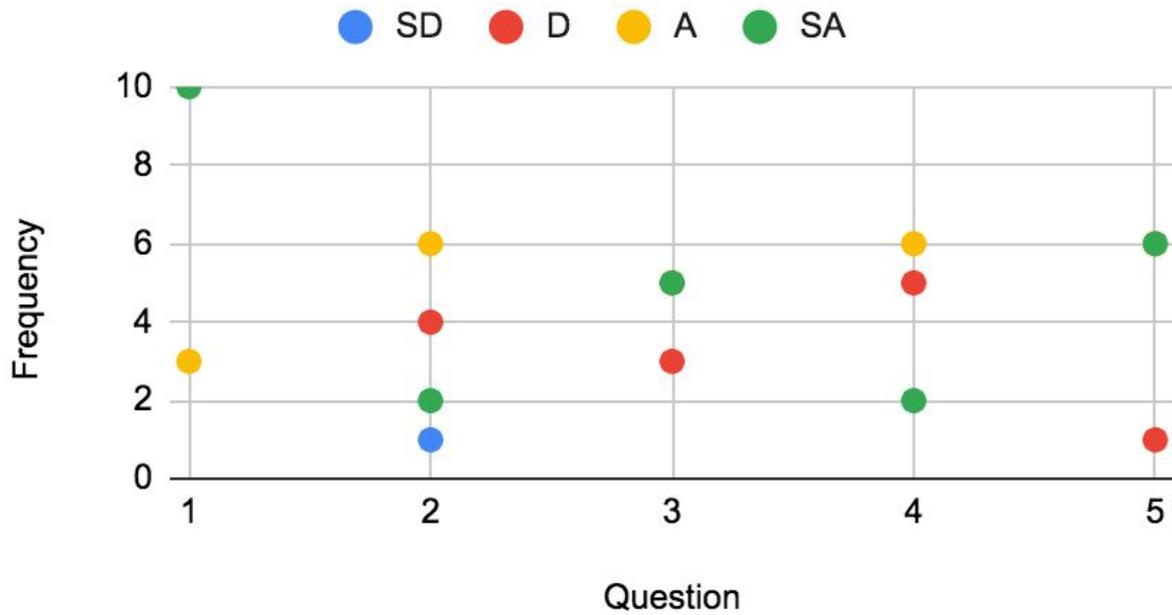
Summative Survey Results



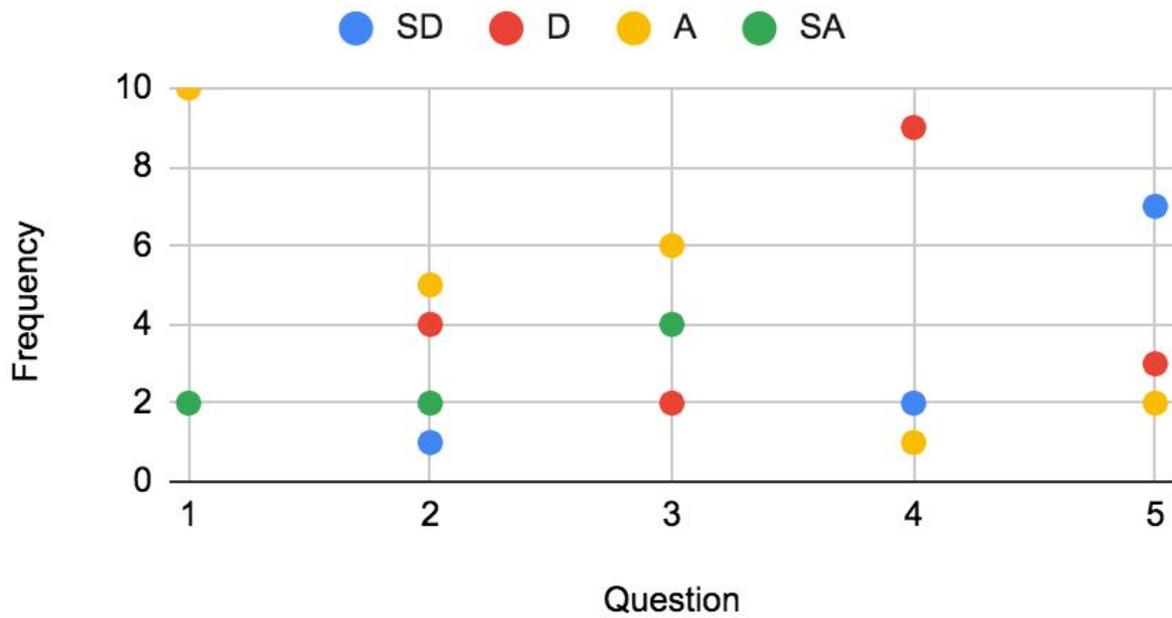
1st Period Survey Data



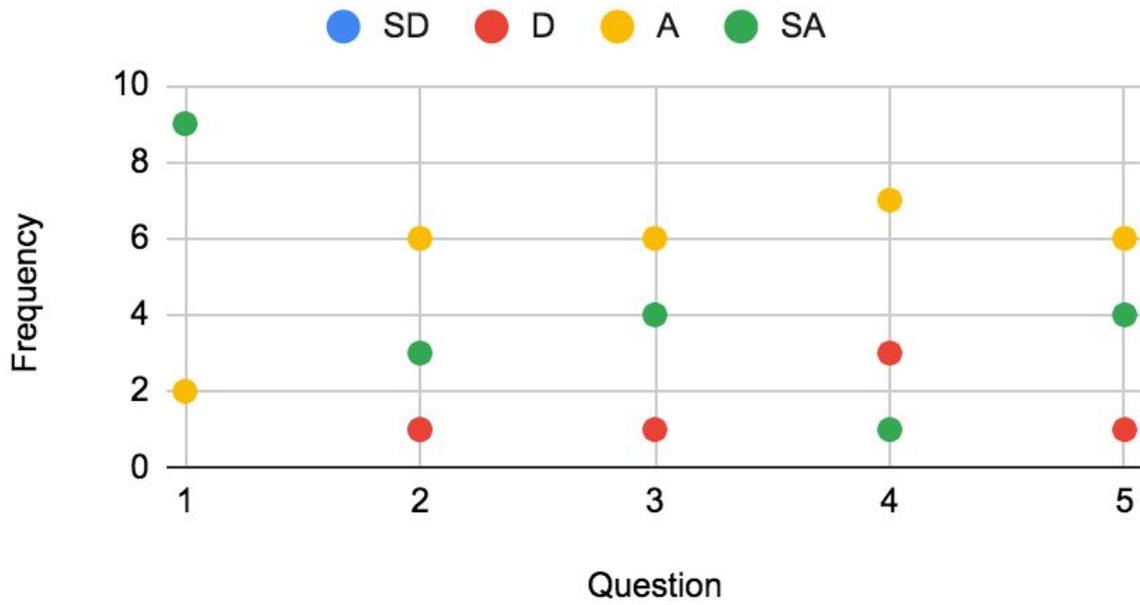
3rd Period Survey Data



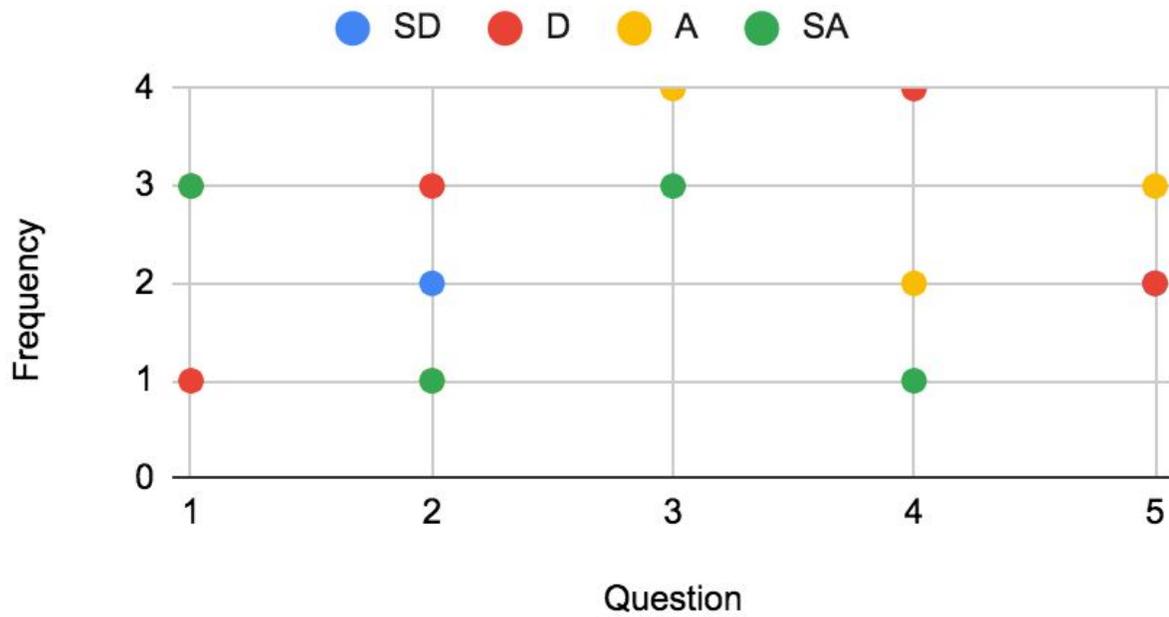
4th Period Survey Data



5th Period Survey Data



6th Period Survey Data



7th Period Survey Data

