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Growth vs. Fixed Mindsets in College Mathematics Education

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Growth vs. Fixed Mindsets in College Mathematics Education: Math Professors and their Perceptions of Student Math Abilities

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Abstract

The purpose of this research is to investigate the relationship between college mathematics professors and whether they have a growth or fixed mindset towards the students in their classrooms. This paper will share the results from a survey that was constructed with 38 participants - all of which are college mathematics professors in the state of Ohio. This survey focused on asking questions that would relate the professors to either having growth or fixed mindset traits. The survey also asked for the demographics of the participants, which helped classify similarities between those with growth or fixed mindset ideals. After analyzing the survey results and the demographics, the results show those with fixed mindset ideals are more likely to be 51 years old or older and those with growth mindset ideals are more likely to be 50 years old or younger. This draws a very generalized correlation between the age of college mathematics professors and their mindset towards the students in their classrooms.

Introduction

Teaching mathematics is more than teaching about functions, shapes, numbers, and so on. Teaching mathematics is about the ability to teach logic and reasoning behind one person's thoughts and ideas. Now, teaching these thoughts and ideas varies from one educator to another and from one subject to another. Educators have vastly different beliefs about how to teach their students and what they perceive their students can learn. This research project is inspired by those educators' beliefs of teaching and perceptions of their students' learning abilities. That inspiration sparked the idea of wanting to know if there is any relationship between college professors and whether they have a growth mindset or a fixed mindset. I wanted to be able to quantify data to demonstrate that growth mindset and fixed mindset ideals are represented at any level of education. This could develop further studies on how to eliminate fixed mindset ideals in higher education to help ensure college students are receiving the best possibilities to be successful in a college classroom. The main focus of the study is on college mathematics professors because mathematics is one of the most difficult subjects to learn and a great deal of studies of growth mindsets within students revolves around them learning mathematics.

The beliefs and perceptions of one person's learning abilities are often classified under two categories of mindset - growth mindset and fixed mindset. The terms growth mindset and fixed mindset were developed by psychologist Carol Dweck. According to Dweck, "in a fixed mindset students believe their basic abilities, their intelligence, their talents, are just fixed traits. Whereas in a growth mindset students understand that their talents and abilities can be developed through effort, good teaching, and persistence" (Heggart 2015). Although having a growth mindset or a fixed mindset is often talked about in the context of a student, educators can be classified as having a growth mindset or a fixed mindset. Educators are the main contributor to whether a student possesses a growth mindset or a fixed mindset. Educators often misuse the strategies of implementing growth mindset ideals in their classroom. These misuses may include praising effort rather than offering feedback to improve performance (Renwick 2016). The intentions of this project are to develop an understanding of how professors at the college level implement growth mindset ideals in their classrooms and if they perceive their students can be successful in learning mathematics.

The common mistake educators make in the classroom is using the wrong verbiage with their students. Those educators with growth mindset ideals should say phrases that encourage students and do not damage their confidence. Growth mindsets are developed if students are willing to try new strategies and seek input from others when they are stuck. Educators should try to practice saying things like “The point isn’t to get it all right away. The point is to grow your understanding step by step. What can you try next?” Those with a fixed mindset will think they are being encouraged, when in reality they are being damaged to the student by only praising their efforts. An example of what not to say to a student is “Don’t worry, you’ll get it if you keep trying.” This may be encouraging for a little while, but if students are using the wrong strategies to learn and be successful in the classroom, their efforts might not work (Dweck 2015). It is important that educators do their best to implement growth mindset beliefs because “learners with a growth mindset tend to embrace lifelong learning and the joy of incremental personal growth. In addition, they do not see their intelligence or personality as fixed traits. They will mobilize their learning resources without being defeated by the threat of failure” (Ng 2018).

Educators are some of the most influential people in society because of the amount of time they spend with young people on a daily basis. With that being said, the beliefs educators hold either positively or negatively affect their students understanding of success and failure. If an educator has a fixed mindset ideal, then they most likely dread failure because they feel it reflects badly upon themselves as an individual (Heggart 2015). Being afraid of failure limits a person's potential in achieving success in learning. Students who cannot embrace a challenge in learning are less likely to have a growth mindset. Now, those students who welcome challenges and are more resilient in the face of failure are more likely to have a growth mindset and learn more effectively (Boaler 2013).

Failure is a major aspect of learning because mistakes foster growth in the brain. In learning material in difficult subjects like mathematics, students often feel down on themselves when they make a mistake because these students are being raised in a performance culture and are not taught the value of learning from mistakes (Boaler 2016). Students at the collegiate level often feel the pressure of performing well and standing out from the rest of their peers. This pressure is brought on by outside factors like a student's family and friends. Now, these students may not receive the support and encouragement in the classroom from their professors, which could raise their stress levels. Thus, if professors are able to instill growth mindset beliefs in their classrooms, they would not only be helping the academic success of their students, but they would also be helping the mental health of their students.

Developing growth mindsets in all classrooms, especially those classrooms where mathematics is the main center of focus, can increase the student's learning and knowledge of the subject. Mathematics educators that showcase growth mindset beliefs see an increase in student success in their classrooms. These educators often teach math conceptually and reiterate mindset encouragement that is helpful to the student. These educators also present mathematics as "an open landscape" that students can explore rather than a "closed, fixed body of knowledge" (Boaler 2016). In doing this, these educators must be able to have time for self-reflection on their teaching, present their students with formative feedback, and have the ability to create space for new ideas and make mistakes (Heggart 2015).

Review of Literature

Findings and research in growth mindsets vs. fixed mindset has helped revolutionize education in the 21st century. A study in 2008 by Carol Dweck explained the findings on how students' mindsets play a crucial role in their learning abilities with mathematics. She presented research for readers that shows how mindsets can predict math achievement over time, why mindsets can contribute to math achievement discrepancies for women and minorities, what interventions change mindsets to boost achievement and reduce achievement discrepancies, and how educators play a key role in shaping students' mindsets. Dweck explained that students who believe that they are not capable of learning or being successful in mathematics are associated with having a fixed mindset and this mindset puts those students at a significant disadvantage compared to other students who have a growth mindset, which are those students who believe that they are capable of learning and being successful in mathematics.

In 2018, Dweck revisited the concepts and theories behind the growth mindset and expanded on the research from years prior. She explained what educators can do to implement growth mindsets within their classrooms. She wanted the readers to know about the "common pitfalls, the misunderstandings, and what to do about them." Dweck emphasized that the growth mindset is not just about effort, but also about how students seek new strategies and gather input from others when they are stuck. She makes it a point that effort is not enough, but rather a collection of approaches to conquering challenges is what will help students improve and learn. Students are often praised for their effort, but not their learning, where the growth mindset approach should make students strive to seek and challenges and conquer setbacks on their journey to learning the material before them.

Research has been brought forth that there may be a relationship between certain brain functions when developing a growth mindset. Studies in 2013 by Jo Boaler explain the data and research for brain plasticity regarding growth mindset and how mindset messages can be communicated through classroom and grouping practices. In England, Boaler mentions that schooling practices are based off of assumptions that learning and thinking within a classroom is a fixed ability, which often hinder student success and cause inequality among the learning needs of students. Then in 2016, Boaler expands on the modern brain research to show how changes in instruction and parenting can change students' mathematical mindsets to be more growth mindset-oriented rather than fixed mindset-oriented.

Also, in 2016, Heggart dove deeper into how teachers and staff can develop a growth mindset. He reiterates the definitions and findings for the growth mindset vs. fixed mindset by Dweck, then examines how teachers might be able to explore growth mindsets and cultivate one of their own. In 2016, Renwick outlined how educators can help cultivate and promote growth mindsets within students. He explained that promoting a growth mindset can be achieved by creating an environment that sets everyone up for success, being clear about goals and what excellence looks like, offering feedback in a productive manner, and providing an authentic audience to display work. He emphasized the importance of how a growth mindset is about what educators do, rather than what they might say. Renwick explained that creating a growth mindset is about believing in one's actions and displaying them in day-to-day life. In 2018, Ng drew on the theories of growth mindset and intrinsic motivation by using methods and ideals found in neuroscience. Establishing a growth mindset to help foster intrinsic motivation through neural responses is examined, which helps explain the relationship between the growth mindset and intrinsic motivation. Ng states that “educating students about growth mindset and how they can improve their learning experience is a step toward increased intrinsic motivation in our society.” Ng suggests that if growth mindsets can be promoted within the classroom, then that can support the learning needs of individuals because they understand intelligence is malleable.

Methodology

To help find a relationship between college mathematics professors and whether they had a growth mindset or a fixed mindset, I conducted a survey. In this survey, I wanted answers to the following four questions - (1) Do college mathematics professors have more of a growth mindset or a fixed mindset? (2) What traits do professors with growth mindsets or fixed mindsets have in common? (3) What are the beliefs the professors hold when teaching mathematics? and (4) How does a professor in college mathematics education with a growth mindset or fixed mindset perceive the way their students are able to learn? The central goal of the survey was to develop an awareness of fixed mindsets in college mathematics education and its impact on students. The first objective was to collect and create a data set to determine how many college mathematics professors have a growth mindset or a fixed mindset. The second objective was to organize and present the data in a readable manner and connect it to the impact that fixed mindsets have on students in college mathematics education.

The survey was approved by the University of Akron Institutional Review Board (IRB protocol #20201010). The survey was to be distributed using The University of Akron’s Qualtrics system to college mathematics professors from the Midwest (Appendix A.2). The college professors were chosen from eight institutions - three of which are large, public/state institutions and the other five are small, private institutions. These selected institutions gave the researchers a diverse population of state institution professors and private institution professors. (**Table 5**).

After the consent form was signed (Appendix A.1), the professors could proceed to complete the survey in The University of Akron's Qualtrics system. The survey was comprised of a series of questions that directly correspond to having a growth mindset or a fixed mindset. The questions in the survey were slightly modified from their original version based off of the work from Carol Dweck (Mindset Quiz). The professors had to either strongly disagree, disagree, agree, or strongly agree to each question in the survey. Each question had a point value attached to it for only the researcher to know. When a professor had completed the survey, the researcher was able to add up the total point value for each professor and determine whether or not that professor has a growth mindset or a fixed mindset. For example, a question that is related to having a growth mindset will have a point value of 1 point for strongly disagree, 2 points for disagree, 3 points for agree, and 4 points for strongly agree (this points scale is the opposite for a question that is related to having a fixed mindset). The higher the point total a professor has, then the more likely the professor has a growth mindset.

Attached after the growth mindset and fixed mindset questions in the survey were two short answer questions for the professors to answer - (1) What makes a student accountable in your classroom and why do you believe that? and (2) How do you think your teaching style impacts your students and their learning? These short answer questions gave the researcher direct insight into how professors feel about how their students are learning and if they are capable of learning the material presented to them. These short answer questions also allowed the researcher to see how the professors think their students are learning based on their teaching strategies.

The end of the survey was where the professors would answer questions regarding their demographics. There were six questions regarding demographics - (1) What is your age?, (2) How long have you been teaching mathematics at the university level?, (3) Where is your college/university located?. (4) Define your college/university, (5) What is your current rank?, and (6) What is your gender? These demographic questions would help the researcher classify the survey results as to who is more likely to have a growth mindset or a fixed mindset and what traits are consistent with those who have a fixed mindset.

Data

Table 1. Results for the Growth Mindset vs. Fixed Mindset Survey Questions. 1 = Fixed Mindset, 2 = Fixed Mindset with Some Growth Mindset Ideals, 3 = Growth Mindset with Some Fixed Mindset Ideals, 4 = Growth Mindset, and Red = Did Not Answer.

Participant	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Participant
1	Yes, I give consent.	4	4	4	4	3	3	4	4	4	3	4	4	3	4	4	3	3	3	1
2	Yes, I give consent.	2	2	3	4	2	3	3	2	4	3	2	2	2	2	3	3	2	3	2
3	Yes, I give consent.	2	3	3	3	2	3	4	3	3	2	3	3	3	3	3	3	2	3	3
4	Yes, I give consent.	3	3	3	4	2	3	3	3	3	3	3	3	3	3	2	3	2	3	4
5	Yes, I give consent.	3	3		4	3	3	3	3	3	2	4	3	3	3	3	4		3	5
6	Yes, I give consent.	2	2	3	4	2	3	3	2	2	2	2	3	2	2	3	3	3	2	6
7	Yes, I give consent.	3	3	4	3	2	3	4	3	4	3	3	3	3	4	2	3	2	4	7
8	Yes, I give consent.	1	1	3	4	2	3	4	1	3	3	1	1	1	1	3	3	2	3	8
9	Yes, I give consent.	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	9
10	Yes, I give consent.	3	3	3	4	2	3	4	3	3	3	3	3	3	3	3	3	3	3	10
11	Yes, I give consent.	3	3		4	2	3	4	3	3	3	2		3		3	3		4	11
12	Yes, I give consent.	3	3	3	3	2	3	4	3	3	3	4	3	3	3	3	3	3	3	12
13	Yes, I give consent.	3	3	4	3	1	3	4	3	3	3	4	3	4	3	3	3	3	4	13
14	Yes, I give consent.	3	3	3	4	2	3	3	2	3	3	3	3	3	4	3	3	3	3	14
15	Yes, I give consent.	3	3	3	4	1	4	3	3	2	2	3	3	3	3	3	3	3	3	15
16	Yes, I give consent.	4	3	4	3	1	4	2	3	4	3	4	4	3	3	4	3	3	3	16
17	Yes, I give consent.																			17
18	Yes, I give consent.	3	3	4	3	3	3	3		4										18
19	Yes, I give consent.	2	2	4	4	2	4	4	2	3	3	3	3	2	2	3	3	2	3	19
20	Yes, I give consent.	2	3	2	4	3	3	4	2	3										20
21	Yes, I give consent.	4	3	4	3	2	3	4	3	4										21
22	Yes, I give consent.	3	3	3	3	2	3	3	3	3										22
23	Yes, I give consent.	2	2	3	3	1	3	4	3	3	3	3	3	2	3	3	3	2	3	23
24	Yes, I give consent.	2	2	3	3	2	3	3	2	3	2	3	2	2	2	2	2	3	3	24
25	Yes, I give consent.	3	2	2	2	2	3	3	3	3	1	3	3	2	2	3	3	2	3	25
26	Yes, I give consent.	4	4	4	4	2	2	4	4	4	3	4	4	4	4	4	4	3	4	26
27	Yes, I give consent.	4	3	4	3	2	3	4	3	3	2	4	3	3	3	4	3	2	4	27
28	Yes, I give consent.	3	3	4	4	2	3	4	4	3	3	4	4	4	4	4	3	4	4	28
29	Yes, I give consent.	3	2	4	2	2	3	3	3	3	2	3	3	3	3	3	3	3	2	29
30	Yes, I give consent.	4	1	4	4	2	3	3	3	4	2	4	3	3	4	3	3	3	3	30
31	Yes, I give consent.	4	4	4	4	3	4	4	4	4	3	3	4	4	4	4	3	3	3	31
32	Yes, I give consent.	4	3	4	4	2	3	3	3	3	4	4	4	4	4	2	4	3	3	32
33	Yes, I give consent.	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	33
34	Yes, I give consent.	3	3	4	4	2	3	4	3	3	3	3	4	4	3	4	4	4	3	34
35	Yes, I give consent.	3	4	4	3	2	3	4	4	4	2	3	4	4	4	4	4	3	2	35
36	Yes, I give consent.	4	4	4	4	2	3	4	4	3	2	4	4	4	4	3	4	3	3	36
37	Yes, I give consent.	4	3	3	4	2	3	4	3	3	3	3	3	3	4	4	3	3	3	37
38	Yes, I give consent.	4	4	4	2	2	3	4	2	4	3	3	4	3	3	3	3	4	2	38
	Average	3.1	2.9	3.4	3.5	2	3.1	3.5	2.9	3.24	2.7	3.18	3.19	3	3.13	3.15	3.15	2.81	3.06	

Table 2. Answers to the first short answer question for each participant.

Participant	Q20 What makes a student accountable in your classroom? Why do you believe that?
1	True interest in the subject. If they are not interested then they won't bother to learn
2	
3	I don't understand this question.
4	Self
5	
6	Evaluation
7	
8	Performance on homework and exams (and to a lesser extent for some students, not wanting to disappoint me).

9	
10	I assume that by accountable you mean they take responsibility for doing the work. In that case, I think it is a matter of upbringing; they learn responsibility at home.
11	Interest in mathematics. Trying to better themselves. Asking questions during class.
12	Being confident in their answers, being able to justify their approaches, and being able to produce examples on their own.
13	I have explicitly state, high expectations for all of my students, which I hope they internalize. I give feedback on assignments and assessments trying to push them to achieve this goal.
14	Students should be first accountable to themselves and, when appropriate, to their peers. Learning mathematics at the collegiate level is really a personal choice (which may be made for many reasons). But once that choice is made, it the student who needs to try to remain on track; it's my job to help with that through course structure, classroom routine, and personal support as needed.
15	I have a daily in-class assignment as well as a homework assignment due every other day.
16	One of the ways that students take hold of their learning is when they find values in the class lessons and activities. Intrinsic motivation among students can also be fostered when the math concepts are presented in a way that interest them. Productive difficulty and a growth mind set would help students persist and not giving up easily on difficult tasks.
17	
18	
19	
20	
21	
22	
23	Sorry, I don't really know what you mean by accountable. They must behave in a socially appropriate way otherwise they get unpleasant looks from other students and possibly a reprimand from me. They must do their work carefully, otherwise I will mark off points or ask them to re-do the work.
24	I do. I grade them.
25	Grades, because they're being judged.
26	
27	To be honest, I don't know what this question means. Sorry!
28	
29	Accountable to who and for what? Ultimately, their grade is what may hold them accountable if that is something they care about.
30	Class participation; Completing assignments on time; shows responsibility
31	they have to have motivation of why they are in the class.
32	I am not sure what you mean by "makes a student accountable" like encourages them to show up and participate or what exactly? I expect my college students to attend and engage in mathematics when in class because that is how one does and learns and self-assesses.
33	Doing their work and participating.
34	

35	Math is not learned by listening, it can only be learned by thinking and practicing. Very frequent short homework and quick assessments seem to make them learn much better. The longer a math concept stays in minds of students, the better they assimilate it. And thinking about something continuously for a long time goes a long way.
36	Although I don't believe I have control over a student's accountability, I think there are ways to engage student that increase accountability. From anecdotal evidence suggests to me students perform better with more structure. There are some students who are responsible regardless of the amount of structure I give them, but I can't speak to to what makes them that way.
37	Students must decide for themselves whether they are accountable in my class. I provide a number of routes for them to decide to be accountable such as interesting problems, homework, exams and grades, but in the end the student must decide whether they want to do the work of in-depth learning.
38	their peers, the course grade. if working with a grooup they do not want to appear as if they are not prepared. Of course theri grade is somenthign to many fcous on and not the learning.

Table 3. Answers to the second short answer question for each participant.

Participant	Q21 How do you think your teaching style impacts your students and their learning?
1	My teaching style is a huge component in their learning process. I need to create an environment where they don’t feel stigmatized while making mistakes but instead use the mistakes and learn from them
2	
3	By providing the scaffolding they need to engage in the material sufficiently to learn.
4	Make learning fun
5	
6	Positively
7	
8	I try to teach than how to do mathematics, not how to do tests. This benefits the students who want to learn, not merely get a grade.
9	
10	Tough question. I like to think that my positive attitude towards the potentiality of students to succeed gives them some courage to persevere.
11	They learn - mostly.
12	I tell students about topics that were difficult for me when I first encountered them. I try to show students the process I go through when I prove something for class: think about simple examples, think about the core idea that may be involved in the proof, then try to make the proof work. If it fails, then look at why and try to modify the proof. I try to show this process to students and not just a polished, succinct proof.
13	I hope my laidback, conversational approach helps student realize that learning is a continual process that anyone can undergo.

14	I like to believe that I model good practice, so that I hope that I instill some good technical habits. I also hope that I convey enthusiasm for the content and that the ideas we explore seem worthwhile and interesting. Motivating students is important.
15	I think it impacts those students that want to learn.
16	I believe in providing students resources and opportunities to learn, relearn, practice often, be available to help students so they have better chance to succeed. During the semesters, I often ask feedbacks from my students on my teaching and solicit them ways on how I can help improve their learning experience. Overall, students' feedback are very positive. My students know that I am available to help them succeed in my courses. I had a student from Cleveland area who served jail time for being a drug dealer. He is a cage boxer/fighter who was failing my math class til closed to mid semester. Once I invited this student to come chat with me, over the next several weeks, I was able to convince him that he could chanel his hard work and passion for boxing into learning and practicing math. He was willing to work hard with my help/ tutoring hours. When he believes he can understand and learn math with lots of practicing, he was able to catch up and thus he completed the course successfully.
17	
18	
19	
20	
21	
22	
23	I give partial credit and in some classes I explicitly require students to rewrite and rewrite their work until it is correct (or stop, with fewer than 100% of the points). This forces students to focus on learning all details, instead of just trying whatever comes to mind and moving on.
24	I can motivate them.
25	Yes
26	I use teamwork. They help each other learn and grow.
27	My philosophy is: everything I say or do matters very little. Everything students do matters quite a lot. So, I attempt to have them actively doing things as much as humanly possible. I think this trains them to be active participants in their own education process... but I can't prove that, of course.
28	
29	I'm not sure I believe it does.
30	interacitve lessons engage students
31	The math teaching should be easy to understand to all students no matter what their level is.
32	My teaching style aims to provide opportunities for students to develop their own conjectures, draft arguments/justifications for these conjectures, refine the conjecture or argument to make it more mathematically accurate or efficient, and communicate these ideas clearly to others. So this student-centered approach allows students to develop their own connections and understanding of the material, and become better critical thinkers.
33	Hopefully it impacts them in a positive way.
34	

35	In undergraduate classes I do assign a lot of homework, and get them to have very quick feedback. On the other hand, for graduate courses I don't assign much homework and ask them difficult questions and think about those. It turns out, that some students get interested and they work well, others don't gain much out of it in the end.
36	If it is engaging they care more about learning the material.
37	I attempt to provide a large number of problems which clarify and expand the concepts from my lectures.
38	I am always giving feedback, hopefully in a way the promotes students to go back a revisit their work. I always have students work together, complete pre-class work for most every class.

Table 4. Point totals and answers to each demographic question for each participant. Red = Did not answer each question. Green = Score indicates a growth mindset. Yellow = Score indicates a growth mindset with some fixed mindset ideals. Purple = Score indicates a fixed mindset with some growth mindset ideals.

Participant	Total Score	Questions Omitted	Points Possible	Percentage	Q22	Q23	Q24	Q25	Q26	Q27
1	65		72	90.28	41-50 years old	11-15 years	Suburban	State/Public University	Male	Professor
2	47		72	65.28	61+ years old	More than 30 years	Rural	Private University	Male	Professor
3	51		72	70.83	51-60 years old	More than 30 years	Rural	State/Public University	Female	Professor
4	52		72	72.22	51-60 years old	More than 30 years	Urban	Private University	Male	Instructor
5	50	2	64	78.13	51-60 years old	21-30 years	Suburban	State/Public University	Male	Professor
6	45		72	62.50	21-30 years old	Less than 5 years	Urban	State/Public University	Male	Assistant Professor
7	56		72	77.78	21-30 years old	Less than 5 years	Suburban	Private University	Rather not say	Instructor
8	40		72	55.56	61+ years old	More than 30 years	Urban	Private University	Male	Professor
9	52		72	72.22	61+ years old	More than 30 years	Urban	State/Public University	Male	Professor
10	55		72	76.39	61+ years old	More than 30 years	Urban	Private University	Male	Professor
11	43	4	56	76.79	51-60 years old	21-30 years	Urban	State/Public University	Male	Professor
12	55		72	76.39	41-50 years old	21-30 years	Rural	Private University	Male	Associate Professor
13	57		72	79.17	21-30 years old	5-10 years	Rural	Private University	Male	Assistant Professor
14	54		72	75.00	61+ years old	More than 30 years	Rural	Private University	Female	Professor
15	52		72	72.22	51-60 years old	21-30 years	Suburban	State/Public University	Female	Other
16	58		72	80.56	51-60 years old	21-30 years	Urban	State/Public University	Rather not say	Other
17	0	18	0	0.00						
18	26	10	32	81.25						
19	51		72	70.83						
20	26	9	36	72.22						
21	30	9	36	83.33						
22	26	9	36	72.22						
23	49		72	68.06	51-60 years old	21-30 years	Suburban	State/Public University	Male	Professor
24	44		72	61.11	61+ years old	More than 30 years	Urban	State/Public University	Male	Professor
25	45		72	62.50	51-60 years old	21-30 years	Rural	State/Public University	Rather not say	Associate Professor
26	66		72	91.67	31-40 years old	16-20 years	Suburban	Private University	Female	Associate Professor
27	57		72	79.17	31-40 years old	5-10 years	Suburban	Private University	Male	Associate Professor
28	64		72	88.89	51-60 years old	More than 30 years	Suburban	State/Public University	Female	Professor
29	50		72	69.44	41-50 years old	16-20 years	Suburban	Private University	Female	Associate Professor
30	56		72	77.78	51-60 years old	16-20 years	Suburban	Private University	Female	Associate Professor
31	66		72	91.67	41-50 years old	11-15 years	Urban	State/Public University	Female	Professor
32	61		72	84.72	31-40 years old	11-15 years	Rural	State/Public University	Female	Associate Professor
33	53		72	73.61	61+ years old	More than 30 years	Urban	State/Public University	Male	Professor
34	61		72	84.72	31-40 years old	5-10 years	Rural	Private University	Male	Assistant Professor
35	61		72	84.72	51-60 years old	21-30 years	Urban	State/Public University	Male	Professor
36	63		72	87.50	31-40 years old	Less than 5 years	Suburban	Private University	Female	Assistant Professor
37	58		72	80.56	41-50 years old	21-30 years	Urban	State/Public University	Male	Associate Professor
38	57		72	79.17	61+ years old	21-30 years	Suburban	State/Public University	Female	Associate Professor

Table 5. Chart for the eight different universities selected. Listed is their average enrollment each year and if the university is a public/state or private institution.

University	**Enrollment**	**Public/State or Private Institution**
A	66,444	Public/State
B	16,912	Public/State
C	40,782	Public/State
D	3,673	Private
E	5,150	Private
F	2,978	Private
G	3,088	Private
H	2,964	Private

Results

In total, 37 college mathematics professors completed the survey and only one of the professors did not give consent to complete it. The data in **Table 4** helps break down the survey results and what they mean. Out of the 37 college mathematics professors that completed the survey, 32 of them answered the demographic questions which helped to classify the data. To determine whether or not a participant had a growth mindset, a growth mindset with some fixed ideals, a fixed mindset with some growth mindset ideals, or a fixed mindset, their overall scores had to be calculated from the 18 questions related to having a growth mindset or fixed mindset traits. Each one of these questions had the point values of 1-4 assigned to them, with 1 being the lowest someone could score and 4 being the highest someone could score on one particular question. If a participant answered a question and received a score of 1, then that participant is attributed to having a fixed mindset in regard to that question. If a participant answered a question and received a score of 4, then that participant is attributed to having a growth mindset in regard to that question. If a participant answered every question, then the most points they could score is 72 points.

The data in **Table 1** shows the scores for each participant. Notice, in **Table 1**, not every participant answered every question, hence further calculations had to be done in **Table 4** to determine whether a professor had a growth mindset or a fixed mindset. In order to receive the classification of having a growth mindset, a participant had to receive a score at or above a 75% based on the questions they answered. If a participant scored between a 56% and 74.99% based on the questions they answered, then they received the classification of having a growth mindset with some fixed mindset ideals. If a participant scored between a 35% and 55.99% based on the questions they answered, then they received the classification of having a fixed mindset with some growth mindset ideals. If a participant scored at or below a 34.99% based on the questions they answered, then they received the classification of having a fixed mindset (Mindset Quiz). The percentages for each participant were found by adding the scores from each question and dividing by the total points possible. Now, the points possible vary from one participant to next depending on how many questions they answered. For example, participant 1 answered every question so their total possible score could have been 72 points, whereas participant 5 did not answer 4 of the questions so their total possible score could have been 54 points.

Looking at **Table 1**, the question that had the lowest average score was question 6 with a score of 2. The questions that had the highest average score were questions 5 and 8 with a score of 3.5. After analyzing the results in **Table 4**, 59% of the participants were classified as having a growth mindset, 38% of the participants were classified as having a growth mindset with some fixed mindset ideals, and 3% of the participants were classified as having a fixed mindset with some growth mindset ideals. Out of those participants who either had a growth mindset with some fixed mindset ideals or had a fixed mindset with some growth mindset ideals, 67% of them classified themselves as being 51 years old or older. Those results directly correlate to how long they have been teaching, where 67% of them classified as to have been teaching at the university level for more than 20 years.

While still looking at **Table** 4, out of all the participants who classified themselves as males, 44% of them have fixed mindset ideals, whereas out of all those participants who classified themselves as females, 27% have fixed mindset ideals. In regard to location as to where these participants with fixed mindset ideals teach, 20% of them said they teach in a rural area, 40% of them said they teach in an urban area, 20% of them said they teach in a suburban area, and 20% of them did not answer the question. Finally, 53% of the participants with fixed mindset traits said they teach at public/state institutions, 27% of them said they teach at private institutions, and 20% of them did not answer the question. However, out of all the participants who said they teach at a public/state institution, 44% are related to having fixed mindset ideals. Now, out of all the participants who said they teach at a private institution, 29% are related to having fixed mindset ideals.

Finally, in **Table 4**, the rank for each participant was analyzed for further detail. For those participants who said they were a professor, 47% classified as having fixed mindset ideals. Participants who said they were an associate professor, 33% classified as having fixed mindset ideals. Only 50% of those who said they were an instructor or other classified as having fixed mindset ideals and 0% of the participants who said they were assistant professors had any fixed mindset ideals.

One final analysis of the results in **Table 4** was to look at the participants who said they are 51 years old or older. Out of those 16 participants who said they were 51 years old or older, 10 of them were attributed to having fixed mindset ideals.

Table 2 and **Table 3** were the responses to the short answer questions. Most participants took the time to answer the questions thoughtfully, but some did not understand the question, some did not respond to the question with great detail, or some just skipped the question entirely. It was important to examine the responses by those professors who are classified with having fixed mindset ideals in their teaching beliefs because the research could get a better understanding of these professors' thought processes. In response to question 20, the majority of the participants referred to the students' grades making them accountable in their classroom. One participant even said that they make a student accountable in their classroom because they grade them. In response to question 21, some of the participants said they hope their teaching style impacts their students positively, engages them, is fun, motivates them, or impacts those students who want to learn. One participant even said they were not sure their teaching style even impacts them. Now, for those participants with growth mindsets, their responses to these questions varied, and some of them even shared some of the same beliefs as those with fixed mindset ideals. What stood out, however, were some of these participants with growth mindset ideals specifically said they wanted their students to feel like they could communicate with them in the classroom and give them feedback. These professors showed a great understanding for pinpointing their students' needs and would provide help whenever it was possible to do so.

Conclusions

If this survey were to be repeated, it would need more responses to get a better representation of the data. Based on the results of the data, this survey shows there is a correlation between the age of a college mathematics professor and whether they have a growth mindset or a fixed mindset. The data tells the researcher that overall, the majority of college mathematics professors have growth mindset traits that influence their teaching. These traits help the students be more successful in the classroom and can generate a better learning experience for them. A generalized conclusion can only be made that professors who are 51 years old or older are more likely to have fixed mindset ideals in their teaching beliefs. If this survey were to expand its sample size and receive more responses, I would hypothesize that the majority of the college mathematics professors with fixed mindset ideals would be 51 years old or older. I firmly believe this because, from the small sample size of responses that were generated, there is a pattern of the older generations having more of a fixed mindset over the younger generations. The ideals that the older generation of professors shares are attributed to their teaching styles, which were developed during a different time when teaching and learning did not have much access to research and knowledge of mindsets. The data also showed that teaching at a public/state institution increases the chances of encountering a professor with fixed mindset ideals. This should be the case because there are more professors that teach at public/state institutions versus private institutions, hence the chances of a student having a professor with fixed mindset ideals will be increased.

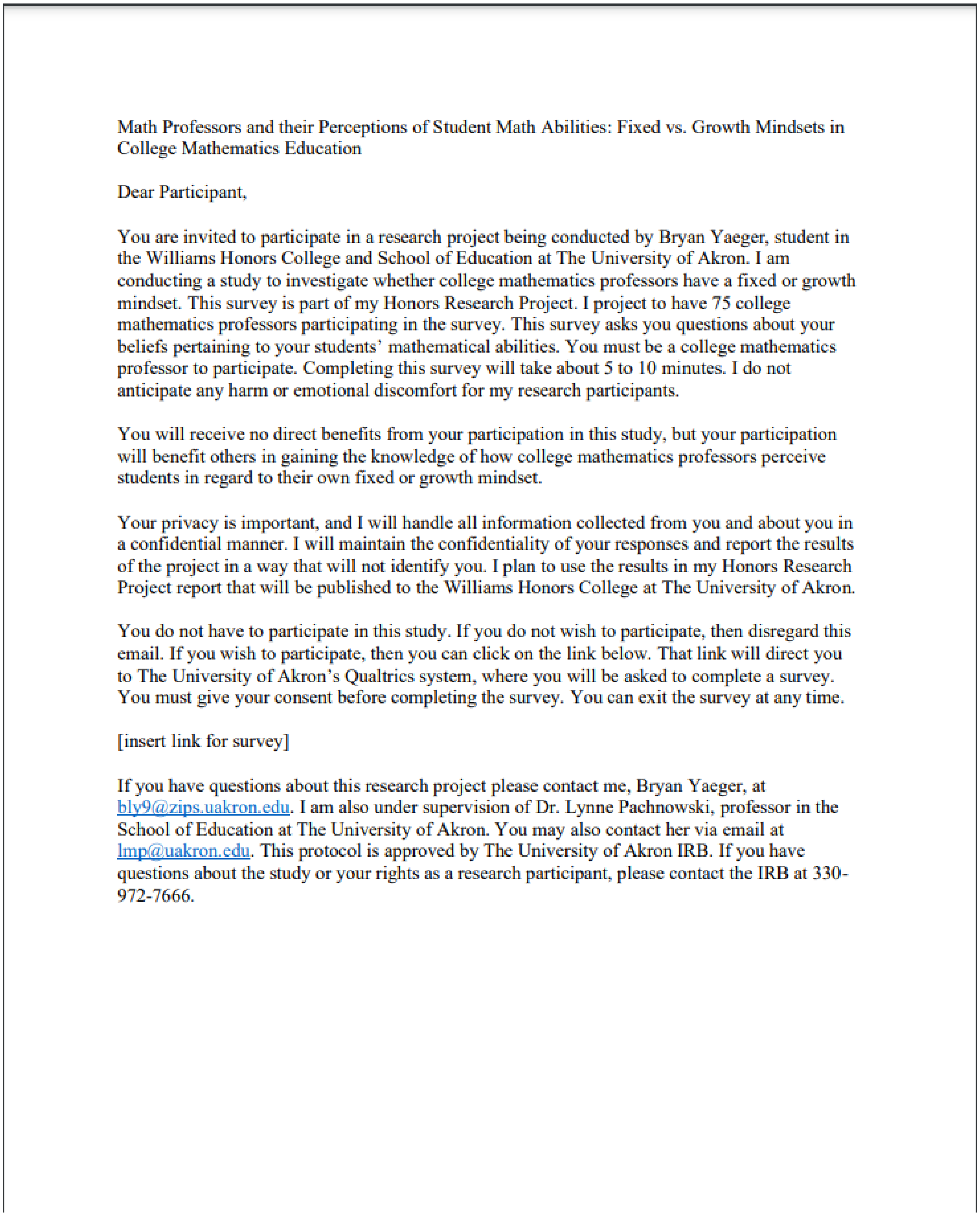
Professors with growth mindsets are continuously communicating their expectations to their students are asking their students to communicate their difficulties back to them. These professors show they understand what they expect from their students and are constantly looking for ways to improve their students' learning. For professors with fixed mindset ideals, they have the beliefs that the students who want to learn, will figure out a way to learn the material with how they are presenting the material. These professors believe they are what holds the students accountable since they are the lone contributor giving grades to their students. These practices by professors can be damaging to students and cause the students to have "feelings of powerlessness and learned helplessness" (Heggart 2015). Students need their professors to be relatable to them, so they can feel comfortable learning in their classroom. "When math professors are presented to students as born geniuses, it puts students into a fixed mindset; whereas when math professors are presented as people who loved and devoted themselves to math, it conveys a growth mindset to students" (Good, Rattan, & Dweck 2007).

Therefore, it is important that educators across the spectrum, whether that be in kindergarten or higher education, practice having growth mindsets within their classroom. Students have a better chance of being successful when these practices are put into place. It is still shown today that educators are still walking into the classroom with fixed mindset ideals, which is damaging student success in the classroom. Will fixed mindsets ever go away entirely?

No, there will always be some fixed mindset ideals that stick around. But can the beliefs and myths of teaching with a fixed mindset be broken? The answer to this question is yes because educators have access to the tools to implement strong, growth mindset ideals in their classroom with the proper training and techniques. One way for fixed mindset ideals to be minimized, education can be changed at the top of the spectrum. Professors and educators at the higher education level can set the examples for the rest of the education spectrum because they are the ones who are seen as the experts of knowledge in the field of education. If growth mindset beliefs can be found at the highest levels of education, then the successes can be translated down into classrooms in K-12 education. Those future educators who were once students in their professors' classes are now educators with students of their own, and those future educators would have the opportunities to approach teaching the way teaching was taught to them at the highest level. The goal should be to maximize student success in the classroom so there can be a better understanding for tomorrow.

Appendix A: Forms completed by each participant

1. Informed Consent Form



Math Professors and their Perceptions of Student Math Abilities: Fixed vs. Growth Mindsets in College Mathematics Education

Dear Participant,

You are invited to participate in a research project being conducted by Bryan Yaeger, student in the Williams Honors College and School of Education at The University of Akron. I am conducting a study to investigate whether college mathematics professors have a fixed or growth mindset. This survey is part of my Honors Research Project. I project to have 75 college mathematics professors participating in the survey. This survey asks you questions about your beliefs pertaining to your students' mathematical abilities. You must be a college mathematics professor to participate. Completing this survey will take about 5 to 10 minutes. I do not anticipate any harm or emotional discomfort for my research participants.

You will receive no direct benefits from your participation in this study, but your participation will benefit others in gaining the knowledge of how college mathematics professors perceive students in regard to their own fixed or growth mindset.

Your privacy is important, and I will handle all information collected from you and about you in a confidential manner. I will maintain the confidentiality of your responses and report the results of the project in a way that will not identify you. I plan to use the results in my Honors Research Project report that will be published to the Williams Honors College at The University of Akron.

You do not have to participate in this study. If you do not wish to participate, then disregard this email. If you wish to participate, then you can click on the link below. That link will direct you to The University of Akron's Qualtrics system, where you will be asked to complete a survey. You must give your consent before completing the survey. You can exit the survey at any time.

[insert link for survey]

If you have questions about this research project please contact me, Bryan Yaeger, at bly9@zips.uakron.edu. I am also under supervision of Dr. Lynne Pachnowski, professor in the School of Education at The University of Akron. You may also contact her via email at lmp@uakron.edu. This protocol is approved by The University of Akron IRB. If you have questions about the study or your rights as a research participant, please contact the IRB at 330-972-7666.

2. The Survey

Growth Mindset vs Fixed Mindset

Start of Block: Block 4

Q1 You are invited to participate in a research project being conducted by Bryan Yaeger, student in the Williams Honors College and School of Education at The University of Akron. I am conducting a study to investigate whether college mathematics professors have a fixed or growth mindset. This survey is part of my Honors Research Project. I project to have 75 college mathematics professors participating in the survey. This survey asks you questions about your beliefs pertaining to your students' mathematical abilities. You must be a college mathematics professor to participate. Completing this survey will take about 5 to 10 minutes. I do not anticipate any harm or emotional discomfort for my research participants

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You do not have to participate in this study. If you do not wish to participate, then do not give consent and exit the survey. If you wish to participate, then you must give your consent. You can exit the survey at any time

If you have questions about this research project please contact me, Bryan Yaeger, at bly9@zips.uakron.edu. I am also under supervision of Dr. Lynne Pachnowski, professor in the School of Education at The University of Akron. You may also contact her via email at lmp@uakron.edu. This protocol is approved by The University of Akron IRB. If you have questions about the study or your rights as a research participant, please contact the IRB at 330-972-7666

Do you give consent to take this survey?

- ○ Yes, I give consent.
- ○ No, I do not give consent.

End of Block: Block 4

Page 1 of 10

Start of Block: Block 1

Q2 My students' intelligence is something very basic about them that they cannot change very much.

- ○ Strongly Disagree
- ○ Disagree
- ○ Agree
- ○ Strongly Agree

Q3 No matter how much intelligence my students have, they can always change it quite a bit.

- ○ Strongly Disagree
- ○ Disagree
- ○ Agree
- ○ Strongly Agree

Q4 Only a few people are truly good at math; they have to be born with the ability.

- ○ Strongly Disagree
- ○ Disagree
- ○ Agree
- ○ Strongly Agree

Page 2 of 10

Q5 The harder my students work at math, the better they will be.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Agree
- ◯ Strongly Agree

Q6 My students often get upset when I give them feedback about their performance.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Agree
- ◯ Strongly Agree

Q7 My students appreciate when I give them feedback about their mathematics work.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Agree
- ◯ Strongly Agree

Q8 Truly smart people do not need to try hard.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Agree
- ◯ Strongly Agree

Q9 My students can always change how intelligent they are.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Agree
- ◯ Strongly Agree

Q10 My students are a certain kind of person and there is not much that can be done to really change that.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Agree
- ◯ Strongly Agree

End of Block: Block 1

Start of Block: Block 2

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Q11 An important reason why my students do their schoolwork is that they enjoy learning new things.

- ○ Strongly Disagree
- ○ Disagree
- ○ Agree
- ○ Strongly Agree

Q12 My students' intelligence can increase or decrease depending on whether or not they spend time exercising their minds.

- ○ Strongly Disagree
- ○ Disagree
- ○ Agree
- ○ Strongly Agree

Q13 My students are born with a certain amount of intelligence and it isn't something that can be changed.

- ○ Strongly Disagree
- ○ Disagree
- ○ Agree
- ○ Strongly Agree

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Q14 My students can learn new things, but they can't change their underlying level of intelligence.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

Q15 Learning new things can increase my students' underlying intelligence.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

Q16 Talent is something your students are born with, not something they can develop.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

Q17 If your students practice math for long enough, they can develop a talent for it.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

Q18 My students who are good at math were born with a high level of natural ability.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

Q19 My students who are good at math have spent a lot of time practicing it, regardless of natural ability.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

End of Block: Block 2

Start of Block: Block 3

Q20 What makes a student accountable in your classroom? Why do you believe that?

____

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Q21 How do you think your teaching style impacts your students and their learning?

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End of Block: Block 3

Start of Block: Default Question Block

Q22 What is your age?

- ○ Less than 21 years old
- ○ 21-30 years old
- ○ 31-40 years old
- ○ 41-50 years old
- ○ 51-60 years old
- ○ 61+ years old

Q23 How long have you been teaching mathematics at the university level?

- Less than 5 years
- 5-10 years
- 11-15 years
- 16-20 years
- 21-30 years
- More than 30 years

Q24 Where is your college/university located?

- Urban
- Suburban
- Rural

Q25 Define your university/college.

- State/Public University
- Private University

Q26 Gender.

- Male
- Female
- Rather not say

Q27 What is your current rank?

- Emeritus
- Instructor
- Assistant Professor
- Associate Professor
- Professor
- Distinguised Professor
- Other

End of Block: Default Question Block

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