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Connecting Confidence to College Mathematics and High School Ability Tracks

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HONORS PROJECT

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Abstract

Ability tracking within mathematics education is commonplace in American high schools. Some feel that students' ability tracks act as a predictor for their success in university mathematics. Research has shown that many factors, such as socioeconomic status and more, have substantial effects on student success. The purpose of this study was to further investigate variables related to success in university mathematics. Confidence in mathematics is one factor in student performance that is particularly under-researched. This research investigated the relationship between ability tracking in high school mathematics, student confidence level, and performance in university mathematics. Data was gathered via a survey. Findings indicated that high school ability tracks and collegiate mathematics performance were positively correlated with a correlation coefficient of .38. Furthermore, there was a correlation between confidence and performance, as well as ability tracking and confidence, with a correlation coefficient of .56 and .40 respectively. This means that students' ability tracks, confidence levels, and performance all increase with each other. There was a stronger correlation between confidence levels and performance than ability tracks and performance. Because of this, there is no definitive evidence of what begets success. Still, ability tracking is not the ultimate precursor to success and there is more than mathematical content, specifically confidence, that teachers need to nourish in their students. All in all, confidence, ability tracking, and performance have positive relationships with each other, meaning that students need to learn mathematical content but also establish healthy levels of confidence in order to be successful.

Connecting Confidence to College Mathematics and High School Ability Tracks

Researching elements of student success is very important in order to better understand education. There is an ever-growing body of knowledge that analyzes the success and failure of students and the various factors that contribute to it. In particular, Nieto and Bode (2012) show how systemic injustices and teacher expectations affect outcomes for students of differing demographics. Esnard et al. (2021) demonstrate how anxiety and self-efficacy may affect student comprehension and application of materials. Harwell et al. (2013) illustrate the effects of past experiences and achievements in mathematics on a student's persistence and future success. However, there is a need for more literature to further expand the understanding behind student success. Because the factors behind student success are critical to serve students and because that understanding is ever-growing, I intend to further explore this topic through research. By conducting a thorough analysis of modern literature and executing a scholarly survey, I will study the connection between a student's ability track in high school mathematics, their confidence, and their performance in collegiate mathematics.

Research Questions

1. How do students' high school ability tracks in mathematics affect performance in collegiate mathematics?
2. What is the connection between student confidence and performance in collegiate mathematics?
3. What is the relationship between students' ability tracks in high school mathematics classes, their confidence level, and their performance in collegiate mathematics?

Literature Review

History of Tracking in Mathematics Courses.

Ability tracking in high school mathematics is a practice that started off with good intentions. First of all, it is important to remember that the vast majority of people who pursue a career in mathematics education choose the field because they want to spend their lives helping students develop their mathematical skills. Because of this it is reasonable to assume that the majority of instructional decisions are made with the students' best interest at heart. With this in mind, ability tracking in high school mathematics began as a way to enhance teacher instruction and student learning. Particularly, Loveless (2013) demonstrated that tracking was a strategic decision that would allow teachers, using their own professional opinions as well as the results of standardized tests, to enhance their instruction by minimizing the varying needs of students in their classroom. This means that ability tracking was supposed to put teachers in a better position to meet the needs of their students by diminishing the numerous and incompatible needs of various students. Overall, ability tracking in high school mathematics is rooted in good intentions, no matter what the consequences of those separations are.

While it is important to remember that ability tracking began with the hope of enhancing education and better serving students, there are issues with the practice. As most people have experienced in their scholastic careers and students continue to see, standardized testing is a popular way to sort gifted, average, and remedial students. Testing may offer some objectivity in evaluating, but it does not evaluate each student fully. In particular, Popham (2001) argues that "... half or more of what's tested wasn't even supposed to be taught in a particular district or state" (p. 43), meaning that students are often evaluated on what they do not know without ample opportunity to show what they do know. Because of this discrepancy, many students' achievement, learning, and work ethic are not represented in their evaluation, reducing a teacher's ability to accurately identify the needs of that student. In response to testing

discrepancies, many school districts revert to teacher evaluations and recommendations to place students in ability tracks; however, this method also leaves many students behind. Most clearly, while it is necessary to recall that teachers are educated individuals, implicit bias undoubtedly goes along with many important decisions they make. Particularly, ability tracking "... is undergirded by normative beliefs regarding race and class" (Loveless, 2013, p. 15) and "... Black and Latino students are chronically underrepresented in programs for the gifted and talented…" (Nieto & Bode, 2012, p. 68), both of which come as a direct result of teacher bias. Because of this bias, students are judged based on qualities over which they have no control, placing them in inappropriate classes and setting them up for failure. Fundamentally, testing and teacher recommendation are two tools used to organize students in ability tracks, but there are major flaws in both practices that force educators to reconsider what may be the variables that affect student success the most.

Predictors of Success

Important Predictors to Remember

Many citizens and educators look at student success as connected to some sort of innate intelligence that is out of their control, but that could not be farther from the truth. In fact, there are many different factors that contribute to the possible success of a student. For starters, systemic injustice for certain demographics and systemic promotion of others creates an achievement gap between groups of students. Nieto and Bode (2012) assert that "... light-skinned students were able to derive significantly more benefits from their schooling than their dark-skinned peers. Thus, it is clear that racism and other forms of institutional discrimination play a part in students' education success or failure" (pp. 67-68), meaning that students of lighter skin tones are given preferential treatment to those with darker skin. In this way, a predictor of

success is demographics; students within underserved and discriminated demographics do not have the same resources and opportunities to succeed as their adequately served counterparts. Without a doubt, the social injustices that permeate American society allows certain students to achieve more than others.

In addition to systemic obstacles to success, a student's ability to cope with mathematics anxiety plays a major role in their mathematics success. The main idea of mathematics anxiety is not that students are unable to do mathematics or learn; it is that they become stressed when faced with the content and are unable to focus properly. This anxiety seeps from the student's emotional state and into their performance, making them seem less capable than they actually are. It is clear that with greater mathematics anxiety comes lower mathematics scores, with Radišić et al. (2014) showing that "... group[s] displaying anxiety score lowest among the three in math achievement…" (p. 15), meaning that students with a phobia of mathematics and/or failure typically fulfill their own prophecies and perform poorly. Taking into consideration that mathematics anxiety decreases performance, it is logical that low mathematics anxiety would allow students to fully demonstrate their skills, resulting in a typically higher test score. With this idea in mind, another strong predictor of mathematical success is the level of anxiety students experience.

Mathematics anxiety may play a critical role in the success of a student, but whether or not a student feels a sense of community and belonging within their mathematics classroom is also important. A proper learning environment and community is necessary for students to learn. Through her work, Schwartz (2016) demonstrated that connecting with students on an emotional level and creating a classroom community as opposed to defining a classroom as only a place to obtain facts was essential to optimize student success, meaning that students perform better when

there is meaning to their learning that reaches beyond themselves. Not only do students need to feel important in their classrooms, a sense of belonging in especially mathematics classrooms will also make an enormous difference. Horn (2017) showed that reducing social risk and actively working to make students feel that they belonged and deserved to be in mathematics classes created a classroom where students felt comfortable learning and asking questions, priming them for deep understanding. With these two ideas working in tandem, a student must feel that they are an important addition to the classroom and that they are worth teaching; with these two notions on their side, more hard and meaningful work will be put into their own learning, setting them up for current and future success.

Community and belonging primes a student for learning, but past achievement in mathematics also acts as a precursor for future success. While many people may consider this perspective and argue that is due to natural ability, that is not the case. In reality, past achievements in mathematics courses encourage students to remain persistent in their learning, pushing them to move further in their mathematics. On the other side, a poor history of mathematical achievement deters students from continuing their learning, limiting their ability to reach their potential. In particular, Carey et al. (2016) argue that "... poor performance may trigger mathematics anxiety in certain individuals, [and] it may further reduce their mathematics performance in a vicious cycle" (p. 4), further asserting that students need to have a strong background in the subject. Fundamentally, past mathematics performance puts students in the emotional headspace for their future learning and persistence; the conduciveness of that headspace for learning acts as a foundation for mathematics performance. Without a doubt, there are many different variables that work to predict a student's performance in mathematics, but many of those variables intersect at the student's own confidence in their work.

Confidence as the Predictor for Success

The ultimate indicator of success within a student's mathematical career is their individual levels of confidence. Confidence is the general feeling that a student has when they believe that they are able to learn mathematics and produce correct responses (Foster, 2015, p.1). This phenomenon is brought about and is seen through many different avenues. First off, confidence for any student begins when they have the opportunity to succeed mathematically. Post et al. (2010) further assert this truth, stating "... that high school mathematics curriculum was not a significant predictor of the number of college mathematics courses taken, but mathematics grade point average was a significant predictor of the number of college mathematics courses taken" (p. 299), meaning that students who succeed in their mathematics courses feel that they are capable enough to continue in their studies at the collegiate level, increasing their overall mathematical performance. With prior success in their history, a student feels that they are able to learn, causing them to become more curious and questioning. Keeping this in mind, that curiosity leads to higher skill and, with that, higher performance. Truly, it is necessary for students to be in a learning environment where they can succeed in order to augment their own desire for learning.

While prior success definitely acts as an indicator for a student's future success, that does not mean that students will never experience difficulties in their studies; this is where determination becomes a factor. In order to achieve success in mathematics courses, students must have the ability to persevere through struggles in order to reach a conclusion. This holds true across curriculums with Harwell et al. (2013) discovering that differing curricula did not affect the long term performance of a student nearly as much as that student actually having followed through with the completion of said curriculum. Basically, students must have a certain

amount of confidence that they can work through difficult mathematics even if a solution pathway is not immediately apparent. This notion is further supported by Dweck (2008) who demonstrated that those who truly succeed in their chosen field, especially mathematicians, achieve their goals because of the "deliberate practice they devote to their field" (p. 3), highlighting the importance of continuous perseverance. With her idea in mind, it is clear that any student can augment their mathematical performance if they have, not only the resources to do so, but also the confidence that they can learn and are worth the time to teach. Overall, a facet of confidence is the openness and determination to learning, and that aspect of confidence acts as another key indicator for performance.

Moving beyond the important role of perseverance and determination in a student's mathematical success, self-efficacy is yet another concept closely related to confidence that behaves as a predictor. Self-efficacy is "a person's beliefs concerning his or her ability to successfully perform a given task…" (Hackett & Betz, 1989, p. 261), meaning that a person's opinion of themselves may change the outcome of their performance. Self-efficacy is an important factor in achievement because it alters how students handle setbacks. Specifically, Usher (2009) demonstrated that "students with high self-efficacy framed their bouts of heightened arousal in ways that were motivating; those with low-self-efficacy experienced a level of distress that left them feeling disheartened and often paralyzed" (p. 308), highlighting that high self-efficacy is associated with the further desire to learn. Because of this, self-efficacy acts as a predictor of success and future performance since the desire to learn undoubtedly increases what a student learns and how long they study. Basically, self-efficacy predicts a student's success because of how they handle setbacks and view mistakes as opportunities to learn.

Culminating all of the above ideas together, general confidence is a critical predictor for a particular student's success in their mathematical careers. First, students must feel that, even if they run into difficulties, that they are able to learn from difficulties and eventually find a way to reach a conclusion themselves. In particular, Carroll (1995) found that confidence levels are increased in a class where "many students who would typically wait for the teacher when they ran into difficulty found that they could help themselves" (p. 279), showing that confidence creates more independent and determined thinkers. That confidence allows them to conquer current classes and provides resilience for the future; without confidence in their independence, students will struggle even more. Next, confident students display their confidence by becoming actively involved in their learning. From their own experiences, Nebesniak and Heaton (2010) extrapolated that confident students seek deep understanding of their learning, setting them up for success in their current classes but also establishing a strong foundation for future learning. Students with confidence in their ability to learn will continuously push themselves, causing them to study more effectively and augmenting their performance in the long term; without that confidence, they may otherwise quit. Finally, students need a healthy level of confidence in their current abilities in order to succeed at their present classes. Oskar et al. (2014) illuminated that confidence is critical in a student executing mathematical ideas; in particular, they showed that, for students whose mathematical confidence decreased, their performance also decreased while their performance increased as their confidence did. This means that students who were not confident in what they were already capable of questioned themselves so much or stumbled in their work such that their performance was deeply and negatively hindered. Having confidence in current skills is a necessity for students to succeed in the mathematics classroom in which they currently are. Overarchingly, student confidence in a variety of ranges is critical to the success or

failure of said student; because of that, understanding the confidence level of a student is an important tool in predicting future mathematical performance.

Methodology

When beginning this research, the primary research questions were carefully considered. It was necessary to remember that the dependent variable in this case was student collegiate mathematics performance while the independent variables were students' high school ability tracks and their confidence levels. Having this analysis in mind was important because the connection between these three variables, the main focus of the project, seemed to be rather under researched, requiring that the pre existing literature was analyzed by breaking down the study into its various parts. In particular, the history of ability tracking and other views on student success from research were read; from there, studies that more accurately focused on the topics at hand, confidence and separation by ability, were also taken into consideration. With this approach, the necessary background knowledge was obtained as was the clarity on how to appropriately continue research within the scope of the research questions.

Moving forward, it became necessary to determine whether to approach the research quantitatively or qualitatively. In this case, a quantitative method seemed to be the most logical way to initially begin exploring the answers to the research questions. While a qualitative approach may have analyzed single students more holistically, first exploring the relationship between confidence, high school ability tracks, and collegiate mathematics performance quantitatively was appropriate because it allowed the most objective collection of data as possible. Maintaining objectivity was critical because of the novelty of the research. Moreover, the use of a survey of students in Introduction to Statistics, College Algebra, Precalculus, and Calculus I. would be the best data collection tool for two reasons. First, since the data would be

analyzed quantitatively, it was imperative that each participant had the same questions and same possible responses, allowing for easy and consistent analysis. Secondly, the brief nature and plausibility of a larger data set meant that the research could detect larger patterns over students across specialties and classes, making the results more generalizable. To sum up, the survey gathered the data in a way that could be organized and made it possible to draw overarching conclusions about how students succeed in mathematics.

More than conducting a research survey, it was necessary to adequately analyze the data that was collected from it. Because of this, the raw data, which was displayed almost randomly into a spreadsheet, was reorganized in order to compare the independent and dependent variables. To address the research question concerning high school ability tracks and collegiate performance, the independent variable was set as a student's ability track and their current grade in their course as the dependent variable. As a means to answer the second research question, their confidence level was the independent variable and their current grade as the dependent variable. Finally, to best find the connection between ability tracks, confidence, and collegiate mathematics performance, a comparison between ability tracks, as the independent variable, to confidence level, as the dependent variable, was also considered. Moreover, I assigned numerical values to each variable. For ability tracks, numerical values advanced with the level of the course with 0 being remedial, 1 being a standard track, 2 being the honors track, and 3 being the advanced placement or similar track. In order to analyze Likert scale responses, the tool used to analyze confidence levels, the numerical values of responses ranged from “strongly disagree” corresponding to 0 to “strongly agree” corresponding to 4. Their total confidence was found by taking the sum of the values indicated in each response, producing a range of 0 to 24, with a value of 12 indicating neutral confidence, to align with the six questions in this category. Finally,

current grades, used to measure collegiate performance, were assigned numbers corresponding to the standard grade point average with F being 0 and an A being 4. Basically, the data was analyzed by assigning numerical values to concepts in a way that showed standard progression. Overall, the method of study for this research was to break down the various parts into more manageable and analyzable pieces, allowing correlations to be discovered in a standardized method.

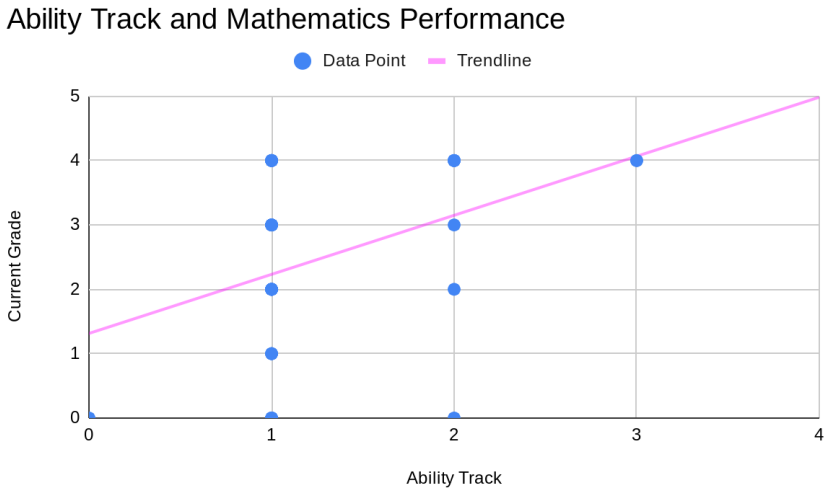
Limitations

While the study and means of analysis is well thought out, three main limitations remain. The first limitation is that the answer to predicting student success is extremely complicated and requires the analysis of too many variables for a single project. For example, this research analyzes confidence in success; that does not mean socioeconomic status is not also an important factor. While the effect of confidence will be revealed, it is important to keep in mind that other variables exist that come with their own complicated interactions. Secondly, another major limitation is that this research will only include data from students pursuing college degrees. This means that there will be missing data from those who chose to study a trade or otherwise did not attend college. Future research must be conducted to ensure that all students are served and studied and not just those with intentions of attending university. Finally, there is also a cultural limitation. With the study including only students from a mid-sized, Midwestern university, the data comes from mainly American students. While the results will still be valid, future readers need to keep in mind that different studies may better indicate patterns in different regions. Fundamentally, the data will be strong, but a too large number of pertinent variables, focus on university students, and cultural bias puts limitations on its applications.

Description of the Results

High School Ability Tracks and Performance in Collegiate Mathematics

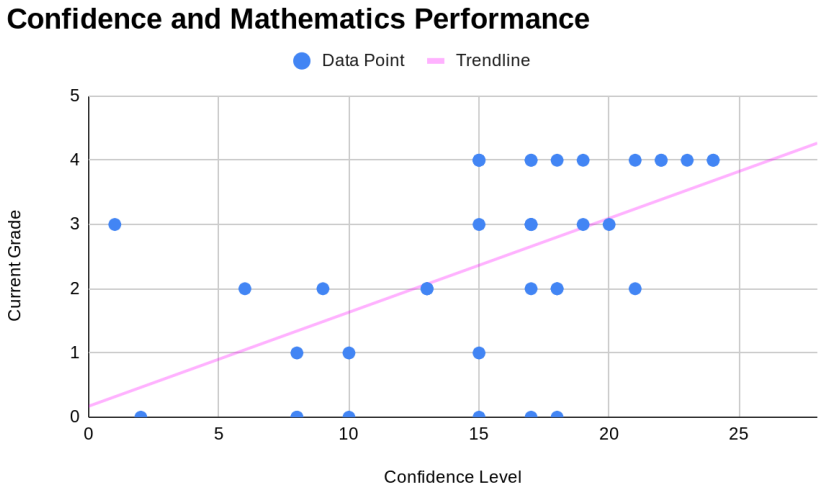
Using the survey data, it is possible to directly answer the research questions that the study intended to investigate. To answer the first question, the relationship between a student's ability track in high school and their performance in collegiate mathematics must be analyzed. For the most part, the data indicates that correlation between these two variables is relatively weak. In particular, the correlation coefficient between high school ability tracks and the current grade being achieved in a mathematics course is about .38. Moreover, a positive trendline can be drawn on the appropriate scatter plot that demonstrates this relationship. Moving forward, it is important to remark on the outliers in this circumstance. For example, students in standard ability tracks, represented by 1 on the horizontal axis, have a wide variety of achievement that ranges from failing to earning the highest possible grade in their respective course. Overall, there is a correlation between ability tracks and mathematics performance in high school, but it is not very strong and many outliers do exist.



Confidence Levels and Performance in Collegiate Mathematics

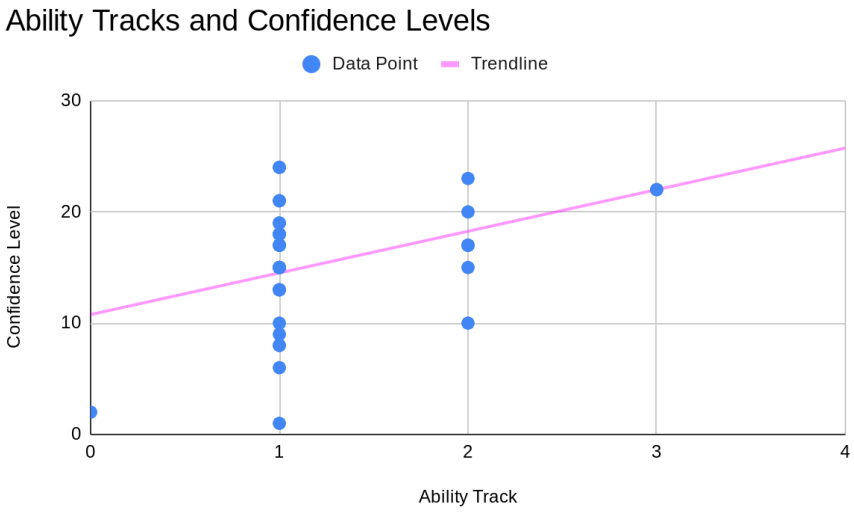
Addressing the second research question, the data concerning students' confidence levels in comparison to their performance in collegiate mathematics is of consequence. The correlation between these two variables is moderate. Specifically, the correlation coefficient between

confidence levels and mathematics performance is about .56. Similar to the data concerning ability tracks, a trendline can also be produced. Both the correlation coefficient and trendline indicate a positive relationship between student confidence levels and their performance in collegiate mathematics. While this correlation is evident and mathematically sound, many outliers are still present.



Particularly, there were many participants who reported relatively high confidence levels while also reporting a failing grade, and then there were also participants reporting almost no confidence while earning a B or C, denoted as 3 and 2, respectively, on the vertical axis, in their course. To sum up, there is a moderate correlation between student confidence levels and collegiate mathematics performance but many outliers in this trend are evident.

The Relationship Between High School Ability Tracks, Confidence Levels, and Performance



Moving beyond simply confidence levels, the data suggests there is a relationship between high school ability tracks, confidence levels,

and performance. This relationship is apparent because there is also a positive correlation between high school ability tracks and confidence levels. To be specific, the correlation coefficient is .40. Moreover, a trendline can also be produced that demonstrates this positive relationship. This means that, bringing everything together, as student high school ability tracks increase, confidence levels increase, and mathematics performance also increases. However, many outliers remain present in this analysis as well with participants from the same ability track reporting a wide range of confidence levels. In this way, there is a positive relationship between all three of the variables in questions, but outliers exist in all of them and must be fully considered in their analysis.

Implications for Future Research and Practice

Future Research

The results of this research show that both a student's ability track in high school and their confidence level are correlated to their performance in collegiate mathematics. However, this research does not delve into the deeper nuances of these relationships. Are confident mathematics students confident because of the ability track in which they were? Does a student's ability track prepare them differently to study mathematics at the university level? Is there a correlation between ability tracking and success but actually a causation between high confidence levels and high collegiate mathematics performance? These are all important questions that should be considered in order to continue to understand the initial research questions more deeply. In this way, one of the most important implications for future research in regards to this study is that it created more questions than answers. Still, the questions it poses are an important beginning to researching the best ways to ensure each student has equal opportunity and access to studying and succeeding within mathematics at an advanced level.

While many important and researchable questions are an essential part of the bounty of this research, there are still some applications that other researchers may consider. Particularly, while this study does not prove that confidence begets success, it does demonstrate that the two variables have a correlation. Because of this, another important implication for future research is studying how to increase students' confidence in their mathematical abilities and capacities to learn. Other mathematics education researchers may study different techniques, such as more engaging tasks or creating mathematical tasks that may initially disguise the mathematics as something else, and see how that increases student confidence. In this way, a practical application of this research would be further pursued and more teaching tools would be invented. At the same time, it may also give more opportunities to truly study the relationship between student confidence and mathematics performance. Overall, implications of future research revolve around two factors: first, deeper study into the predictors for student success, and, secondly, finding practical ways to use the correlations found in this research to help mathematics students succeed.

Considerations for Educators

Using this project as a starting point for deeper and more profound research is a fantastic implication, but educators may still consider some of its discoveries and possible meanings. Most importantly, this study indicates that more than a student's ability track or surface level ability is a precursor to success; as stated, confidence actually has a stronger correlation to higher collegiate mathematics performance than high school ability track. Because of this, teachers may shift their focus from simply drilling mathematics with the students, hoping that they retain their teaching, to working with their students to build up students' sense of self-confidence and willingness to take risks. With this approach, teachers may work with their students to improve

their mathematical foundations day by day through fostering confidence, which is within the students' abilities, as opposed to shifting ability tracks, which is typically beyond the students' control and may even frighten them. In this way, teachers can use research implications to give all students the tools and chance to succeed rather than allow them to work through school aimlessly.

Keeping the importance of fostering student confidence in mind, teachers also need to remember the outliers that occurred in the data. Paying special attention to the relationship between mathematics grades and confidence levels and still respecting the correlation there, there are many students that do not follow the trend. Particularly, some students were overly confident in their skills or simply did not care to meet the level of achievement of which they were confident they could attain. This is evident from the many students reporting that they have high confidence and low performance. On the other hand, many students underestimate themselves, reporting low confidence while achieving high marks in their course. Because of these outliers, teachers should not rely on confidence as the only factor in nurturing successful mathematics students. Instead, they should focus on and continue growing their students' learning through careful task selection and continuous assessment of their knowledge while concurrently working with their students to achieve and maintain healthy levels of confidence in their work. Basically, teachers should consider fostering confidence in their students, but that does not change the fact that their students need to understand the content. By applying the research in this way, teachers may add another tool to their instruction without creating overly optimistic students or being unrealistic with their students' current abilities themselves. All in all, more research is necessary to deepen understanding of this topic, but teachers may also use the

confidence and performance correlation to their advantage when setting their students up for success.

Conclusion

To sum up, success in learning mathematics is central to the field of mathematics education, but finding the correct way to help students succeed is very complex. As is apparent through the literature review, there are many factors that come into play within this mission. For example, systemic discrimination, socioeconomic status, and student motivation are all factors when it comes to student success, but none of them are apparent in the results or implications of this study. What is apparent in this study is that confidence has a stronger correlation to university mathematics success than high school mathematics ability tracks do. This means that, while there are many other considerations and moving pieces to serving students, confidence is one particular factor that is now better researched and something that can be fostered within classrooms. That is important to note because, while others factors beyond student or teacher control, such as systemic discrimination, may be a large obstacle to success, teachers may start to realize that there is a way to help students gain back just a little bit more of their power through their own confidence. Doing this gives students and teachers a path forward to their learning when it seems otherwise impossible. In conclusion, helping students succeed is complicated work with many barriers and obstacles beyond a teacher's or student's control, but confidence, having a correlation to success, is a mindset and skill they do have control over and can work on to achieve success in studying mathematics.

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