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High School Students' Reasons for disliking Mathematics: The Intersection Between Teacher's Role and Student's Emotions, Belief and Self-efficacy

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ABSTRACT

The study presented here depicts the reasons for high school students to have a negative attitude toward mathematics. The students were asked to rate mathematics in comparison to other subjects like history, physics, or computer science. In addition, they were asked about their attitude, beliefs, and motivations toward mathematics. To this end a convergent parallel mixed-method approach was implemented using a questionnaire that combines open-ended, closed-ended (e.g., forced ranking scale, or multiple and single responses), and liker-scale items. One of the main reasons for student's reluctancy toward mathematics is their lack of understanding and self-perception of low content knowledge, which let them to have a negative perception. Students stated that their negative perception was not new, but instead something they knew since elementary.

Keywords: high-school, belief, perception, teacher's motivation

INTRODUCTION

Student's experiences through their academic life affect their perceptions, belief, and opinions toward mathematics (Kane & Mertz, 2012) and whether or not they like mathematics or even how much they like it. Other variables like gender could potentially impact how students perceive mathematics and its usefulness in life. According to Frost et al. (1990) beliefs and ways of thinking about woman regarding mathematics has been harmful to females. In addition, boys tend to interact more often with instructors than girls (Stevens, 2015), something that can create a gender bias, and affect the motivation of female students. In the Program for International Student Assessment (PISA) 2015 that is applied to young adolescences in thirty-one countries, males had a better achievement in mathematics than females in twenty-eight of the countries (Gallagher & Kaufman, 2005). Apparently, gender plays a role in student's achievement in mathematics.

It has been demonstrated that there is a close relation between self-confidence and mathematics achievement (Kloosterman, 1988; Kunhertanti & Santosa 2018; Van der Bergh, 2013). According to Stankov et al. (2011), researchers of the National Institute of Education in Singapore who studied self-beliefs and metacognition in mathematics students, found that students who think that are good in mathematics tend to perform well in tests. Moreover, Stankov et al., implied that student´s self-confidence could better predict performance than any other method and that is "[a] much better predictor of students' achievements [in mathematics] than any other non-cognitive measure" (p. 6). This is a good example of the important role that play self-confidence in mathematics, however it does not represent an indication that student's enjoyment and attitude toward mathematics would increase. In other words, although students could have good performance in mathematics, it does not determinate whether the students like or not mathematics.

When talking about motivation, it is considered to be a strong factor that affect the way that students perceive math. A motivated student works harder in improving their own abilities. Crump (1995) said that motivation is defined as the way of stimulating the student's mind to learn. She goes on to mention that the major components of motivation are enthusiasm, excitement and interest. Teachers should consider and incorporate motivation as a strategy for developing mathematical skills in the learning process and as a way to dissipate students´ misconceptions. Brophy (2013) found that teachers admitted that they have an important role in inspiring students to learn and that they can influence the students' interest toward mathematics.

All factors mentioned above, without a doubt affect student's attitude toward mathematics in a positive or negative direction, but they are not the only factors. In this study, I strived to discover the main reasons for which high school students depict a negative attitude toward mathematics and for rating it as a subject they would not prefer when compared to other subjects like

computer science or literature. To this end, a mixed-methods study was implemented to answer the following questions: What are the main reasons that hamper student's attitude toward mathematics? What is the relation between gender and attitude toward mathematics? What is the relation between student's academic program and attitude toward mathematics? Is there a relation between teacher encouragement and students' attitude toward mathematics? Is there a relationship between student's self-confidence and attitude toward mathematics? Is there a relationship between student's mathematical ability and their attitude toward mathematics?

After analyzing all the qualitative and quantitative data, I found evidence that one of the main reasons students have for having a negative attitude toward mathematics is their lack of confidence in doing mathematics, which affect the student's motivation, engagement, and general perception.

THEORETICAL PERSPECTIVES

Attitudes towards mathematics has been addressed in the literature by many prominent researchers who have defined it in different ways and contexts (Head, 1989; Daskalogianni & Simpson, 2000; Di Martino & Zan, 2001; Larsen, 2013). Kibrislioglu (2016) stated that attitude toward mathematics is related to its perception of usefulness or uselessness, about liking or disliking it, or as the engagement or avoidance of any mathematical activity including homework, assignments, projects, or any other. Similarly, Mazana et al. (2019) defined attitude toward mathematics as an emotional disposition, which could be positive or negative. They also mentioned that relevant factors influencing student's liking of mathematics include how students enjoy the class and teacher's classroom management and instruction.

Student's attitude towards mathematics could be influenced by many different factors, including gender. For example, research has shown that attitude toward mathematics is more negative among girls than boys (Prendergast & Hongning, 2016; Frost et al., 1994), or that attitude seems to shift from positive to negative while students progress during their scholarly years (McLeod, 1994). Other researchers like Haladyna et al., (1983) have found that a teacher's quality of instruction and enhancement and motivation of students is related to their attitude.

There are many factors that have an influence on how we learn. Some of these factors are not related to an individual capacity to retain information or memorize a concept, but rather to the many variables surrounding the process of learning and teaching (Walberg, 1982). In the following paragraphs I address some of the factors and approaches that have guided this study, particularly the ones related to the role of teachers and student's affect (i.e., emotions, belief, attitude, self-confident).

Affect in Mathematics

Affect toward mathematics is composed by several factors identified in previous studies (Ayob & Yasin, 2017; Zan et al., 2006). These factors have a relevant role in the learning process of mathematics. McLeod (1992) stated that affect toward mathematics has three main components that interact among them: belief, emotions, and attitude. Manzana et al. (2019), mentioned that affect toward mathematics also includes self-confidence. Some researchers like Hannula et al. (2016) discussed that Mcleod's categorization of affect toward mathematics needs to be reconsidered arguing that attitude itself as psychological measure includes emotions and belief. In any case, and for the purpose of this study, we are particularly considering the effects of variables like belief, emotions, and self-confidence and its intersection with the role of the teacher in the classroom.

Belief and Mathematics

Belief in mathematics could take many different forms. For students, belief is connected to the skills related to doing mathematics. For example, Lampert (1990) stated that students' mathematical beliefs are directly related to how fast and accurate responses can be provided to a mathematical task, solving them as taught by their teachers and by following the "rules". Then, according to Lampert, students consider that doing and knowing mathematics means following the memorized rules imposed by the teachers. Kloosterman et al. (1996), define beliefs as the "personal assumptions from which individuals make decisions about the actions they will undertake" (p. 39), where personal assumptions depend on the individual –in this case students– inherent characteristics, and social and personal experiences. The later, trigger the actions that students make and take toward mathematics.

Certainly, for many students, the above is true, but for the study presented here, belief takes a different form in which student's belief toward mathematics is related to their own perception of abilities (Bonne, 2016; McLeod, 1992), past learning experiences (Spangler, 1992), relation to other courses (Sanchal & Sharma 2017; Schoenfeld, 1989), lack of knowledge (Suthar et al., 2010), and the role of teachers as motivational catalysts for their success (Brophy, 2013; Johnson, 2017; McLeod, 1992).

Emotions in Mathematics

Student's emotions toward mathematics are influenced by cognitive, affective, motivational, and expressive factors (Gafoor & Kurukkan, 2015; Shuman & Scherer, 2014). These emotions could be positive or negative, and entail psychological reactions that affect the cognitive processes. According to Di Martino and Zan (2011), emotions could affect a student's attention and memory. In addition, emotions could potentially affect a student's abilities to function in a social context and can influence how someone adapts to life circumstances and the decision-making process (De Bellis & Goldin, 2006).

In mathematics, emotions have been proof to affect and influence student's learning and achievement (Schukajlow et al., 2017), and although anxiety has been studied with great emphasis in relation to it, researchers have now focused their attention on the role of emotions in the process of teaching and learning (Chang & Beilock, 2016). For instance, Pekrun et al. (2017)

conducted a longitudinal study with secondary students about the relationship between emotions and achievement. They found that there is a relation between the type of emotions (i.e., positive or negative) and the level of achievement and performance of students saying that the higher the positive emotions a student has, the better the scores in mathematics. In contrast, the more negative emotions a student has, the lower the scores and achievement. Student's achievement is certainly affected by emotions and vice versa. Schukajlow et al. (2017) stated that "students' achievement [positively] effects the development of positive emotions and negative effects on negative emotions... [these suggest that] emotions and [achievement] in mathematics can be linked by virtuous (entailing positive emotions) and vicious (entailing negative emotions) cycles over time" (p. 5).

Emotions can also affect how someone perceives something, in this case how students perceive mathematics. For example, if a student relates low scores and embarrassment with mathematics, it is likely that the students will only have negative emotions toward it, which in result, will hamper the student's interest, and efforts, motivation, and self-confidence.

Self-Confidence in Mathematics

Self-confidence has been defined by Bandura (1990) as someone's self-discernment about their abilities to perform a task successfully, and as the result of the intersection between self-persuasion and confident experiences ––experiences that could come from different sources like personal, social, or performance accomplishments. According to Bandura, someone's perception of performance-accomplishments is one of the most relevant factors influencing self-confidence, because they are related to experiences where mastery was achieved.

In mathematics, self-confidence refers to how students (i.e., the learner) perceive themselves in relation to their own abilities in mathematics (Adelson & McCoach, 2011; Hannula et al., 2004). According to Hannula et al., self-confidence is one of the most influential factor that impact students' learning acquisition, and that affect students' performance and achievement. These ideas are supported by studies carried by Van der Bergh (2013) and Mutodi and Ngirande (2014) who found that students with a high level of self-confidence strongly believe they have the potential and abilities to succeed in mathematics. Student's confidence that they can do mathematics is relevant, since it provides them the conviction to overcome their fears of not being able to perform as desired. In contrast, students with low self-confidence believe that regardless what they do, they would never do well in mathematics, which hampers their desire and possibilities of developing the needed habits, skills, and competence to achieve the level of performance they want or that is needed.

Student's confidence can be influenced by many factors. One factor is the classroom's teacher. Teacher's strategies to provide a high-quality instruction to engage, motivate, and encourage students has an effect on how students build their own self-confidence. Teacher's must set realistic expectations by guiding students in a scaffold way where knowledge is developed gradually. These would allow students to experience a sense of achievement, learning, and understanding, leading to a positive self-confidence.

Teacher's Role as a factor in Motivating Students to Learn

Motivation is strong factor that impact the way that students perceive mathematics (Middleton & Spanias, 1999). A motivated student works harder in improving thier own abilities and could acts as a virus that spread this emotion to other students. Crump (1995) said that motivation is defined as the way of stimulating the student's mind to learn. She goes on to mention that the major components of motivation are enthusiasm, excitement, and interest. Teachers should use motivation as a strategy for developing mathematical skills in the learning process and a way to dissipate students´ misconception. Brophy (2013) mentioned that teachers admitted that they have an important role in inspiring students to learn.

Teachers play an important role and represent a fundamental factor when it comes to motivating, engaging, and encouraging students to learn, have an active involvement in class, and to perform successfully. It is vital that both teachers and students are motivated in the dynamic process of teaching and learning (Anderman et al., 2011). According to Impact Teacher (2017), a teacher with a high level of motivation can attain a stable and energized positive educational practice that would leverage student's behaviors to learn, and ultimately to nurture their scholarly journey by helping students to increase their own personal intrinsic motivation (Reiss, 2012). Chuter (2019) stated that a motivated student will work harder to find solutions to complex tasks, and that their intrinsic motivation will foster in them "strong and flexible critical thinking skills" (p.1) that would otherwise not develop.

Motivated students are no different from those unmotivated ones, neither are more intelligence or with a higher capacity to work on their courses, however they have the necessity of having and finding responses to their questions, doubts, and inquiries. Then, it results relevant for teachers not only to answer those questions or help those motivated students find the answers they need, but to create a classroom environment and culture where unmotivated students feel the necessity of having their questions answered too, by providing opportunities to learn within topics and situations related to their context and reality (Aguilar, 2021; Lesh & Doerr, 2003). This way both motivated and unmotivated students will perform as expected in their courses.

In the classrooms, students must feel that what they are learning matters and that its related to the real-world. It is not uncommon to hear students complain about the usefulness of different courses like science, chemistry, or mathematics. But, the learning in the classrooms and how students' knowledge acquisition occurs depends––among other variables––greatly on what teachers do, the type of interactions that take place between teacher and students, and on how teachers talk, advise, prepare, and engage to their students (Ball & Forzani, 2011). In regard to the latest, Chuter (2019) suggest that to keep students motivated in class, teacher should integrate in their instruction the following practices: growth mindset, self-efficacy, normalize the struggle, create quiet spaces, and auto-acknowledgment. The mindset's growth refers to how teachers help their students realize that success and achievement are mostly related to hard work and commitment, and not really to their perception of how capable (or not) they are to perform well. Students must comprehend that accomplishment is the result of working toward a goal, which teacher should help in creating and reaching. The normalization of the struggle refers to what the National Council of Teachers of

Table 1. Independent variables recoding

Variable	Original	Recoded to
Academic Program	Spanish Track (Bilingual) English Track (Bicultural) Diploma Track (International Baccalaureate)	Bilingual Bicultural & IB
Self-Confident Perception	Very low Low Good Very Good	Low Good
School-level dislike mathematics	Elementary Middle School High School	Before High School High School
Teacher encouragement as a motivational factor to improve mathematics	Very little Little Much Very much	Little A lot

Mathematics (NCTM) calls as productive struggle (2014). Productive struggle does not mean that students should suffer to learn, it is actually the opposite, it refers to the opportunity that students have to explore different possible solutions path, alternative, or solution cycles, in order to achieve a solution to a task or situation. Similar to what happen in real-life when a problem needs to be solved and different responses and routes are followed until the desire result if found (Hiebert & Grouws, 2007; Lesh & Doeer, 2003). Cluter (2019) recommends the use of quiet spaces to enhance the critical thinking and reflection when working in task that require concentration, in particular when it is an individual work. In addition, she recommends that tasks that requires students collaborating in teams are separated from those where the students work individually. Another recommendation is that teachers helps their students realize and acknowledge that failure is always a possibility. In particular, for students that are over motivated, its important that teachers help them understand that not finding a right answer, or perhaps not being the first one in finishing a task, does not means they can't successfully complete the work. Controlling and understanding the above would help students manage their emotions in a more successful way, and will avoid frustration when not having the desire outcome (Kapur, 2014).

METHODOLOGY, DATA COLLECTION, AND PARTICIPANTS

In this study, high school students were asked about their attitude, beliefs, and motivations toward mathematics. To understand the reasons behind student's motives and beliefs toward mathematics, I followed a convergent parallel mixed-method approach (Mills & Gay, 2019) to implement a questionnaire that combines open-ended, closed-ended (e.g., forced ranking scale, or multiple and single responses), and liker-scale items (Sauro, 2018; McLeod, 2019) (see **Appendix A**). According to Creswell and Pablo-Clark (2011) the implementation of a convergent parallel design requires researches to simultaneously implement and collect the quantitative and qualitative components at the same time in the research process, analyze the data independently, and considering equally all the information found for interpretations.

In the quantitative component of the study, I report here the descriptive statistic of the data and an inferential analysis considering a Chi-Square test (Welkowitz et al., 2006), in which I analyzed the association between the variables using the SPPS statistical software. The dependent variable corresponded to whether or not students like mathematics (i.e., Like Math), and as independent variables I considered the participant's gender, academic program, motivation, reported student's attitude toward mathematics (i.e., when students acknowledged they do not like mathematics), teacher encouragement, and their self-confident in mathematics. Some of the independent's variables were recoded to facilitate the analysis (Babbie et al., 2018; Meyers et al., 2013) as its depicted in **Table 1**.

In the open-ended questions participants were asked to state their reasons for which they considered mathematics not to be a subject they like most when compared to other subjects. Almost six-hundred responses were received. These responses were categorize following a descriptive double-round inductive process (Miles et al., 2018; Saldana, 2014). During the first phase of the process all the student's responses were categorize In Vivo (Saldaña, 2014) into 19 main categories (See **Table 2**). These categories were reduced during the second phase of the coding process to five major characteristics of the student's perceptions and belief toward mathematics (See **Table 3**).

All the codes that emerged from the In Vivo coding process were re-coded into five different categories as mentioned before. All the categories correspond to the student's belief and perception toward mathematics and summarized the voice of the students in regard to mathematics. It seems that their own perception about their knowledge of mathematical content knowledge is what led their perception.

Participants

The study took place in a private institution located north Mexico, about two hours from the border with the United States. Participants were high school students in grades 11-12th, from which 350 participated in the study. For the purpose of the report presented here, only responses from participants that rated mathematics as not their first or second most preferred school subject were considered. In total, 197 student's responses were used for the analysis, from which 40% were male and 60% female.

The high school students in this institution were enrolled in three different academic programs: The Spanish track (i.e., bilingual), English track (i.e., bicultural), and Diploma from the International Baccalaureate (i.e., IB) track. In the Spanish track

Table 2. Student's reasons for disliking mathematics

Category	Percentage
I do not feel attracted to	16%
Too much work	13%
It's boring	9%
It's confusing	8%
It's difficult	7%
I don't receive motivation	7%
I am not good enough	6%
I do not understand	5%
It is tedious	5%
Any other subject is easier	5%
Teachers do not explain	4%
Too much to memorize	4%
I forget what I already learn	3%
Teachers way of teaching	2%
Too exact	2%
I never know what to do	1%
I get distracted	1%
Needs to much practice	1%
I have other interests	1%

Table 3. Student's categories for disliking mathematics

Category	Percentage
Confident in mathematics content knowledge perception	38%
Motivation	26%
Lack of interest or apathy	21%
Teacher encouragement and related factors	13%
General Self Perception	2%

program, students took all their courses in Spanish. In the English track, students took their courses in English and are enrolled in a third language. The diploma is a high-rigor academic program that allows students to transfer credits from high school courses to college. Approximately 55% of the students that participated in the study were enrolled in the Spanish track, and 40% and 5% for the English and Diploma program respectively.

The Instrument

The instrument used for this study (See **Appendix A**) was a short-focus questionnaire adapted from several prominent researchers (Kislenko et al., 2007; Prendergast & Hongning, 2016; Schoenfeld, 1985) with the idea to capture in a snapshot the student's perception toward mathematics related to factors such motivation, belief, self-confidents mathematics, and teacher's role as extrinsic agent of motivation.

In the instrument, students were first requested to rate from 1 to 5 several subjects (e.g., mathematics, physics, computer science, literature, and history) based on their perceptions and beliefs, where one represented the most preferred and 5 the least preferred subject. Since the goal of the study was to have a better understanding of the negative attitude, reasons, perceptions, and belief students have toward mathematics, only those students that rated mathematics as their third, fourth, or fifth option, were asked to continue the questionnaire. Immediately after, the students were asked when they did realize that mathematic was not one of their most preferred subjects, and why, for which they were requested to provide at least three reasons. Then, students were asked if their perception toward mathematics was related to their self-confident in mathematics, their study habits, or if it was related to their teachers. Likewise, students were asked about how they perceive their ability in mathematics, and if the motivation and enhancement received from their teachers played any role in their perception toward mathematics. Finally, students were asked if in general they like or not mathematics.

Although the instrument implemented in this study was short in length, it was deep in substance. In the end, the survey was intended to serve as a tool that allowed me to capture student's perception, belief, and opinions toward mathematics in a simple but straightforward way.

FINDINGS AND RESULTS

It is not a surprise that students from different grade levels depict a dislike or negative attitude toward mathematics (Quinn & Jadav, 1987), despite their abilities or proficiency in mathematics. In this study I strived to uncover the reasons behind students' reluctant negative attitude and perception toward mathematics regardless of their academic achievement, and since when they knew mathematics was not one of their most preferred subjects. In this regard, 77% of the students responded that they knew mathematics was not their most preferred subject since elementary or middle school, while 23% stated that they discovered it in high school. These reflect the difficult task that educators have in breaking years of student's bad habits, misconception, low self-esteem, and lack of confident and motivation (Johnson, 2017). In this study, high school students were asked about the reasons

for which mathematics was not one of their most attractive subjects. Since the goal of the study presented here was to find the reasons and motive for which students dislike mathematics, only students that did not rate mathematics as their first or second most preferred subject among five different school subjects were asked to express their motives. In total, the students provided 588 responses. These responses were coded and categorized into nineteen themes (see **Table 2**).

Table 2 depicts all the reasons for which students expressed mathematics was not their most preferred subject. The number one reason for the students to have a negative attitude toward mathematics, was as simple as they do not feel attracted to it, followed by the fact that students find mathematics as a subject that requires "too much work". However, its well known that practice is essential in mathematics to develop fluency (NCTM, 2014), but not to develop conceptual understanding, for which it is understandable that teachers assign homework that is perceived as time consuming (Cooper et al., 2006). As the third most important reason, students mentioned mathematics is "boring", followed by "confusing and difficult" with eight, and seven percent respectively. Certainly, it will be perceived as boring if teachers do not have an inquire approach where mathematics become more that only numbers and letters. In addition, a lack of connection with real life situations could contribute to a lack of student's engagement and motivation toward mathematics, which, could potentially hamper the student's perception about the beauty and benefits of mathematics, and how it is a ubiquity science that can be observed everywhere (de Castro, 2020).

A revealing reason that was not mentioned by the students as much as expected, was the influence that teachers have in motivating, engaging, and encouraging students to do and work in mathematics task and activities. In these regards, only seven percent of the students mentioned that they do not perceive that their teachers motivate them to learn. Similarly, two percent of the students mentioned that their teachers do not have a teaching strategy that support their learning, and four percent that their teacher do not explain at all. The student's perceptions could be related to a lack of teacher preparation and training in both content and pedagogy that projects the teacher's inability to engage their students in the mathematical classroom (Maryani & Martaningsih, 2015).

Several other reasons were related to the student's self-confidence and attitude toward mathematics. For example, six percent of the students expressed not having the ability to perform well in mathematics, or that they simply don't understand, which was mentioned by five percent of the students. A smaller number of students (one percent) expressed not knowing what to do when solving a mathematical task. These reasons for disliking mathematics can be addressed by teachers by paying attention into what the students are struggling with and by using teaching pedagogies that elicit the student's understandings and knowledge (Lesh & Doeer, 2003). All the student's reasons mentioned above were classified into five main categories (see **Table 3**) that highlighted the major reasons for students to feel not interested toward mathematics.

In **Table 3**, all the reasons categorized in **Table 2**, were summarized. The major reason, as mentioned by the students is not having the confidence of a deep content mathematical knowledge. This is an indication that students recognized a lack of content knowledge that hamper their understandings of mathematics. Likewise, this reason is related to the second and third reason: lack of motivation and interest. While understanding is important, if students do not find or have the reasons, engagement, motivation, or encouragement to do mathematics, it is unlikely they will develop a proficiency in mathematics (Yeh et al., 2019). In addition, student's lack of mathematical content knowledge might have been the result of a low-quality mathematical instruction in previous school years (e.g., elementary or middle school) or to a difficult learning experience (Sogunro, 2017).

The second and third category are closely related to the fourth reason since it corresponds to the teacher's effectiveness in providing an instruction that engage, enhance, and encourage students to learn mathematics. Even thought it was not the first reason, teachers can influence students in both a negative or positive direction (Blazar & Kraft, 2017). This includes how a motivated teacher can transfer that motivation to the students in a way that transforms the student's negative mindset (Han & Yin, 2016).

The last category of reasons is related to the student's self-perception and confidence that they can effectively do mathematics. As mentioned above, if the students do not perceive to have the knowledge to do and learn mathematics, they will probably have a low self-esteem and negative attitude toward mathematics, as one of the students participating in the study mentioned, "I am just not good at math". Student's self-confidence play a relevant role on the student's learning acquisition of mathematics (Hannula et al., 2014).

Statistical Analysis

Student's reasons to a negative attitude toward mathematics can be influenced by many different variables as depicted above, and even when some of the reasons were organized and showed, many other aspects (e.g., previous experience, social economic status, background, or access to resources, among others) can also affect the student's perception, motivation, and attitude. However, in this study, I am only showing some of the reasons mentioned by high school students. These reasons can potentially be considered by teachers and curriculum developers to provide a richer learning experience. In addition of studying the student's reasons for a negative attitude toward mathematics, I conducted a statistical analysis of other factors that could potentially have an effect on the students' attitude toward mathematics. These factors are: gender, academic program, teacher motivation, the perception of own abilities, and the grade level for when student's discover their perception toward mathematics.

In the following paragraphs, I depict the results of the statistical analysis that was conducted to better understand the reasons and attitudes of the high schools' students toward mathematics. **Table 4** depicts the descriptive statistic of the different variables.

Several inferential statistical analyses were conducted to examine the relation between the variables. As mentioned above, all the statistical analysis performed was done considering a chi-square test of independence.

The first analysis was performed to test the relation between student's self-confidence and their perception of mathematics as a subject they like or not (i.e, like math). After conducting the analysis, I found that these variables were significant, X2 (2, N =

Table 4. Descriptive statistics

Variables	*N*	*M*	*SD*
Like mathematics	197	1.47	0.5
Academic Program	197	1.55	0.66
Gender			
Male	79	1.61	0.49
Female	118	1.72	0.55
Self-Confident in mathematics	197	1.71	0.45
Schooling level for disliking mathematics	197	1.23	0.42
Abilities in mathematics	197	1.73	0.45

197) = 13.39, p <.01. This means that students who reported feeling confident in solving mathematical tasks, do not depict a positive attitude toward mathematics. It can be inferred here that the student's ability for mathematics or science is not always correlated with a STEM path career in the future.

Similarly, chi-square test was implemented to examine the relation between student's perception in mathematics as a subject they like or not (i.e, like math) and if that perception would change if their mathematical ability improved. I found that these variables were significant, X2 (2, N = 197) = 12.89, p <.01, which means that helping and supporting students improve their mathematical proficiency would change their attitude and belief toward mathematics. Students with a negative perspective about mathematics is mostly related to a lack of proficiency, conceptual understanding, and procedural fluence. Students must be shown the beauty of mathematics and its connection to the real life with examples of how mathematics is ubiquitous.

In this study, I also analyzed the teacher's encouragement, enhancement, and motivation as a factor that could potentially affect the student's perceptions and beliefs toward mathematic. The chi- square test performed depicted that the variables were significant, X 2 (2, N = 197) = 21.14, p <.01. Evidence was found that receiving support from teachers, would significantly help students appreciate mathematics with a different more positive perspective, in particular those students with a negative attitude toward mathematics. This finding aligns with what Schmoker, (2006) mentioned about the importance and impact of teachers on the student's learnings, beliefs, attitudes, and motivations.

When analyzing if gender potentially has an effect in the student's perceptions and attitude toward mathematics, I found the relation between the variables not to be significant with a chi-square X2 (2, N = 197) = 1.05, p > .01. This highlight a contrasting belief that mathematics is mostly a male-gender-driven subject (Kane & Mertz, 2012). According to the evidence found through this analysis, gender cannot be considered as a variable that would have an effect in the student's attitude toward mathematics. Similarly, the academic program the students were enrolled (i.e., i.e., in Spanish, English, or International Baccalaureate) does not represent a significant variable that affects the students' attitude and perception or their opinion if they like mathematics or not. In this regard, a chi-square test X 2 (2, N = 197) = 14.14, p >. 01. resulted not significant.

CONCLUSIONS

Student's motivation, perception, belief, and attitude toward mathematics are influenced by many factors, including social and cultural aspects as Kane and Mertz (2012) stated. If student's confidence and self-perception in mathematics is not met, it is likely that they will develop long-lasting negative attitudes toward mathematics, as found in this study, in which high school students reportedly acknowledge their negative perception toward mathematics since elementary or middle school. Then, teachers at all levels, must instill constructive encouragement and attitude in mathematics to halt student's misconception, and in return develop their cognitive abilities and improve their achievement and attitude toward mathematics.

In this study, we found evidence that some of the most relevant factors influencing high-school student's perception and attitude toward mathematics are related to their self-perception and motivation (Hannula et al., 2004), the confidence and self-perception in mathematics knowledge (Boyer & Mailloux, 2015), their lack of interest (Heinze et al., 2005), and teacher's encouragement (Tambunan, 2018).

The student's self-perception about their mathematical knowledge was the first reason they mentioned to have a negative attitude toward mathematics. This means that the students realized their lack of mathematical understanding. It is likely that this lack of knowledge is a projection of what the students have been missing since the very early stages, which is when the foundational concepts are set. Then, there is an opportunity for teachers to work on changing the student's point of view regarding mathematics by breaking their misconceptions and scaffolding their mathematical knowledge acquisition.

In terms of teaching motivation and encouragement, it is crucial that teachers give their students words of praise not only when they get an answer correct, but also when the students have done an effort to externalize their thought and provide a solution to a task, even if the solution still needs work.

Finally, I would like to say that more research is needed with the purpose of correlating this type of study with assessments. In this way, it could be tested whether such variables like gender, program, teacher´s motivation and other variables, have a real impact in the improvement of the student´s skill, enjoyment, motivation, and achievement.

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REFERENCES

Adelson, J. L., & McCoach, D. B. (2011). Development and psychometric properties of the math and me survey: Measuring third through sixth graders' attitudes toward mathematics. *Measurement and Evaluation in Counselling and Development, 44*(4), 225-247. https://doi.org/10.1177/0748175611418522

Aguilar, J. J. (2021). Modeling through model-eliciting activities: An analysis of models, elements, and strategies in high school. The cases of students with different level of achievement. *Mathematics Teaching Research Journal*, *13*(1), 51-72.

Ajzen, I. (1993). Attitude theory and the attitude-behavior relation. In P. Schmidt, & D. Krebs (Eds.), *New directions in attitude measurement* (pp. 41-57). De Gruyter.

Anderman, L. H., Andrzejewski, C. E., & Allen, J. (2011). How do teachers support students' motivation and learning in their classrooms. *Teachers College Record*, *113*(5), 969-1003.

Ayob, A., & Yasin, R. M. (2017). Factors affecting attitudes towards mathematics. *International Journal of Academic Research in Business and Social Sciences, 7*(11), 1100-1109. https://doi.org/10.6007/IJARBSS/v7-i11/3548

Babbie, E., Wagner III, W. E., & Zaino, J. (2018). *Adventures in social research: Data analysis using IBM SPSS statistics*. Sage Publications.

Ball, D. L., & Forzani, F. M. (2011). Building a common core for learning to teach: And connecting professional learning to practice. *American Educator*, *35*(2), 17.

Bandura, A. (1990). Perceived self-efficacy in the exercise of personal agency. *Journal of Applied Sport Psychology*, *2*(2), 128-163. https://doi.org/10.1080/10413209008406426

Blazar, D., & Kraft, M. A. (2017). Teacher and teaching effects on students' attitudes and behaviors. *Educational Evaluation and Policy Analysis*, *39*(1), 146-170. https://doi.org/10.3102/0162373716670260

Bonne, L., & Johnston, M. (2016). Students' beliefs about themselves as mathematics learners. *Thinking Skills and Creativity*, *20*, 17-28. https://doi.org/10.1016/j.tsc.2016.02.001

Boyer, J. C., & Mailloux, N. (2015). Student teachers' self-perception of their mathematical skills and their conceptions about teaching mathematics in primary schools. *Procedia-Social and Behavioral Sciences*, *174*, 1434-1442. https://doi.org/10.1016/j.sbspro.2015.01.772

Brophy, J. E. (2013). *Motivating students to learn*. Routledge. https://doi.org/10.4324/9780203858318

Chang, H., & Beilock, S. L. (2016). The math anxiety-math performance link and its relation to individual and environmental factors: A review of current behavioral and psychophysiological research. *Current Opinion in Behavioral Sciences*, *10*, 33-38. https://doi.org/10.1016/j.cobeha.2016.04.011

Chuter, C. (2019). *The role of motivation in learning*. The Education Hub. https://theeducationhub.org.nz/motivation/

Cooper, H., Robinson, J. C., & Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Review of Educational Research, 76*(1), 1-62. https://doi.org/10.3102/00346543076001001

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research*. Sage.

Daskalogianni, K., & Simpson, A. (2000). Towards a definition of attitude: The relationship between affective and cognitive in pre-university students. In T. Nakahara and M. Koyama (Eds.), *Proceedings of the 24th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 217-224). Hirishima, Japan.

De Bellis, V., & Goldin, G. (2006). Affect and meta-affect in mathematical problem solving: A representational perspective. *Educational Studies in Mathematics*, *63*(2), 131-147. https://doi.org/10.1007/s10649-006-9026-4

De Castro, J. (2020, January 26). *Challenging the ubiquity of mathematics*. https://medium.com/@joaquindecastro/challenging-the-ubiquity-of-mathematics-6ad95686c9fe

Di Martino, P., & Zan, R. (2001). Attitude toward mathematics: some theoretical issues. In M. van den Heuvel-Panhuizen (Eds.), *Proceedings of the 25th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 209-216). Freudenthal Institute, University of Utrecht, Utrecht, the Neatherlands.

Di Martino, P., & Zan, R. (2011). Attitude towards mathematics: A bridge between beliefs and emotions. *Zdm, 43*(4), 471-482. https://doi.org/10.1007/s11858-011-0309-6

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Harcourt Brace Jovanovich College Publishers.

Frost, L. A., Hyde, J. S., & Fennema, E. (1994). Gender, mathematics performance, and mathematics related attitudes and affect: a meta-analytic synthesis. *International Journal of Educational Research, 21*, 373-385. https://doi.org/10.1016/S0883-0355(06)80026-1

Gafoor, K. A., & Kurukkan, A. (2015). *Why high school students feel mathematics difficult? An exploration of affective beliefs* [Paper presentation]. The UGC Sponsored National Seminar on Pedagogy of Teacher Education, Trends and Challenges, Kozhikode, Kerala, India.

Gallagher, A. M., & Kaufman, J. C. (2005). *Gender Differences in Mathematics: What We Know and What We Need to Know*. Cambridge University Press. https://doi.org/10.1017/CBO9780511614446.016

Haladyna, T., Shaughnessy, J., & Shaughnessy, M. (1983). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education, 14*, 19-29. https://doi.org/10.5951/jresematheduc.14.1.0019

Han, J., & Yin, H. (2016). Teacher motivation: Definition, research development and implications for teachers. *Cogent Education*, *3*(1), 1217819. https://doi.org/10.1080/2331186X.2016.1217819

Hannula, M. S., Di Martino, P., Pantziara, M., Zhang, Q., Morselli, F., Heyd-Metzuyanim, E., Lutovac, S., Kaasila, R., Middleton, J. A., Jansen, A., & Goldin, G. A. (2016). Attitudes, beliefs, motivation, and identity in mathematics education. In *Attitudes, Beliefs, Motivation and Identity in Mathematics Education, ICME-13 Topical Surveys.* Springer, Cham. https://doi.org/10.1007/978-3-319-32811-9_1

Hannula, M. S., Maijala, H., & Pehkonen, E. (2004). Development of understanding and self-confidence in mathematics; Grades 5-8. *International Group for the Psychology of Mathematics Education*.

Head, J. (1989). The affective constraints on learning science. *Adolescent Development and School Science*, 162-167.

Heinze, A., Reiss, K., & Franziska, R. (2005). Mathematics achievement and interest in mathematics from a differential perspective. *ZDM*, *37*(3), 212-220. https://doi.org/10.1007/s11858-005-0011-7

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. *Second Handbook of Research on Mathematics Teaching and Learning*, *1*, 371-404.

Impac Teachers (2017, February 7). *Why a motivated teacher is key to the classroom*. https://www.impactteachers.com/motivated-teacher-key-classroom/

Johnson, D. (2017). The Role of Teachers in Motivating Students to Learn. *BU Journal of Graduate Studies in Education*, *9*(1), 46-49.

Kane, J., & Mertz, J. (2012). Debunking the myth: Sex differences in math performance. *Notices of the American Mathematical Society*, *59*, 10-21. https://doi.org/10.1090/noti790

Kapur, M. (2014). Productive failure in learning math. *Cognitive science*, *38*(5), 1008-1022. https://doi.org/10.1111/cogs.12107

Kibrislioglu, N. (2015). An investigation about 6th grade students' attitudes towards mathematics. *Procedia-Social and Behavioral Sciences, 186*, 64-69. https://doi.org/10.1016/j.sbspro.2015.04.024

Kislenko, K., Grevholm, B., & Lepik, M. (2007). Mathematics is important but boring: Students' beliefs and attitudes towards mathematics. In *Nordic Conference on Mathematics Education* (pp. 349-360). Tapir Academic Press.

Kloosterman, P. (1988). Self-confidence and motivation in mathematics. *Journal of Educational Psychology*, *80*(3), 345. https://doi.org/10.1037/0022-0663.80.3.345

Kloosterman, P., Raymond, A. M., & Emenaker, C. (1996). Students' beliefs about mathematics: A three-year study. *The Elementary School Journal*, *97*(1), 39-56. https://doi.org/10.1086/461848

Kunhertanti, K., & Santosa, R. H. (2018, September). The influence of students' self confidence on mathematics learning achievement. In *Journal of Physics: Conference Series* (Vol. 1097, No. 1, p. 012126). IOP Publishing. https://doi.org/10.1088/1742-6596/1097/1/012126

Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal, 27*, 29-63. https://doi.org/10.3102/00028312027001029

Larsen, J. (2013). Attitude in mathematics: A thematic literature review. Simon Fraser University.

Lesh, R. E., & Doerr, H. M. (2003). *Beyond constructivism: Models and modeling perspectives on mathematics problem solving, learning, and teaching*. Lawrence Erlbaum Associates Publishers. https://doi.org/10.4324/9781410607713

Maryani, I., & Martaningsih, S. T. (2015). Correlation between Teacher's PCK (Pedagogical Content Knowledge) and student's motivation in primary school. *International Journal of Evaluation and Research in Education*, *4*(1), 38-44. https://doi.org/10.11591/ijere.v4i1.4490

Mazana, M. Y., Montero, C. S., & Casmir, R. O. (2019). Investigating Students' Attitude towards Learning Mathematics. *International Electronic Journal of Mathematics Education, 14*(1), 207-231. https://doi.org/10.29333/iejme/3997

McLeod, D. (1992). Research on Affect in Mathematics Education: A Reconceptualization. *In D. Grows (Ed), Handbook of Research on Mathematics Teaching and Learning* (pp. 575-596). McMillan Publishing Company.

McLeod, D. (1994b). Research on affect and mathematics learning in the JRME: 1970 to the present. *Journal for Research in Mathematics Education, 24*, 637-647. https://doi.org/10.5951/jresematheduc.25.6.0637

McLeod, S. A. (2019, August 03). *Likert scale*. Simply Psychology. https://www.simplypsychology.org/likert-scale.html

Meyers, L. S., Gamst, G. C., & Guarino, A. J. (2013). *Performing data analysis using IBM SPSS*. John Wiley & Sons.

Middleton, J. A., & Spanias, P. A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for research in Mathematics Education*, *30*(1), 65-88. https://doi.org/10.2307/749630

Miles, M. B., Huberman, A. M., & Saldaña, J. (2018). *Qualitative data analysis: A methods sourcebook*. Sage publications.

Mills, G. E., & Gay, L. R. (2019). *Educational research: Competencies for analysis and applications*. Pearson.

Mutodi, P., & Ngirande, H. (2014). The influence of students perceptions on mathematics performance. A case of a selected high school in South Africa. *Mediterranean Journal of Social Sciences*, *5*(3), 431. https://doi.org/10.5901/mjss.2014.v5n3p431

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*.

Prendergast, M., & Hongning, Z. (2016). A comparative study of students attitudes towards mathematics in two different school systems. *International Journal for Mathematics Teaching and Learning*, *17*(2).

Quinn, B., & Jadav, A. D. (1987). Causal relationship between attitude and achievement for elementary grade mathematics and reading. *The Journal of Educational Research*, *80*(6), 366-372. https://doi.org/10.1080/00220671.1987.10885785

Reiss, S. (2012). Intrinsic and extrinsic motivation. *Teaching of Psychology*, *39*(2), 152-156. https://doi.org/10.1177/0098628312437704

Saldaña, J. (2021). *The coding manual for qualitative researchers*. Sage.

Sanchal, A., & Sharma, S. (2017). Students' attitudes towards learning mathematics: Impact of teaching in a sporting context. *Teachers and Curriculum*, *17*(1), 89-99. https://doi.org/10.15663/tandc.v17i1.151

Sauro, J. (2018, August 14). 15 Common Rating Scales Explained. *Measuring U*. https://measuringu.com/rating-scales

Schoenfeld, A. H. (1985). Students' beliefs about mathematics and their effects on mathematical performance: A questionnaire analysis. Paper presented at the annual meeting of PME-NA.

Schoenfeld, A. H. (1989). Explorations of students' mathematical beliefs and behavior. *Journal for Research in Mathematics Education*, *20*(4), 338-355. https://doi.org/10.5951/jresematheduc.20.4.0338

Schukajlow, S., Rakoczy, K., & Pekrun, R. (2017). Emotions and motivation in mathematics education: theoretical considerations and empirical contributions. *ZDM*, *49*(3), 307-322. https://doi.org/10.1007/s11858-017-0864-6

Shuman, V. & Scherer, K. R. (2014). Concepts and structures of emotions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 13-35). Taylor & Francis.

Sogunro, O. A. (2017). Quality Instruction as a motivating factor in higher education. *International Journal of Higher Education*, *6*(4), 173-184. https://doi.org/10.5430/ijhe.v6n4p173

Spangler, D. A. (1992). Assessing students' beliefs about mathematics. *The Mathematics Educator*, *3*(1). https://doi.org/10.5951/AT.40.3.0148

Stevens, K. (2015). *Gender bias in teacher interactions with students* (Master of Education thesis). Department of Education, Dordt College, Iowa.

Suthar, V., Tarmizi, R. A., Midi, H., & Adam, M. B. (2010). Students' beliefs on mathematics and achievement of university students: Logistics regression analysis. *Procedia-Social and Behavioral Sciences*, *8*, 525-531. https://doi.org/10.1016/j.sbspro.2010.12.072

Tahar, N. F., Ismail, Z., Zamani, N. D., & Adnan, N. (2010). Students' attitude toward mathematics: The use of factor analysis in determining the criteria. *Procedia Social and Behavioral Research, 8*, 476-481. https://doi.org/10.1016/j.sbspro.2010.12.065

Tambunan, H. (2018). The dominant factor of teacher's role as a motivator of students' interest and motivation in mathematics achievement. *International Education Studies*, *11*(4), 144-151. https://doi.org/10.5539/ies.v11n4p144

Van der Bergh, E. (2013). *The influence of academic self–confidence on mathematics achievement* (Doctoral dissertation), North-West University.

Walberg, H. J. (1982). Educational productivity: Theory, evidence, and prospects. *Australian Journal of Education*, *26*(2), 115-122. https://doi.org/10.1177/000494418202600202

Welkowitz, J., Cohen, B. H., & Ewen, R. B. (2006). *Introductory statistics for the behavioral sciences*. John Wiley & Sons.

Yeh, C. Y., Cheng, H. N., Chen, Z. H., Liao, C. C., & Chan, T. W. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning*, *14*(1), 1-19. https://doi.org/10.1186/s41039-019-0100-9

Zan, R., Brown, L., Evans, J., & Hannula, M. S. (2006). Affect in mathematics education: An introduction. *Educational Studies in Mathematics, 63*(2), 113-121. https://doi.org/10.1007/s10649-006-9028-2

APPENDIX A – QUESTIONNAIRE

Gender:

Academic Program:

Grade Level:

1. List your favorite subjects from 1 -5 where 5 is the most attractive and 1 the least attractive.
2. Since when you know math is not once of your favorite subjects?
3. Mention the 3 most important reasons why mathematics wasn't your first or second option.
4. The fact that mathematics is not your most attractive subject, in your opinion, is because: (select at least one): Your math abilities, school habits, Teachers, other.
5. If you could measure your mathematics proficiency, how would you say it is?
6. Would you say that receiving motivation from your math teacher would help you improve your abilities and skills?
7. In general, do you like math?