Let's Talk Math: Effects of Discourse

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Abstract: In 2020, the COVID pandemic greatly affected students when schools closed and they started attending school virtually. When students came back to school in August of 2021, there were problems with students talking in excess. In addition, during virtual learning students found math difficult to learn online and some have admitted they resorted to cheating. This made students constantly question themselves and not believe in their ability to complete a math problem. In the current study, the effect of discourse on the students' math self-efficacy, intrinsic motivation and overall attitude towards math was explored. Open tasks and talk moves were utilized to encourage discourse. There were 71 Algebra 1 Core students from a rural high school that participated in the study. Students completed a pre- and post-Likert scale survey to measure their self-efficacy, intrinsic motivation and aspects of attitude: enjoyment, anxiety, value, confidence and intrinsic motivation. They answered questions specifically if the activities affected their self-efficacy, intrinsic motivation and overall attitude towards math. Finally, the students were observed to see how often specific behaviors were seen each week. There was no significant change with enjoyment (*p-value* of 0.42). self-efficacy (*p-value* of 0.14), confidence (0.56), anxiety (*p-value* of 0.54), and overall attitude (*p-value* of 0.08). While there was a significant change with intrinsic motivation (*p-value* of 0.01) and value (*p-value* of 0.008), the mean decreased between pre-survey and post survey Likert scale. Using the responses from the post survey, almost 56% believed that they were more intrinsically motivated, about 56% feel like their ability to complete a math problem changed, between 27.7% and 55.6% of the students believed that their math self-efficacy increased because of the activities and finally about 46% of the students like math more because of the activities. The observations showed a decrease in the behaviors of giving up on a problem and saying they can't do it. Overall, the results demonstrate that teachers should utilize math discourse in the classroom as they support that discourse improves student understanding and can positively affect self-efficacy, intrinsic motivation and attitude towards math.

Introduction and Justification

Teachers have seen a difference in their students' behaviors when most schools started in person in August of 2021 (Ryder-Marks, 2022). A majority of the students had been out of school for over a year. The students did not receive the socialization and access they needed to do well in school and to grow as a person. As a result teachers have had more disruptions from the students than in previous years (Ryder-Marks, 2022). There were more fights and students were having difficulty controlling their emotional reactions. School staff have noted that they have seen more students with anxiety and depression than in previous years before the pandemic. Additionally, schools had problems with students who follow social media trends as some trends have been started to make threats and to deface school property. Students had trouble with their time management as the students got used to the virtual school routine where school days were shorter, they had an asynchronous day each week and teachers gave students less homework. Coming back to school and trying to acclimate themselves to that routine takes time and now some students have more commitments like jobs, and extracurriculars such as clubs and sports. A seventh grade teacher believed that her seventh graders were acting like fifth graders in

regards to their immature behavior. In my placement, the high school teachers saw a big difference as their 9th grade students acted more like middle schoolers as for most of the students this is the first time they have been in an actual classroom since COVID-19 shut down schools. Therefore, they want to socialize but they don't have any time in class to socialize. I have noticed more students off topic and socializing during instructional time. They have also lost their confidence in their ability to do math. Some have admitted to cheating while in virtual class and others did poorly compared to previous years. The overall students' attitude towards math has been negative. Some students refuse to participate and barely do any work during class. Several students have already asked why they are learning math because they consider it pointless as they believe they will never use any of the content. Therefore, I implemented math discourse to address post-Covid issues seen in the classroom.

The purpose of this study is to aid teachers who want to implement discourse and understand the relationship between discourse and their students' intrinsic motivation, self-efficacy and attitude towards mathematics. For the purpose of this study, discourse has been defined as "the genuine sharing of ideas among participants in a mathematics lesson, including both talking and active listening" (Hancewicz et al., 2005). Sharing can happen in four ways: the teacher and student, a student and another student, small groups and whole discussion. Open tasks are problems that give students choice, have less information to encourage productive struggle, allow students to find more than one solution path, have students explain their reasoning and include a real-world context (Hodge & Walther, 2017).

Intrinsic motivation is defined as the reason for doing an activity is because of the activity itself (Liu et al., 2019). It involves a persons' interest, pleasure, perseverance and development. Research has found that greater intrinsic motivation can cause an increase in the effort students put into class, learning quality, adaptive manners and perseverance. Liu et al. (2019) found that intrinsic motivation has strong and favorable effects. Intrinsic motivation was found to positively affect the students' academic performance. It also was found to have long term effects on students' self-efficacy, identity, and amount of effort they put forth in class. The study also showed that the effects of intrinsic motivation will decrease over time.

Bandura (1994) defines self-efficacy as a person's belief that they are able to produce results. Self-efficacy is affected by a person's own success, seeing other people achieve success, encouragement from others and negative factors such as stress and fatigue. Other definitions of self-efficacy are similar to Bandura's definition but can be more specific. For instance, Palestro & Jameson (2020) define self-efficacy as a person's belief in their ability to finish an assignment. In addition, self-efficacy is the foundation of self-regulatory learning. Students who have a higher self-efficacy are more likely to utilize productive learning and problem-solving practices, greater intrinsic value for education and greater performance results. Performance results involve educational achievement, standardized test scores, and classroom success. High levels of self-efficacy was also found to improve math performance directly as they are more likely to believe they can succeed and also indirectly though instrumental motivation (Liu et al., 2020). A high level of self-efficacy can also lead to students being less likely to develop extreme anxiety because students with higher self-efficacy think of bad circumstances as a chance to develop and utilize their personal skills.

Researchers have found that the students' attitude can affect their learning (Mazana et al., 2019). One reason for students' poor math achievement is the students' negative attitude towards math. Mazana et al. (2019) used the ABC Model of Attitude in their study to look at five characteristics of attitude: self-confidence, math anxiety, math enjoyment, intrinsic motivation and usefulness of math. They found that students' attitude had the strongest relationship with usefulness of math, self-confidence, math enjoyment, and intrinsic motivation. Although there was a positive significant relationship between academic achievement and the attitude characteristics of usefulness, confidence, enjoyment and motivation, the relationship was not strong. The correlation between a students' math anxiety and their grade was not significant.

My research questions are

- How does math discourse affect students' intrinsic motivation?
- How does math discourse affect students' math self-efficacy?
- How does math discourse affect students' attitude towards mathematics?

In the next section, I will discuss the existing literature pertaining to discourse; next, I will describe my methodology and the data I will collect.

Literature review

Discourse: What is it and why is it important?

Hancewicz et al. (2005) has defined discourse as people sharing their thoughts through discussion and actively listening. Discourse can happen between the teacher and student, between a student and another student, in small groups and a class discussion. They also talk about how discourse helps students develop efficient algorithms for better computation skills, allows students to develop their understanding of the mathematical concepts while slowly integrating vocabulary and assists students in their problem solving by aiding students in exhibiting their work and showing their diverse range of strategies to solve a problem. Discourse allows students to develop their math reasoning and demonstrate their knowledge (Walshaw & Anthony, 2017). If teachers are effectively using discourse as a strategy, they utilize the students' understanding and answers as discussion topics. This can then show students that their input is appreciated which helps students see math as something that is produced by communities, assists students' learning by making them a part of the creation and validation of ideas and aids students in becoming aware of more conceptually complex ideas. There is also a direct correlation between teacher-student relationship quality and the students' discussion of their math understanding (McChesney, 2005, as cited in Walshaw & Anthony, 2017).

Implementing Discourse

There are five categories of discourse with four different levels (National Council of Teachers of Mathematics, 2014). The five categories of discourse are: teacher role, questioning, explaining mathematical thinking, mathematical representations, and building student responsibility with the community. Level 0 is the lowest level which is characterized by the teacher dominating the discussion, staying only at the front of the room, and only asking questions based on correctness. In this level, teachers provide no representations or they only display the representations and the classroom environment

encourages students to give answers only when asked. Level 3 is the highest level which is characterized by students leading the discussion, asking each other questions, justifying and critiquing strategies and answers, supporting the use of representations and seeing themselves as mathematical leaders. In another study, Wachira et al. (n.d.) looked at four practices which were like the four levels of discourse NCTM discussed. They found that students were opposed with strategy four establishing formal discourse which includes students leading the discussion while the teacher helps when needed and observes. This shows that the teacher needs to start at the beginning of the year creating a classroom environment in which students will not oppose practice 4. To support classroom discourse, teachers have to establish the classroom environment as one that thinks the students' understanding is more important than the correct answer.

Kersaint (2015) discusses how the first step to create a discourse rich community is to make the classroom environment one that supports and encourages student participation. She also gives seven approaches to creating a classroom environment that encourages discourse: support student collaboration, students thinking for themselves before allowing them to share their ideas, using questions and suggestions, deliberately choosing questions that increase student participation, reminding students mistakes are how they learn, assisting students by utilizing collaborative learning approaches and including various pedagogical practices to increase student participation. Teachers also have to be willing to let students take control in the classroom discourse. In Nathan and Knuth's (2003) study, when the teacher interrupted a student's presentation a few times, the student started talking to the teacher instead of the students like she was before. Students were less likely to talk to one another directly when the teacher showcased their authority.

Hodge & Walther (2017) discussed four strategies to create a foundation of effective discourse. The first strategy was to use a more open task. The second strategy was to encourage students to think, pair and revoice/compare. This is a modified version of *think-pair-share* in which students think over the problem, talk with a partner, and then as they work with their partner restate their partner's ideas/thoughts. The students can also compare and contrast their thoughts and ideas with their partners' thoughts and ideas. The next practice is to give students three methods to participate. Students can ask questions, rephrase the information and provide additional information. The final practice is to clarify what students should be contributing to the discourse. This means explaining there should not be any responses of only yes or no. They need to explain what they did and why they did it.

Teachers also need to be prepared to scaffold students. There are six scaffolding functions teachers can use to help students continue their discussions and develop their explanations (Antón, 1999). They are recruitment, reduction in degrees of freedom, direction maintenance, marking critical features, frustration control and demonstration. The recruitment function is about engaging students in the task. Reduction in degrees of freedom involves making the task easier. Direction maintenance includes making sure the students stay engaged and willing to work. Marking critical features requires emphasizing critical features and discussing differences between what students did and the correct solution. Frustration control means minimizing stress and anger while solving problems. Lastly, the demonstration function consists of showing students how to solve the problem by completing a similar problem.

Strategies for Discourse

Classroom discourse should include accountable talk and academically productive talk (Suresh et al., 2019). Within accountable talk, teachers should utilize classroom discussion to encourage student participation in a rigorous learning atmosphere. There are six teacher talk moves discussed. The first two talk moves are in the category of accountability to the learning community. The first talk move is making sure everyone is on the same page. The teacher has to ask questions to make sure students are listening and understanding before they can move on. The second talk move is to give students the opportunity to relate to others' ideas by asking if they agree or disagree with other students' thoughts. The second category is verifying that the discourse is purposeful, logical and effective. The two talk moves in this category are restating and revoicing which is restating and then adding more to the discussion. The last category is accountability to rigorous reasoning. The talk moves are being persistent in asking for accuracy and for their reasoning. Herbel-Eisenmann et al. (2013) discuss how talk moves are used as the beginning framework for teachers as it has been found to be effective in students' learning. Talk moves include restating information or another person's reasoning and adding on, asking students to apply their own thoughts to a classmates' thinking and using wait time.

Ballard (n.d.) also reviewed talk moves. Some talk moves for discourse are think time, wait time, revoice, rephrase, correct, add on, pair-share, reason about, think-write-pair-share and think-pair-share-write. Some approaches to start discourse are to ask engaging and difficult questions, give time for students to think and time to discuss, and before beginning tell students what they should be doing and everything expected of them which can be done through the use of a rubric. Practices for directing discourse are before starting students should know everything expected of them in the discussion and the time in which they are expected to do it, the teacher should observe students and their discussions, and the teacher should be ready to aid and redirect students as needed. Finally, strategies for relating discourse are to select specific students to share their thoughts, correct any misunderstandings, relate the students thoughts to each other or ask students to relate the thoughts and relate the discussion to math concepts.

Research Questions

1. How does math discourse affect students' intrinsic motivation?
2. How does math discourse affect students' mathematics self-efficacy?
3. How does math discourse affect students' attitude towards mathematics?

Methods

Intervention

The intervention took place over three weeks starting in January. As part of the intervention, the students were given open tasks. Tasks become more open when students are given choices, the problem has less information so that there is less teacher assistance, students are asked to figure out more than one way to solve the problem, students have to defend their solutions and the problem can be put into a real-world scenario (Hodge &

Walther, 2017). Various talk moves such as think time, revoice and think-pair-share were also implemented in the classroom.

Participants

The participants were ninth grade students at a predominantly white public high school in southern Maryland. The participants were from three Algebra 1 Core classes. The participants include 71 students with 42 female students and 29 male students. Thirteen students are economically disadvantaged, six students have 504 plans and one student has an IEP.

Data sources

Table 1:

Research Questions and Data Sources

	Data source 1	Data source 2	Data source 3
How does math discourse affect students' intrinsic motivation?	Pre-post Likert scale survey	Post-survey questionnaire	Observations with a behavior tally chart
How does math discourse affect students' math self-efficacy?	Pre-post Likert scale survey	Post-survey questionnaire	Observations with a behavior tally chart
How does math discourse affect students' attitude towards mathematics?	Pre-post Likert scale survey	Post-survey questionnaire	Observations with a behavior tally chart

Data collection

The first source of data collection is quantitative data through a Likert scale survey. Students were given the link to the online survey where they read a statement and chose the number that best represents their agreement or disagreement with the statement. Data source two is qualitative data as students answered questions about their experiences. The survey questions were given to the students with an online survey. The final data source is also qualitative data. My mentor teacher and I observed students with a behavior tally chart which looked at six behaviors. Additionally, self-efficacy was measured by a general self-efficacy scale by Chen et al. (2001) and adapted to be specific to the math classroom. It was also adapted further as the scale written by Chen et al. (2001) had some statements that contained the phrase "I will". Bandura (2006) stated that items should be written as "I can" instead of "I will" as self-efficacy is a belief in the person's ability not that they will do

something. Intrinsic motivation and attitude towards mathematics was measured through an adapted Fenema-Sherman instrument (Kalder & Lesik) and will be further adapted to fit the ABC Model of Attitude (Mazana et al., 2019).

Data Analysis

To analyze the data from the pre- and post-Likert scales, I conducted a *t-test* to see if there was a significant impact on students' intrinsic motivation, self-efficacy and attitude towards mathematics. The post survey questions were analyzed for any patterns within the students' responses. These questions would show how the experiences differed for the students like what they liked and did not like about the intervention which could impact their intrinsic motivation, self-efficacy and attitude towards mathematics. Additionally, the observations were analyzed for any patterns, such as if the amount of times the behaviors changed or stayed relatively the same, and anything interesting that would be put in the additional comments section of the observation paper. Any additional comments could be if there were any new behaviors observed or a change in other behaviors not being observed.

Validity Concerns

Validity was attended to with the utilization of three data sources for each question. This showed if the students changed, if they felt they changed and if teachers could see a change. Additionally, there were two observers who utilized the behavior tally chart. The average and the highest number observed was utilized to better determine how the observations changed each week. When analyzing the data, reverse scoring was utilized to ensure that the *t-test* results were accurate.

Results

How does math discourse affect students' intrinsic motivation?

Looking at the *t-test* for intrinsic motivation, the results were statistically significant with a *p-value* of 0.01. Unfortunately, looking at the overall means of the pre-survey and post-survey, the mean decreased between pre-survey and post-survey. Additionally, looking at Cohen's d (0.260905), there was a small effect. The Bayes Factor of 3.206439 shows that there is substantial evidence that there is a difference between the pre- and post-likert scale survey. In my post-survey, students were asked if they were more or less motivated to work in class because of the activities. From the 54 students who answered the post-survey questions, about 55.6% believed that they were more motivated. In addition, 7% said that they were motivated for some activities but unmotivated for others. About 15% of students said that they were less motivated and almost 15% felt that their motivation level was the same. About 3.7% said that they had a different reason for motivation and a little over 3.7% were unsure if their motivation had changed or stayed the same. In the behavior tally chart (Appendix B), the behavior of refusing to work/participate was observed. Although the data shows that the behaviors increased, the data isn't completely accurate. As this was in the third quarter, some students knew that no matter what they do they will fail the class and there are a few who haven't participated for most of the school year. Some students continuously do nothing and they were counted as students who do not participate. This behavior should have been observed twice. One where all students are tallied who refuse to

work/participate. Then another tally chart where students who never work/participate are not included. Together, the two charts could have shown a more accurate representation of the class and how the activities affected their intrinsic motivation. As intrinsic motivation affects students' perseverance, I observed how many students gave up on problems. Looking at the tally chart, the behavior decreased.

Table 2

Intrinsic Motivation

	n	*M*	*SD*	*p*	*d*	*BF*
Pre	71	21.6779661	5.522527056	0.01	0.260905	3.206439
Post	71	20.13793103	6.25973134			

How does math discourse affect students' math self-efficacy?

Using the *t-test* on the Likert scale data, there was not a significant change with a *p-value* of 0.14. Looking at the Bayes factor of 0.373861405, there was no real difference between the pre- and post-survey. According to the short answer responses on the post-survey, About 56% feel like their ability to complete a math problem changed because of these activities. Unfortunately, the way in which the question was written, several students didn't write how their ability changed. Out of the 30 students who believed their ability changed, half of them specifically stated or implied their ability to complete a math problem increased. Thus between 27.7% and 55.6% of the students believed that their math self-efficacy increased because of the activities. A little over 40% of the students felt that their self-efficacy didn't change. Finally, about 3.7% of the students were unsure. As self-efficacy is related to perseverance and about believing in yourself and your ability to complete a task, I observed two behaviors: student gives up on trying to solve a problem and student says they can't do it. Looking at the tally chart, the behaviors decreased each week.

Table 3

Self-Efficacy

	n	*M*	*SD*	*p*	*d*	*BF*
Pre	71	18.22033898	4.620042661	0.141	0.147861	0.373861405
Post	71	17.5	5.110912695			

How does math discourse affect students' attitude towards mathematics?

Overall, looking at the Likert scale data for attitude, the results were not significant. Therefore, Cohen's d can't be interpreted. The Bayes Factor (0.558269365) shows there was no real difference. Looking at the individual aspects of attitude, two were significant. First, motivation which was discussed earlier was statistically significant with a *p-value* of 0.01 (refer back to table 1), had a small effect based on Cohen's d (0.260905) and had substantial evidence of a difference based on the Bayes Factor (3.206439). The other aspect of attitude that was statistically significant was value with a *p-value* of 0.008. Again, when looking at the overall means of the pre-survey and post-survey, the mean decreased from pre-survey to post-survey. Looking at Cohen's d of 0.269918, there was a small effect and looking at the Bayes Factor of 3.836207 there was substantial evidence of a difference between the Likert scales. Utilizing my short answer responses on the post-survey, I found that about 46% of the students like math more because of the activities. Only about 18.5% liked it less, and a little over 35% felt that their attitude towards math hadn't changed. For the behavior tally chart, I observed behaviors that corresponded with the characteristics of the ABC Model of Attitude: self-confidence, anxiety, enjoyment, intrinsic motivation and value. For self-confidence, I observed the behavior of students saying they cannot do it. This characteristic decreased each week. For the characteristic of anxiety, I listened in an effort to hear students saying anything about math making them uncomfortable or nervous. This behavior wasn't seen at all. I observed students saying they thought math was boring to observe the students' enjoyment of math. This behavior decreased the second week and increased the third week. To see if students were motivated, I took note of how many students refused to participate or work. This behavior increased each week. Finally, I tallied how many students questioned why they are learning math or the specific content. The results yielded that behavior decreased the third week.

Table 4

Value

	n	*M*	*SD*	*p*	*d*	*BF*
Pre	71	15.08474576	3.874046005	0.008	0.269918	3.836207
Post	71	13.98275862	4.28115932			

Table 5

Confidence

	n	*M*	*SD*	*p*	*d*	*BF*

Pre	71	13.74576271	2.718157045	0.561	0.071854	0.153665561
Post	71	13.94827586	2.91509573			

Table 6

Anxiety

	n	*M*	*SD*	*p*	*d*	*BF*
Pre	71	15.33898305	2.616487119	0.537	0.067092	0.156951081
Post	71	15.15517241	2.857580016			

Table 7

Enjoyment

	n	*M*	*SD*	*p*	*d*	*BF*
Pre	71	25.55932203	6.782901163	0.423	0.083352	0.178146168
Post	71	24.96551724	7.44970531			

Table 8

Attitude

	n	*M*	*SD*	*p*	*d*	*BF*
Pre	71	41.33898305	8.596693998	0.084	0.170753	0.558269365
Post	71	39.79310345	9.487975278			

Discussion of Results

The study experience is supported by the National Council of Mathematics (2014) who discussed the levels of discourse. When discourse is first implemented, the classroom discourse will likely be at level 0. Effective discourse should be at level 2 or level 3 but this takes time. This means that discourse should be implemented at the beginning of the year to ensure that the discourse is effective and will better improve students' self-efficacy, intrinsic motivation and attitude towards math. This was observed with some students who

had difficulty talking with their peers as they aren't used to interacting with their peers who aren't friends or find it awkward to discuss their thoughts and ideas. When students were asked what they felt didn't work well for them, several students talked about the collaborative nature of some of the activities.

The findings support that discourse helps students understand the content better (Hancewicz et al., 2005). If students are participating in effective discourse, then their understanding would increase. Thus, students would be achieving their own success, seeing their peers achieve success and they would receive help and support from the peers they are working with, which are three of the four ways self-efficacy can be affected (Bandura, 1994). Therefore, effective discourse would likely increase self-efficacy. This can be seen in the students' responses and observations from class.. Additionally, Liu et al. (2019) found that intrinsic motivation affects self-efficacy. Looking at the post-survey responses, a majority of the students who believed they were more motivated believed their self-efficacy had changed which supports Liu et al.'s (2019) research. The students' overall attitude towards math is affected by their enjoyment, value, confidence, intrinsic motivation and anxiety (Mazana et al., 2019). When looking at the behaviors, only confidence and intrinsic motivation behaviors decreased each week which could be one reason why only 46.3% of students felt like they liked math more than before. Another reason less than half of the students like math more could be because the behaviors of saying math is boring and the behaviors of questioning why they are learning math stayed about the same and the behavior of refusing to work/participate increased.

Conclusions and Implications

The study's purpose was to determine if math discourse can affect students' intrinsic motivation, self-efficacy and overall attitude towards math. At the beginning of the school year, students were continuously talking instead of doing what they were supposed to be doing. They were constantly questioning themselves, not motivated and hated math. In an effort to combat this, open tasks and talk moves were implemented. The results showed that when looking at the Likert scale questions, there was no significant change except for intrinsic motivation and value but the means decreased between the pre- and post-survey. The students' negative behaviors for their self-efficacy and confidence decreased each week. Almost 56% of the students believed their self-efficacy had changed and intrinsic motivation increased as a result of the activities. Over 46% of the students felt their attitude towards math became more positive.

Limitations

This study took place over three weeks. This is not enough time to fully determine the effects of discourse. Additionally, this was implemented in January. When they took the pre-survey, they had gotten 4 extra days off of their winter break which could have affected their pre-survey as they probably were more enthusiastic and happier in general. Also, the content for the day they took the pre-survey was almost entirely calculator based and was very easy for the students. Furthermore, students were apprehensive about doing something new in class. There was some difficulty with students who refused to discuss or share their answers. If this had been implemented at the beginning of the year and was

tracked throughout the year with surveys at the end of the marking periods, the data would have been more accurate.

Implications

The results showed that over 55% of the students felt their self-efficacy had changed and their intrinsic motivation increased and about 46% of the students liked math more. This should be explored further in another study that takes place over the school year to ensure that the math discourse is effective.

About 18.5% liked math less because of the activities and almost 15% felt they were less motivated by the activities. In the post-survey, some students said they had difficulty with the social aspect of discourse. As several of the activities included them talking about their ideas and answers with other students, then the activities would not be fun or something they like which could be a reason several of the students were less motivated and liked math less. Overall, for teachers facing similar issues of students talking too much, low self-efficacy, low intrinsic motivation and hatred for math, teachers should be implementing math discourse. Discourse has already been shown to increase academic achievement (Hancewicz et al., 2005; Walshaw & Anthony, 2017) which was also seen in some of their responses. Additionally, I believe the number of students who liked math less or were less motivated would decrease if discourse was implemented at the beginning of the school year as it would allow students to get used to discussing with each other and making them more comfortable sharing their ideas and their thoughts on the content. This would ensure the classroom environment is one where students are supported and encouraged to participate (Kersaint, 2015) and an atmosphere where students' understanding is more important than the correct answer (Wachira et al., n.d.) which is instrumental in effective discourse.

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Appendix A

Pre/Post Likert Scale with Post Survey Questions

Email *

Your email

This is a required question

I can achieve most of the goals that I have set for myself in math.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I generally have had difficulty relating new mathematical concepts to those I had previously learned.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I have usually been at ease during math courses.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Mathematics is enjoyable and stimulating to me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

When facing difficult math tasks, I am certain that I can accomplish them.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I have never liked mathematics, and it is my most dreaded subject.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am interested and willing to use math outside school and on the job.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Even when things are tough, I can perform quite well in math.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Mathematics is dull and boring because it leaves no room for personal opinion.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I have always enjoyed studying math in school.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Compared to other people, I can do most math tasks very well.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

My mind goes blank and I am unable to think clearly when doing mathematics.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Math is very interesting, and I have usually enjoyed courses in this subject.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I was frequently lost and had trouble keeping up in my math classes.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am confident that I can perform effectively on many different math tasks.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I would like to develop my mathematical skill and study this subject more.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

There is nothing creative about mathematics, it's just memorizing formulas and things.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

If I go to college, I will avoid taking math classes.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I believe I can succeed at most any math endeavor to which I set my mind.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am interested and willing to acquire further knowledge of mathematics.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Next

Clear form

Read the question and answer to the best of your ability.

What do you feel was the goal for these activities? Do you feel like the activities achieved this goal?

Your answer

What do you think worked well for you? Why?

Your answer

What do you think didn't work well for you? Why?

Your answer

Back Next Clear form

Read the question and answer to the best of your ability.

Do you feel like your belief in your ability to complete a math problem changed because of these activities?

Your answer

Were you more or less motivated to work in class because of these activities?

Your answer

Do you like math more or less because of these activities?

Your answer

Back Submit Clear form

Appendix B

Behavior Tally Chart

Tally marks will be made to indicate the number of times this behavior occurred.

Observed Behaviors	Monday	Tuesday	Wednesday	Thursday	Friday
Student gives up on trying to solve a problem					
Student says they can't do it					
Student says math makes them uncomfortable or nervous					
Student questions why they are learning math					
Student says math is boring					
Student refuses to participate/work					
Any additional comments related to students' self-efficacy, intrinsic motivation and overall attitude towards math:					