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What Do You Meme? An Investigation of Social Media and Mathematics Identity

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Mathematical spaces extend far beyond the classroom and physical environments into virtual spaces. Today's students have more to consider than just their face-to-face experiences with mathematics inside or outside the classroom; they have the online perspectives of others to consider as well. To gain critical insight, we conducted this research with semistructured focus groups using an interactive mathematics Internet meme activity. Using positioning theory, this article highlights students' stances and three storylines as conceptual tools for a better understanding of their off- and online mathematics identities. Results show that the two spaces are not mutually exclusive and that students are succumbing and adhering to a larger hegemonic construction of mathematics found in the online communities with various points of tension found.

KEYWORDS: Social Media, Internet Memes, Mathematics Identity, Sociotechnological

As a former high school mathematics teacher, I remember finishing up a lesson on factoring polynomials (i.e., completing the square), and one of my freshman students (at the time), Pedro, waited until class was over to hand me a folded-up piece of paper. Immediately, Pedro jovially headed out of the classroom and yelled to me, "Told you so." As I unfolded the paper, I noticed the mathematics Internet meme in Figure 1, smiled, laughed, and thought, "That's just Pedro being Pedro." But as the year went on, I noticed a change in him. Anytime Pedro struggled in mathematics, he would say, "I'm never going to use this anyway." And I thought back to the mathematics Internet meme. It appears Pedro's new demeanor aligned with the Internet meme's message. I questioned whether Pedro's experience was unique. Subsequently, I began to consider my former and present students' mathematics beliefs and how societal representations of mathematics have influenced or are still influencing them.

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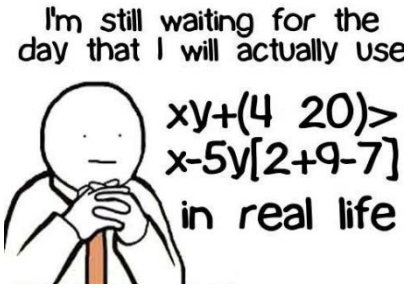


Figure 1. Pedro's Mathematics Internet Meme

The narrative story above illustrates the current critical period we find ourselves in with regard to mathematics education, where we must acknowledge and examine how the social milieu interacts and reinforces other dimensions of mathematical teaching and learning (Stephan et al., 2015). What was once a field that focused traditionally on classroom activities, sequencing, and execution of lessons has been pushed to consider the many social perspectives that influence it (Gutiérrez, 2000; Jackson, 2009; Lerman, 2000). Although mathematics education researchers have considered the socialization process that occurs inside and outside of schools to be influential to a student's mathematics identity (Anderson, 2007; Boaler, 2000; Boaler & Greeno, 2000; Hodge & Cobb, 2019; Nasir & McKinney de Royston, 2013), the online socialization process that also perpetuates ideologies of mathematics has yet to be studied (Benoit, 2018). The various social media platforms accessible to K–12 (primary and secondary) students today are full of mathematics messages contributing to young people's mathematics identity, especially when they are developing ideas about themselves and their relationship with mathematics (Benoit, 2018; Salopek, 2018). Martin (2012) observed that

> social media such as YouTube and Facebook are not only responsible for exporting and importing culture, ideology, protest, and revolution, but also for exposing the human condition and helping black children to contextualize their lives vis-à-vis the conditions in which other children live and learn. (p. 51)

As students negotiate their way through the world, they make sense of who mathematicians are and who can or cannot be mathematicians. The perceptions and images students process about mathematics or mathematicians ultimately affect their beliefs and attitudes and play a decisive role in mediating whether young people (dis)engage with the mathematics field (Ernest, 2008).

Young people today live in a world that is vastly different than that of their parents' adolescence. We must acknowledge that today's generation lives in an accelerated, interconnected, and sociotechnological world—where part of a young person's everyday routine consists of spending large amounts of time online engaging in virtual spaces. Previous generations were influenced by popular media such as newspapers, magazines, television, movies, and radio. Today's generation of students has an assortment of media sources, including social media platforms such as Twitter, Facebook, and Instagram. With the introduction of social media platforms, students can connect and form online communities with users they feel a stronger sense of affinity to regardless of their geographical locations (Chen et al., 2014).

Marshall and Sensoy (2011) argued that social media offers snapshots that document life, and its popularity continues to grow with many people having a social media account. Social media offers today's youth a "portal for entertainment and communication and [has] grown exponentially in recent years" (O'Keeffe & Clarke-Pearson, 2011, p. 1). This virtual space is an expressive medium (Radovanovic & Ragnedda, 2012) that widens accessibility to most and allows users to share at their discretion. Social media integration allows students to access the uncensored thoughts and feelings of other users on mathematics, not just their own. Also, as students engage and spend time on social media platforms, it becomes virtually impossible to "protect" them from unsympathetic messages about mathematics that can strongly influence their perceptions of mathematics or mathematicians. Consequently, today's students have more to consider than just their face-to-face experiences with mathematics inside or outside the classroom; they also have the online perspectives of others.

It is also important to recognize the relationship between social media and mathematics identity as sophisticated work, even if issues of sociotechnological perspectives may not "easily translate into large-scale policy recommendations" (Gutiérrez, 2013, p. 1). However, the goal of mathematics education research should reflect not only the diversity and complexity of the individuals they are trying to serve but also the social context they are doing it in. Just as the social turn in mathematics education research sought to examine the emergence of "theories that see meaning, thinking, and reasoning as products of social activity" (Lerman, 2000, p. 23), the sociotechnological lens seeks to do the same in virtual spaces. Issues framed around the sociotechnological realm are powerful cornerstones that may lead to helping students negotiate their continuously developing mathematics identities in a more productive and positive light. For this reason, they deserve an increase of attention in the mathematics research field.

This research investigates the results of a study with 31 high school students as they explored and discussed a set of curated mathematics Internet memes that sought to capture the negative, neutral, and positive depictions of mathematics that can be found on the web. Further focus group interviews with the students about their social media responses (SMRs) provided evidence of how such memes could impact their developing identities in this digital age.

This article starts with an overview of relevant literature on the portrayal of mathematics in the media. It then presents a discussion on the theoretical perspectives of social media and Internet memes, as well as a framework to conceptualize students' SMRs.

Literature Review

Influence of Mathematics Media Portrayals

Over the past decades, researchers have focused on the representations of mathematics and mathematicians in the media from a mathematics education context, mainly exploring how popular cultural images influence students' relationship with the subject (Appelbaum, 1995; Epstein et al., 2010; Mendick, Epstein, et al., 2008; Mendick, Moreau, et al., 2008; Moreau et al., 2010; Picker & Berry, 2000). Medick and colleagues collected over 500 questionnaires, facilitated numerous focus groups, and found that images of mathematics and mathematicians in popular culture are "simultaneously invisible and ubiquitous" (Mendick, Moreau, et al., 2008, p. ii). Although some students could not reference any mathematics examples in popular culture, most drew on common mathematics stereotypes popularized by the media. Interestingly, although students were aware of the conventionalized notions of mathematics in their answers, it did not prevent or alter their responses. Epstein et al. (2010) stated that students

> knew they were drawing on stereotyped images—which did not stop them from finding these the first that came to their heads. Indeed, it would be surprising if these were not the first images that came to them, given their pervasiveness in popular culture. (pp. 54–55)

The authors posited that students mainly drew on stereotypical imagery because of their pervasiveness in popular culture and the lack of alternative images available.

Lisa Darragh (2018) looked at popular young adult fiction books as a conduit to better understand the relationship between mathematics and the societal perceptions of mathematics. In particular, she paid close attention to the storylines about school mathematics and mathematics teachers embedded in each fictional book. Darragh's (2018) final analysis included 59 books listed on the *Teen's Top Ten* list from the *American Library Association* (ALA). She partitioned books into four categories—positive, negative, neutral, or mixed—based on how they depicted mathematics and thematically coded excerpts regarding school mathematics or mathematics teachers. Findings from her study indicated that over 50% of the sample depicted a negative mathematics storyline. In fact, mathematics was characterized as "nightmarish, inherently difficult, and something to be avoided" (Darragh, 2018, p. 197). Although it was obligatory, mathematics was often seen as unimportant in these popular texts. Mathematics class was generally seen as useless and something to endure rather than productive and fruitful. Additionally, mathematics teachers had various negative storylines attached to them as well. Darragh (2018) stated mathematics teachers were commonly depicted as boring and crazy, and they were overall "positioned as villains" (p. 197).

These studies examined popular culture artifacts coupled with student discourse, only to conclude that stereotypes of mathematics and mathematicians (or the people who do well in mathematics) are salient in their respective popular culture domains. Today, these messages have transcended former mediums of popular culture and appear on social media platforms through Internet memes. As in previous studies, there is potential for these artifacts to influence students' mathematics identities. Although social media was once considered a trivial pastime, researchers recognize it as a point of concern in academic conversations (Appelbaum, 1995; Knobel & Lankshear, 2007; Milner, 2012; Schifman, 2013; Wiggins, 2019; Yus, 2018;).

Social Media and Internet Memes

Researchers have found that defining popular culture is an extremely difficult proposition due to its trendy nature; it can become dated as quickly as it is produced, rendering its definition susceptible to constant revision (Fiske, 2017; Marshall & Sensoy, 2011). The task of understanding popular culture becomes even more difficult because today's generation of students will have a different perspective on it than the previous one. Fishwick (2002) suggested that, in defining popular culture, the operative term is *new*: new age, new generation, and new definition. For decades, institutions such as broadcast television, radio, recorded music, and film have been increasingly responsible for creating and distributing popular culture (Hrynyshyn, 2017). However, today's mass media is being displaced by social media and digital culture. Although interactions are still "face-to-face," technology is used to facilitate communication user to user. Digital culture helps to describe the way technology shapes the communication mechanisms, interactions, and behavioral patterns we exude toward one another on and off social media platforms (Wiggins, 2019).

Social media has manifested a great deal; it is made up of several networking sites, including Facebook, Twitter, TikTok, and Instagram, connecting the world to ideas, beliefs, and different perspectives. Social media harnesses today's participatory culture by creating networks and connecting peers, as well as empowering users to share their ideas and exchange messages and news items, including photos and videos. Social media provides an outlet for dynamic interaction and cultural production (Wiggins, 2019). Unlike previous technologies, such as television and film, social media provides its users with unique access to public discourse, cultivating a wide variety of societal perceptions on various content in one central location (Hrynyshyn, 2017).

Previously, popular culture was based on the concept of single institutions disseminating content to the masses, but social media allows users, who were once merely consumers, to produce user-generated content (Hrynyshyn, 2017; Schifman, 2013). In this way, social media users have agency that they never had before; they have the capacity to constitute or reorient discourse, which can be both liberating and constraining (Wiggins, 2019). During this 21st-century digital era, social media has not only impacted our social, cultural, and political worlds by circumventing traditional pathways into public discourse but also decentralized communication practice. By eliminating some communication barriers and restructuring modern-day communication practices, social media has helped give a voice to more individuals, including students, so they can participate in a democratic fashion.[1]

Internet Memes

Although slightly different than its original conception,[2] Internet users defined a *meme* as a virtual phenomenon. Wiggins (2019) defined an Internet meme as a "remixed, iterated message that can be rapidly diffused by members of participatory digital culture for the purpose of satire, parody, critique, or other discursive activity" (p. 11). An Internet meme acts as a vehicle carrying ideas, practices, culture, or symbols from person to person in various forms, including social media (e.g., Facebook, Instagram, Twitter). Internet memes can take on various forms and formats, such as image macro memes—a line of text on top of the meme, another one at the bottom, and one picture in the middle; GIFs—compressed data image files that support both animated and static images; and so much more. Although Internet memes are often regarded as humorous discourse, to simply regard them in this manner is merely surface-level understanding (Benoit, 2018; Schifman, 2013; Wiggins, 2019; Yus, 2018). In this digital age, Internet memes offer a cultural analysis of public discourse and popular culture (Johnson, 2007). Within the participatory power of social media, Internet memes that are shared on a micro basis have the

[1] Although digital culture allows certain accessibility to public discourse, it is not without its complications. A common misconception could be that digital culture and social media act as social equalizers providing an equal "playing field" for public discourse. Although digital culture is participatory (content is user generated) and helps provide accessibility to public discourse, notions of power such as access and impact are still not equally distributed. Consider the 21st-century job title *influencer.* The financial negotiation of an *influencer* is to use their social capital of amassing an established large following for persuasion of products, goods, and services, and, in return, they receive a monetary contribution. In this case, an *influencer* serves as a liaison from corporation to consumer and is compensated for it. Other social media users simply operate on a whole different scale; they do not have the mass followings and have a different definition and objective of participation. Although this is just one of many lenses, it helps illuminate that the shareability of digital items and discourse is not equally distributed and too can be informed by capitalism.

[2] The term *meme* was first introduced by the biologist Richard Dawkins in his book *The Selfish Gene* (1989), where he defined memes as "an idea, behavior, or style that spreads from person to person within a culture" (p. 192).

potential to scale up and spread to countless individuals within minutes, having a macro impact. The decentralization of user-generated content posits new arguments, visually influencing discourse and social norms (Baym & Burnett, 2009; Boyd, 2008; Jenkins, 2006; O'Reilly, 2007).

The Discursive Power of Internet Memes

The discursive power of Internet memes is best rooted in their ideology, semiotics, and intertextuality (Wiggins, 2019). The Internet meme–creation process is not passive. A great deal of contemplation goes into the organization of images and chosen words (Benoit, 2018; Schifman, 2013; Wiggins, 2019; Yus, 2018). The author of an Internet meme makes intentional choices throughout the whole process, from conception to completion, that reflect the Internet meme's purpose. Intertextuality also plays a critical role; it assists in shaping the meaning of the Internet meme (Wiggins, 2019; Yus, 2018). Internet memes do not exist in a vacuum; they rely on a shared cultural and semiotic understanding for collective interpretation. They are entangled in their sociocultural environments and cannot exist outside of the events and practices in which they appear (Schifman, 2013). They are experienced as encoded information that demands shared knowledge to properly understand and can therefore create barriers of discursive specificity for those unable to access the Internet meme's meaning. In this way, intertextuality and relationality become "purposeful, unavoidable, and ubiquitous" (Wiggins, 2019, p. 35). Further, in Foucault's (1989) writing on discursive power, he explained the duality of the social relations embedded in discourse as consisting of "practices that systematically form the object of which they speak" (p. 49). A parallel from this idea of discourse to Internet memes is that meaning is created and negotiated socially and not in terms of the actual physical world.

Framework for Positioning of Internet Memes

Identity and Positions are Multifaceted

Researchers have categorized identities in a variety of ways. What was once considered relatively stable and generalizable and that had the connotation of an essentialized self (Stinson, 2013) is now referred to as increasingly fluid (Chronaki, 2011; Solomon et al., 2011) and as an always-developing process (e.g., Black et al., 2015, Nasir, 2002) of multiple identities forming in different moments of time (Esmonde, 2009; Wood, 2013). Identities can be conscious or subconscious (Bishop, 2012), independent (based on self-perception; Davies & Harré, 2001), or interdependent (based on affiliation with a group [institution or affinity]; Gee, 2001). Identities can be formed by material, relational, and ideational resources (Nasir & Cooks, 2009) and impacted by characteristics such as race, gender, and disciplinary performance (Varelas et al., 2012). Identities can zoom in and look at specific moments or expand over periods of time (Darragh, 2018), and they depend on various factors and life experiences such as culture, race, gender, and so on (Gee, 2001; Wenger, 1998). Using these ideas as a basis, we use Bishop's (2012) definition of *identity,* "a dynamic view of self, negotiated in a specific social context and informed by past history, events, personal narratives, experiences, routines, and ways of participating" (p. 38).

Closely related to identities are positions that are either self-perceived or offered by others. Davies and Harré (2001) explained that "positions are identified in part by extracting the autobiographical aspects of a conversation in which it becomes possible to find out how each conversant conceives of themselves and of the other participants by seeing what position they take up" (p. 264). Positions are dynamic; they are negotiated in the moment and can be accepted

or refused (Suh et al., 2013). Positioning is not unidirectional but relational depending on wider contexts of history and life experiences (Gee, 2001; Wenger, 1998) and only if one accepts that positioning (Davies & Harré, 2001). Harré et al. (2009) explained that individuals "use words (and discourse of all types) to locate themselves and others" (p. 3).

Three constructs are key to understanding how students engage in positioning within digital culture: stance, SMRs, and storylines. We define and describe each briefly below and exemplify them with a short analysis of Pedro's mathematics Internet meme discussed in the opening vignette.

Stance

An Internet meme's *stance* serves to make connections between the information conveyed by Internet memes and subtler categories of identity. S*tance* signifies the ways in which authors and users position themselves in relation to the Internet meme, its text, its linguistic codes, the addressees, and other online participants that engage (Schifman, 2013). For example, let us examine the meme Pedro handed to his teacher (Figure 1). The internet meme's content, namely the ideas and ideologies communicated, relate to the caption, which reads, "I'm still waiting for the day that I will actually use $xy + (4 * 20) > x - 5y[2 + 9 - 7]$ in real life." The caption questions the purpose of mathematics and exemplifies its uselessness. This is further supported by the caption that includes an invalid inequality that cannot be understood. Another thing to note is that the image, which depicts an individual with a straight face, is often used to convey mild irritation (Emojipedia, 2020). Overall, the Internet meme conveys the ideological message that mathematics is not relevant, which describes where Pedro wants to locate himself. Like identity and positions, stances are not concrete but are rather fluid (Chronaki, 2011; Solomon et al., 2011) and can be in an always-developing process (e.g., Black et al., 2015; Nasir et al., 2013). As artifacts, Internet memes are created with both cultural and social attributes and possess the power to reconstitute our social system (Wiggins, 2019).

Social Media Responses: The acts of positioning relevant for this analysis are SMRs, which are the communicative actions individuals can perform on social media platforms such as Facebook, Twitter, and Instagram. SMRs include but are not limited to the following: liking,[3] commenting,[4] tagging,[5] sharing,[6] and creating[7] (Muntinga et al., 2011). Although many SMRs are available today, at the time of data collection in 2017, only the "like" button was available. Like in-person conversations, online users can use SMRs as positioning tools that negotiate and locate themselves and others. SMRs enable social media users to openly accept or reject social media content, all while opening the door for follow-up communication.

Consider Pedro's earlier action in a social media context. He not only *shared* an Internet meme but also *tagged* his teacher in the meme. *Sharing* places the user at the controls as they select, confirm, and broadcast content for their friends and others to see. Presumably, when users engage with Internet memes on social media platforms, they "decide to imitate a certain position

[3] Liking is a quick-and-easy way to express your support of a certain content.

[4] Commenting is a response to a post on social media.

[5] Tagging a user ties that particular user to an Internet meme. If users are friends on social media, they do not have control of the Internet meme or piece of content they are tethered to.

[6] Sharing is when a user broadcasts web content on a social network to their connections (their friends, followers, associated groups, etc.).

[7] Creating and posting: authoring content on social media.

that they find appealing" (Schifman, 2013, p. 367) and that aligns with the discourse they are choosing to replicate or engage in. *Tagging* explicitly directs the social media content to specific people; it is akin to saying someone's name in a conversation.

Multiple people can be *tagged* on a social media post, drawing them to regard the post (in this context, the meme) and creating a positioning opportunity for them to accept or deny it. Further, if the teacher *liked* the meme, it would signify support for the meme's content, or the teacher could openly comment in a variety of ways, including rejecting the meme's ideology. In other words, SMRs can communicate textual, verbal, and visual cues that illustrate a position (Wiggins, 2019). These, too, are not arbitrary actions; users make intentional decisions to perpetuate the discourse they are choosing through social media for future deliberation. We are not claiming individuals' SMRs to be synonymous with their identity and that like identity is complex to understand. We are saying it is important to examine what students are choosing to perpetuate and why they choose to do that.

Storyline: Through such positionings, students can construct storylines through their SMRs regarding mathematics and their mathematics identities. Storylines are the broader, culturally shared narratives intertwined in the social interaction (Herbel-Eisenmann et al., 2015). Within conversations, several storylines can exist simultaneously, all drawn on and from the participants' cultural, historical, and political backgrounds, and that help to define conventions for interactions online (Herbel-Eisenmann et al., 2015). Participants can interact differently as storylines can operate on different scales; therefore, it is crucial to listen to what students are saying and how they are saying it. Again, let us consider Pedro's meme. The more global storyline of mathematics, as a difficult subject that few students do well (Walker, 2012), can make it seem useless. This storyline is fostered through acts in socially recognized ways such as an overemphasis on algorithms, correctness, and speed, as opposed to deep conceptual thinking (Sherin & Jacobs, 2011). We understand both students' stances and storylines to be situated in a larger social and cultural context in which mathematical discontent is not only widely accepted but to be expected and encouraged in some cases. It appears to be quite normal behavior and socially acceptable to hear or say, "I am bad at mathematics" or "I am not a mathematics person." Storylines can illuminate the point of view for students, influenced by moral or personal traits (Harré & van Langenhove, 1998). Storylines help to frame positionings as they "draw on [the] knowledge of cultural structures and the positions that are recognizably allocated to people within those structures" (Ritchie, 2002, p. 27).

Research Questions

The overarching research questions guiding this study are the following:

1. What mathematics Internet meme stances can be identified in students' social media responses (SMRs)?
2. What mathematics Internet meme storylines are evident in students' collective social media responses (SMRs)?

Methodology

Participants

The researchers recruited 31 students between the ages of 13 and 18 in New York City via a short promotional YouTube clip and/or informational session at their respective schools.

Twenty students were from public schools (Westpine High School,[8] Silvercliff Academy, and Moorhall), five were from a private school (Fairbourne Prep), and six were from a charter school (Marblepond Charter). The researchers organized focus groups for participating students at the respective schools outside instructional time that lasted 60 min. Students received food for their participation. Fifty-two percent (16) self-identified as males and 48% (15) self-identified as females. Forty-five percent (14) were in 9th grade, 29% (9) were in 10th grade, 19% (6) were in 11th grade, and 6% (2) were seniors. Participants represented diverse racial and cultural communities: 48% (15) identified as African American, 26% (8) identified as Hispanic, 10% (3) identified as Asian, 6% (2) identified as Caucasian and "Mixed," and 3% (1) identified as Indigenous American.

Research Activities

The goal of this research was to gain insight into students' SMRs regarding their mathematics identities. To accomplish this, we used a mixed-methods design that included an individual Internet meme activity (IMA) and small focus group–based follow-up discussions about the IMA. In this section, we describe the methods and materials associated with each.

Individual Internet Meme Activity

To acquire the math memes for the individual IMA, the researchers used a Google search, typing "math memes" into the search bar.[9] Researchers gathered a sample of 100 mathematics-related memes from the search. A "convenient jury"[10] of 10 mathematics experts (i.e., teachers, doctoral students, and mathematicians) were asked to examine the sample of memes and categorize them as positive, negative, or neutral. Positive Internet memes were defined as memes that emphasized good and laudable characteristics about mathematics or when the character(s) was portrayed as loving the subject; negative Internet memes emphasized bad and negative characteristics about mathematics or when the character(s) was portrayed as hating the subject or finding it unreasonably difficult; and neutral Internet memes referred to mathematics but did not impose any feeling (positive or negative) about the subject (e.g., an Internet meme that illustrated a mathematics problem) or explained a description of a mathematics experience that did not incite negative or positive reactions. An 80% agreement (8 out of 10 experts) threshold was needed to obtain each Internet meme's code. The jury selected a subset of nine memes. (See Table 1 for a display of the nine memes chosen for the study and their expert evaluations.)

To start, each participant was asked to identify their grade level, age, gender, and ethnicity and to rate themselves as a mathematics student (Self Perceived Math Ability [SPMA]) on a scale from 1 to 10, with 1 being the lowest and 10 being the highest. Later, when examining student responses, researchers partitioned the scale into the following categories: excellent (10), good (7–9), average (4–6), bad (2–3), and poor (1). So, in total, 3% of my sample identified as a

[8] Student pseudonyms were intentionally chosen to match their focus group; for example, students in Westpine High School's focus group will all start with a "W."

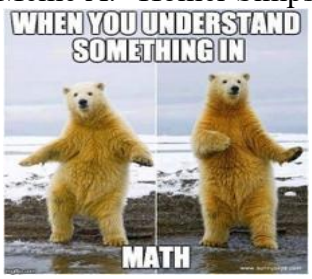
[9] A preliminary finding was that of the 13 predetermined categories, three (23%) had labels associated with women (e.g., lady, blonde, women) and two (15%) were focused on confusion (e.g., confused, confused math). These filters provide insight on the abundance of math Internet memes created having these tags or associations; hence, there is a wide variety of Internet memes that center on women and confusion.

[10] The jury assembled in 2017 consisted of eight males. Seven of whom were White, which had implications on how Internet memes were eventually coded (e.g., Internet Meme 7 was coded as positive but might be perceived differently, as it can be considered biased toward females).

bad mathematics student, 16% identified as an average student, 77% identified as a good mathematics student, and 1 student identified as an excellent student. On average, students rated themselves at a 7.69, with a standard deviation of 1.5. Approximately 80% of my sample identified as having above-average mathematics skills. Students' self-assessment is included in Appendix A.

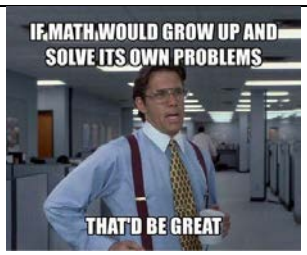
Next, everyone was presented with nine 5x7 index cards showing each of the Internet memes depicted in Table 1, all at once in random order. Participants were asked to place the nine memes into one of three predetermined groups (positive, neutral, or negative) according to how they perceived the message or determined the relationship. Students were instructed to give a short description of why they made the selections. Students were in control and were strongly encouraged to express whatever mathematical idea(s) they wanted. As part of the research design, participants were asked to select one Internet meme they would post on their social media account, simulating students' "posting" regiment. A blank copy of the complete IMA protocol is included in Appendix B.

Table 1. Memes Used in Mathematics Internet Meme Activity

Mathematics Internet Meme	Expert Jury's Judgments	Mathematics Internet Meme	Expert Jury's Judgments
 Meme A. "Homer Simpson"	Negative	 Meme F. "Chicks dig math help"	Positive
 Meme B. "Polar Bears"	Positive	 Meme G. "it gets complicated"	Neutral

Meme C. "Me neither"

Negative

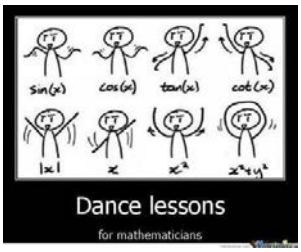


Meme H. "That'd be great"

Neutral

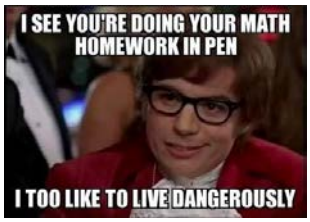
Meme D. "Nice try, math"

Negative



Meme I. "Dance lessons"

Positive



Meme E. "Live dangerously"

Neutral

Focus Group Follow-Up Discussion

After students completed the IMA, they came together as a focus group to share their selection choices and were asked how they would comment (if at all) to the other Internet memes if they were to come across them virtually. Furthermore, participants were asked an open-ended set of questions designed to probe their exposure to mathematics Internet memes, their SMRs, and their mathematics identities. Although the focus groups varied according to students' interests and responses, they all had the same overarching structure: Discussions began with a set of planned questions, which were followed up with impromptu questions to stimulate further discussion and additional probes as needed (Lindlof & Taylor, 2002). A copy of the protocol is included in Appendix C. At times, the researchers found it helpful to repeat a question and the students' verbal responses to ensure their own comprehension. All focus groups were audiotaped and later transcribed. In addition, the researchers took extensive notes on phrases, sentences, actions, concepts, body language, opinions, and quotes as the discussions unfolded.

Data Collection and Analysis

Analysis consisted of five semistructured focus groups of 31 student participants across New York City. The researchers used a grounded theory approach first, in which codes and theoretical themes could emerge inductively from the data and be used as lenses (Creswell, 2012). As such, transcription data were organized in several ways (i.e., questions and schools), several different lenses (i.e., frequently repeated ideas, reference to the literature, and shocking or surprising remarks), and several different variables (i.e., grade, gender, and students'

perceived mathematical ability [SPMA]). The researchers then used indexing (Miles & Huberman, 1994) as a process of defining codes according to research questions and the theoretical framework, cross-referencing and pairing them into an axial coding system. Later, a hierarchical tree diagram was created to interpret the connectivity between current codes. The researchers then used selective coding to help build and illustrate a story to connection between codes into overarching themes (see Table 2 as an example of the *Ability Affects Susceptibility* theme). Codes were cross-referenced from all five focus groups and then combined into three salient storylines: *Vindicate or Villainize Mathematics; Ability Affects Susceptibility;* and *Influence or Isolate, That Is the Question?* These will be discussed later in the article.

Table 2. Data Analysis Framework

Question	Westpine High School	Silvercliff Academy	Marblepond Charter	Fairbourne Prep	Moorhall	Theme
Do you think math Internet memes are perceived the same way? For example, if we were to all look at an Internet meme, would we have the same understanding ?	Willow: Because, for some people, math is easy, and for other people, math is hard; like, they would have a different perception of them [negative mathematics memes].	Samuel: Yeah, it's true 'cause, as long as you understand math, then you're going to probably relate to at least one of these. Sharon: It probably has nothing to do with ethnicity or race. Joshua: Or gender.	Alfred: Depends on someone's personalities and how they perceive things. Daniel: Yeah, because it depends on if you like math or you don't. Alfred: If someone was really good at math, then	Felicia: It depends because, when you grow older, you also have a bigger mindset of knowledge then a younger child may have, depending on what they learn from other people. Falyn: I think it's also	Michelle: 'Cause some people are good at math, and some people are bad . . . some cannot relate, and some of them can. Mike: Someone can take it as an insult . . . 'cause, you know, people can get bullied	*Ability Affects Susceptibility :* People who are good at math are not affected by an Internet meme's message. Different abilities will interpret things differently.

	Samuel: It also depends on your math skills, like, even if you're good at math.	they will probably have a deep debate about these kinds of memes.	experience that affects your interpretation of things.	for being smart . . . it's like saying, "oh, he's smart . . . let's trouble him."

Limitations

The researchers were cognizant of the various degrees of bias used throughout, including how the memes were collected and selected, the questions that were asked by the researchers, the themes and codes that were created, and the messages that were highlighted. This study was facilitated in 2017, and the individual IMA sheet only listed male and female as genders. Although there was space to write in "nonbinary gender," the fact that we did not have it as a predetermined choice could have pigeonholed students to make a selection that may not have fully represented how they identify. However, we do refrain from presenting data from a gendered perspective. Furthermore, the main purpose of this study was to gain insight on how students interact with mathematics messages on social media, and the convenient jury ultimately selected the memes students eventually engaged with. As stated previously, the convenient jury was not a representative subset of the diversity contained in the mathematics education community and not well positioned to recognize the problematic nature of some of the meme selections (i.e., that many feature White males and that at least one is offensive to those who identify as a woman). However, we do believe that what students claimed as their "why" speaks to a larger context that extends beyond the selection of memes and the IMA, and we focus our analysis on that.

Findings

In this section, we present findings from the IMA and the focus group discussions. First, we present numerical data regarding the mathematics Internet meme that students selected to share via social media. Then we present an overview, based in thematic analysis, of students' reasons for choosing the meme they did and how they would expect to position themselves with respect to that meme. Finally, we present three salient storylines that emerged during our close analyses of the focus group discussions: *Vindicate or Villainize Mathematics; Ability Affects Susceptibility;* and *Influence or Isolate, That Is the Question?*

Students' Mathematics Internet Meme Selections

Students were asked to choose a single Internet meme from among eight options (see Table 3) to post and share (e.g., students' SMRs), providing insights into their affiliation with mathematics messages on social media. Table 3 shows findings from the IMA task.[11]

Table 3. *Mathematics Internet Meme Activity Cards*

[11] Although 31 students participated, five did not identify the mathematics meme they would post, decreasing the sample from 31 to 26 for the IMA.

Mathematics Internet Meme	Percentage of Students' Selection ($N = 26$)
Meme A. "Homer Simpson"	27% (7)
Meme B. "Polar Bears"	15% (4)
Meme C. "Me neither"	15% (4)
Meme D. "Nice try, math"	12% (3)
Meme E. "Live dangerously"	12% (3)
Meme F. 'Chicks dig math help"	8% (2)
Meme G. "it gets complicated"	8% (2)
Meme H. "That'd be great"	4% (1)
Meme I. "Dance lessons"	0% (0)

Memes A (Homer Simpson), B (Polar Bears), and C (Me neither) were the three that were most often selected by students to post on their social media accounts. (See Table 2 for images of the memes used in the IMA.) Twenty-seven percent (7 of 26 students) chose Homer Simpson, 15% (4 of 26 students) chose Polar Bears, and 15% (4 of 26 students) chose Me neither.

Memes A (Homer Simpson) and C (Me neither) were judged by the convenient jury as negatively depicting mathematics, and Meme B (Polar Bears) was judged by the jury as positively depicting mathematics. Meme A, Homer Simpson, is titled with the phrase, "Me in math class" and shows a picture of Homer Simpson, a relatively dimwitted character on *The Simpsons* TV series, asking the question, "Can you repeat the part of the stuff when you said all about the things?" Internet Meme C (Me neither) shows a man laughing, sarcastically asking the question, "Do you know that awesome feeling when you finally understand math? . . . Me neither." Both of these Internet memes convey negative ideologies about mathematics (i.e., "math is confusing" and "math is hard"). Although both emote a humorous tone, their stances reflect a negative one regarding mathematics identity. Meme A, Homer Simpson, asks viewers to locate themselves within the meme (i.e., "Me in math class") and to consent to its message about being confused. Senders of Meme C, Me neither, directly engage in the social community by asking a question and then positioning themselves as not knowing mathematics (i.e., "me neither"). Meme B (Polar Bears) is titled with the phrase "When you understand something in math" and shows two polar bears dancing. Although the convenient jury judged it as positive, its stance can be perceived in multiple ways. One is the right to feel a sense of accomplishment when solving a mathematics problem. A second unrelated message is that the feeling of understanding is so infrequent in mathematics that, when it happens, it is a cause for celebration: a mixed message at best. Perhaps tellingly, no student chose Internet Meme I (Dance lessons), which illustrates a connection between mathematical functions and dance moves and was judged positively by the jury.

Overall, 54% of all student participants selected a negative Internet meme to share, more than double the selection rate of positive (23%, *N = 26*) or neutral Internet memes (23%, *N = 26*). Perhaps most telling is that approximately 80% of the students self-identified as average or above in their mathematical ability, and yet most memes they selected illustrated negative positions with regard to mathematics. Perhaps not surprisingly, student selection choices are consonant with the negative and widespread story of mathematics that is portrayed in popular culture, as discussed above in prior research (Darragh, 2018; Mendick, Epstein, et al., 2008; Mendick, Moreau, et al., 2008).

Overview of Student Positioning Through Social Media Responses (SMRs)

As they selected their Internet memes, students also chose other SMRs (e.g., "liking," "tagging," "commenting") that they would tag to their meme and that described a similar routine. First, they would assess a meme for its relatability, which often included laughter, some type of phatic communication like emojis, and tagging other friends who might also relate to the meme's message. For example, Steven and Scott, 9th graders from Silvercliff Academy, felt that Internet memes often reflect true circumstances:

Steven: Like, sometimes, you realize how this can relate to you in a certain way.

Scott: If they're more relatable, it means more entertainment . . . funnier.

Willow, a senior from Westpine High School, agreed, acclaiming, "Well, it's funny because they agree with it; that's why they relate to it and laugh." Other focus groups shared similar sentiments.

Students elaborated on the theme of relatability, suggesting the kinds of comments they would expect others to post or that they themselves might post. For example, Steven, from Silvercliff Academy, stated, "[Homer Simpson] would get *facts*, likes, and laughing emojis." Samuel added, "All you would see under [Me neither] is *facts*[11] and the skull face."[12] Also, Sean, a 9th grader from Silvercliff Academy, said, "[If I posted Meme E (it gets complicated)] there would be laughing emojis, and it would get all likes." Melissa, a 9th grader from Moorhall, indicated she would expect to see comments such as, "Oh my God, this is so true [referring to Polar Bears]." Mary, also a 9th grader from Moorhall, indicated that she would put "the tears of joy" emoji under Memes A (Homer Simpson), D (Nice try, math), E (Live dangerously) and G (it gets complicated).

In addition, students explained they would tag—create a direct link to—their friends to the original meme. Unlike sharing, tagging calls specific users' attention to the post. Sharon, from Silvercliff Academy, specifically voiced, "I'll tag a friend under it [Internet Meme C, Me neither] and be, like, 'this is so true.'" Additionally, Mike from Moorhall ecstatically chose Meme C and stated, "I'm tagging, like, 30 friends." Francine from Fairbourne Prep said she would laugh at Homer Simpson because, "that's how I feel" and would tag a friend. In short, the students' choices and discussions of SMRs (e.g., sharing or "liking" negative Internet memes, "tagging," putting a "joking" comment beneath a negative post) portray a clear stance toward a socialization that reflects a public degrading of mathematics.

[11] To add further clarity to the students' dialogue, "facts" implies "factual" and is generally used to concur a proposition.

[12] Here, "skull face" is being used to represent "died" laughing.

Interestingly, students rarely decided to share positive Internet memes that depicted uplifting messages about mathematics. In addition, students did not express "liking," "tagging," or "commenting" on positive mathematics Internet memes, reflecting their disinterest in sharing positive math messages. Our analysis indicated that positive mathematics Internet memes did not generate the same desire; only one (Polar Bear) garnered students' attention. These findings support previous work, as discussed earlier, and suggest the dominance and prevalence of negative images and messages about mathematics. Although students may not associate their SMRs as mathematical in nature per se, their choices and discussions of SMRs call attention to, reinforce, preserve, and amplifiy negative messages about mathematics in virtual spaces.

In the next section, we present findings with respect to three storylines that emerged from close analysis of the focus group discussions. These storylines were present across discussion groups, and, in our analysis, they both reflect and perpetuate negative rhetoric and public images about mathematics.

Storylines in Students' Discourse

After examining all transcripts and facilitating the coding process described above, three centralized storylines emerged: *Vindicate or Villainize Mathematics; Ability Affects Susceptibility;* and *Influence or Isolate, That Is the Question?* Each theme will be presented in a subsequent section.

Villainize > Vindicate Mathematics:

As described above, an initial analysis of students' SMRs demonstrated several negative tagging practices toward mathematics, illustrating an active culture among young people of socially accepted contempt for mathematics. Closer examination of students' responses in the focus groups revealed that although students rated themselves highly as mathematics students, they were more comfortable in adhering to a socialization that demeans it. Students did not feel compelled to defend or endorse it, positioning themselves as spectators with no vested interest in how mathematics is discussed, or they portrayed a theme we call "vindicate or villainize." This theme was present in the responses of 24 students. We present the statements of six, whose responses are particularly revealing.

Willow, an African American senior from Westpine High School's focus group, expressed that, on social media, "most of the time, with stuff like that [negative mathematics memes], everyone agrees. Nobody will disagree; everyone will just agree." Samuel from Silvercliff Academy similarly added, "When everyone is making fun of math, you're also going to want to make fun of math. When everyone's saying math is hard, even if you're good at it, you're probably going to say it's hard." Both Willow and Samuel's comments are extremely powerful statements that call attention to the established culture of social media regarding mathematics and mathematics Internet memes. These remarks indicate that negative mathematics Internet memes and their associated messages are not only met with acceptance; they are also not confronted or challenged. These negative social media practices help illuminate a seemingly valid truth of the assimilative culture online (Wiggin, 2019), one that legitimizes a negative affinity with mathematics and adds to a negative narrative.

Perhaps even more telling are the contradictory stances students took on the vindication of mathematics on social media. On one side, Willow, who self-identified as an average mathematics student (SPMA 7), expressed, "I would not like or comment [on a negative mathematics Internet meme], but I would share it." Interestingly, as a student who sees herself as

a good math student, Willow did not feel obligated or positioned with the need to defend it. Moreover, her actions to perpetuate Internet memes that display contempt for mathematics contradict her own personal identity as a skillful mathematics student. This reflexive action provides insight on the possible internal tension social media users engage in. As a student with supposedly high reverence for mathematics, Willow can disregard and distance her own personal performance and opinions from her SMR, highlighting a deeper socialization and affinity toward the popular stance and collective identity than her individual one.

Alfred and Antwon, two African American students from Marblepond Charter School's focus group, offered a different perspective. When probing further about their SMRs, the boys revealed the following:

> Alfred: If someone was really good at math, then they will probably have a deep debate about these kinds of memes [negative mathematics Internet memes].
>
> Antwon: Yeah. Like, people who leave school, who really like math and they actually do it for fun, they might see this [negative mathematics Internet meme] and be serious.

It is clear from the onset that both Alfred and Antwon do not feel obligated to protect or defend mathematics. Although both students have high self-perceived mathematical ability (both self-identified as a 9), they do not perceive people teasing mathematics or those who do well at mathematics as a problem. Additionally, they separate themselves from other "good" mathematics students (e.g., *they actually do it for fun*) and create a storyline where it is the responsibility of the other "good" mathematics students to endorse/defend mathematics on social media. Alfred's justification emphasizes *really good* as if there is this abstract threshold of ability needed to act. Antwon, on the other hand, distinguishes between ability and affection for his defense.

Ability Affects Susceptibility:

As students described the villainization of mathematics online, their comments revealed the belief that negative messages from Internet memes are not uniformly received by all. Further, their comments suggested that mathematical ability may dictate the perceptions and susceptibility level of an Internet meme's message. Students' commentaries point to lower mathematically performing students being more susceptible to negative mathematics Internet memes, as it may more closely relate to their experiences, and higher mathematically performing students being less susceptible, as it may relate less (or not at all) to their experiences. As a result, we call this emergent theme *Ability Affects Susceptibility*. This theme was salient across various focus groups, as it was present in 15 student responses. We include five such student remarks.

For example, when asked why people would perceive Internet memes differently, Mike from Moorhall clarified that, "[for] some people, math is easy, and for other people, math is hard; they would have different perceptions of them [Internet memes]." Here, Mike is making the claim that individual mathematics experience and ability potentially influence susceptibility. During another focus group, Francine from Fairbourne Prep added to these sentiments as she described her sister's mathematical ability and her beliefs of what she is now afforded. She explained, "No, my sister likes math, and she's good at it, so I don't think it's [negative

mathematics Internet meme] going to affect her like that." Here, Francine is building on previously mentioned claims and explicitly drawing a link from high mathematical ability to susceptibility; in particular, strong mathematical abilities are less susceptible to negative mathematics messages because they are not relatable to her. Francine expressed that, due to her sister's high ability, she is shielded from negative mathematics messages.

These students articulated that those with positive mathematics experiences would not relate to negative Internet memes. This limited view sees mathematics experiences, whether positive or negative, as mutually exclusive and having nothing to do with one another. They take mathematics experiences and abilities to be static, as they create concreate labels as "good" and "bad." The overall implication here is that they perceive mathematics as one overall mathematics experience instead of collective combinations of multiple experiences. It neglects the tendency to see mathematics experiences on a continuum, conjoin past mathematics experiences with the present, and allow shifts and growth to happen.

To further add to this storyline, Michelle from Moorhall stated, "Some people are good at math, and some people are bad . . . some cannot relate, and some of them can." Additionally, Antwon from Marblepond Charter School stated, "It depends on who you [are] showing it to; probably someone who struggles with it [mathematics] might think something different." Francine's and Antwon's comments help to elucidate the storyline as they explicitly mentioned mathematical ability as the deciding factor of susceptibility. Although Francine's statement regarded the lens of a strong math student and Antwon's regarded that of a struggling math student, both ultimately positioned those with a higher mathematical ability to be impervious to negative mathematics messages. The students believe that "good" mathematics students have direct in-person examples to counteract the negative messaging they are receiving, whereas other students may not have those experiences and are vulnerable to the meme's message.

Influence or Isolate, That Is the Question?:

Although not as significant as the Shakespearean work of *Hamlet*, contemplating life and death, this storyline was named after the philosophical ways in which students attended to the specific question, "Would they share these [negative] Internet memes with their younger sibling?" Witnessing students construct complex arguments to explain the advantages and disadvantages of their choice, while having to address rebuttals and counterexamples, was truly philosophy in motion. This line of questioning was asked to every student and was important because it removed participants from the focal point, which emphasized their honest perceptions of social media influence and delivered an unpredicted storyline. Below we include the comments of 10 students.

Influence. As predicted, most participants affirmed that they would not want their younger sibling(s) to view negative mathematics Internet memes because of their subliminal influence. Antwon from Marblepond Charter admittedly stated, "If they see a whole lot of [negative] things about math, they might not see math as the best, or maybe not interesting or popular to be good at." Antwon's response aligns with an earlier comment about the prevalence of negative mathematics messaging impacting students' views about mathematics. Further, Scott from Silvercliff Academy declared that he would not expose his younger sister to negative Internet memes because "My sister, just like Samuel's sister, dislikes math, but I want her to like math . . . for me, I say that the subject is very important . . . you have to learn it [math], and without math, you can't do anything." Scott's reactions convey his fear. He is convinced that sharing negative Internet memes would only confirm and normalize his sister's conceptions

about mathematics. Also, as a brother, he would not want to see her lose tenacity or to stop trying.

Alternatively, Mary from Moorhall shared that although her sibling was doing well in math, she would not share negative Internet memes with her. She stated, "They might even be, like, 'oh, I'm the only person who could understand this stuff; maybe I'm weird.'" Here, Mary is expressing her fears that her sister would be outcast among other people for not agreeing with the Internet meme's message, and she is alluding to the social pressures that exist for K–12 students.

Willow and Wakanda from Westpine High school respectively asserted that negative Internet memes would influence their sibling's conception about mathematics as well.

> Willow: No, because I feel like, in these [Internet] memes, they are more negative than positive or neutral. So, it's like I want them to see the better side of math, not people complaining about math.
>
> Wakanda: I wouldn't want my younger siblings to see that math is really complicated or confusing. I want them to excel, to do better and be strong, so that the positive things can come to them.

Intriguingly, the duo opted to only portray one side of mathematics to their siblings, a side that consists of rudimental and effortless mathematics. One concern is that this decision appears to be an overcorrection (e.g., students see all negative messaging about mathematics, so let us instead show all positive messaging), and eventually this conception of mathematics can be troublesome when mathematics becomes onerous.

Felicia and Fae from Fairbourne Prep affirmed that they too would not share negative Internet memes with their younger siblings. They expressed the desire for their siblings to encounter mathematics in an unbiased manner and define it through their experiences, not others' perceptions. Felicia added that she wanted her younger sibling "to have an expectation of what math is going to be like. Even though it is going to be challenging, they will figure it out eventually." Fae correspondingly added,

> I do have a little brother, and when he comes home and shows me all this stuff, he says math is going to be so hard. And I want him to be able to not think like that; I want him to think he can be able to do it.

It is important to note that students are not misleading their siblings or falsifying the mathematics experience. In Felica's case, she even acknowledges that math will be difficult, setting the expectation for her sibling, but is overall optimistic that her sibling's perseverance will hold true.

Isolate. Unexpectedly, 23% (7 out of 31) of participants took a different approach and agreed that exposing their younger siblings to negative mathematics Internet memes would be a benefit. Participants' responses mainly emphasized that the sharing of memes is a method to alleviate feelings of isolation and become socially accepted. For example, Sharon from Silvercliff Academy mentioned that although negative memes are dissatisfactory, they help attract people to a shared experience or view, which ironically is a sign of relief for not being the only one. She stated, "It's like, sometimes, when you think you're the only one who experiences that, but, like, it's actually not only you." Michelle from Moorhall similarly stated that she would show negative mathematics Internet memes to her sister because she is "bad" at mathematics and the memes would help her feel "normal." She added, "It will make her feel better about herself

because then she knows she's not the only one out there that's bad at math." In each of these statements, participants express seclusion as the root of their actions because they view negative Internet memes as a sign of support. They stated that sharing allows their siblings to release therapeutic feelings, express virtual empathy, and validate social acceptance. Although their actions may seem outwardly negative, their rationale provides insight into the socioemotional and sociocultural lenses of mathematics online.

In the same vein, Samuel from Silvercliff Academy added, "Yeah, 'cause it's not like my little sister is dumb. She obviously understands she also hates math. She's past the point in kindergarten where you're counting, you know." Although the rationale of Samuel's statement is not grounded in the same theme of isolation like the others, it still draws on the perspective of being part of a community. Here, it seems Samuel's actions are a sign of confirmation. Samuel implies that his younger sibling's identity is fixed and concrete; therefore, negative Internet memes would not change her or reorient her perceptions toward mathematics. Samuel's statement also eludes to the fact that his sister's dislike for mathematics is a result of its level of difficulty; once it became challenging, her affection changed.

Conclusion

This study serves as a catalyst, signifying the conceptualizations of power and identity that are rooted in social media. Through the course of focus group interviews and the IMA, we were able to deduce students' SMRs (e.g., liking, tagging, commenting, creating, sharing), which highlighted their stance toward mathematics messages. Students' SMRs to internet memes reinforced negative messages about mathematics. Furthermore, students' comments inspired three storylines: *Vindicate or Villainize Mathematics; Ability Affects Susceptibility;* and *Influence or Isolate, That Is the Question?*

Vindicate or Villainize Mathematics

Given the participatory nature of digital culture and its invisible but rigid enculturation process, social media becomes saturated with negative mathematics messages, with little to no resistance. In other words, social media users understand the memetic social system, and with no oppositions, they are motivated to produce and reproduce negative mathematics Internet memes. This potentially has the power to skew the perceptions of other users who engage with Internet memes, permitting the perception that it is acceptable to publicly belittle mathematics, a continuous harmful cycle where mathematics is left defenseless. One deep concern is that social media is an open medium that young people can access and that it can be extremely difficult to form a positive mathematics identity when negative Internet memes and pervasive thoughts of mathematics are constantly portrayed, as this collective identity may be difficult to resist.

Ability Affects Susceptibility

This storyline explicated students' perspective of mathematics experiences as a static or singular experience, instead of dynamic and having the ability to change from moment to moment. High mathematically performing students are perceived as individuals who have never, or will never, face difficulties with mathematics, making negative Internet memes unrelatable to them. Lower mathematically performing students are seen to have never, or will never, be able to succeed in mathematics, making them always susceptible to negative Internet meme messages.

Influence or Isolate, That Is the Question?

A majority of students opted not to display negative Internet memes to their siblings for fear it may impact their perceptions about mathematics. Students wanted their siblings' feelings toward mathematics to be defined by them and not by another's perspective. Although the reality is that students cannot shield their siblings from negative mathematics messages forever, some students suggested intentionally displaying positive messages to counteract the negative ones. Surprisingly, some students saw sentimental benefits in displaying negative Internet memes to their siblings, as they may signify there are others who dislike mathematics. Students' discussions about negative Internet memes could become a sign of relief (i.e., "not being the only one"). Collectively, students' testimonies illustrate mathematics Internet memes as influential to one's mathematics identity.

Lessons Learned

Though the study was facilitated 5 years ago, there are some pressing lessons that are applicable for today. We watched as the pandemic shut down the world and people gravitated to online spaces for human interaction and connection. And although these virtual spaces extend far beyond the classroom and are often regarded as fun and unacademic, they are inherently full of mathematics messages. We offer students' stances and storylines as conceptual tools leading to a different perspective, as well as an insight into possible tension points of student identities and their SMRs. In this discussion, we share some lessons on the intersection of students' mathematics identities (off- and online).

Throughout the stances and storylines displayed above, we noticed that students who identify themselves as being good at mathematics not only chose to post and redistribute negative mathematics Internet memes but also "liked" and left supportive comments on other negative Internet memes, adding to their notoriety. Although we expected students who think highly of themselves in mathematics to choose to share positively messaged mathematics memes, they did not. Instead, they chose to perpetuate negatively messaged ones, even if they disagreed with their individual identity. A lesson learned is that students' responses do not necessarily mirror their own mathematics identity. They are not just considering their own experiences with mathematics; it is deeper than that. These results lend themselves in support of students' succumbing and adhering to a larger hegemonic construction of mathematics and embracing the online community's perspectives over their own. When looking at Willow's and Samuel's comments above, they are highlighting the deeply rooted culture surrounding mathematics in the sociotechnological space and the pressure to follow it. Part of the online socialization process is learning to read the social cues and reacting to them accordingly (Boyd, 2008; Buckingham, 2008). As students join online communities, the already-established social norms about mathematics undergird their interactions way before their accounts are created. Looking at other users' profiles provides critical clues of what is socially acceptable and what is not (Boyd, 2008). It is apparent that they are following suit with the established culture and how everyone else is talking about mathematics.

As online spaces grew, we watched as students took time to carefully curate their online personalities. Also, as we stand back to examine their design choices, they call attention to possible tensions between their digital bodies and their offline selves. When Alfred and Antwon, who both think highly of themselves in mathematics, were reluctant to post positive mathematics Internet memes or defend mathematics online, what were they saying and why? Offline, in person, both students were happy to proclaim their mathematical brilliance, but online they faltered, each declaring someone else should vindicate mathematics. In addition, Mary's

comments above indicate she does not want her sibling to be ridiculed for being a good mathematics student. Instead, she wants her sibling to "play the game." Consequently, she presents her sibling with online mathematics discourse to become familiar and camouflage into the charade. Another lesson learned is that writing oneself online can be a difficult process, especially when it is in direct opposition with the dominant sociotechnological perspectives (Boyd, 2008). For a lot of students, being mathematical is synonymous with being a "nerd," and, in some cases, students may think being a "math person" means subverting parts of their identity (Boaler & Greeno, 2000). Although students theoretically have the potential to (re)create themselves online, the social structures that regulate popularity offline are present online as many students' online networks primarily consist of their localized friends (Buckingham, 2008). Thus, the looming pressure for validation present during offline face-to-face conversations may also exist in online communication. Understandably, students are cognizant of what they post, knowing that there may be some face-to-face interactions following.

Although these two spaces (off- and online) may be presented as unique, they are not mutually exclusive. Students' comments and actions illustrate a duality that tethers their on- and offline mathematics identities that may not be as simple to align. Offline, the structures of schools and classmates provide a sense of community (Walker, 2012), but online it is unclear what those supportive structures are, as their actions are individual experiences that cause students to learn primarily by doing. Therefore, one thought is to create a formal space (in person or virtual) for young people to deliberate and debrief their thoughts, curiosities, and sentiments about mathematics and/or mathematics messages. These discussions can offer students a space to openly reflect on their past and present experiences, including experiences that might support mathematics stereotypes, in hopes of dispelling misconceptions and possibly helping students reimagine and reconstruct their experiences moving forward.

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Appendices

Appendix A: Focus Group Demographics

Focus Group Data Table

School/ Type/ Location	Students	Grade	Self-Perceived Math Ability (SPMA) (1–10)
Westpine High School Public/ Bronx, NY	W1-Wilma	12th	8
	W2-Willow	12th	6
	W3-Wilbur	11th	7
	W4-Wilson	11th	5
	W5-Wakanda	11th	7
	W6-William	11th	7
Silvercliff Academy Public/ Brooklyn, NY	S1-Sharon	9th	8
	S2-Sean	9th	8
	S3-Susan	9th	6
	S4-Samuel	9th	8
	S5-Scott	9th	9
	S6-Steven	9th	8
Marblepond Charter Charter/ Manhattan. NY	MA1-Adam	10th	8
	MA2-Alex	10th	10
	MA3-Anthony	10th	8
	MA4-Antwon	10th	9
	MA5-Akil	10th	9
	MA6-Alfred	11th	9
Fairbourne Pr	F1-Felicia	10th	6

Moorhall Public / Queens, NY	F2-Francesca	10th	8
	F3-Falyn	11th	3
	F4-Francine	10th	9
	F5-Fae	10th	9
	M1-Mike	9th	5
	M2-Maureen	9th	8
	M3-Michelle	9th	9
	M4-Melissa	9th	8
	M5-Mark	9th	8
	M6-Matt	9th	9
	M7-Mary	9th	8

Appendix B

Internet Meme Activity (IMA) Protocol

Name: Grade Level: Age: Gender: M F

Ethnicity:
Caucasian / Hispanic / African- American / Asian
Other:_____

On Scale 1– 10 (10 being the best) rate yourself as a Math students
1 2 3 4 5 6 7 8 9 10

POSITIVE:	Numbers:	Discuss:
	WHY:	
NEUTRAL:	Numbers:	Discuss:
	WHY:	
NEGATIVE:	Numbers:	Discuss:
	WHY:	

If you had to choose one meme to post which one would it be? _____

Appendix C

Student Focus Group Questions

Name of school:

Day:

Date:

Time:

Script for students:

My name is _____. We are researching math in popular culture. The focus group will be in three parts. We will ask you a couple of questions about math in popular culture as a group, give you some memes to sort, and then return as a whole group for more discussion. Your answers will help us determine if there is a link between math education and popular culture, so we need you to be open and honest. This focus group could take anywhere from 45 min to 1 hr. Your participation is totally voluntary, and refusal to participate will not result in any consequences. Should you need to stop the interview at any point, we can reschedule it for another time. Everything you say will be confidential; this is a safe space, so we encourage you to tell the truth. Any questions, comments, or concerns about what we just talked about? What is the best method to follow-up with you should we need further clarification on anything you said?

Group (Part I)

1) While on the Internet, do you go on any social media websites? Which ones, how many times?
2) What images do you see now? Do any of them pertain to math?
3) What are the people doing when math is being portrayed?
4) How do the people look? (jeans/clothes/braids, etc.)

   Show them an unrelated meme → Funny meme has nothing to do with math

5) What do you see in it? Describe it. Do you see this as positive, negative, or neutral?
6) Have you seen this one before?
7) In your own words, what's a meme? What do you think its general purpose is? Do you think all memes have the same purpose? Do you think there are messages in them?
8) Do you think memes are influential in any way?

9) If you had to pass a message, would you use a meme? Do you think they are influential ways to pass messages?
10) Have you seen any memes relating to math? (If yes, describe them.) Explain.

Individual (Part II)

Show them math memes on the table

{READ} Direction: In front of you are nine different mathematics memes. Your job is to place each meme into one of the three categories (P/Neu./Neg). Place the number located on the back of the meme in the appropriate category on your student answer sheet. There is no right or wrong answer. There may not be an even number of each category present; as a matter of fact, one or two categories may not be used. It is up to you to place the memes where you feel they should go. You are in complete control! So, when you are done, write a description of why all of those memes are in their category (i.e., why are the ones you've selected positive?). Afterward, write down the number specifying which memes you would post. Also, if you come across an interesting one and you want to discuss it further, place the number in the discussion category, and then we will discuss the most frequently chosen meme as a group.

If you come across one that you **absolutely** agree with or **absolutely** disagree with, write the number in the "Agree with" box or the "Disagree with" box. Also, use the tape recorder and explain why you disagree or agree with it.

Group (Part III)

11) Have you seen any of these memes before or memes like these? Please describe them.
12) Which meme would you post? Have you shared or posted any memes like this? If so, where? Why do you think you did that? What were the comments like?

Student may choose a number to discuss

13) Do you feel like there are messages behind any of them? What's the message behind it? How do you know?

14) If you had a younger sibling, would you let them read or see these memes? Why do you think?
15) Was it the picture that decided the message or the words (caption)?
16) Do you think these memes are influential in any way?
17) Do you think everyone interprets the meme in the same way? Do you think the message changes depending on gender, race, or age?
18) If students consistently see these memes, do you think it will influence the way they think about mathematics?