Memengful Calculus

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This study explores student-generated memes submitted as a part of a Calculus II homework assignment. Drawing on a twofold theoretical perspective that combines Bini et al.'s (2023) heuristic model for the creation of a mathematical meme and Bolman and Deal's (2008) Four Frames framework of an organizational culture, we analyzed 32 memes and corresponding reflections. We found that via memes, students reflect on and communicate their struggles with Calculus and draw connections between Calculus concepts. Memes also became a vehicle for reflecting and shaping the classroom culture, offering students an opportunity to "laugh back" at the course authority. Together, these findings illustrate how memes can serve as reflective artifacts that capture both cognitive and socio-cultural dimensions of learning. We argue that meme-based assignments hold promise for fostering higher-order thinking, humanizing instruction, and promoting engagement in a challenging Calculus course.

Keywords: memes, Calculus, assignments, classroom community and culture

The term *meme* was first introduced by Richard Dawkins in his book *The Selfish Gene* (1976) to describe a cultural unit transmitted between people in a manner analogous to genes. With the rise of the internet, memes initially appeared as simple captioned images circulating in online communities for humorous purposes. Today, they encompass a wide range of formats, including photographs, videos, and hashtags, and play an increasingly prominent role in modern digital culture. Beyond entertainment, memes now function as tools for communication, creativity, and self-expression, offering ways to comment on current events, challenge mainstream narratives, and participate in shared community life.

While research on memes in education is still emerging, scholars have increasingly recognized their significant educational potential. Studies demonstrate that memes can be a valuable and effective addition to higher education classrooms, fostering student engagement, critical thinking, and creativity across a range of disciplines, such as psychology (Kath et al., 2024), pharmacy (Brown, 2020), nursing (Bradley et al., 2022), and others.

Mathematics educators have likewise begun exploring the role of memes in teaching and learning. One line of work focuses on *mathematical memes* (memes containing a mathematical statement that can be validated) circulating in global online communities (e.g., Benoit & Salopek, 2023; Bini et al., 2022). For example, Benoit et al. (2025) found that engagement with mathematical memes can influence students' mathematical identity and their perceptions of who can become a mathematician. Another line of research examines *pedagogical memes* – memes intentionally integrated into mathematical instruction. Studies suggest that such memes support effective learning practices, enhance students' motivation, and reduce math anxiety (Akin et al., 2025; Sidekerskienė & Damaševičius, 2025). In particular, Sidekerskienė and Damaševičius (2025) presented a case study of a university Calculus instructor who incorporated a set of memes into her lessons as visual aids, thereby making complex Calculus concepts more accessible and engaging, which in turn improved student understanding and motivation.

The purpose of the present study is to extend the exploration of memes in undergraduate mathematics education by focusing on student-generated memes. Specifically, we analyze memes created by undergraduate students as a part of a homework assignment in one section of Calculus II, taught by the first author during the Spring 2025 semester. This study is guided by the following research questions:

1. How can undergraduate students use memes to reflect on and communicate their experiences with Calculus? In particular, what Calculus concepts and learning experiences do they reflect on and communicate through memes?
2. What pedagogical implications emerge from incorporating meme creation into a homework assignment in a Calculus course?

Theoretical Perspective

In answering these research questions, we adopt a twofold theoretical approach. First, we draw on Bini et al.'s (2023) heuristic model for the creation of a mathematical meme. This model views meme-making as an iterative process of linking between a specific meme template and a mathematical concept. According to Bini and colleagues, mathematical memes integrate three partial meanings: structural (the visual and textual conventions of meme formats), social (the cultural resonance of the chosen template), and specialized (the mathematical content to be expressed). The creative act lies in identifying a *linking idea* that bridges these domains. Although this model was originally developed for mathematical memes, we extend its application to encompass memes that capture both Calculus concepts and students' learning experiences.

As it was pointed out by Benoit and Salopek (2023), "… memes do not exist in a vacuum; they rely on a shared cultural and semiotic understanding for collective interpretations. They are entangled in their sociocultural environments and cannot exist outside of the events and practices in which they appear" (p. 45). In our study, memes were created by the members of a specific sociocultural environment with its own rules, practices, and shared meanings. Therefore, we adopt another framework that complements Bini et al.'s model by providing in-depth insights into classroom culture – the *Four Frames* perspective. Originally, this perspective was developed in organizational science (Bolman & Deal, 2008) and later adapted for undergraduate STEM department contexts (Reinholz & Apkarian, 2018). In this study, we extend its application to an even more local setting – a single classroom community.

In the Four Frames perspective, culture is defined as "a historical and evolving set of *structures* and *symbols*, and the resulting *power* relationship between *peopl*e" (Reinholz & Apkarian, 2018, p. 3). This definition highlights four interrelated dimensions of organizational culture. Table 1 summarizes the definitions of these dimensions and illustrates how they manifest in a mathematical classroom setting. Specifically, we view classroom *structures* as the syllabi, assignments, routines, and assessments; *symbols* as the cultural and humorous artifacts, informal rituals, and shared meanings; *people* as the permanent and temporal members of the classroom community (i.e., students, teacher, and the substitute teacher); and *power* as the authority and explicit (and implicit) hierarchy in a mathematical classroom.

Table 1. Definitions and aspects of the elements in the Four Frames framework, and their applications to a mathematical classroom setting.

Frame	Definition (adapted from Reinholz & Apkarian, 2018)	Application to a Mathematical Classroom
Structures	Formal arrangements, policies, and practices that organize how people work.	Syllabi, assignments, routines, and assessments.
Symbols	Cultural artifacts, language, rituals, stories, and meanings that community members use to guide their reasoning.	Cultural and humorous artifacts, informal rituals, and shared meanings.
People	Individuals and groups within the community.	Students, course instructor, and substitute teacher.
Power	Status, control, position, and political coalitions which mediate interactions between people.	Authority and explicit (and implicit) hierarchy in a mathematical classroom.

Methods

The data for this study stem from a second-semester Calculus course (Calculus II) taught by the first author in Spring 2025. The course enrolled 33 students, the majority of whom were STEM majors. Throughout the semester, the instructor regularly incorporated memes into his instruction, using them in lecture notes, handouts, online announcements, and a specific homework assignment called *Memengful Calculus*. This assignment, which accounted for 3% of the overall course grade, required students to submit a meme accompanied by a brief written reflection. In their reflections, students were asked to explain the choice of meme context, describe the Calculus concept or learning experience they were referring to, and elaborate on the connection between the two. By the time the assignment was due (around the middle of the semester), the following topics had been covered: Riemann Sums, volumes of solids of revolution, various integration techniques, and improper integrals.

The data corpus consisted of 32 submissions (32 memes and 32 corresponding reflections). All submissions were completely anonymized. The analysis proceeded in multiple iterations. In the first round, we conducted open coding, focusing on three dimensions of each submission: the context of the meme, the Calculus concept or learning experience it referenced, and the links between them. The submissions were divided into four equal sets, with each researcher coding the assigned set independently. During weekly research meetings, we reviewed and discussed all codes as a team, reaching consensus through the process of constant comparisons (Glaser & Strauss, 1967). Related codes were then grouped into categories, which served as the foundation for developing higher-level themes through thematic analysis (Braun & Clarke, 2006).

The final step of the analysis involved interpreting the resulting themes through the lens of the Four Frames framework. This allowed us to examine how students' submissions reflected their positioning within the social and cultural dynamics of the course.

Results

Our thematic analysis revealed four themes: two *cognitive themes* that captured students' engagement with mathematics and two themes related to different aspects of the *classroom community and culture*. In what follows, we describe each theme and illustrate it with the most salient examples from the students' memes and corresponding reflections.

Cognitive Themes

Through memes, our participants expressed their struggles with Calculus, particularly in relation to quizzes and exams. At the same time, the Memengful Calculus assignment provided a space for students to reflect on their mathematical knowledge by comparing various Calculus concepts and even making connections across different branches of Calculus.

Struggles with Calculus. A persistent myth surrounds mathematics–undergraduate mathematics, and Calculus in particular–that portrays it as "nightmarish, inherently difficult, and something to be avoided" (Darragh, 2018, p. 197). Many of our participants' memes echoed this characterization. Figure 1, for instance, illustrates students' struggles with two integration techniques – integration of rational functions by partial fractions and trigonometric substitution. As one student explained in their reflection, "Trig sub has been my biggest downfall in this class, so I would rather do any type of integration over that."

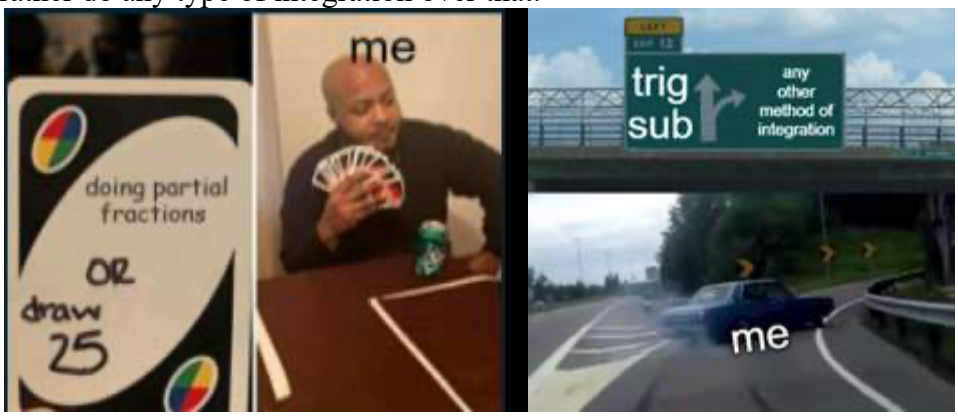

Figure 1. Students' memes illustrating struggles with two integration techniques.

In addition to communicating struggles with particular Calculus concepts, our participants' memes often conveyed the stress and frustration they and their peers experienced in relation to quizzes and exams. For example, one student described the discouraging experience of forgetting to adjust the bounds when applying the substitution rule in a definite integral on a midterm (Figure 2, left). Another student created a meme capturing their classmates' struggles with an in-class quiz on partial fraction decomposition (Figure 2, right). As they explained in their reflection, "I made this meme in the wake of the ***devastating*** news of quiz 5. While I personally did not struggle with the question, I know others who did and thought this would be a lighthearted representation of that struggle."

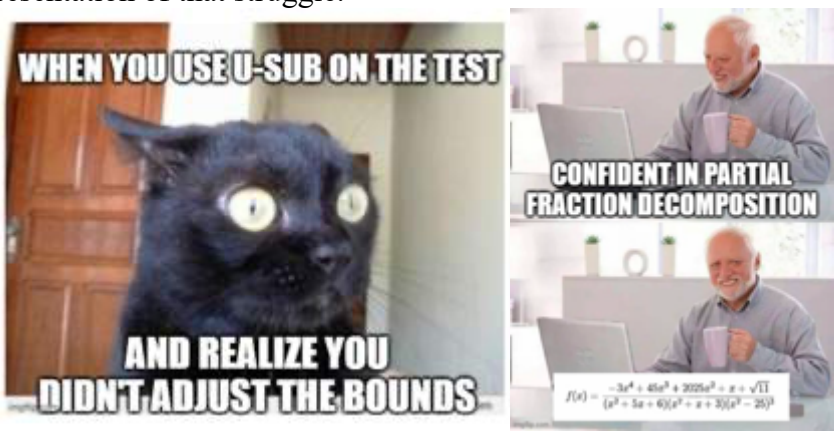

Figure 2. Students' memes illustrating struggles with quizzes and exams: forgetting to adjust bounds on a test (left) and the collective difficulty with the partial fractions problem on an in-class quiz (right).

Reflecting on conceptual connections. Some students used memes as an opportunity to reflect on and articulate conceptual connections between Calculus concepts, including drawing links between material previously learned in Calculus I and new content introduced in Calculus II. One student created a meme contrasting the processes of differentiation (Calculus I) and integration (Calculus II) of the same function, noting that the former was "easy to find," whereas the latter produced a lengthy and complicated formula (Figure 3, left). Another student used their meme to highlight a key distinction within Calculus II itself, focusing on the subtle differences between the proper and improper integrals (Figure 3, right). In their reflection, the student explained that their meme offered a playful way to emphasize the "improperness" of the latter, showing that a seemingly minor change in the integral bounds may result in a significant change in the type of integral – an idea humorously conveyed through the distorted appearance of Winnie the Pooh.

Figure 3. Students' memes illustrating conceptual connections: comparing differentiation and integration of the same function (left) and contrasting proper and improper integrals (right).

Classroom Community and Culture

When completing the Memengful Calculus assignment, many students went beyond interpreting Calculus solely as mathematics learned in this course and created memes that captured various aspects of the classroom community, which they were a part of. This aligns with the idea that a meme is strongly connected to its socio-cultural context (Benoit & Salopek, 2023; Bini et al., 2022), even when the overarching community is a single Calculus II class with its integral elements – students, instructor, rituals, shared meanings, and the power dynamics.

Classroom experiences. Many submissions reflected students' everyday experiences in a Calculus classroom. These experiences are shaped by many factors, such as the students' schedule, seating arrangements, interactions with their peers, inside jokes, and memorable sayings from the instructor. For example, one meme reproduced a recurring phrase the instructor used to close the class (Figure 4, left). As the student explained in their reflection, "Instead of saying just 'any questions?' like a normal teacher, [the instructor] adds a little spice to this saying by asking, 'any questions, comments, complaints, or compliments?" By humorously elevating this classroom ritual, this meme underscored how certain phrases and routines contributed to shaping the unique classroom community.

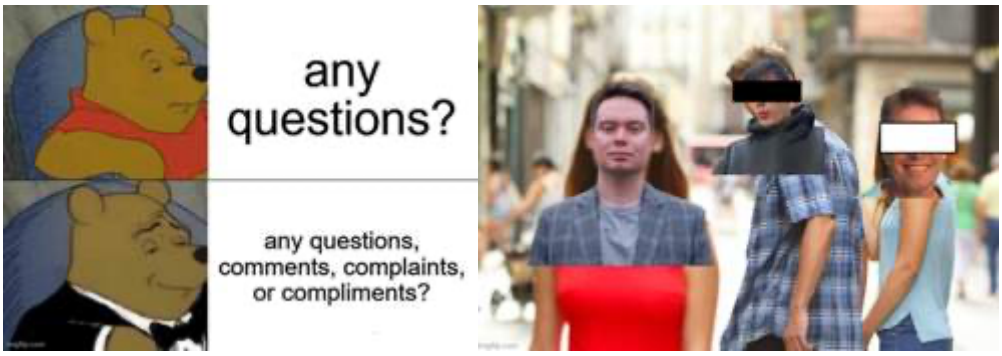

Figure 4. Students' memes illustrating aspects of the classroom experiences: recurring instructor's saying (left) and the student's reluctance to adjust to another instructor's new teaching style (right).

In some submissions, students positioned themselves as integral members and even gatekeepers of this community. The meme presented on the right side of Figure 4 illustrates a student in the role of a "distracted boyfriend" who turns away from his "girlfriend" (a substitute teacher) and directs his attention to "another girl" (regular course instructor). This meme reflects the student's experience of (an award-winning) teacher subbing for the regular instructor for several classes, humorously underscoring the student's loyalty to the familiar classroom culture and reluctance to adjust to a new one. The temporary disruption of the established classroom community thus induced the student's dissatisfaction that turned out to be memorable enough to be immortalized in their meme.

Memes as an opportunity for students to "laugh back." Several students also used pictures of the instructor found on the internet to create their memes. However, in these cases, the instructor's image carried structural meaning (a part of the meme's visual and social context), rather than a mathematical meaning tied to a particular Calculus concept or learning experience.

One student contrasted a German U-boat with the *u*-substitution technique, humorously modifying the famous *Drakeposting meme* by placing the instructor's image on top of Drake's face (Figure 5, left). This meme is typically used to express one's disdain and admiration for certain or different subjects. In the student's submission, the Calculus instructor is humorously positioned as "choosing" the integration technique over a submarine. Another meme depicted the instructor's face with a stern expression, captioned to suggest his reaction to students resisting "to do the hardest integration problem known to man" at the end of a Friday class (Figure 5, center). The student learning experience referenced here is their mental exhaustion that builds up at the end of the week, with the instructor's face serving as a humorous foil for this frustration.

Figure 5. Students' memes utilizing the instructor's image: the instructor choosing u-substitution over a German U-boat (left), depicting the instructor's stern reaction to students resisting "to do the hardest integration problem" at the end of a Friday class (center), and students' productive struggle with irreducible quadratics (right).

Perhaps the quintessential illustration of this theme is presented in the meme on the right side of Figure 5. Similar to one of the cognitive themes described in the previous section, this meme references the students' (productive) struggle with a challenging Calculus concept – integrating irreducible quadratics. However, the context for this meme was shaped by the instructor's picture, which anchored the meme's humor. The student even added a playful nod to the instructor's accent through the tiny caption "I'm smort" embedded in the image. Taken together, these three memes demonstrate how the Memengful Calculus assignment created space for students to "laugh back" at the course authority, humorously re-negotiating classroom power.

Discussion and Conclusion

This study set out to explore how students can use memes to reflect on and communicate their experiences with Calculus and what pedagogical implications this type of assignment might have. Our analysis revealed that memes provided a flexible medium through which students expressed both cognitive and socio-cultural dimensions of learning.

With respect to our first research question, we found that memes allowed students to both articulate their struggles learning Calculus and reflect on conceptual connections across different topics. The former echoes a popular societal perception of mathematics as "nightmarish" and "inherently difficult" (Darragh, 2018), while the latter suggests that the Memengful Calculus assignment encouraged engagement in higher-order cognitive processes, such as creation and metacognition (Bloom, 2010). In this sense, memes functioned not only as humorous artifacts but also as learning tools. This finding contributes to the growing body of research suggesting that memes can promote students' learning across disciplinary domains (e.g., Bradley et al., 2022; Brown, 2020; Kath et al., 2022).

We also found that students reflected on and communicated about the classroom experiences and various aspects of the classroom community and culture. Students' submissions captured each of the Four Frames of Bolman and Deal's (2008) framework. Specifically, memes aligned with the *structural* frame by highlighting students' struggles during course assessments and the necessity to work on a challenging mathematical task at the end of a Friday class. They reflected the *symbolic* frame through inside jokes and the instructor's recurring catchphrases. The *people* frame emerged in memes that incorporated images of the community members, emphasizing the personal and relational aspects of classroom life. Finally, the *power* frame was evident in students "laughing back" at the course authority by using the instructor's images as the memes' contexts. Taken together, these findings further shed light on how memes reflect and contribute to the development of the epistemic culture of overarching communities (e.g., Bini et al., 2022, 2023) – in our case, the classroom community – thus addressing our second research question.

Finally, as became evident in our last theme, this assignment has further pedagogical implications not previously documented in the mathematics education literature. Iloh (2021) discussed the utility of memes in qualitative research, highlighting their potential for building rapport between researchers and participants. Our findings extend this argument to a mathematical classroom, suggesting that meme-based assignments can also foster rapport between instructors and students by creating space for students to "laugh back." In this way, this assignment allowed the instructor to humanize his teaching practice, while the students were empowered to infuse humor into their mathematical learning experiences. Therefore, incorporating student-generated memes in a mathematical course can reduce the traditional power distance, foster a more collaborative learning environment, and support student engagement in a challenging Calculus course.

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