Students’ Perspectives of Proof Community Values and Goals

Tenchita Alzaga Elizondo — University of Texas Rio Grande Valley
Lino Guajardo — Central Michigan University
Brittney Ellis — Texas State University

Undergraduate students’ views on proof provide insight into how they engage with mathematical practices, yet little is known about the values and goals they associate with proof. We surveyed 32 students at two Hispanic-Serving Institutions and identified themes related to values and goals of the proof community across three domains: the proof itself, the utility of proof, and the prover. Students’ perspectives often echoed mathematicians’ values such as rigor and explanatory power, but also emphasized less-documented dimensions, including creativity, problem solving, and educational aims. By highlighting both alignment and extension of disciplinary norms, these findings suggest ways to better support students’ participation in proof-based mathematics.

Keywords: Proof, values and goals, norms, proof community

Undergraduate students’ experiences with mathematical proof offer important insights for the mathematics education community, yet this area remains relatively underexplored. Prior research has examined what students retain from proof-based instruction (Krupnick et al., 2018; Lew et al., 2016) and their beliefs about various dimensions of proof, such as reading, writing, and comprehension (Guajardo et al., 2025; Lew & Mejia-Ramos, 2019; Weber & Mejia-Ramos, 2014). These studies illuminate students’ perceptions and learning outcomes, but further work is needed to understand how students engage with the norms and practices of proof-based mathematics throughout their coursework.

Several aspects of mathematical proof present challenges for students, including abstraction (Rowland, 2001; Weber, 2004) and unfamiliar writing norms and conventions (Dawkins & Weber, 2017; Lew & Mejia-Ramos, 2019; Melhuish et al., 2025). For example, prior research has documented that students may struggle with making implicit arguments explicit (Samkoff & Weber, 2015; Selden & Selden, 2003). These difficulties can impact students’ self-efficacy and their sense of identity within the mathematical community (Wrightsman, 2025). Additionally, a common narrative in mathematics is that ability is innate and success comes easily for those with high aptitude (Melhuish et al., 2024). Together, these challenges and perceptions can contribute to an exclusionary and elitist culture in mathematics.

Community values and goals serve as foundational elements for the norms that shape how individuals see themselves, and are seen by others, within the mathematical community. The values and goals students perceive as important to the proof community influence which norms become salient in their experiences in proof-based courses. While existing literature has identified values that professional mathematicians associate with proof (e.g., Dawkins & Weber, 2017), we know less about how students perceive these values and goals. This is especially relevant as instruction in proof-based courses increasingly emphasizes student-student interaction, creating more opportunities for societal narratives about mathematical ability and participation to influence classroom dynamics (Battey & McMichael, 2021). To address this, we investigated the following research question: What values and goals do students perceive as important to the proof community?

Theoretical Perspective

For this study, we leverage Lauden's (1984) work on scientific communities' norms, values, and goals. A scientific community has various accepted results that it produces, these are referred to as theories of the community. A value can then be defined as the "good" attributes of these theories (Laudan, 1984). For instance, for the mathematics community, proofs are considered part of their theory and as such, a *value* would be for a proof to be rigorous and follow deductive logic (e.g., Dawkins & Weber, 2017). Additionally, a community has certain goals that they aim to achieve which then guide the rules and methods of the community (i.e., norms, Laudan, 1984). These norms are upheld by the shared values and goals that a community aims to achieve (Dawkins & Weber, 2017). Goals and values are inextricably linked, in that, goals are specific aims that a community or individual hopes to achieve and values are the underlying motivations and rationale for wanting to reach those goals (Laudan, 1984). Within the math education community, specific mathematicians' values and norms have been identified, however we are interested in understanding students' perspectives of the proof community's goals and values.

In proof classrooms, students are expected to embrace mathematicians' proof norms, yet they may not be aware of the mathematicians' value and goals underlying those norms (Dawkins & Weber, 2017). For example, the norm that "justification in proof should be deductive and not admit rebuttals" (p. 129) reflects the shared value that mathematical knowledge is a priori. Although students are often expected to write proofs in this way (Dawkins & Weber, 2017), they may perceive this practice as forced upon them without understanding the rationale (i.e., value) behind it. Without a shared understanding of the values and goals tied to these norms, students may find them arbitrary or meaningless (Dawkins & Weber, 2017). Further, Dawkins and Weber, citing Solomon (2006), noted that "asking students to adapt norms without corresponding values can leave students feeling passive and marginalized with respect to their learning of proof" (p. 133). Understanding the values and goals students associate with the proof community can help make these norms feel more meaningful and less arbitrary or imposed.

When goals and values of proof and proving are not explicitly discussed, students are left to infer them on their own. For example, while *a priori truth* is a valued aspect of mathematical proof (Dawkins & Weber, 2017), conciseness is also valued—unnecessary justifications are often omitted in published proofs (Selden & Selden, 2013). Students may not recognize this norm, as Weber and Mejia-Ramos (2014) found that students often believe every step should be included in a proof and that readers should not be expected to fill in gaps. Students may, in fact, prioritize clarity over conciseness. Another commonly held value is the exclusion of references to the author of the proof (Dawkins & Weber, 2017; Melhuish et al., 2025), as proofs are intended to be "autonomous objects," independent of their authors. Additionally, de Villiers' (1990) roles of proof—verification, explanation, systematization, discovery, and communication—highlight goals (and values) focused on the proof itself, such as its structure and presentation. However, these goals provide limited insight into values and goals related to other aspects of proof, such as the role of the prover or the proving process. Exploring the values and goals students identify can further efforts to make these aspects more explicit.

Methods

Data collection

We designed a survey that asked students to identify values and goals that they associate with the proof community. The survey included a short introduction to our study and described what we meant by a community's perceived values and goals. We then asked them: 1) *In your* *experience, what are some things that are valued about proof within the mathematics community?* and 2) *In your experience, what are some goals related to proof that people work toward within the mathematics community?* Following each question, we asked students to describe a situation from their experience as math students that reflected their identified values and goals. Responses to this question gave us insight and context into the students' personal experience with these values and goals. The survey was distributed to students across two institutions in the southwestern United States, both of which are Hispanic-Serving Institutions with one school having over 90% Hispanic student population. Students were asked to complete the survey if they had taken at least one proof-based course. We received a total of 32 responses from students, see Table 1 for description on the students' proof experience (students selected 1-2 or 3+ courses), gender, and race/ethnicity (both self-reported). All 32 respondents answered the question on values and 28 of the 32 respondents answered the question on goals.

Table 1. Student demographic information (number of students indicated in parentheses)

Proof Course Experience	Gender	Race/Ethnicity*
1-2 courses (14)	*Female (10)*	*African American (1)*
3+ courses (16)	*Woman (2)*	*American Indian (1)*
	Male (16)	*Asian American (1)*
	Non-binary (2)	*German (1)*
	N/A (2)	*Hispanic (19)*
		Latinx (3)
		Mexican/Mexican American (2)
		White (8)
		White Hispanic (3)

**Some students self-identified as multiple race/ethnicities*

Analysis

To analyze our data, we used an open coding approach to identify themes related to proof community values and goals. We started by collaboratively coding the values: the authorship team reviewed each survey response and assigned tags summarizing the student-identified value(s). Students' personal stories of their experiences were used to help contextualize their identified values and resolve disagreements among the team. Since students often reported multiple values, we applied as many tags as needed to capture their full response. Disagreements were addressed in real time during the group coding process. After completing the value coding, each author individually open coded the goals. We then met to compare tags, discuss discrepancies, and reach consensus on the final coding.

After tagging all responses for values and/or goals, the first author synthesized the codes into overarching themes. During the initial coding, the team noticed that students' responses often referenced different aspects of proof—such as the proof itself versus the person constructing it. With this in mind, the first author categorized each theme according to the aspect of proof it described. For example, when students noted that the proof community valued *the structure and strength of a proof,* this was classified as a theme related to the proof itself. Once the themes were developed and grouped, the full authorship reviewed them, resolving any disagreements through discussion until agreement was reached among the full team. These finalized themes are presented in the next section.

Results

We found that the students identified values and goals of the proof community referenced three aspects of proof: (a) the proof itself, (b) the utility of a proof, and (c) the prover behind the proof. Within each category, we identified themes pertaining to both values and goals. The results are organized accordingly, with themes related to values presented first, followed by those related to goals. Table 2 summarizes these themes.

Table 2. Values and Goals Identified by Students

Aspect of proof	Value Themes	Goal Themes
The Proof Itself	*Truth and Objectivity of a proof* *Structure and Strength of a proof* *Clear Communication & Language of a proof*	*For proofs to be accessible and approachable* *For proofs to be clear and rigorous* *For proofs to be logically sound*
The Utility of the Proof	*Proofs' explanatory power* *Proofs' power to justify the validity of a claim* *Proofs' General Applicability*	*Use proofs to prove general statements* *Use proofs to understand why mathematical concepts work*
The Prover	*Problem Solving Skills* *Creativity and Ingenuity* *Knowledge and Expertise*	*To have a mathematics research career* *To improve proof skills* *To educate others*

The Proof Itself

Values and goals that fell into this category reference attributes about the proof itself. In other words, these are values and goals that students identified that related to the aesthetics of a proof or features that a proof should have.

Values. We found three themes related to attributes that are valued in a proof. The first value was related to the *truth and objectivity of a proof*. Students highlighted the axiomatic basis of proofs and the objectivity of deductive logic. One noted that the proof community valued "that the steps to get to the proof are logical [...] proof is a logical based construction that follows order and does not require opinions," while another emphasized that a proof "establishes certainty through logical rigor, ensuring that conclusions follow inevitably from accepted assumptions." Students also identified values related to the *structure and strength of a proof*. Students saw value in rigor, resilience, and adherence to precise structural rules. Some pointed to the value on "how organized [proofs] can be," with one recalling a professor describing an entire course on proof organization. Others emphasized rigor, such as a student reflecting on epsilon–delta proofs: "Being almost right wasn't enough. Every inequality and bound had to be airtight." Lastly, students identified values related to *clear communication and language of a proof*. Students saw value in clarity, conciseness, and precise mathematical language. One recalled an instructor's reminder "that while proofs do require logically sound steps, they are still meant to be read," while another noted losing points on "proofs that are correct in every way, except they are 'too long/complicated'". Precision with notation also mattered; as one student explained, "I mistakenly switched up delta and epsilon [...] it was not 'wrong,' but my instructor noted it's best to stick to traditional convention."

Goals. Similar to the values, we found three themes related to goals that students identified that the proof community has for a proof. The first was a goal for proofs *to be accessible and approachable*. Students saw this as the goal of making proofs intuitive and understandable, with one student explaining that they "try to make my proofs easy enough to understand so that everyone can be able to be involved within a proof whether they're a contributor or simply learning from it," while another emphasized the importance of this goal as they felt "discouraged by terms like 'obviously' or 'clearly'" when intermediate steps were omitted. Students also noted there is a goal for proofs *to be clear and rigorous*. That is, students saw it as a goal to construct rigorous proofs that cleanly use mathematical symbols and notions. One student noted that proofs should "establish rigorous truths," another noted that "it's only through rigorous definitions and components that proofs are constructed," while another described relying on notation "to make things better and clearer for the reader." Lastly, students identified a goal for proofs *to be logically sound*. This goal primarily referred to constructing proofs by building on axioms and deductive reasoning to establish truths, as one explained, this involves "a showcasing how certain truths can be used to further demonstrate assumed truths (or contradictions) logically," a goal they connected to their practice of structuring proofs through lemmas and theorems.

The Utility of the Proof

Values and goals that fell into this category reference attributes about the utility of a proof. In other words, these are values and goals that students identified that related to the purposes and uses of proofs.

Values. We found three themes related to attributes that are valued in the utility of a proof. First, students valued *proofs' explanatory power,* noting how proofs can deepen understanding of mathematical concepts. For instance, one student noted "proofs give us a window into WHY math works the way it does, allowing in-depth understanding of mathematical concepts." They explained how they have seen this in action as they have "been able to apply concepts I learned from proofs presented to me in a Complex Variables course to solve proofs in other classes." Second, students saw value in *proofs' power to justify the validity of a claim,* highlighting their function in establishing the truth (or falsity) of a claim. As one student noted "a proof ensures that a statement that can be taken as fact is actually factual" and then notes the power this has in their own schoolwork: "theorems and lemmas are what power my work. It ensures that what I'm 'stating' is actually meaningful and correct." Lastly, students valued *proofs' general applicability*. This refers to a proofs' power to establish general results that extend across contexts. For instance, one student stated that proofs are valued "for their ability to provide general statements to solve a certain type of problem," and that their ability to "provide a statement that solves a multitude of problems is essential for math to function."

Goals. Students identified two goals related to the utility of a proof. First, they noted that a goal for the proof community is that proof should be used to *prove general statements,* highlighting how proofs can be particularly useful the more general the statement is that they prove. For instance, one student mentioned that by proving general statements they can "actually put proofs to use, using them to solve problems and such." Second, many students identified that a primary goal of proof is to *use proofs to understand why mathematical concepts work.* This goal refers to how proofs can provide insight to the prover about how the proofs work and the mathematical concepts they can be applied to. One student noted how proofs can provide insight into different algorithms they use in their math courses, stating that these algorithms are "based on a strong understanding of mathematical structures, which are founded by theorems that are justified by proofs." Another student recalled how one of their math professors researched algebraic partitions and how proofs helped them "better understand how they worked inherently." Lastly, one student reflected on how "proofs have helped me [understand mathematics] such that I feel it adds meaning to mathematics."

The Prover

Values and goals that fell into this category referenced attributes about the prover. In other words, these are values and goals that students identified that related to the person who creates the proofs.

Values. We found three themes related to attributes that are valued about the prover. First, students valued provers' *problem-solving skills*. This value addressed skills like critical thinking, deductive reasoning, and the ability to approach a proof in different ways. One student commented how "being critical in questioning proofs is of high value" explaining how their professor encouraged them to question "our inherent trust in the proofs and challenged us to think deeply about why it worked." A different student highlighted the value of approaching a proof in multiple and unique ways recalling a class where they "would all provide our own version of the proof. This made us think about how to go about problems and different ways we could look at these things." Second, students identified *creativity and ingenuity* as valued traits in a prover, referring to how provers who have original ideas and can generate novel proofs are valued. For instance, one student stated that "original thoughts and ideas are greatly valued within proofs" while another reflected that in advanced mathematics, value lies in "being able to create not only an accurate proof, but also an elegant one, which, if possible, is a novel way of solving the problem." Lastly, students captured the notion that *knowledge and expertise* are valued in a prover. In other words, deep content knowledge and mastery of the proving process is of great value. As one student mentioned, "[w]hat matters is the steps that are taken to get there, the knowledge that the mathematician has to make the proof clean and beautiful," while another recalled a professor's remark that "the great graduate students and researchers always take the extra step and review proofs and extra problems in the textbook to receive those skills" underscoring the effort required to develop expertise.

Goals. We found three themes related to goals students identified for a prover. The first goal for a prover is *to have a mathematics research career*. This goal encompasses many aspects of being a research mathematician like advancing the field, making new discoveries, and proving new results. One student reflected that their professors "are also excited to discuss proofs of new or recent results, emphasizing that this is the ultimate goal" while another noted how their professor often shared their "post-doctoral experience and opportunities to receive jobs and how to achieve these goals." The second goal focused on *improving proof skill*. Here, students often reflected on their own educational journey and noted that the goal was to continuously improve. For example, one student described a personal milestone: "Be able to read and understand a proof independently," recalling a time when they were reading a proof on infinitely countable sets, saying "I read along this proof understanding the argument, and when I asked the professor if my interpretation was correct he said yes. I was so joyous and proud of myself and being able to understand the proof." Lastly, students recognized that there was a goal *to educate others*. This goal referred to both the classroom and peer support. As one student put it, the goal was to "train others to think critically" recalling class discussions where students were asked to critique sample proofs and propose improvements. Another, reflecting on tutoring and helping out their peers, commented that a goal would be to clearly explain "details of a proof for student understanding."

Discussion

In this study, we investigated the values and goals that students perceived as important to the proof community. Their perspectives were both varied and nuanced, reflecting attributes of the proof itself, the utility of proofs, and attributes of the prover (see Table 2). The themes we identified connect with and extend findings from existing literature. For instance, the value themes *Truth and Objectivity of a proof* and *Structure and Strength of a proof*—highlighting the value of axiomatic foundations, deductive logic, and rigor in proofs— align with the mathematician value that "mathematical truth is a priori" (Dawkins & Weber, 2017, p. 128). Similarly, the value theme *Proofs' Explanatory Power* directly corresponds with the value that "proofs should increase mathematical understanding" (p. 130). Finally, the theme *Clear Communication and Language in a proof*, including consistent use of notation, resonates with the value "mathematicians desire a consistent set of norms and practices" (p. 131). These parallels suggest that many student perspectives are well already aligned with the broader mathematical community.

At the same time, our findings introduce dimensions not previously documented in the literature. While much prior work has focused on values related to the proof itself (e.g., Dawkins & Weber, 2017; Melhuish et al., 2025; Selden & Selden, 2013), our participants also identified values connected to the utility of the proof and attributes of the prover. Notably, their attention to the prover reflects an awareness of the proving process, recognition of the human element in proof production, and appreciation of skills such as problem solving, creativity, and expertise. These responses challenge the tendency to treat proofs as "autonomous objects" divorced from their authors (Dawkins & Weber, 2017, p. 130). Although not often explicitly captured in prior literature, we believe these values are ones many mathematicians would likely endorse. Additionally, our study extends the field by documenting student perspectives on the goals of proof—an area often left implicit. Closely tied to values, goals illuminate the purposes behind proof values and provide insight into how students make sense of the proof community.

An important observation from our findings is that the themes related to the values and goals students identified often aligned with their respective groupings—namely, aspects of the proof, its utility, and the prover. For instance, the value themes *Proofs' explanatory power* and *Proofs' power to justify the validity of a claim* correspond with the goal theme to *Use proofs to understand why mathematical concepts work.* Similarly, the value theme *Problem-Solving Skills, Creativity and Ingenuity, and Knowledge and Expertise* aligned with the goal theme *To have a mathematics research career*, as these attributes are central to advancing the field. While these connections are unsurprising given the intrinsic relationship between values and goals (Laudan, 1984), it is notable that this alignment emerged clearly in the students' responses. This suggests that although students may sometimes view mathematical norms as arbitrary or meaningless (Dawkins & Weber, 2017), they are attuned to many of the values and goals upheld by the proof community. Moving forward, the challenge is to help students make these connections more explicit as they deepen their engagement with the community.

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