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Article

Remythologizing Mystery in Mathematics: Teaching for Open Landscapes versus Concealment

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Abstract: Mathematics is full of mystery. We illuminate the myth to expose two conflicting senses of mystery at work in mathematics and its education practices. There is a sense of boundlessness with mathematics—the idea that we never fully know. There is also a practice of concealment, in which an answer or solution is known by special people who may support or provide a scaffold for students' navigation to the "special" knowledge, but may also challenge their access to it by erecting barriers and boundaries. In remythologizing mystery, we identify that the valorization of mystery in mathematics is rooted in the wonder of exploring boundless landscapes and is used misleadingly to justify school mathematics with the other sense of mystery—uncovering the concealed.

Keywords: mathematics education; myth; mystery; abstraction; popularization; discourses

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1. Mystery in Mathematics

> The underlying magic of numbers is no longer hidden behind abstract algebra and complex equations. *Incredible Numbers* makes clear some of the most intriguing mathematical mysteries.

Ian Stewart, perhaps the most famous mathematics popularist, has put out a new app called Incredible Numbers (http://induciblenumbersapp.com) and advertised it with this focus on mystery. His use of mathematical mystery to attract an audience exemplifies the power of what we, in this article, call the mystery myth in mathematics. This myth describes the appeal of mathematics by positioning people doing mathematics as explorers who solve mysteries, but this attraction is problematic. We elaborate and recast the myth to highlight conflicting orientations to mystery in mathematics education. What educators and others describe as exploration tends to be fabrications of mystery.

Often the word "myth" is used to describe something untrue. Anthropologists use the word to describe a culturally significant narrative or set of narratives and objects (e.g., Geertz [1]). We follow Barthes's [2] conceptualization, which is less structuralist: "Myth is a semiological system" (p. 133) not "concerned with facts except inasmuch as they are endowed with significance" (p. 134). Myth is a sign system that interprets other sign systems. Myths can include a variety of forms and messages that mediate the sense people make in discourse. What matters most is the strength of the stories and other objects in explaining the way people make decisions across a culture or society: "Myth is not defined by the object of its message, but by the way in which it utters this message" (p. 131).

The mystery myth in mathematics is most commonly referenced with the ubiquitous verbs *explore* and *discover*, which suggest the kind of intrigue suggested in our opening quote. These words, which are common in curriculum documents, textbooks, and even research in mathematics education to describe an approach to mathematics, assume an important set of unknowns that compel exploration. For example, the *Common Core Standards* in the United States explains that "technology is valuable for varying assumptions, *exploring* consequences, and comparing predictions with data" [3] (p. 72). The word "explore" is much more common in the older *Principles and Standards* documents of the National Council of Teachers of Mathematics [4] in comparison to the relatively new Common Core document. The Singapore O-level mathematics curriculum [5] says, "Students should have opportunities to [...] *explore* number patterns and write algebraic expressions to represent the patterns" (p. 36). And the UK National Curriculum says, "Pupils explore the order of operations using brackets; for example, 2 + 1 × 3 = 5 and (2 + 1) × 3 = 9" (https://www.gov.uk/government/publications/national-curriculum-in-england-mathematics-programmes-of-study/national-curriculum-in-england-mathematics-programmes-of-study).

In our investigation of this mystery myth, we make a distinction between two forms of mystery solving: discovery in an open landscape and discovery of concealed unknowns. We notice, and explain, that the valorization of mystery in mathematics is rooted in the wonder of exploring boundless landscapes, and is used misleadingly to justify school mathematics with the other sense of mystery—uncovering the concealed.

To elaborate our reflection on the mystery myth in mathematics, we first describe our two analytical frames, in which we position ourselves as remythologists who are interested in the rights and duties [6] constructed by the myth. We follow this with selected texts and their contexts to identify key aspects of the myth and thus the way the myth positions mathematics students and the people around them. Our contexts come from our experiences as mathematics teachers, from literature search, and from our empirical research. We close with a consideration of implications for mathematics teachers and research.

2. On Being a Mathematical Remythologist

In this article, we take the position of remythologists in the tradition of Barthes [2]: "The best weapon against myth is perhaps to mythify it in its turn [...] and this reconstituted myth will in face be a mythology. Since myth robs language of something, why not rob myth?" (p. 161). Barthes provided a series of this kind of remythologization, and closed his book with some reflections on how he approached this work. In his examples, he used well-known texts (including objects, writing, etc.) and described how they operate on meaning that is prevalent in society. His interpretations are contentious, of course, for he pushes against conventional wisdom. He pushes against the myths. He underscored the difficulty of such a role (which he called "mythologist"): "when a myth reaches the entire community, it is from the latter that the mythologist must become estranged if he [*sic*] wants to liberate the myth" (p. 185). We do not seek to destroy the mystery myth in mathematics, but rather to recast it to promote reflection by mathematics educators.

We use two frameworks for exposing and reconstituting the mathematics mystery myth. We choose positioning theory to complement our interpretation of the myth, because we are most interested in the way the theory helps us focus on the rights and duties made available with a myth. We are most interested in the way the mystery myth in mathematics positions students. It is important for us to clarify that we are not using the term "remythologization" in the same sense that one of us (Dave) used it previously— where remythologization meant the generation of new stories within mathematics to change its face for students [7]. Perhaps a better word for this earlier use would have been "neomythologization," because it asked for new stories. Our work in this article is significantly different, because we are interpreting and recasting common stories.

To elaborate our analytical frames for identifying the way the myth works, we first identify rhetorical devices that Barthes described as common to myth-making, listing here the ones significance to our analysis [2].

- With "Identification, [...] the Other becomes a pure object" (p. 179), we never really judge a person, but rather judge the identification of the person.
- A "statement of fact" (p. 182) assumes everyone agrees.

- An "inoculation" (p. 178) exposes us to small doses of something otherwise harmful or distasteful to desensitize us from the myth's power.
- A "tautology" (p. 180) positions an idea as true because we already know it is true.

We looked for these devices at work in texts and storylines that we find pervasive in mathematics education discourses.

Our second analytical tool draws on positioning theory, which states that people interpret experience through known storylines (which we identify here as strongly related to myth). The theory describes how people's communication acts are shaped by the positions they attribute to the people in the interaction based on a known *storyline*. Most significant to our analysis of the mystery myth, storylines make available certain positions, which have accompanying rights and duties [6]. These storylines are different than narratives, as they define relationships and the kinds of action that are possible within these relationships. They are not scripts or accounts of particular events. The positionings available with storylines (myths) are a form of what Barthes described as identification [2]. In interaction, people are identified as a certain kind of person, and the interaction follows this identification of the person. In our analysis, we consider what rights and duties the mathematics mystery myth makes available, and to whom.

Positioning theorists describe in considerable detail the nature of positioning, but for the purposes of our remythological work, we identify aspects most relevant to this context. First, positioning theory focuses on the immanent: language is taken only as a concrete occasion of language in use [8]. This focus on immanence has been problematized in the mathematics education context by Wagner and Herbel-Eisenmann [7], because some scholars have described positioning of students and/or teachers in relation to mathematics, which is transcendent, not immanent. However, our remythologist interests highlight the power of focusing on immanence, because we seek to identify the rights and duties of people when the texts we analyze gloss over those rights and duties in deference to some truth outside of the people doing mathematics. Related to this, reciprocity is also an important aspect of positioning theory [9]; we are not content to identify the positioning of one person in a relationship, we also consider how that positions others in the relationship. For example, if we become interested in the way a mathematics student is positioned, we are compelled to consider the others in that student's context, including other students and the teacher.

3. Elaborating the Mystery Myth

In our elaboration of the mystery myth in mathematics, we use two kinds of texts: (1) culturally significant texts related to mathematics and mystery, and (2) situated stories that suggest pervasive relationships and expectations within mathematics education. With these examples, we develop the following elaboration. First we describe how mystery involves the exploration of something unknown. This can be (and often is) envisioned as an exploration of an open landscape, which we call *boundlessness*. This characterization of exploration is set in tension with mathematics' interest in control and certainty. This interest in control results in a different approach to mystery, where a teacher fabricates a mystery by concealing a known object and positioning it as unknown. There are power relations associated with this approach to mystery, which we call *concealment*. This concealment often includes the erection of barriers, which may seem arbitrary to students. It requires careful attention to the level of difficulty. This concealment is an instance of what Foucault (1982) calls pastoral power.

3.1. Working with the Unknown

> There are known knowns: there are things we know we know. We also know there are known unknowns: that is to say we know there are some things [we know] we do not know. But there are also unknown unknowns—the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tends to be the difficult one. [10] (p. xiii)

This well-known quotation underscores the fear that can be associated with unknowns. These words of Donald Rumsfeld, US Secretary of Defense, were spoken at a Pentagon press briefing in 2002 as justification for going to war in Iraq. These words, which reflect a culture of fear of the unknown, demonstrate how people in power can manipulate others using that fear.

Unknowns are common in mathematics. Algebra comprises operations on unknown values. Equation solving has students revealing the unknown: "Solve for x." However, not all algebra is equation solving. Algebra work, for example with functions, has students working with variables—working with unknowns while leaving them unknown: "Translate the function 3 units to the left: $f(x) = 2x^2 - 3x$." In this way, abstraction may be seen as operations removed from things known and concretely experienced. Even in geometry, a generalization such as the Pythagorean theorem operates on an abstracted triangle, severed from particular triangles (but of course applicable to particulars). Thus we see that mystery, working with separation from the known, is at the heart of mathematics.

Operations on the unknown may inoculate students from the fear of the unknown, but of course the inoculation requires operations that are within reach. Mystery can be gratifying and then empowering due to its inoculation, but it can also remain uncomfortable and even terrifying for people who do not want to let go of the known.

This abstraction work with unknowns can position students and others as alienated from mathematics, as illustrated in a poem by Genevieve Ryan, "Trigonometry and me" [11]:

I am X.
I don't know my own value.
I'm waiting for someone else to work me out.
There are no clues
I've never been able to understand the logic of mathematics
I don't have the
ability to know what I'm worth
I'm lost in a vicious triangle.
How can I simplify myself?

3.2. Boundlessness and the Pursuit of Mystery

The protagonist in the novel *Smilla's Sense of Snow* [12], enthused about deeper and deeper number systems (counting numbers, then negative numbers, fractions between them, and continuing to number systems beyond reason), and said mathematics "is like an open landscape. The horizons. You head toward them and they keep receding" (p. 113).

Searching for "mystery" and "mathematics" in English publications, we have generally not found scholarly articles. Besides Bishop's identification of mystery as a value in mathematics [13], which we will address in the next section, we found popularizations of mathematics.

There are books featuring "mystery" and "mathematics" in their titles; for example, *A Mathematical Mystery Tour: Discovering the Truth and Beauty of the Cosmos* [14], *Mathematical Mysteries: The Beauty and Magic of Numbers* [15], and *Mathematics, Magic and Mystery* [16]. There are articles in the popular press that position mathematics as mysterious and mathematicians as pursuers of its mysteries, including *The New Yorker*'s account of Yitang Zhang solving a "pure-math mystery" [17] and an essay in *The American Scholar* comparing applied mathematics to poetry: "Like poetry, applied mathematics combines multiple meanings, economy, pattern, and mystery" [18]. And there are tablet/phone applications, such as the one developed by Ian Stewart that advertises itself with a focus on mystery (including the quote that begins this article): "unwrap the mysteries of pi, explore infinity."

Again, in the popular press, mathematician Charles Fefferman characterized mathematics with a focus on mystery. In the interview behind that article, he described mathematics and its exploration of the unknown as a frustrating game of chess [19]:

> [Mathematics] is a process that [Fefferman] likens to “playing chess with the devil.” The rules of the devil’s game are special, though: The devil is vastly superior at chess, but, [he] explained, you may take back as many moves as you like, and the devil may not. You play a first game, and, of course, “he crushes you.” So you take back moves and try something different, and he crushes you again, “in much the same way.” If you are sufficiently wily, you will eventually discover a move that forces the devil to shift strategy; you still lose, but—aha!—you have your first clue.

These populist representations of mathematics are intended to draw people in so they will identify with this desire for freedom. This is like Smilla in *Smilla’s Sense of Snow* articulating the seduction of mathematics [12]. We draw on Smilla’s imagery to call this the *boundlessness* form of the mystery myth, which we will contrast to the *concealment* form of the myth.

The boundlessness aspect of mystery positions students and others who do mathematics as explorers: free, not restricted by boundaries. This is the kind of freedom that allows for non-Euclidian geometry, the conception of negative and imaginary numbers, play with infinity and its calculus, and the list goes on. We will ask in our reflections what the role might be of teachers if students are to be positioned as unbound.

Complementing the popularizations of mathematics, curriculum documents similarly identify the sense of exploration fundamental to mathematics—for example, Swedish curriculum documents position mathematics as evolving “both from the practical needs of human curiosity and a desire to explore” [20], and there are more examples in the introduction to this article.

The clichéd images of mathematicians in popular culture substantiate this identification of mathematics as a mystery. They describe mathematicians as special and odd people—with the kind of mysterious deviant power necessary to understand real mysteries. From a Western perspective, films such as *Good Will Hunting* and *A Beautiful Mind* and the men/boys in *The Big Bang Theory* may not portray the typical characteristics of a mathematician, but they do inform and reproduce popular images of mathematicians as nerds or geeks, informed with special knowledge others cannot access.

A T-shirt was recently advertised to us on a social media platform (which targets its advertising), with a slogan that identifies the otherness of people who identify with mathematics and the association with mysticism: “Mathematician: noun [math-uh-muh-tish-uhn], someone who solves a problem you didn’t know you had in a way you don’t understand. See also *wizard, magician*” (http://www.kapparel.co/math-06?p=eu#pid=377&cid=100069&sid=front).

We add a tangential note here to acknowledge that myths in general, and the mystery myth in mathematics in particular, are gendered and racialized. We recognize that the main characters in these films and books are white English-speaking men. Damarin provided evidence that being a female mathematician becomes a double marker: “The bodies of [male] budding scientists and mathematicians are marked as always already remote from ‘the rest of us’” (p. 75) in this particular “discourse of deviance” [21] (p. 69). Even if research by Moreau, Mendick, and Epstein show students’ critical awareness of these images [22], the students also drew on the images, hence reifying parts of the discourse described by Damarin [21].

3.3. Mystery in Tension with Control

Our tacit knowledge of school mathematics from years of teaching it, substantiated by research in schools, tells us that the kind of boundlessness described by the popularists is not the experience of most students of mathematics.

We see mystery in tension. For people who enjoy mathematics, one of the compelling aspects is the mystery of mathematics—the wonder experienced in connections within and among patterns. Bishop, too, reveled in mystery, which he identified as one of the six values compelling mathematics [23]:

> Anyone who has ever explored a mathematical problem or investigated a puzzle knows how mystifying, wonderful, and surprising mathematics can be. For example, [...] if you take any Pythagorean triple, such as 3, 4, 5 or 5, 12, 13, and multiply the three numbers, the result is always a multiple of 60. Why should it be 60? (p. 99)

In contrast, another one of the six values identified by Bishop is "control" [13]. While we may revel in the pursuit of mystery, we also crave certainty and its related feeling of control. This desire was illustrated in a poem by mathematician Chandler Davis, who reflected on what draws him into mathematics: "If I took alarm at the prospect of things spinning out of control (and I might; for they are; oh, I well might); this refuge would tempt me" [24] (p. 52).

In Herbel-Eisenmann and Wagner's quantitative analysis of a large corpus of mathematics classroom transcripts, two relevant authority structures were identified as pervasive [25]. They found that expressions of necessity were very prevalent in the discourse. Expressions like "we have to," "you need to," and "it has to be" position the discourse as being in authority over the mathematical actors—Herbel-Eisenmann and Wagner called this structure "discourse as authority." Other prevalent expressions, like "we're going to" and "it's going to be," more subtly position the discourse in control, as they suggest the inevitability of mathematical actions and results; they called this structure "more subtle discursive authority." This kind of inevitability, where students are positioned as workers producing results that are already known, is the ultimate form of a "statement of fact," one of the rhetorical devices of myth identified by Barthes [2].

3.4. When the Unknown Is Already Known

The kind of inevitability described above is perhaps best illustrated in a form characteristic of mathematics textbooks—the correct answers in the back of the book. This form is so ubiquitous that it even has its own word in Swedish—the answer section in the back of a book is called the *facit*. In Latin, *facit* literally means "it does," a form of the verb *facere*, which means "do." In Sweden, the facit is a collection of answers to exercises. It is often the last chapter in a mathematics book.

If the answers are known, can there still be mystery? Yes. But we claim that this form of mystery is very different from the boundlessness form of mystery. It is more like a game of hide-and-seek. We call this the *concealment* form of mystery, focusing on the necessary act of obscuring in order to construct a problem that can be offered as a mystery for students. For some students, the "problem" is not really a problem, because the solution is available in the back of the book. The myth identifies student tasks as problems to align with the sense of wonder that is more seductive than repetitive procedures. Even with problem-based learning, teachers choose the problems, because they know what they want students to discover and they know the solutions.

This sense of inevitability and known outcomes is also present in mandated mathematics curriculum guides, which list "outcomes" that are known in advance. These are known concepts that students are expected to find by working through the barriers.

Certain people with specialized knowledge construct barriers or obstacles that challenge or support others to access that knowledge. Mathematics teachers or textbook authors may have pedagogical intentions in constructing such boundaries, but the boundaries may seem arbitrary to students. For example, word problems or puzzles are constructed and given to students with the intent of making them sufficiently difficult but also within the students' reach.

The root of the word "mystery" is the Greek word for concealment, so perhaps it should not surprise us that concealment is mixed up in the mystery myth.

3.5. Power in Concealment

To illustrate the positioning of the concealment form of the mystery myth in mathematics, we draw on our own experiences of "solving problems." Here we give one example. At a conference for mathematicians and education researchers, a participant, Luke (Luke and other names given here are pseudonyms, except for the researchers' names), posed a mathematical problem to his peers at dinner—a problem about a sadistic prison warden making his inmates play a game with life-and-death consequences, in which the prisoners each have to say what color their hat is in order to live. Dave gave a viable solution to the problem; however, Luke responded, "You can't do that." Dave asked why: "You didn't say that in the rules, so why should I care whether or not you like my answer? What counts is if I am satisfied with it." Others at the table laughed at Dave's resistance to the power relations at play. But Dave was still disturbed. His public resistance masked the compulsion that lingered. He still felt the need to figure out Luke's preferred solution to the problem, even though he had already identified a viable and efficient solution.

The bizarre problem was the mystery. Luke thought the solution was within reach of this crowd. There was a sense of urgency at the table to solve this mystery, while Luke sat smug in his knowledge of the "answer." Here is the power. Luke was positioned with special knowledge, and with the authority to evaluate whether or not others were party to that special knowledge. How did he get that power? He was an equal in the group, but he took up the positioning by posing the mystery and guarding the secret. The fabled "aha moment" in mathematics education may sometimes feel like an "aha," but when we consider the power relations at work, it may be better described as an "ahhh" or "oh" moment for the student: "Ahhh, that's what you wanted," or "Oh, that's the trick you had in mind."

Mystery and mysticism are inscribed in diverse cultural practices, which can give us insight into the power relations we identify here. In these traditions, priests, gurus, and prophets are esteemed for their insights and knowledge; they are an elite group. The sense of inclusion that goes with this elitism rests on the exclusion of others from the special knowledge.

3.6. Hard, but Not Too Hard

As mentioned in the above reflection, for "problem-solving" to work—that is, for the problem to capture its audience—the problem has to be within reach. It has to be hard, but not too hard. To illustrate this nuance in the concealment aspect of the mystery myth in mathematics, we recount an episode from our recent research. In fact, this is the episode that struck us and directed our attention to examine more carefully the way mystery works in mathematics learning.

In our research aimed at identifying language repertoires of mathematics students (e.g., [26,27]), we sought to attend to the language people use for locating things. We led rock-hiding activities with 4-year-olds, students, and teachers. We asked each group from the class to hide a rock marked with permanent marker (a happy face ☺). The groups returned to the central location, where each group explained to another group how to find the rock they hid. Each group then went to find the other group's rock, following the directions they received. We did this to pay attention to the communication strategies used in the descriptions and among group members when searching for the rocks, but in an episode with 14-year-olds in Sweden, we were instead captivated by the assumptions in the group discussions about where to hide the rock. The students assumed it had to be hard to find the rock, yet possible. They looked for a difficult hiding place, but not too difficult. (All transcripts from Swedish contexts were translated by Annica.)

- Well, we just like hide the stone then?
- So the others can find it, cool.
- A little like Sherlock Holmes then.
- Hm, well, we can't make it too hard then.
- I think, if we walk up there, between... there are loads of smaller stones.
- Loads of stones, preferably smaller.
- Okay, shall we decide on that? It is rather difficult, but it is maths so then it shall be a little sneakier.

This context is a departure from the usual mathematics classroom discourse, because the students were positioned as the ones who created the mystery for other students. They discussed the level of difficulty required to make the problem difficult yet accessible: "It is maths, so then it shall be sneakier." They were the ones erecting the barriers. They concealed the treasure (the happy-face rock). Though the students were positioned with power to conceal the treasure, the teacher's power still trumped theirs. Annica, in this case, initiated the activity as a treasure hunt. The students strove to play the game as they saw it. Their assumption that the concealment myth was in force demonstrates that they had been experiencing it in mathematics contexts through nine years of schooling. The same kind of hard-but-not-too-hard discussions happened among the 4-year-olds and every group that we engaged in this activity, giving evidence to the pervasiveness of this concealment aspect of the mystery myth.

3.7. Erecting Barriers

Another aspect of the concealment form of the mystery myth in mathematics is that when we hide a treasure, we may also erect barriers. Again, we recount an episode from our research using rock-hiding activities with 14-year-olds in Sweden.

A group came out of the building happily chatting and ready to look for their complementary group's hidden rock. After receiving the group's instructions on how to find the hidden rock and the geographical boundaries, this previously chatty group turned quiet. They did not talk for five minutes; they simply walked on. At one point, Annica tried to prompt them into dialogue by asking if they remembered the last time they had given directions. They answered no, followed by silence again. Annica tried again, "Hello, it is okay to talk with each other," and laughed. Silence continued. When the group came closer to the hidden rock, the students continued their search quietly, in different directions; no collaboration or conversations were recorded. At one time they seemed irritated, and a student from the first group (with the knowledge) reminded them about the directions. They continued their search quietly, until they found the rock. When they returned to the building, they chatted happily again. When Annica asked why they had chosen to be quiet, their faces revealed bewilderment and one student answered: "But it was a math task, wasn't it?"

The students showed that they knew the mystery myth, and thus assumed the presence of rules or boundaries that made the task more difficult. These kinds of rules within mathematics are a form of boundary erected to protect the secret. These students had often been implored to work quietly in mathematics over the years. Perhaps they imagined the imposition of silence as necessary, since there were no other restrictions given. It is clear that the students assumed that the process they employed would have to be restricted. Annica did not say it was a mathematics task, but they assumed it was, probably because they knew she was a mathematics education researcher.

3.8. Pastoral Power

Following the norm in education research, we take a pedagogical turn and reflect on the implications of the mystery myth in mathematics. For this we turn our attention to Annica's conversations with 16-year-old Henrik, a confessed "math disliker," who was in his first year of the social science upper secondary program in Sweden (for more on this conversation, see the work of Andersson [28] and Andersson and Valero [29]). One day, Annica greeted Henrik as he left the classroom looking weary, with drooping shoulders: "What's up, Henrik?" He replied, "Sometimes we come here and know we only have to do them, all the boring exercises, to learn this stuff the teacher tells you to do." Annica asked him what he meant, and he replied with resignation, "Well, somebody has to take the decisions for us, because I don't know what or how I have to do to learn this stuff or when to use it." Annica checked his meaning with, "Do I understand you right here? Do you mean it is boring because you yourself can't make any decisions on what to do?" Henrik confirmed, "Yes, exactly."

We note a connection between Henrik's complaint and what Foucault called *pastoral* power [30]. Pastoral practices are built on the idea that one person knows what is good for another. For example, the mathematics teacher knows what problems are good for a student to do. Following the concealment aspect of the mystery myth, the teacher knows what to conceal and how to conceal it so that a student may find it. Presumably, this is done in a way that prompts certain insights or experiences for the student. Henrik's assessment of the situation depicts a teacher positioned as the one who knows better, and who knows what is good for him to learn. The teacher possessed secret knowledge about mathematics, but also about what was good for Henrik. The teacher revealed only enough to guide Henrik to a special place of knowing. This positioned Henrik as passive, someone who would play along, seeking out what is expected within the boundaries of the discourse.

The pastoral power of the teacher extends to society as a whole, mediated through government departments, with their expectations for students in mathematics. Another related myth (and all mathematics myths are interrelated) describes the importance of mathematics. This myth is evident in national mathematics curricula—for example, the Swedish national curriculum outlines specific skills that students need to find or develop, skills that will be "good for" the students. Ironically, the same curriculum demands an agentic positioning for students and states that mathematics teaching in Swedish compulsory schools

> should aim at helping the pupils to develop knowledge of mathematics and its use in everyday life and in different subject areas. Teaching should help pupils to develop their interest in mathematics and confidence in their own ability to use it in different contexts. [20] (p. 59)

The pastoral power also manifests globally, positioning mathematics as one of the most important school subjects. Global economic and political reasons, as outlined in rhetoric from PISA (Programme for International Assessment and the Organization for Economic Cooperation and Development (OECD) [31], claim "the need for individuals and nations to understand the role that competence in mathematics plays in today's global innovation economy" [32] (p. 310). Thus, OECD countries invest more than 230 billion US dollars in mathematics education annually [33] (p. 186).

We have probably all heard and perhaps even asked this question in mathematics class: "Why do I have to do this?" [29]. Similarly, there is a common sentiment that "only geniuses can do mathematics" [34,35]. These common ideas undermine the curriculum assertions of practical value and accessibility. Furthermore, word and world problems in textbooks are usually not relevant to personal lives [36,37]. Gellert and Jablonka refered to Freudenthal when labelling these contexts as "magical" [38] (p. 41). Countless comics poke fun at the absurdity of "real-world" mathematics problems ("Dave has 57 watermelons... "). Figure 1 shows a picture Henrik shared with Annica that captures his reflection on his experience of algebra as being a mystery for him, and where the teacher knew what was best for him.

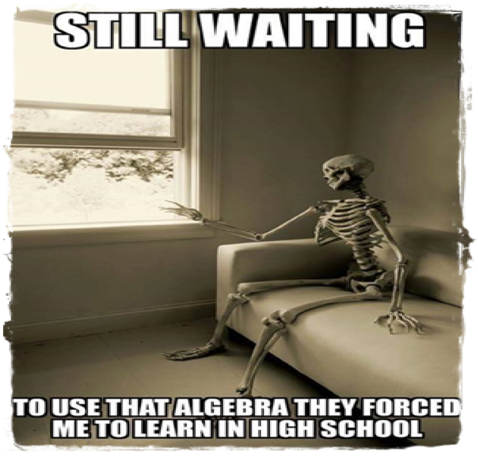

Figure 1. A student's expression of his experience of algebra.

There also seems to be an incommensurable conflict between school mathematics and real-world problems. If outcomes are prescribed as necessary knowledge for students, teachers are positioned as administrators of concealment. They know the outcomes and construct situations with boundaries and challenges for students to work through to eventually grasp that specialized knowledge. Teachers do this by using problems and questions to which they already know the answers. On each of these tasks, the students are positioned as the ones who need to navigate the barriers and challenges to gain this knowledge. Skovsmose contrasted this "landscape of exercises" with real-life problems for which there are no solutions at hand [39]. Real-life problems ("landscapes of investigation") are more like the boundless form of mystery, often with high stakes. There are no predetermined answers to real-life problems, unlike the last section in mathematics textbooks with "correct" answers, the *facit*.

4. Reflection

Our reflections on our experiences as teachers and researchers, which underpin our remythologizing of mystery, help us see the reach and depth of the myth. To summarize our observations from above, there is an important distinction between the concealment at play in school mathematics and the boundlessness idea promoted in curricula and the popular press. We claim that the similarities between the forms of mystery mask the significantly different authority structures between them. With this deception, it is easy to congratulate ourselves for constructing one kind of relationship for students while actually giving them a very opposite experience.

The most obvious form of concealment is in algebra, in which students work with and find the unknown. But the mystery structure has much more breadth. Many mathematics textbooks have exercises for which students are asked to find answers that are unknown. Yet the answers are either given in the back of the book or available elsewhere.

Concealment goes much deeper, too. Answers are hidden in the backs of books, but the structure of classroom tasks seems to erect barriers to further the concealment. Students often work alone and in silence. They have to use certain methods and not shortcuts. These barriers are so common that when students are given freedom, they imagine barriers that are not actually part of the task. They know (or believe) that their teachers know the unknowns and set tasks to guide them to learn to search for the unknowns. In this way, teachers are assumed to have pastoral power. The power of this mystery myth extends beyond classroom walls and is associated with mathematics elsewhere. We ourselves are not immune to this power, as we feel bound by the mystery when people pose mathematical problems for/with us.

People who set mathematics problems, who conceal the object of beauty and erect barriers for others, have a certain power over others. Whether this is teachers or textbook authors setting problems for students, or colleagues or friends setting problems for each other, they position themselves as gatekeepers of specific knowledge.

This authority structure was evident in almost all the conversations we listened to in our data collection on students' linguistic choices and language repertoires when counting and locating, and also in our previous research projects. This myth is evident in the students' talk about mathematics and about mathematics as a learning practice.

In our reflection, we see that the mystery myth is part of playing the "mathematics school game," to use the words of Boaler [40] and others [40], and connected to the sociomathematical norms in Yackel and Cobb's distinction [41]. Bernstein's idea of "invisible pedagogy" also applies, as it is characterized by weak framing rules: "The rules of regulative and instructional discourse are implicit, and largely unknown to the acquirer" [42] (p. 14). There are many theoretical frames that could be used to describe the mystery myth and the authority structures at work in it.

A number of curricular demands address student confidence, creativity, and communication when learning mathematics as a school subject. For example, the Swedish national curriculum states (emphasis is ours):

> Mathematics has an ancient history with contributions from many cultures. It evolves both from the practical needs of human curiosity and a *desire to explore* mathematics as such. Mathematical *operations are by their nature a creative, reflective and problem-solving activity,* which is closely linked to the societal, social and technological developments. Knowledge of mathematics gives people opportunities to *make informed decisions* in everyday life's many choices and increasing opportunities to participate in community decision-making. [20]

We argue that these demands resemble boundlessness and the demands seem contradictory to the idea of concealment. Though the curriculum demands the boundless approach to mystery, practice typically performs concealment; quiet tasks or textbook work with goals to find predetermined answers seems to be the outcome [28,43].

Further, we also notice a distinction related to another mathematics myth—that mathematics is powerful. (We reiterate that all mathematics myths are interrelated.) From the conversation episodes in this article, we noticed that the power is not in the mathematics; it is in the talk and relationships among people and mathematics. Within the concealment form of mystery, the power of mathematics is in human authority structures. Who constructs the boundaries, and who searches for the concealed truths? Within the boundlessness form of the myth, the power may be elsewhere, but we claim that this aspect of mystery is too rarely present in the experience of school mathematics.

In our brief interactions with strangers, we frequently hear disclosures about their not-so-good experiences of learning mathematics. These stories appear in our work with teachers, too. This widespread acknowledgment of the common rejection or fear of (school) mathematics has been researched as well. Solomon showed that it is not uncommon for students to have excluding identities of mathematics education [44]. These feelings of exclusion were expressed by students of all ages and even by those who performed well.

Considering the pervasiveness of the concealment aspect of the mystery myth, we wonder to what extent its presence is required. The boundlessness aspect of the myth seems more benign, or possibly wonderful. We wonder about students' experiences of concealment. We also wonder about the pedagogical values that underpin the sustenance of this myth that pervades mathematics classrooms. A myth belongs to everyone. There are so many people (teachers, authors, parents, etc.) who love their students and children and want the best for them, and yet mathematics education becomes oriented around concealment. This tells us that there is likely some good in it. This, along with student experiences of the mystery myth, begs further research. In other words, the mystery myth makes us both curious and cautious.

Until further research on people's experiences with mystery is developed, we are left to consider suggestions based on our experiences researching classrooms. We see concealment eclipsing boundlessness, and thus would advocate more intentional foregrounding of classroom experiences that open up space for students to sense boundlessness and amazement.

We think it would be helpful for students to be exposed to real model exploration—to pose and invite questions that they do not yet know how to answer, and to play with and work at these questions together with educators and their peers. These may be pure mathematics questions or questions that connect mathematics to real (not semi-reality) problems in the world around them. Either way, this might require teachers and others to operate outside their comfort zones [39], pushing their own boundaries of knowledge of mathematics, and knowledge and opinions about the world.

We close by making a strong distinction between the two aspects of the mystery myth. Concealment is like the game of hide-and-seek. This is where someone knows some mathematical truth and then hides it behind an (odd) word problem context, behind some restrictions, some tricky wording, or just something like wrapping article (e.g., an equation in which a teacher knows x and makes an equation to hide it so that a skilled student can unwrap the equation and find x). Concealment is at the root of the word "mystery."

Boundlessness is the aspect of mystery that invokes freedom. It has the idea that if we look in interesting or new ways, there are always more possibilities, more perspectives. It is like what Smilla described in the earlier quote [12]—the vast open landscape where you approach the horizon only to see that there are further horizons. The vast open horizon is the boundlessness. It goes in all directions outward, but it also goes inward as we look within something we think we know.

The joy of discovery is sometimes used as a rationale for concealment, when it really belongs to the idea of boundlessness. There is little joy in finding something that we know is known by someone who is hiding the truth from us. Yes, we feel driven to overcome the barriers and find the unknown, but probably not by joy or wonder.

While popular mythologies of mathematics (reflected in curricula and people's imaginations) revel in the freedom proffered by mathematics—the exploration of open landscapes—students too often experience a different kind of mystery investigation: a game of hide-and-seek, in which they are always the seeker and others are always concealing the treasures.

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