# What Sustains Mathematical Expertise

*Understanding, employment, and independent capability*

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Mathematical understanding can remain valuable even if the work needed to provide it changes. The question for paid expertise is which contributions people will need, who can supply them, and how those capabilities will be maintained.

Demand for proof, explanation, and shared learning need not create the same jobs. A service can combine automated guidance, a facilitator, and occasional specialist review; another may depend on a research-active teacher throughout. Comparing these arrangements requires specifying the outcome and the expertise each uses.

There is a further complication. Technical help that becomes inexpensive in an individual encounter may still depend on expertise that is costly to maintain. Unbundling a service and sustaining the capabilities behind it are different achievements. A complete comparison must account for both.

## The occupation is a bundle

Mathematical activity, mathematical competence, paid employment and the institutions that organize it need to be kept separate. A person can enjoy mathematics without being paid, possess substantial competence without institutional recognition, or work within an institution whose functions have changed. The survival of one does not settle the fate of the others.

The academic occupation combines research, problem selection, explanation, assessment, mentoring and the maintenance of a community. The balance varies between research and teaching positions. Richard and Daniel Susskind describe the general possibility of decomposing professional services and supplying them through different people and systems.[1] Their historical combination does not establish permanent technological inseparability.

Separating services may lower costs and widen access. It may also destroy useful coordination. A research-active teacher might notice a misconception that a generic tutor misses; a community might transmit judgment that an isolated explanation cannot. Those benefits belong in the comparison, alongside the costs of verification, supervision, infrastructure and failure recovery. So does the work of renewing the expertise on which each arrangement depends.

Compare the alternatives by first holding the desired outcome fixed. For a lesson, producing a fluent solution is not enough: can the learner transfer a method to an unfamiliar problem, recognize when it fails, and explain why it applies? Apply that test to a researcher with AI, an independent scholar with AI, a facilitator with AI, peers with AI, and AI alone.

Then ask where an arrangement falls short and who repairs the failure. If a research mathematician contributes an indispensable correction, that work belongs in the cost and capability comparison. If

another arrangement develops the same understanding reliably, the value of understanding alone cannot identify the occupation needed to supply it. Comparing job titles before making this test would assume the conclusion.

## Changing technical contributions

One proposed role is explanation. If machines discover results that humans cannot follow, interpreters might become more valuable. Whether they remain technically necessary depends on what they add to the complete arrangement, including its cost. In his discussion of the Leiden Declaration, Timothy Gowers considers human curation and then asks whether AI could also provide personalized exposition and teaching.[2] The next useful human contribution need not be permanently reserved to humans.

The same reasoning applies to problem selection, taste and interdisciplinary connection. These may be difficult capabilities to reproduce. Their difficulty is an empirical question, rather than a guarantee of enduring exclusivity. Conversely, a system that proves many theorems may still select uninteresting questions or fail to understand a learner. Progress need not be uniform.

Intermediate arrangements can change which human skills matter. Kasparov's account of freestyle chess illustrates the importance of coordinating people and computers.[3] Krakowski, Luger and Raisch's observational comparison of conventional, centaur and engine chess likewise associates AI adoption with changes in the capabilities linked to competitive advantage.[4] These examples suggest that effective decomposition, checking and coordination can alter the value of prior expertise; they do not establish that amateurs generally outperform experts.

Educational evidence supplies a closer, limited example. In the randomized Tutor CoPilot study, students whose tutors received AI guidance were more likely to pass lesson exit tickets, with larger gains among students assigned to lower-rated tutors.[5] This measures immediate topic mastery, rather than the durable transfer described above, and does not settle advanced mathematics. It does show why the distribution of gains matters: assistance can change who delivers a service effectively.

A mature system could reduce the contribution of human orchestration as well. Richard Borcherds discusses this possibility in an Epoch AI interview.[6] The relevant economic question is the benefit of adding a paid expert relative to the cost. An ideal human–AI combination can always defer to its AI, so AI alone need not strictly outperform every conceivable team. Human presence can remain possible after its former technical premium disappears.

## What human participation adds

People may nevertheless want company while learning. Attention, encouragement and a shared sense of discovery matter. The Koberda–Kontorovich dialogue, The Dialectical Theorem, makes social learning central to a defense of paid human expertise under unusually strong AI assumptions.[7] It already allows institutions and hiring standards to change. The unresolved step is narrower: why does a demand for human social learning require advanced mathematical expertise in the person supplying the social relationship?

Consider a small group learning geometry. AI handles explanations, examples and checks of proposed arguments. Participants supply continuity, conversation and motivation. A facilitator keeps the group functioning and follows independently tested procedures for escalating uncertainty. The arrangement requires a defined level of mathematical competence; if reliable escalation needs advanced expertise, its cost must be included. If the group achieves the desired understanding and social experience, its social needs alone do not establish the need for a research mathematician in that role.

Facilitation itself requires skill. Patience, conflict management and judgment need not coincide with the ability to publish original mathematics. Selection could shift toward these capabilities while retaining whatever mathematical competence the work requires. A paid role might survive with different credentials, compensation or institutional support.

Some learners want more than technically adequate guidance and human company. They want a companion who personally understands the mathematics. Authentic shared comprehension is a real feature of an experience, and people can rationally value it even when AI could supply the same explanations. This could sustain expert-led seminars, apprenticeships or publicly supported cultural institutions. Its employment implications depend on the level of expertise desired, the number of participants and the resources committed to providing it.

## From demand to a livelihood

A familiar objection is that humans retain comparative advantage even if machines become better at every task. Daniel Susskind distinguishes the existence of remaining human tasks from wages sufficient to earn a living.[8] For mathematics, the issue is how much expert labor an arrangement uses and what that labor costs relative to its contribution. A costly autonomous system can leave room for human work even when it performs better. An inexpensive one may remove the expert premium without removing every human contribution. Restricted access to compute or proprietary systems can also preserve institutional advantages that have little to do with superior individual understanding.

Task-based economics separates further mechanisms. Acemoglu and Restrepo distinguish displacement through automation from productivity effects and the creation of new tasks that can restore demand for labor.[9] Lower costs could bring mathematical methods to more settings and advanced learning to more people. Whether this creates more expert employment depends on whether demand expands enough to outweigh the reduction in expert labor required per outcome. Increased mathematical output alone does not answer the employment question.

The payer matters too. Students purchase education along with selection, networks and other benefits. Investors seek returns; public funders and philanthropists may support scientific, cultural or strategic purposes. Noah Smith argues that human understanding is intrinsically valuable, that human comprehension will remain scarce, and that supporting mathematicians is inexpensive relative to society's resources.[10] These are reasons support may continue. They do not determine which actors will pay, which capabilities they will purchase, or why they will choose existing departments over alternatives.

Concrete proposals and funding commitments have already appeared. AGMAI's responsible-release statement recommends support for workshops, working groups, students, postdocs and exposition.[11] The October 2026 Simons announcement describes a combined $15 million effort in funding and resources involving Simons, Anthropic and OpenAI. A related institute call anticipates up to five nonrenewable two-year Simons awards, each totaling at most $500,000; these awards are one part of the broader initiative.[12]

Finite awards and in-kind resources do not constitute recurring salaries, just as the size of an initial program does not fix the limits of future support. Human mathematical culture can deserve support for its own sake; its funding case need not depend on every supported activity remaining technically indispensable.

## Sustaining independent capability

The cost of a lesson is only part of this comparison. An AI-supported group may draw on curricula, libraries, verification tools and standards developed by people elsewhere. If fewer experts are needed in direct encounters, the remaining work could move to maintaining those shared resources. A cheaper service may reorganize expert employment rather than eliminate it. The comparison must include how each arrangement trains the people and renews the knowledge on which its future performance depends.

Consider a seminar studying an AI-generated proof. A formal checker may verify a derivation without establishing that its statement captures the intended question. If the aim is independent judgment, participants must learn to examine assumptions, relate the result to the literature and test nearby examples, even when AI guidance is unreliable. The cost comparison therefore includes the work of developing that ability.

This collective concern already has substantial advocates. Gowers describes the possible loss of living mathematical culture and the difficulty of rebuilding it.[2] Etingof and Gerovitch develop an intellectual-reserve argument: expertise takes years to form, education renews it, and continued research keeps frontier competence active.[13] Koberda connects the preservation of human expertise with epistemic self-government; the Koberda–Kontorovich dialogue also takes up both concerns.[14,7] The further question is what a sustained community must be capable of doing, and which arrangements can keep those capabilities effective.

The possible public benefit extends beyond an outage. A society dependent on a small number of systems may lose the means to recognize shared blind spots, question standards embedded in proprietary tools, formulate alternatives or pursue an independent research direction. An arrangement efficient for each purchaser can weaken a capability valuable to everyone. That gives a reason to consider collective support even where ordinary transactions no longer require an expert beside each user.

Design should begin with the failures being addressed. Broad mathematical literacy, independent checks of formalization, and advanced research judgment serve different purposes. A program intended to preserve them needs a viable network and a training pipeline. Bainbridge's analysis of automation explains why specialists retained for rare interventions can lose the practice needed to perform them.[15] In mathematics, continuing research, teaching and apprenticeship may therefore

be part of the capability's operating cost. Existing departments possess accumulated expertise and coordination that an alternative must reproduce or replace; those assets deserve weight alongside possible improvements.

The network should be able to demonstrate the independence for which it is supported. Can it detect failures ordinary use misses, contest an automated judgment with a checkable alternative, and train successors without relying entirely on the infrastructure it scrutinizes? Staffing follows from the chosen standard: which activities must continue under which failures, and how quickly? Coverage across specialties, redundancy and training lead times may require substantial ongoing support.

Open tools, public compute, independent verification and diverse providers can complement human expertise or reduce particular needs for it. Different providers may nevertheless share errors, and open weights may remain costly to use. Human specialists also share errors and cannot be assumed to reproduce every capability of a lost superhuman system. The objective must be a specified degree of independence and resilience.

Arrow's analysis of invention explains why uncertainty and imperfect capture of social benefits can justify public support.[16] It supplies a general rationale, rather than a workforce estimate. Where probabilities are unknown, explicit scenarios and sensitivity tests can inform comparison without inventing precise expected losses. Funding decisions should consider the ordinary scientific and cultural contribution of a community alongside the option of drawing on its independent expertise. An institution supported to provide that expertise should be able to explain its costs, demonstrate its capabilities and remain sufficiently independent from the systems it evaluates.

## A larger mathematical life

More people could acquire substantial understanding outside established institutions, and established experts could undertake more ambitious work. Those gains would matter even without a corresponding expansion of academic careers.

The comparison therefore has three parts: expertise needed in direct teaching and research, relationships people choose to support, and shared capabilities that need collective provision. An alternative to the present occupation must account for all three, including how its experts are trained and its resources maintained.

## Notes and sources

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