Dwarkesh Podcast #57 - Andy Matuschak - The Reason Most Learning Tools Fail

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Dwarkesh Patel
Today I have the pleasure of speaking with Andy Matuschak, who is a researcher, engineer, and designer working on tools for thought. In addition to this podcast we did an interesting collaboration on Andy's YouTube channel which I encourage you all to check out, where I just watched Andy try to learn some new material.

It was just an intro chapter of quantum mechanics. Honestly I was expecting to see some cool techniques or be impressed but I was way more surprised than I expected to be by the deliberateness and the effortfulness of the practice.

It was 15 minutes a page in this textbook. And for every small thing that Andy thought, "I don't fully understand this, the author's trying to say something here, he's trying to draw an analogy or relationship, I'm not sure I totally comprehend the relationship between classical mechanics equation and the quantum mechanics equation, the author thinks is analogous," just really delving deep in that.

I thought that it was really interesting that this is a way to approach new material. So in this conversation I'm looking forward to talking with Andy about not only that experience, but a whole bunch of his other research and the other tools he's built.

Let me ask you this. That experience made me think that this is somebody who actually cares about understanding the material. Do you think people in general care about actually integrating and understanding the material they're consuming in books and textbooks? Don't you think they'd make more effort to actually assimilate that information if they cared to?

Andy Matuschak
I think the statement is just a little too general to comment on. I think it's certainly the case that most students don't actually want to do this because they're learning stuff that they don't actually care about learning or even if they do care about learning it, often there isn't a clear connection between whatever reading or activity they're doing in the moment and the thing that originally inspired them for the subject and what they actually want to do. So there's always something tenuous going on. On the other hand, it's amazing to look at subreddits and to look at the level of nerdy and fascination that will be brought to bear on gardening equipment or knots, for instance. People are competing to tie some very obscure 18th century knot or whatever, and they're flipping through almanacs from the period. So when people are interested and it connects to something that's truly meaningful for them, they really do want to absorb and we see that in their behavior.

There is a second thing that I think is relevant. To explain this, I will reference Mortimer Adler and Van Doren's How to Read a Book, which is a great guide on serious reading. They consider the case of people who often have difficult or demanding books on their bedside

table. So these are kind of aspirational, like, “Oh, I wish I could read King Lear. I want to be the kind of person who reads King Lear.” You put it on your bedside table and people will read it before bed. They'll find that they fall asleep while they're reading it, they're not really absorbing or understanding this book. It's not just an issue of memory, they simply are not apprehending the words on the page. The authors of How to Read a Book make the case that the issue with these people who are falling asleep reading King Lear is not that they don't want to stay awake and to really deal with that text, in many cases, it's that they actually don't know how. They butt their heads up against this very difficult wall of material. It's almost like a rock climber who's not very experienced going up against a wall that only has these really subtle notches. To an experienced rock climber, those subtle notches are like a ladder and they can get right in there and start making some progress and seeing what's up with this wall. But if you're an inexperienced rock climber, it just looks like a solid wall. The claim, maybe this is an optimistic claim, you can take me to task, is that there is such a thing as being a more skillful reader and being a more skillful reader will actually, in practice, in many cases, when the reading is aligned with your actual interests, produce a more serious, more understanding, forward kind of reading.

Dwarkesh Patel
Right. So there's two models of why people might fail to retain the material they're consuming. One is they got it at some point, but they forgot it. And the other is they never understood it in the first place and they just never noticed that they never understood it. What I found really interesting was you going paragraph by paragraph, sentence by sentence, and asking “Have I got this?” This was material that I had tried to go through the week before. And there were things when you dwelled on something, I'm like, “Actually, I don't understand that either.” and I didn't notice I didn't understand that. How are you able to notice your confusion while you are going through it?

Andy Matuschak
This is a kind of habit. It's a skill that can be built. Adler and Van Doren suggest that the first and most important rule of skillful reading, active reading, is asking questions and trying to answer them. If you just dwell on that, what kinds of questions should I be asking and how should I go about asking them? How should I go about answering them when the author isn't present? And so on and so forth. [Unclear] They also say conversely, and this is meant as a criticism, an undemanding reader asks no questions and gets no answers. I certainly have read many, many books that way, particularly before I developed this habit and I often found myself falling into that second category. The issue was not that I failed to remember things, but rather that my eyes just skidded across paragraphs without even realizing.

Dwarkesh Patel
You're halfway through a chapter and you're thinking, what is the chapter about?

Ok, the broader question is — now that we have all these online resources, some of which you've helped develop like Khan Academy, it seems that the value of conscientiousness as a trait has dramatically increased. If you can motivate yourself to learn these things, the world is out there for you to absorb. What are the sort of design or UI or even content modifications that can be made to give you a conscientiousness boost? In the past you had a professor, you had peers, you had in-person deadlines to motivate you. Is there something equivalent to a pen and paper and how that boosts your mathematical IQ for conscientiousness?

Andy Matuschak
Right. One enduring result in education psychology is that when you're doing a lot of cognition, metacognition is difficult. What I mean by that is when you're thinking really hard about the stuff on the page, it's very difficult for you to plan, to regulate yourself, to figure out what the best next action to do is, to reflect and evaluate on whether you're understanding things. All that gets harder as the material gets harder and as it gets less familiar. So one common thread, at least in learning science stuff, has been outsourced metacognition. Some of the ways we outsource that are actually very familiar, they're things like somebody gives you a syllabus and tells you what to read when and you reference that. That is a user interface, that is a design practice. If you're a self-motivated student, one thing you can do and that I've done, is just go appropriate a syllabus from some graduate level course that corresponds to the text that you're reading as that might be a good guide to what's most important and how to approach this.

There are also lots of things that one can build directly into the interfaces. Just as one example, in Quantum Country, which was a textbook that Michael Nielsen and I developed to explore some ideas around augmented reading experiences, we embedded a bunch of review questions every 1500 words or so in this text on quantum computation. Our primary intention in doing this was to help people remember what they read. We had this theory that part of what makes it hard to learn a complex subject is that there's all these new definitions and notation and terms and things being thrown at you at once and you're being asked to combine these things, which are still unfamiliar. And so you're constantly having to retrieve these elements and struggling to do it, either it's taking a while or your success rate is low.

That was our motivation but it had this other metacognitive benefit that was really important. When you're asked these questions after reading 1500 words it is an opportunity for you to notice that you did not in fact absorb what was in that thing. Not that you don't remember but that there's a word in the question that is apparently important that you simply didn't even notice. And so not only does that give you feedback, it tells you that maybe you need to reread that specific section, but it may also change your behavior towards future sections. In interviews, readers told us that after they reached the first set of questions or a particularly difficult set of questions, they found themselves slowing down

and reading more attentively or actually realizing that their reading practices were ineffective in general. In the way that you were mentioning towards the start of the conversation. There's been a bunch of research on adjunct questions, questions that go along with a text, and they have all kinds of effects. The adjunct questions have the kind of effects on forward material I was just describing and they also have the effect of making you reflect on what you've just learned. And in addition to the questions being asked, you might find yourself pondering, "Well, I'm being asked about this. But why does this matter?"

Dwarkesh Patel
Yeah, on the point of adopting a syllabus from somebody else. One problem you might have as a self learner is you have some goal, a reason for learning, and then you start thinking, "Well, do I really need this chapter? Do I really need this content?" At this point, you're doing the metacognition that you were trying to use a syllabus to avoid.

Andy Matuschak
Yeah.

Dwarkesh Patel
If you are trying to self learn and there is a resource that is a close approximation of the syllabus you want. Should you just think "Hey, I don't know why I need this chapter. I'm just going to go through it." or should you use your own judgment there?

Andy Matuschak
This is a pretty classic issue for learning in general. You have this problem where to bootstrap yourself in a domain you have to outsource the question of what is necessary to know. You might know, for instance, that you really want to build a model that can generate images given descriptions, like Midjourney, but you don't even know what you need to study to do that. So you pick up some textbooks on machine learning. You're outsourcing the answer to this question to the author. What is necessary to know to build things? Maybe you can find a book that's actually labeled "What you need to know to make an image generating model" But even then, you're outsourcing the answer to the author.

You can take that answer as a start and treat it as tentative and revise it iteratively. And as you become more skilled you can lean less on it. And you probably should. I think a very common mistake that people make is to feel that they need to do the thing the right way and that is exhaustive and completionist. If they fail because they find themselves bored or unmotivated because the material doesn't actually seem to relate to what they want to know, but they're just going on faith that, "Well, if I follow what the author says, everything will be good." Anyway, they find themselves having trouble for that reason, and then they just stop. This is bad. They would be better off just skipping around according to their interest and continuing.

One other thing I'll say about this is that the role that these syllabi play is as a scaffold. This is a term of art from learning science, but it relates to the thing we're familiar with. If you want to get higher up a building, you may not be able to climb it yourself, but you can build some scaffolding around it and then suddenly you can reach that top shelf or the top of that building. The scaffolding is ubiquitous in education. We give you simpler versions of questions first, that's a kind of scaffolding. We partially work the answer first, that's a kind of scaffolding. We give you worked examples first, where we might ask you to predict the next step of the work example. That's also a kind of scaffolding. Where the metaphor breaks down is that once you become more capable, we try to remove the scaffolding. It's called fading. The idea is that once you have solved a lot of calculus problems, you don't need half of it worked out and you're just filling in one of the blanks anymore. And in fact, doing that would not be as effective a learning experience.

If I'm studying something in computer science, which is a domain that I know really well, I don't need those syllabi, not in the same way for most subjects, and I think that's mostly just because the amount of cognitive demand that's placed on me by the subject is just much lower than it is for other subjects. So much of it is familiar already that I can deploy my own planning more effectively as I go. But it's also the case that because I know so many things about the subject, I can do a better job from the get go of making a plan. Because making a plan requires modeling a path or predicting a path or saying, "Well, I guess I'd need to see how this connects to that or something like this." And if your destination and your starting point are very far away, then you can't necessarily see all the things in between or how to draw those lines. But if those things are only a couple hops away, you can maybe infer pretty accurately.

Dwarkesh Patel
Right. I guess this maybe implies that if you do want to learn about a subject, it might just be helpful to just do an Intro to X subject course or textbook, not necessarily because it is instrumentally valuable to whatever problem you're interested in but because it'll give you the context by which to proceed on, the actual learning.

Andy Matuschak
That's true. It's also the case that you don't even know all the stuff there is. This is another key problem and this is another reason why we outsource stuff. There's a fundamental tension in unschooling, for instance. Just let the kids pursue what they're interested in. That's cool. There's a lot of good things about that. But say that a kid's true passion turns out to be ocean geology or something and they're in a landlocked country and there's just no one around them that talks about ocean geology, then they're missing out on some great opportunity. But if the school had a program where they are bringing in guest speakers and then there's a special lecture on ocean geology from this person and it lights up the kid's world, even if they wouldn't have chosen that lecture, that's a good thing.

Dwarkesh Patel
Yeah. Unschooling is actually an interesting subject to talk to you about.

But before that, I want to ask you about this excerpt from a Paul Graham blog post titled How You Know and it says, "Reading and experience train your model of the world. And even if you forget the experience or what you read, its effect on your model of the world persists. Your mind is like a compiled program you've lost the source of. It works, but you don't know why." So it's a compiled program, you don't need the source code. Is it okay that we're forgetting so much of what we're reading?

Andy Matuschak
What he's saying is true, to some extent, whether or not that extent is sufficient is going to depend a great deal on the situation and on what you need. If your aspiration actually depends on having a deep, detailed understanding of the material, then the imprint on your worldview or on your automatic responses made by the book may not be sufficient. On the other hand, if what you want is to absorb a lot of different ways of looking at the world, knowing the details of these isn't necessarily important. Maybe you just want to know that Confucius emphasizes community and society as a moral patient in contrast to the individualism of a bunch of humanist philosophers. And if that's kind of the level that you feel like you need to make decisions in that domain then I think that's fine.

Very practically speaking, it's funny that he uses the word compile, because one of the prominent theories of cognition, that is how we come to know and learn things, is this theory called ACT-R by John Anderson. A key part of it is this process that he calls knowledge compilation. This is the process by which we take individual facts and turn them into higher level patterns that we can generalize and apply in more contexts. And I think that's what Paul is gesturing at. By reading a book which contains a story or a case study you learn to generalize to some extent and you apply it in other contexts when it seems relevant.

The reason why I bring up Anderson's theory is just that he has a bunch of specific claims about what's necessary for knowledge compilation to happen and what you'll be able to do as a consequence of certain degrees of knowledge compilation. I think he'd probably respond to this by saying that — actually, in order to effectively compile things that you've learned into schemas that will match feature scenarios effectively, you need to be exposed repeatedly to those things, you need to use them, you need to do a variety of things that will basically show your brain that is relevant to apply these things in combination. And simply reading probably won't do that. But if you read and you have a lot of conversations and you're in a context where it's demanding and it's drawing on what you read, then you may naturally do that kind of compilation step.

Dwarkesh Patel
I've actually been thinking about this in preparation of talking with you. I've had the pleasure of talking to a lot of interesting people across a lot of different fields. When I look back on some of my old conversations, I notice that I actually had a lot more context at the time I interviewed them and had done all the prep than I can remember now. Sometimes I'll listen back to a conversation and I won't even remember the content in the conversation. And I remember thinking after the conversation, I knew so much more about this field than was compressed into this one hour interview, right? I had to prep other things that might come up. And afterwards I'm like, "I don't even remember the things that were in this one hour." But then the other part of me thinks, "Well, I'm getting better at doing the podcast", that might imply that I've picked up something. But it is a shame that I didn't have some sort of rigorous practice throughout the time of retaining the material that I was keeping.

Andy Matuschak
Well, yeah, I expect the main [unclear] in which you're getting better, is actually not really about any of the details of those materials. I think it's about your practices as an interviewer, the way that you generate questions, you probably have a bunch of patterns, whether you know it or not. You read a thing that a person has written in hopes of generating good questions about it. And even though you maybe don't have this habit for textbooks yet, of constantly demanding things of the textbook, you have started to develop this for essays or blog posts that interesting people you're interviewing have read. And to point to this Anderson theory, in the course of repeatedly doing that, you've made parts of it automatic, so that you don't need to do it consciously, you can focus more on the material, you can probably take on more difficult material, or actually understand material at a higher level than you could have before, because less of yourself is engaged in this question of how do I make the questions from the material?

Dwarkesh Patel
Yeah, I certainly hope so. Otherwise, there's a question to be asked of what I've been doing all these years.

Having interviewed some of these people who are infovores and have consumed and continuously consume a lot of content, they don't have a note-taking practice.

This is something you also noticed and pointed out in your notes. Tyler Cowen, for example, I don't think he has any sort of note-taking practice. He just devours information. What is your theory of how these people are integrating things that they're reading?

Andy Matuschak
Tyler's a good example. I think he's actually a little easier than some others we might discuss. So, let's talk about Tyler for a second. One of the other things that's so interesting about Tyler is his writing obligations. This is a man who's blogged every day since 2007 or

something and has a weekly Bloomberg column, something like 1500 words, and also has published something like a book a year for a decade or more, and occasionally publishes some academic articles, plus like a bunch of other collateral. That is notes. And I think it's also important to note that like the way that Tyler writes these blog posts and the way that Tyler does these columns and even the books is very different from the way that many other book authors work. Tyler's blog posts often have this a real first draft mentality to them. He's just thinking out loud and he's got decades of practice thinking out loud and like writing down a decent take the first time. And so he gets something pretty good, the first time, much of the time. And that works for him. So that is a note, right? Your initial thoughts on the subject is what you would write in a note.

Dwarkesh Patel
Yeah, one of my former guests, Scott Young, was comparing Bryan Kaplan's books and Tyler Cowen's books and he said, when you read a Brian Kaplan book it's like a chess game. If you try to move a pawn up on this case for education, I've got this rook that I can move here. With Tyler, it's more like he's shooting the shit on a subject.

Andy Matuschak
Bangladeshi train stations

Dwarkesh Patel
Yeah, right, right. On a separate question, do LLMs make memorization more or less valuable? There's a case you can make for both. But on net, is it more important to have more Anki cards in your deck now that GPT-4 is out?

Andy Matuschak
Maybe this is a good time to talk about what memorization is or what it's for. We could use that word to refer to the practice of learning more trivia. For instance, a thing that I and some people I know have done is, we've gone through a book called Cell Biology by the Numbers, which says all of these things like, how big exactly is a nucleotide? Like how much volume does it take up? It's kind of helpful occasionally to know that it's about a nanoliter. And that can help you model things. So you can just commit all of those things to memory, right? That's one kind of memorization. And we could talk about how LLMs affect that. But I just want to make the case that so much of what you do and experience day to day is memory bound, or is memory influenced in important ways. For instance, your ability to understand a difficult argument, even in the course of a text, is memory bound. Some of that's working memory. But your ability to understand an argument that has many steps in it, more steps than you can keep in your working memory, depends on your ability to think of some of those steps in terms of some stuff that you already know, so that you can kind of reduce it or abstract it.

Likewise in creative work, there's a bunch of studies trying to catalog case studies of how it is that people have flashes of insight. It's a little hard to talk about that but one of the things that's a pretty consistent source of insight for people is noticing a surprising connection or a surprising contradiction. It probably feels pretty familiar, right? You're reading through the newspaper and you see that people have finally figured out how to do X and you're like, "Wait a minute, that means if I combine it with this other thing, like we'd be able to do Y!" or something like that. Now that's only possible if the other thing is in your memory. If you have to think to look up the other thing, the newspaper wouldn't seem so salient to you.

Early on in my time in Khan Academy I learned a whole lot of details about the education market in a very thorough way using memory systems. This let me be in high level executive kinds of conversations where we're trying to figure out strategy stuff and somebody would propose a particular direction and I could say things like, "Well the total budget spending for instructional materials is this and that market is growing by this percent per year and 10% of students in the US are in this place" and so on and so forth. Basically I could evaluate ideas on the fly in a way that others couldn't. Anyway, this and other things are just part of my rant about how people in general under-appreciate the role that memory has in our lives.

So just to come back to the question, explicit memorization or explicit making sure that you can recall the thing reliably. We can test it against these things. So for the case of the creative instinct, for instance, noticing the contradiction, noticing the connection, I imagine that we will have future notebooks that will do some of this noticing with us and that will decrease our need to be able to rely on our own sense of salience or something like that. But I guess I don't know how much. My own experience coming up with weird ideas that feel very new is that it feels very personal, it feels very [unclear]. I often haven't been able to describe, textually, the constituents of the thing very clearly. There's just kind of a feeling that something in this general direction is connected with something in that general direction, or there's a tension. That makes me a little hesitant. LLMs depend on our ability to externalize things and to make them legible. Back to the learning point about the role of memory. If what you're trying to do is to understand something pretty difficult, your ability to understand that thing is still absolutely going to be bound on your memory of the constituent material.

Dwarkesh Patel
Do you think there's pedagogical value in forgetting? Some anecdotal or unrelated evidence is in neural networks where sometimes you can improve performance by pruning some of the weights. Obviously, we forget things and we don't remember everything. When we sleep, we lose a lot of our memories. Is it possible that by not getting the details and only getting the gist, that actually helps us better generalize the insights we're getting from text and things like that? What do you think of that way of thinking?

Andy Matuschak
Yeah, it could be. Memory is very connected to attention. And we can't attend everything. So one of the roles of memory is to help guide us to the things that are important. Maybe I happen to know that the magnitude and energy of an electron volt, that's something I can draw on because of the memory system stuff, but I also don't want that to be front and center in my mind all the time. I don't want it to be hyper salient the way that I want some very important design principles to be. So yeah, there's some role there. There's also some theories that the reason we have forgetting is that our environment or ancestral environment was very traumatic. So we would like our episodic memory in particular to maybe not be all that faithful. I actually don't know the status of those theories.

Dwarkesh Patel
Probably why you forget dreams as well, right? Dreams are pretty traumatic. If you thought of them as the same as a real life experience.

Andy Matuschak
Yeah. Another weird thing about memory is that as far as we can determine, memories aren't lost exactly, at least not completely. There's a series of interesting experiments that people have used to demonstrate that decades later, things are still there. If you can cue them right, people can bring things back, even things that they feel are lost. And of course, you can also cue people in ways that are hallucinatory so you need to be careful about that. I guess the reason why I bring that up is that it flies in the face of this view that there's a limit.

One of the things that I think is kind of weird about this memory system stuff, or like memory champions, or something like that is "Oh, if you do these things, will you start to forget other normal human stuff?" And what's weird is, no. I've been doing this memory system stuff for years and I just know more stuff now. This is aligned with the experimental literature, which seems to suggest that, there's probably upper bounds but we're not close to them. Some of these memory champions have memorized maybe two orders of magnitude more things than I have practiced. Certainly people who are multilingual have really, really absurd numbers of things memorized. So there isn't a resource management argument.

Dwarkesh Patel
If there isn't, why do we forget so many things? Is there some reason the brain just forgets some of the things we're coming across? Maybe we were training the ancestral environment to find certain things salient that don't just map onto books?

Andy Matuschak
It's a good question. We're getting to a part of the cognitive science space that I'm less familiar with and also that I suspect we simply know less about. But let me just riff a little bit. One of the things that we sort of know is this idea of spreading activation. When you go

to try to look something up or when you try to deal with a particular situation, there's something almost kind of like DNS exchanges or like routing on a network or something where we start from some point that is like a stimulus, and speaking very informally, we kind of expand outwards from there and there are effectively like weights on those connections. By tuning those weights effectively, we route the packets on the network effectively. Memory is encoded in these weights, at least partially. So if you didn't forget things, then you might just have this weird cacophony on the network and in particular, what's salient? What to do next? Which response seems most appropriate to this question? You might answer those kinds of things very effectively, because all this stuff is coming up for you, that is much less relevant. One of the theories about how well we remember stuff in what circumstances is actually called predictive utility theory. And it suggests that the probability of retrieval of a particular item in a given situation actually does correspond with basically a model of to what extent the brain predicts it will be useful.

Dwarkesh Patel
Right. And then the prediction but doesn't necessarily map on to...

Andy Matuschak
Doesn't necessarily, exactly. So when you repeatedly access something, when you practice retrieving it, the prediction of the utility of the thing goes up. And when you do it in a variety of situations, it goes up across a broader distribution.

Dwarkesh Patel
Okay, so this is interesting. When did you start your memory practice? Presumably it was after after Apple?

Andy Matuschak
Yeah.

Dwarkesh Patel
Okay. Let me ask you this. At Apple, you were in charge of a bunch of important flagship features on iOS and I'm guessing other things. Presumably you didn't have some sort of practice but since you were encountering these things day to day, that natural frequency and way in which problems came up, did you have a worse understanding of those problems then compared to now, knowing what you do and having the practices you do, you're able to comprehend now? I don't know if that question made sense.

Andy Matuschak
No, that's a great question. Here's a fun thing. I was much better at what I was doing then than I am at what I'm doing now. That's pretty funny. It was just totally different. Let's talk about this a little bit. This feels very, very juicy for me. Most of what I was doing was engineering. Some of it was very difficult engineering, but mostly engineering, and mostly

on things that were fairly well understood. I wasn't trying to decide what should be done, sometimes I was from a technical perspective, but certainly rarely from a product perspective. It was rarely a relevant question for me. I was a somewhat design minded engineer and I did a bunch of engineering and design-ish things on tasks which were set out for me. By the time I joined Apple I had been programming for a really long time, 13 years maybe, and programming in Apple's ecosystem for probably two to three thirds of that time. So everything was just really familiar. It was mostly flow all the time, every day. I was just in it. I knew the stuff that I needed to know. I was very well practiced. And the space didn't change that much. Most engineers at Apple most of the time are not pushing the frontier of what is known, like trying to discover. They're doing very difficult technical work, mostly applying things that they already know and understand quite well to problems which are usually not always pretty well understood. Memory was essential to me doing that job well, but I had already built most of it by the time I got there. I'd already built just tons of stuff for Apple's platform. I had to learn a lot of stuff. I learned a ton of stuff about the internals of those systems. But because I already had such a rich understanding, both of Apple's platforms and of computer science and engineering in general, I had this really rich network for stuff to slot into. Learning stuff is easier when you have other stuff to connect to. It's a nice principle. Metacognitive load on me was lighter because others were figuring out what we should be doing. Just like by contrast, now I'm doing research, I'm trying to discover things that are not known. I'm trying to make things that didn't exist. The hard questions that I answer are mostly, what should be done or what should I do? And that question is not just a technical one of how I should implement this feature that needs to get built, but what intervention on a reader should be taken? That requires synthesizing lots of different unfamiliar literature.

Dwarkesh Patel
There's two different threads I want to go on. Maybe I'll just mention the other one. This is also related to the thing we're talking about a few minutes ago with LLMs. Swanson-Linking. Swanson was just somebody who read the medical literature and he was just familiar with a lot of esoteric results. Different things would come up and he would be able to figure out what different things are connected. For example, he noticed in one case that headaches are linked to some other symptom and that other symptom is linked to magnesium deficiency. Apparently a whole bunch of people's headaches were solved once they were given magnesium supplements and he noticed that connection. Again, this is the kind of sort of combinatorial thing that you wouldn't notice otherwise.

But on this subject itself, there's this natural way in which you're able to get up to speed in all the things that are happening at Apple. Is it possible and maybe advantageous to do similar kinds of things in other fields? For example, instead of doing an explicit space repetition system when you're trying to absorb material from books, you just read a cluster of books and hopefully things would just come up that are relevant to get in again. Or is there a value in having explicit practice of setting up cards and so on?

Andy Matuschak
Yeah, again the answer is going to be it depends. Maybe the most familiar example of what you're talking about is immersion learning a new language. Immersion learning is like a great thing and it's going to be more interesting and more effective than doing space repetition practice. It's going to be integrative. It's going to be socially based. So there's a bunch of stuff about social learning that's relevant. A problem though is that say you decide you want to learn Swahili today and you go down to the local Swahili community center and you're like, "Cool, I'm going to immerse myself" Good luck. You can't even get started. So through this lens, explicit practice is a way to bootstrap yourself. All of the best pianists at sight reading that I knew in university played with churches. They were so good at sight reading because they had to show up every Sunday and they're playing a different thing. New hymn every Sunday. So this is immersion also. Over time, they're learning all these cadences and these things that are really common and whatever. But you can't show up and be the church pianist every Sunday in the first place if you don't already have some decent foundation. This is a bootstrapping argument. One role for explicit practice of this kind is to get yourself into a position where you can more naturalistically reinforce. But there are still going to be instances where naturalistic reinforcement isn't going to work. For example, the linking that you brought up, one issue for doctors is rare diagnosis. So if it's only going to be once every couple of years that you see a patient that's going to present with these symptoms, that's not going to be frequent enough to naturally reinforce your memory of that. You're going to need some out of band mechanism. And unfortunately, I think for many kinds of creative leaps and creative insights, that may be closer to the regime that we're in.

Dwarkesh Patel
Yeah, that makes a lot of sense. Where in many fields, the things you're regularly doing is the thing you need to reinforce. It makes a lot of sense that if you're a researcher, the long tail of events that might come up is a thing, it might happen once every few months but the regularity is not a thing that matters, right? It's [unclear] on your work.

Here's a question I actually have. When we were doing the quantum mechanics textbook, it was like three hours and afterwards, I was just exhausted. I was actually surprised that you went the entire three hours without interruption. Afterwards, I was packing up and you're like, "Hey, I'm about to actually go to my piano lesson." I was so confused at how you had the stamina to keep going. Is the stamina just inherent in you? Or is that something you did to develop?

Andy Matuschak
One of the things that I think is funny about stamina is first off, there's some kind of weird grass is always greener kind of situation where, I often feel struck by other people's stamina and feel like I have very little of it. I struggle with energy. I've actually written extensively about all my struggles with energy and ways of managing energy. I spent a lot of time thinking about it, managing the energy levels and structuring my day around it. So I think

there is something where one often feels maybe lower stamina than one actually is because one misapprehends other's stamina. Okay, in that particular situation, how do I explain why three hours of studying, etc. First off, social. So if I were alone and studying that book for three hours, and I weren't effectively trying to perform for you Dwarkesh, it wouldn't have been nearly as energizing for me. And I definitely would have taken breaks. I still would have been able to go for three hours, I think. Part of the reason for that is that it's simply way less hard than things I normally do.

In some sense, learning quantum mechanics should be much harder and it kind of is cognitively demanding in a lot of ways. It's much more cognitively demanding in kind of a direct way than what I actually do day to day. But it's much less demanding on what William James calls the Energies of Men, which is something like a life force that permits you to act according to your will or something like that. Maybe it's gumption, maybe it's willpower, maybe some people call it [unclear], these aren't all the same thing exactly. But sitting and staring at a page and deciding what you should do next on a research project is incredibly draining on that resource. The sitting and not knowing is the hardest thing that I do in my work. It's a wonderful vacation to be presented with, "Oh great, somebody else is going to tell me what to do. This is great."

Dwarkesh Patel
So although it might be less demanding than our usual work, it is definitely more demanding than the way in which I or most people approach textbooks or other material in the sense that, I would just read through and then once I get to the exercise, I'm like, "let's see what I didn't understand." Whereas just the attention and the intensity to go through sentence by sentence and constantly being paying attention seems to be way more exhausting.

Andy Matuschak
Yeah, I mean, so this is sort of true. It's definitely the case that I will occasionally do some of this before bed reading, where I think "Oh, let me just do a little bit more." and it's basically useless. But I want to make the case that there is a kind of pocket that you can fall into. Maybe you call it flow where the demandingness that you're bringing to bear is matched to your ability, the book is not overwhelming, you feel like you can make your way through it, and this is actually more engaging. I occasionally will find myself reading as an undemanding reader and finding my attention kind of slipping because I'm just not that attached to the text emotionally, I'm kind of reading dutifully, I'm like trying to get through it. That sometimes produces an adversarial aspect where the text is in my way or it's kind of something to be accomplished. And often I will find that I need to bring more gumption to bear to power through and make myself sit there and keep flipping the pages than I need if I actually just open my curiosity and attention and really start engaging the book.

Dwarkesh Patel
There are ideas that people have come up with for different pedagogical tools, which are mediums that give closer connection to the reader. One is, you have some sort of fiction account, where a concept is introduced and reinforced, or you have a video game with characters you care about. As far as I know, there isn't something that has really taken off using these sorts of new mediums. Why do you think that is? Is it just an inherent limitation of everything but text and lectures or people just haven't given it the right content and design?

Andy Matuschak
Yeah, I'm fascinated by this question. Let's see, I can say a few things about it. One is that I would argue that one medium has taken off in an absolutely enormous way and that's video. People love video. People will watch Grant Sanderson spend an hour going through some explanation of an esoteric math problem, people who would never crack a Springer graduate textbook in mathematics or something like that. The issue is that they will not walk away from that interaction with much understanding but they're much more engaged. So that's cool. That's suggestive and it suggests the question, is there a version of that which actually produces detailed understanding? Maybe one approach to producing that might be like a game. My favorite example of this is The Witness by Jonathan Blow. Have you played The Witness?

Dwarkesh Patel
No.

Andy Matuschak
I think The Witness is an absolutely extraordinary work of art. It's a game that has no text, at least no text that's relevant to the game elements. In kind of classic Myst style, you wake up on an island, and figure out what's going on. And the game proceeds to explain to you, without using words, but just by shaping your environment, a series of extremely complex mechanics of a system that exists in this world. You learn a bunch of stuff and it gets to the point where it feels like you're in conversation with the game's designers. It's like, "Ah, he's asking me to do this here." No one's asking you, right? There's no text, but you can feel that you are being asked. You perform some interaction in the environment and you feel that you have answered the game's response in kind. This is very, very interesting. It's like a medium of action. Some people have tried to make educational games, games that are explicitly about arithmetic or something, Jonathan Blow's game is not about that. It's the mechanics that you learn are they're about the environment. I don't think anybody has yet really succeeded in doing this about explicit subjects. There are, for instance, things like Kerbal Space Program. Maybe people learn some things about project management or orbital mechanics from that. Zachtronics has a bunch of games that are sort of about assembly language, roughly speaking. Maybe you can learn some things about that. The issue seems to be that games are ultimately in aesthetic form.

The purpose of the game is to have an experience that feels a particular way. And so they're sort of serving a different purpose than Grant's videos or a text. Grant's videos are also serving a different purpose from the text. The text you might pick up because you're like, "I want to be able to build a robot." So you pick up a textbook on robotics or something. And so is there something that you can pick up that's sort of like a game in so far as it's an active environment that you use in a similar situation to "I want to learn to build a robot?" Maybe kind of? We don't quite have those yet. We have some things that are kind of like that. I don't know if you've seen From Nand to Tetris. This is a very interesting project that's kind of along these lines. And what characterizes it, like games, is doing. It's active. So when I was asking all those questions of the book, that was active learning, active reading, Nand to Tetris is naturally active. So this is a course in which you kind of start with basically nothing. You start with memory and you build a virtual computer and build Tetris. You build a processor and stuff. The whole thing's active. The whole time you're making the computer grow. This is doing a similar job to the question asking that I was doing, except that you don't have to regulate all of that yourself. The regulation, the choice of what activity to do, is in the course, is in the structure of the material. I think some kind of mass medium that is like that is waiting to be created, but that can be applied in many, many circumstances. We have the non-mass medium version of it already and it's apprenticeship. If you want to be a good yoga teacher, you go hang out in yoga studios. If you want to be a good surfer, you go to the beach when the other surfers are there and you participate peripherally and you talk to them and you learn about their tactics. They might give you some feedback eventually and you'll start to participate less and less peripherally over time and eventually you'll be part of the community. This isn't a mass medium. We can't print billion copies of it like we can with a book.

Dwarkesh Patel
What is the experience of watching George Hotz on the stream code up tiny grad? How does that compare to just being in an office with him? Because even if you're in an office with him, there would be constraints on his time and how much engagement there would be. Why isn't video a scalable way to increase apprenticeship?

Andy Matuschak
I'm actually incredibly excited about streaming as a medium for this. We're gesturing at a particular kind of learning that needs to happen. It's often called tacit knowledge. One of the things that you have to learn to do as an engineer is to learn to deal with 100,000 different weird situations where something is not behaving the right way. Eventually you learn pattern recognition, you learn ways of dealing with this. Much of this is not described in any book. It's not explicitly taught. You just learn it by doing it over a long period of time. By watching George do it, I think that people do absorb stuff. They can absorb some of that knowledge. That's part of how apprentices absorb that knowledge. There's a few things that are missing. You're not getting feedback. There's a whole lot of chaff there. There's a whole lot of stuff that probably isn't all that meaningful. It's also true for apprentices. I'm pretty

excited about streaming videos. I've complained loudly that there aren't more designer streamers.

One of the things that I think is really interesting is that we have some disciplines like programming where there are a million books on courses about how to learn to program. They don't give you everything you need. There's this tacit knowledge stuff that you need to develop. If you work through these courses, if you go through the MIT OpenCourseWare for computer science, you'll be able to build some stuff and you'll be able to lift yourself up. This is not true in all domains. In particular, design, but lots of other domains that are like that, like musical composition, architecture, something like this. Nope. It's normally done in studio classes. Lots and lots of hands-on feedback. The feedback is highly contingent. It's highly contextual. We just haven't figured out how to communicate this. It's good to see lots of programmer streamers, but I really want to see the streamers in these other domains.

Dwarkesh Patel
On the point about more programming books. Ironically, the reason why there's some more resources on programming is that it's just so legible, but it already makes it easier to understand in the first place. You just have this reinforcement. Nand to Tetris is like a video game analog to learning, maybe not just programming, but how things in the internals of a computer work but programming has an element where it already feels like a video game. I have a friend who has a sort of intense sort of manic energy, and he used to be addicted to video games when he was a teenager, and now he just stays up all night in these coding binges. It's just the same part of the brain. Are you optimistic about things like video games and fiction being able to work and feel as though they're not already kind of like a video game, like programming?

Andy Matuschak
I think what makes programming feel like a video game is this sense of instantaneousness, this sense of direct contact with the environment. You're learning about a conceptual world, but that world is right underneath your hands, and as you manipulate it, you're constantly getting this feedback, the red squiggly lines, you're pressing command R regularly, and you're seeing it fail, and that feels great. There's this feeling that's very common for programmers, and it's laden with doom. The feeling is it's like 9 p.m., and you've been working on a thing all day, and it's almost working. It's almost working. And you know, if you just debug this one thing, then your project will be done, and you'll be able to go to, so you're like, "Well, I'll just stay up and I'll debug this one last thing." And then you start debugging it, and you get it, and you solve it, and that feels great then immediately you run into one more thing, like, "Oh, it's almost running all the way through, it's almost going end to end," and you're like, "Well, I'll just stay up a little bit longer." Before you know it, it's 2 a.m. You keep going because it feels so good. You feel the sense of forward progress. You're not just staring at a wall. For the programming problems where you are at a brick wall, it doesn't feel like this. It feels bad. Can every field be transformed into something where you can feel

the sense of forward progress? You can get this rapid feedback cycle. I think that's really hard. It's not clear to me that some fields can be transformed in that way. I think we can get a lot closer in most cases than we're at right now.

What's hard about designing a user interface is that often there's this feeling of exploring a combinatorial search space. Programming often feels like a search problem too. You have a sense that there's some right way to solve the problem. There might be some set of right ways to solve the problem, and you're looking for it. And you have some heuristics that guide you to, like, "Oh, this might be a dynamic programming problem!", or this might be something that is solved well by separating concerns or something like that. Design often feels less like that. You have those heuristics, too. You have those patterns, too. Often it just feels like, "Nope, I just need to try 300 things." The core action of Figma is to duplicate. You have an artboard, you tried something, and that didn't work so you select it, and you press Command D. And what you end up with, and when you look at Design Twitter, it's just all these screenshots of people's Figmas with a million artboards. They're just trying stuff. And you don't have this feeling, or at least I don't, and I think many designers don't have this feeling of progress. You're just kind of exploring parts of the search space, and you're learning that parts of the search space don't work. And eventually you stumble on one that does, but you don't have this feeling of getting closer often. Often there will be like weeks that go by without feeling like you're getting closer, because what you're doing is just kind of like narrowing the search space.

Dwarkesh Patel
Interesting. Although there are people who are obsessed with Design. What is the sort of loop that keeps them obsessed with a process that doesn't feel intrinsically forward feeding?

Andy Matuschak
So to some extent, I think they are skillful. The people that I know who are like this, it's a combination that they're often skillful and the nature of the problems that they're solving are highly tractable. An example of a kind of thing that designers will often rabbit hole into is designing a poster. It actually often used to be kind of a cliche that at Facebook, there were all these posters up on the wall of the office. Very, very elaborate, beautifully designed posters for a talk that someone was coming to give at Facebook. Why did somebody put all this effort into it? Well, it feels really good, because a poster is really constrained, it's finite, it's ephemeral. You can start it and yeah, there's a search space, but you can find a decent part of the search space pretty rapidly. And once you're there, there's this beautiful and very enticing feeling of turning the crank and like making it better and polishing it and trying this or that. But when you're trying this or that, like, all of the options are kind of okay. And you're kind of trying them out of curiosity, or like maybe it can be even better. And that's very different from the kind of design where you're just like, "I simply don't know how to do this."

And I think it's part of why those designers loved making those posters. It's a snack. It's a treat. It's also something they get to control whereas ordinarily, they don't.

Dwarkesh Patel
Yeah, just don't tell the manager how many software engineering hours were used up in the poster designing at Facebook.

Andy Matuschak
Well, no software engineering. It's only designers. But for the software engineers, code golf is the equivalent, right?

Dwarkesh Patel
What is code golf?

Andy Matuschak
You know, in golf, you try to get the lowest score. So code golf, you try to solve the problem as minimally as possible. Like, "Ah. I don't need this. I can combine this. I can do it in three lines. If I use Haskell, I can do it in one line." That's a kind of thing programmers do that's like this. But just endless refactoring is another thing that's kind of like this. You have the thing working, but it could be more beautiful.

Dwarkesh Patel
Right. So it seems like the tools and the ideas you're developing seem especially geared towards very intelligent and very motivated students. If they would be different, what would the tools that you would develop for a median student in the education system look like? Both in motivation and in other traits?

Andy Matuschak
Yeah, they'd be super different. I kind of got out of the educational space in part because I don't like the framing of this problem. For the median student, the education system mostly wants to make the student do things they don't want to do. It's not about helping them achieve their goals more easily or more effectively. For the most part, it's about achieving goals that aren't theirs. Obviously, that's not always true. But for the median student, it kind of is true. When I was at Khan Academy I was kind of thinking about this problem. At Khan Academy, we were mostly thinking about not just the median learner, but like maybe the 25th percentile learner. One of the angles that felt most relevant, maybe not from an efficacy perspective, but for me, from like a breaking out of this, getting them to follow goals that aren't their own perspective, was to focus on inquiry learning and to focus on transforming the learning experience into something that actually is related to their goals. That is, we're asking questions that are authentically interesting, that they authentically want to answer, and that they can participate in in a way that feels natural. We did a lot of experiments with dynamic media, representations of things. The idea being that, you've

probably seen these like plastic blocks or things that people can play with when they're kids to get an idea of numbers and number systems. Kids will play with these things unprompted because they're fun. It's just a pleasure to handle them. It's a pleasure to manipulate them. When you have them in hand, it's very natural to suggest, "Ah, can you make a pattern like this? Why can't you seem to make patterns like that? Why is that?"

Cuisenaire rods is the name for a set of 10 rods that have basically unit length 1 to 10, and they're all different colors. You can do things like take the rod that represents 8, and put 2 of the rods that represent 4 up next to it, and show that this one you can divide into 2 rods effectively. But then if you take 7 there is no other pair of rods, for the same color, you can put it next to it. So, you get these different patterns and things kind of naturally suggest themselves by experimenting with these materials and having conversations with people around these materials.

One of the things we were interested in was, are there things that are like that that are more advanced topics? Can we create something that's kind of like those rods, but that is about a more advanced topic in math or about debates in history or something like that? One of our tactics was to lean heavily on social interaction. People like talking about stuff with people, if it's a real conversation. For the same reason that I had to use less willpower to study that quantum mechanics text, because you were there with me, a student who's engaged in a real activity with a peer will need less willpower as well. They'll also learn from their peers if you structure things right. Social learning becomes interesting. But I think at a high level, I mostly have abandoned this question to others. Basically everyone in the educational space, this isn't totally true, but like 90+% of people in the educational space are focused on the bottom quartile, not even the median. And there's a good reason for this. Many people who are in education are motivated by arguments of equity and opportunity. They want everybody to have the opportunities they had. They're very motivated by the injustices that they see in the differing access and the differing support that different people have. And they're very motivated by the very real disadvantages that accrue to the bottom quartile performing students. It's also true that the marginal impact that you'll have in that student's life will be much greater, probably, than the marginal impact on say an 80th percentile performing student or so the argument goes, like that student will be fine, which is probably true.

Dwarkesh Patel
But there's a big marginal difference between fine and supercharged.

Andy Matuschak
Yeah, that's true. Anyway, I say all this to say that I understand why the vast majority of people in education are focused on what they're focused on. And I think it is good. And I'm glad they're doing it. I have mostly decided to let them do that. I'd focus elsewhere.

Dwarkesh Patel
Yeah. No, I see tremendous value in focusing on the cool new shit that's coming out, where's that coming from? And what's the way to increase that? It's interesting to know that the same tools might not just work across the spectrum.

Andy Matuschak
Yeah. Part of the trouble here is that the cool shit is very likely to come from students who are performing at the 20th percentile in school, because they're disaffected and bored and none of this stuff matters to them, right? Part of the trouble here is that by opting out of helping these people learn, there are all kinds of interesting inventions that could probably occur that aren't occurring. So I don't quite know how to contend with that. I guess basically I'm trying to bite off a piece of a problem that feels maybe tractable.

Dwarkesh Patel
Once all the tools are built, when you're at the end of your career, is the learning process supposed to feel fun? Or does it have to feel fun? Is there an element of even when all the tools are there, that there's just like a level of David Goggins, this is going to be miserable, but I've decided to learn this in this way and I just had to go through it.

Andy Matuschak
Where does misery come from? I'm asking this honestly, not really rhetorically. Let me try to answer my own question. Let me say first off that I am, broadly speaking, very opposed to what I understand to be David Gogginsesque attitude towards almost anything. In this particular instance, I think what I think is something like, if I ask why is it miserable to learn a particular subject? The answers that come to mind are things like, first off, I don't care about this subject. And I think that's not what we're talking about. You're asking about a world in which these great tools exist and someone's using one of these tools to try to do something they really care about. So another reason why it could be miserable that I think is pretty common is that you have some idea about, you're not going fast enough, or you're failing, or you're struggling, and the misery comes from resisting that. It comes from feeling like you're doing poorly and you shouldn't be doing poorly, it's bad that you're doing poorly. And maybe you're feeling fearful that others are going to judge you or you don't have enough time or something like that. And I think that's basically like an emotional problem that needs to get healed, rather than like a practical problem with learning. In the case of something like organic chemistry, where you truly do just need to learn 200 names or something. One answer is that it can be done very cheaply using modern memory systems. Organic chemistry students suffer through this and they don't need to. But even with modern memory systems, you're probably going to spend a total of 100 or so minutes across some weeks, studying all of these formulae. That still is unpleasant so can that be resolved? And I think the answer is yes, actually. I was thinking about this in the context of the Cell Biology By The Numbers book I was telling you about where there's all of these things like the volume of the nucleotide is a nanoliter. To study the flashcard “What's the volume of a

nucleotide?" is not terribly pleasant. I'm not sure it constitutes suffering exactly. It's fine. I'll do it while waiting in line. But I think there is a better version of that, which is like solving an interesting Fermi problem which involves that term. So something like, if I have a vial of the COVID vaccine, how many copies of the COVID RNA are likely to actually be in it if the vial is a milliliter large? That's a fun little question and I can enjoy sitting and noodling on that. And in doing so, I will need to retrieve the volume of the nucleotide to help me make that approximation. So I think there's moves like that you can use to paper over any remaining stuff that feels kind of necessarily unpleasant or rote.

Dwarkesh Patel
I'm actually surprised to hear you say that because one way in which I read some of your stuff is that this is actually a way of endorsing the traditional way of thinking about education, but using new tools to get the traditional ones. To give you an example of what I'm talking about, you go back to a headmaster from the 1900s, and you say, is it important to have the taxonomy of a subject memorized? You say, of course it is, that's why you're going to spend a year memorizing the taxonomy. And then you would say memorizing is actually important so that you have a dictionary by which to proceed on the subject. So in those ways you have new systems for doing that same kind of thing. And the reason in this particular case, I was expecting you to say, No, you have to be disciplined if you decided to learn something. I expected that in the case of the three hours of intense learning followed by an intense piano session, you were just really tired at the end and you're like, "But no, this is something I have to do this evening." So yes, I'm actually surprised to hear you say that.

Andy Matuschak
Yeah, no, I really enjoy this tension. I'm probably reacting to the Goggins reference with a bit of an over extreme overcorrection or something but this really is how I feel. And I feel this tension all the time. The histories in educational psychology that I'm most aligned with are the most robotic, authoritarian kind of histories, and also the ones that are most kind of unschooling and Montessoriesque. I really have a ton of sympathy for elements of both of these directions and there's kind of a weird synthesis of this in my head that I can't fully externalize. I guess part of what I'm saying is aspirational. It certainly is the case that I do in practice use willpower to make things happen. Just as an example of something totally contrary to everything I was saying, I use a tool called Beeminder, which charges me if I don't do certain things. This sounds kind of military, but it's certainly more authoritarian than this kind of freewheeling butterflies kind of gesture I was making a moment ago. And I use it to make sure that I do my memory practice. Shouldn't my memory practice be so joyful? It's at the center of my research, right? It should be the most interesting, exciting part of my day, but often it's not. And so I use this to do it anyway. So there's some tension here.

I think I do want to say the reason why I'm willing to endorse this headmaster's view about the taxonomy has to do with the price. I did a bunch of memorization in high school, and it

was very inefficient, and it was very uncertain. It was emotionally difficult because I wouldn't even feel confident that I'd learned the stuff. I didn't know what it was to learn something reliably, to be confident that I'd be able to recall it. And it was hugely time consuming because I didn't have techniques or tools. And now, part of why I respond so favorably to just learning the taxonomy is that, for me, it's just trivial. Like, yeah, sure, whatever, throw it into the deck. It'll consume a total of 15 minutes over the next few weeks and then I'll know it. It just doesn't cost anything. Other things in learning do still have real costs and those are maybe more difficult to negotiate.

Dwarkesh Patel
Actually, this is maybe a good place to ask you about unschooling and your attitude towards it. Somebody on Twitter had this question, how are you structuring the education of your kids as they're growing up?

Andy Matuschak
Well, okay, so to be clear, I don't have kids.

Dwarkesh Patel
Right. Hypothetical kids.

Andy Matuschak
So yeah, so you're gonna hear the foolish response of a person talking about what one would do hypothetically. This is very difficult. The school, of course, has many purposes other than instructional, right? It has a social purpose, it has a societal purpose, it has a behavioral purpose, and it also has like a pragmatic purpose of basically babysitting. Those things can be unbundled. I think it's pretty interesting to consider that. If I actually did have a kid, I would probably consider that project pretty thoroughly. I think it's pretty likely that some kind of homeschooling situation would occur. It probably wouldn't be [unclear] the teacher, but it would probably be the people I would hire. I have some resources. I'm not wealthy but I have some resources, that is maybe a difference. During the pandemic, I was struck by a company called Schoolhouse, which is now defunct, started by Brian Toball. The idea was that he noticed that people were getting together in pods, right? That was the thing we did during the pandemic. And in particular, they got together in pods with their classmates from school, maybe five or six kids. And some of these pods started hiring elementary school teachers who were not working because of the pandemic. And the elementary school teachers would come to the backyard of one of these people's houses, and the five or six kids would get together with the elementary school teacher, and they do stuff all day. Buying this one teacher's time split five or six ways was actually really very tractable. Say you want to pay the person $50 an hour, maybe that seems reasonable for a teacher, this is not that hard to do, and actually costs substantially less than a private school. I think Schoolhouse costs something like a fifth or whatever, the cost of an elementary school. Once you get to older grades you may need specialists. It's actually not

clear if you do. My friend, Alec Resnick, is working on a very interesting school called Powder House in Somerville, Massachusetts, that does something like the model I just described, where you have adults who are in more of like a coaching role, and they aren't necessarily domain specialists, but they'll connect people with domain specialists. Anyway, I would explore something like that model. I'm sorry, this is a little bit vague. If you want to ask about something specific...

Dwarkesh Patel
Sure, let me ask you a more specific question. This child grows up and is now 12. At this point, you have taught arithmetic, reading and everything. Do you proceed and say you have to learn your biology, you have to learn chemistry, or do you just say, what are you interested in? Are you interested in Roman history? Oh, let's learn about the aqueducts. Or is there an actual curriculum that proceeds until they get to college?

Andy Matuschak
Yeah, this is really challenging. One of the heroes of the reform school movement is this philosopher named John Dewey, and he has a lovely book called Experience and Education, sort of written near the end of his time, looking back on all of his efforts to reform schooling in a kind of unschooling-ish direction. He was never as extreme as that, but broadly looking for freedom on the child's part. And he makes this wonderful argument that because these kids don't have a fully developed prefrontal cortex, certainly don't have a fully developed kind of sense of self, to let them do whatever it is that their whim commands them to do in any given moment is actually not freedom, but rather is chaining them to whatever that impulse is. It makes them the subject of these tides of impulse. And I think that's a pretty compelling argument. It doesn't authorize tyranny, but it also suggests that, you know, you got to be a little bit skeptical about the planning or the plans of 12-year-olds, I guess. How skeptical should one be? I don't know. I think I would probably have stronger opinions on that if I had a 12-year-old. But my instinct as a foolish non-parent would be something of a mix. I would be interested in exposing the 12-year-old to lots of topics and possibilities. I would be voluble in expressing the consequences of any particular actions. Like if they just want to compose music all day, we could talk about like, well, what does that mean? What kind of life does that look like? I would try to be non-coercive in this as much as possible. And I think to some extent, the child should be allowed to feel the consequences of their choices. This is complicated by the fact that, again, I'm not wealthy, but any child of mine would have chances. If they made some weird choice about a career path when they're 13 and so they didn't get into Harvard or whatever, that would be okay. They could be 24 and finally figure it out then, or 32 and finally figure it out then. It would probably turn out fine. This doesn't seem like reliable guidance. You should notice I'm feeling very confused about it.

Dwarkesh Patel
Yeah, no worries. So one question I have is historically, and maybe even to the modern day, it seems like improving education has been a very intractable problem. And you did reference this earlier when we were talking about gearing towards median student versus whatever percentile you're working with. But I don't know. Do you feel like there's been progress even in the percentile you're gearing your stuff towards? And if not, what is the explanation for the relative stasis? I mean, this is something you talked about. We have so many new tools with IT. What explains the broader sort of stagnation here?

Andy Matuschak
The funny answer to your question is actually there's been a ton of progress. Actually, things are pretty good. I think the stat is that in 1900, 6% of teenagers graduated high school in the US. Now, that doesn't mean that 94% didn't have an education that we would regard as a high school education, but it roughly means that. Now, these people are homeschooled. It's also the case that a high school education meant something lesser back then. A substantial fraction of high schoolers now study AP courses and complete them in high school. That's at the high end. On the low end, illiteracy was a very live situation 100 years ago in the US and is emphatically not now. Now it is the case that something like 10 to 15% of adults, depending on which polls you use, maybe would struggle to perform simple kinds of number manipulation or reading or writing kind of tasks, but our bar is basically moved. It used to be like, can you read it all? These tasks are maybe a little artificial. They're maybe not relevant to their day to day, and that's actually why they're experiencing this. The number of people, the fraction of the population who graduates at 17 or something, knowing a particular amount of stuff has basically moved up monotonically. And this is mostly about the bottom portion of the population. It used to be the majority were effectively uneducated past age 10 or something other than informally and in their trade. And really the story of the 20th century has been in part one of mass education. Part of why we have a service economy, an IT economy, is that basically all of our population is educated to a particular level. If you look at the national tests of fourth, eighth and 12th grade math and language proficiency, you'll see really pretty slow movement in the 75th percentile and practically none at all in recent decades. But you'll see absolutely enormous movement in the bottom quartile. And so in some sense the story, especially the last 20, 30 years, has been closing what's often called the performance of achievement gap where certain groups, part of underfunded schools, or who might have households that are unsupportive, or difficult, were just not having anything like the educational attainment of their peers. And that story has changed.

Dwarkesh Patel
One thing I'm curious about is that every other part of the distribution has been moved upwards. Has the ceiling been raised significantly?

Andy Matuschak
Depends on what we mean by the ceiling.

Dwarkesh Patel
Because you can go back like hundreds of years and the most learned people around. It's just incredible you look back on how many books Thomas Jefferson read. There's some story where Kennedy was hosting a bunch of Nobel laureates in the White House in 1963 or something. And he says, this is the greatest collection of genius and insight and wisdom that has been collected into this room ever since the time that Thomas Jefferson dined alone.

Andy Matuschak
Right. I think it's very hard to raise the ceiling. The ceiling has aristocratic tutors. The ceiling has whatever family dynamics and heritable propensities produce tremendous intellectual greatness. Early 20th century schools produced von Neumann. Right. And it's certainly not at all clear that they're now producing more von Neumanns or something like that.In fact, von Neumann's productions seem to have probably very little to do with any kind of mass schooling that we would recognize. As far as the very top, I think that's difficult. We're talking about an institution that was created for the masses. I guess there have always been people who have been using resources outside of those kinds of systems. So the mass system doesn't seem to help those people, I guess. That doesn't seem surprising.

Dwarkesh Patel
By the way, on the von Neumann thing. Okay, a mass system doesn't help them. What is the production function for a von Neumann?

Andy Matuschak
Yeah, so lots of people have studied this. I actually am not a student of Von Neumann's history. I know that many of his peers, the 20th century greats, got something like aristocratic tutoring or came from small Eastern European incredible schools that there's stories about these things. I actually don't know them. I'm sorry.

Dwarkesh Patel
I mean, I'm sure you've heard about that one high school.

Andy Matuschak
Yes. Yes.

Dwarkesh Patel
Okay, interesting. Are we getting worse at the von Neumann production or is it just static?

Andy Matuschak
Well, maybe. I don't know. So let's see. Here's the theory that seems kind of plausible. If someone was going to have aristocratic tutors in the late 19th century, would they now go to

a fancy private school and would that experience now actually be less good for them? I don't know. I think it's probably more likely that they'd go to the fancy private school and also still have fancy tutors and then go to a very exclusive university where they're going to get a bunch of highly hands-on kind of interaction with professors.

Dwarkesh Patel
Although the reason that might not be the case is the opportunity costs for people who might become teachers or aristocratic tutors is much higher now, whereas the kind of person who would be, your tutor can now directly be making lots of money on Silicon Valley or Wall Street.

Andy Matuschak
That's interesting. Okay, so that would be an argument that maybe it's not so much about the 20th century that we've gotten worse about this, but more like over history. Maybe Aristotle was a tutor to Alexander the Great, and now Aristotle would be like a full professor and wouldn't need to take that job. That might be so. It may be the case that some tutors have been priced out of the market, but it's not clear to me that the most expensive tutors actually would be the best. There is a bunch of empirical research on tutoring, and one of the questions they ask is, what kind of experience level do the tutors need to have? And it's interesting, how far you get in tutoring efficacy when the tutor doesn't necessarily know anything. Just having another warm body there actually contributes a very large effect. I mean, things get better as you get an expert. And I also have a kind of healthy skepticism of these studies. I think part of the role of having Aristotle as a tutor is communicating a worldview. It's not something that would show up on a test or something that these studies would be measuring. And so having an extremely inspiring individual might actually be the important component, and inspiring is going to be highly correlated with expensive, I think. Not necessarily, I don't know. That feels complicated.

Dwarkesh Patel
I mean, especially today, the material is available. What the tutor is bringing is the inspiration and the motivation. Not exclusively but one of the large parts.

Andy Matuschak
That's right. They're not really responsible for instruction. I'll also say that I know lots of people who have postdoc tutors right now. These people, as graduate students, they're very pleased often to have a $60 an hour tutoring kind of commission. And that's a little sad. But, you know, the pool of available postdocs to hire as tutors is very large now compared to how it would have been 100 years ago. The pool being bigger doesn't mean that the top 1% are getting more though. So I think that's undecided. There is a question of, have teachers gotten better at their jobs over the last 50 years? And there are some ways in which maybe they have. There's been a bunch of projects of trying to disseminate certain research results, ways of instruction that are more effective in other ways. For instance it's better to

interleave stuff than doing blocked units where it's like, "Okay, like, we're going to talk about the Civil War, and then we're going to talk about women's suffrage." It's somewhat far apart but it's better to kind of weave these things into each other, not just in history, but in general. So that kind of dissemination has been happening more systematically in the last few decades. I'm unaware of any kind of studies or results trying to establish anything about the efficacy of teachers now versus long ago.

Dwarkesh Patel
Well, I'm sure you've seen the claim that one of the consequences of the very unforeseen circumstance of the mid-20th century, was that one of the very few occupations an intelligent woman could pursue was teaching. And now that other options are available, which is obviously hugely good, you know, there's other competition for the same very intelligent woman.

Andy Matuschak
Oh, that's interesting. I haven't heard that claim. Yeah, I'd have to think about it. I guess it's not clear to me how much intelligence matters. If you want to think of that as some kind of separable quantity.

Dwarkesh Patel
Or whatever trade is relevant to just that. You just had a population that was hostage to either housework or teaching.

Andy Matuschak
I guess what I'm saying is something like, if that were true, and there are like a bunch of people who are now astrophysicists or something, it's not clear to me actually that they would have been good teachers. Being a good teacher is often about empathy and effective communication and care. It's very personal. It's very intimate. You need to understand the subject but to teach a 15 year old or something, you actually don't need to understand it at a postgraduate level necessarily. It's very interesting to see that there's a bunch of studies of the impact of domain knowledge on teaching efficacy. I've read some in math, I'm sure they exist in all fields. And one of the things that comes up is like, if you aren't very familiar or comfortable in math, then you will struggle specifically to do inquiry oriented classes, classes that are more about creative ways of thinking with math, or open ended problems, as opposed to like here's how to do this algorithm. Because to conduct those kinds of classes, you have to be able to think on your feet. You pose a difficult question to which there may not be just one appropriate answer and your students will throw all kinds of stuff at you. And you have to be able to take that stuff and integrate it and show how one student's answer relates to another student's answer and show how those conceptions can be built upon in order to produce some useful understanding for what you had in mind. Anyway, this kind of improvisation requires a mathematical familiarity and ability. But I don't think it requires anything like extraordinary ability.

Dwarkesh Patel
Yeah, but more than the extraordinary have been pulled out of teaching as a consequence.

Andy Matuschak
Yeah, I guess I'm just wondering what the correlation is. If it's the case that actually effective teaching is mostly about empathy, then maybe it's anti-correlated. Like the people who are going to be good particle physicists are actually like they wouldn't make good teachers anyway. Maybe.

Dwarkesh Patel
Interesting. Why hasn't hypertext changed how people write more? Often I write a blog post and I actually do wonder how much different it is with the knowledge that I can add footnotes and I can link to things. I'm actually kind of a fan of how Wikipedia organizes content. It is genuinely surprising how often the best explanation of a subject is just this resource that is trying to explain every single subject. Because there's this practice of you don't need to do exposition in every single topic. You can just hide it behind links and things like that. Anyway, so why hasn't hypertext changed online writing more?

Andy Matuschak
This is a really good question. I think the reason why Wikipedia works as well as it does is that encyclopedia entries are already forced to stand on their own. And that was true before hypertext existed. In fact, encyclopedias were already hypertext-ish before there was hypertext. There are some other interesting kinds of hypertext that existed pre-computers. There is this very interesting book called The Syntopicon from Adler. If you wanted to understand what classical authors had to say about a topic like the father's responsibility to a daughter, you can look that up in The Syntopicon and you will get references across Rousseau, through the Bible, and so on and so forth. And those are kind of hyperlinks. They were printed on dead trees, but you're expected to get the books down and look up the appropriate pages. The Syntopicon wasn't that successful. I think it's in part because those concepts, unlike the Wikipedia entries, don't quite stand on their own so cleanly. You kind of need sinews, you need linkages. And actually, I want to make the case that while Wikipedia is an astounding resource, I find it rarely to be the best available introduction or explanation of a topic. I find it often to be like a good jumping off point. It'll help me know the right thing to ask about. It's good as a reference. Hypertext is a very effective navigational aid. It can help you get to a spot that you're looking for very quickly because it's about automating flipping through pages. And so for a reference, it's very effective. If what you have is a book of chemical compounds and their properties, hypertext is going to let you navigate that book very effectively. Likewise, dictionaries have been revolutionized by hypertext. Navigating around the sources by clicking on links to say like, “Oh, shade it a little bit more like that.” It's like a much better thesaurus. I guess I'm making the case that there are certain kinds of texts that are more amenable to hypertext, because they are more amenable to having the reader dropped in the middle of them. Encyclopedias are like that,

dictionaries are like that. Most texts are not like that and most concepts are not like that. I guess most ideas are embedded in something kind of holistic or richer. They require a narrative arc. They're difficult to excerpt. Not everything, but things that are not so raw and atomically informational. There were all these dreams of hypertext novels, for instance, and some people wrote them. And one of the problems that a hypertext novel has, and it actually can be seen in a choose your own adventure book that existed before there was digital hypertext, that the author is forced to write something like a lowest common denominator story, the page that is the destination of a hyperlink, it has to work as the endpoint of all of its reference. And so it can't establish any kind of coherent or consistent arc, unless there's a kind of sameness to all of the reference. And the more that there's sameness to the reference, the less useful hypertext is. So a lot of people have been disappointed by this conclusion. I, among them. I'll say that I do find hypertext very useful in my own notes, not really for reading. I actually don't think it makes for a very good reading experience for others.

Dwarkesh Patel
Having been a reader, you have a separate webpage where you have your working notes. It is a very cool UI to explore your thoughts.

Andy Matuschak
Thanks. It does an interesting thing for me as a writer. It lets me build stuff up over time. Today, I was reading this very old cognitive psychology paper on the topic of adjunct questions, which we discussed earlier, the effects of asking questions while you read, not on remembering the information covered in the questions, but on the general effect it has on stuff that isn't touched by the questions. I have some notes on the design decisions of the mnemonic medium, this Quantum Country thing that I was talking about earlier, interleaving the questions into the text. Those notes are kind of partial. They evolve over time. What was the impact of doing this? My notes about that, they've come from interviews with readers. They expand when I read a paper that's relevant to them. It means that when I go to design the next system, and I'm thinking about the role of questions in text, I'll have a place to look. The role of hypertext is roughly a navigational aid. It's possible to do this without hypertext. You'd just end up with what Neumann had, a giant dresser-like thing, but made of card files rather than drawers for clothing.

Dwarkesh Patel
This actually goes back nicely to the original conversation we had about why people like Tyler are able to integrate so much information without an explicit note-taking system. Another person who comes to mind immediately is Byrne Hobart. Again, you have an example of somebody who is extremely prolific and writes a tremendously detailed and insightful daily financial newsletter. It's a daily note-taking practice in some sense.

Andy Matuschak
Nothing quite accumulates for either of them, at least not in the same way. It's very interesting. They're doing the whole thing over again every day. One thing I find interesting about Levine's newsletter is that when he's talking about a topic repeatedly, like the recent bank collapse or something, he will have to explain some concept like interest rate risk over and over again for days. Every day he has to explain it, but every day he explains it anew, and every day the explanation is colored a little bit by that day.

This is an argument against the kind of note-taking that I do. It's an argument for ephemerality, for recreating the thing every day, because it will change and it will become inflected by what you're thinking about and your experiences. It's pretty interesting. I find myself doing a mix these days. I have a journal that's about today, and I'll do a bunch of writing. Often I'm recapitulating stuff I've written before, and I have other things that are trying to be more durable, and be a useful reference that can stand outside of time. The combination feels useful. I don't yet have a clearer model of when one is better than the other.

Dwarkesh Patel
An interesting way to tie in what you just said with the hypertext: Byrne's newsletter doesn't give that much context. Often you'll find yourself lost about the concept being talked about if you're not familiar with the topic. I asked him at some point, have you considered doing narrations of your blog post? Scott Alexander has somebody who has a podcast where they narrate his blog posts. He said, "I don't think it would work out as well for mine, because I heavily rely on the old blogosphere's norms around hypertext, where you can add jokes and sarcasm." One example of this is his write up about SBF and his collapse. It has a bunch of links - if you want to learn more about margin calls, read this. And he goes, and if you want to learn more about the psychology of utilitarian bets, read this, and it's just a link to the Amazon page of Crime and Punishment. That kind of stuff is harder to do.

Andy Matuschak
Yeah, you're right. He's leaning more on his past explanations, which is interesting, because he can't update them. That format of writing a newsletter and then linking it to past newsletters, or as you say, the former blogosphere thing to do, you have a series of six words and each word is linked to a previous post on the topic. I certainly have written stuff like that. It's kind of funny. It's approximating the durable note thing I was writing about, but without the ability to revise it over time. Maybe for many topics, you don't need that ability. I wonder now what fraction of my notes are in the state they were when I did my first major revision of them. It's probably at least a third, it might be more than half.

Dwarkesh Patel
What percentage of notes have you published?

Andy Matuschak
By word count? By note? I don't know. For instance, my journal notes are not published. There's one of those every day so there's a lot of them. If we're looking by note, we're excluding all of those. I also have a note about all of the people in my life and those are not public, unless they're public individuals. There's a lot of notes that are not public, but they're mostly not durable. They wouldn't be all that meaningful to others. The journals might be, but they're also intimate.

Dwarkesh Patel
Are they written in a way that would be intelligible to somebody else?

Andy Matuschak
It depends. Usually my journals are complete sentences, complete paragraphs. Sometimes bullets, sometimes veering and breaking and changing to new subjects suddenly. They tend to be filled with links to the things that I'm talking about, in part because I'm trying to accumulate context in those things.

Dwarkesh Patel
How come they're not just shorthand?

Andy Matuschak
It's partially because past me is another person, it's kind of a cliche. I am routinely looking at journal entries from a year ago. You could view that as a failure of this note writing system. In some ideal sense, I shouldn't be looking at these journal entries, because if something's important, and it's going to be something I refer to a year later, it should be in some durable evergreen note. I don't know. You don't always want to do that. It feels like prepping. Maybe there's an amount of prepping that's good. We live in California and maybe everybody should have an earthquake kit. Maybe that's good, but maybe you don't need to hoard 300 cans of beans. There's an amount of prepping that feels like a reasonable amount to do and there's an amount that feels kind of dutiful and unpleasant.

Dwarkesh Patel
As a researcher, who is in the Silicon Valley circles, what is your opinion on the startup advice “Do things fast. Fail fast. Get to users immediately with an MVP.”? As somebody who is making products, but is also in a different mode than a typical startup, how do you think about advice like that?

Andy Matuschak
I have complicated feelings about this. I need different advice on different days. Of course, different people need different advice on different days. When I was getting into this kind of work, what that advice led me to do is to not think all that deeply about the ideas I was exploring. An idea would come up and I’d think, “Oh, I can try that.” I would try that, then I'd

learn something, and then I'd repeat. There wasn't this sense of building a theory of what the problem is and what it would mean to solve it. Instead, it was just a theory of action. A theory of action as opposed to a theory of change is, imagine you're in your current position, and eventually want to get to some goal state, a theory of action is you look around you and you say, "Well, what can I do? What can I build? What do I see as possible?".

A theory of change is to look at the endpoint to try to work backwards. The metaphor is imperfect because in research, you don't exactly know what the endpoint is and you certainly don't know how to work backwards. I guess what I'm saying is that following that advice historically has led me to try things that were straightforward. The most powerful design work has ideas in it. What makes a nonlinear text editor, the text editors that we all know and love, so powerful is this observation that writing is a nonlinear process, but writing with a pen linearizes it. Many, many other observations like that and on the nature of what it means to have a thinking environment is how we got that particular interface. Likewise, the way that we got powerful programming environments is by people thinking very hard about what it means to specify a system and coming up with new primitives that express those ideas.

The most powerful interfaces are often the expression of new ideas or new primitives that capture new ways of doing, new kinds of objects that can be manipulated. In Photoshop, for instance, you can manipulate a photo by means of a construct called a layer. This is a very strange idea. It has some precedent in dark rooms where you could potentially have sheets of film. I don't mean the negatives, I mean sheets of gels that you could potentially put over lights to affect the exposure - to make there be more exposure here and less there. But in Photoshop, they're non-destructive and they're continuously manipulatable. The layer is like a new primitive that is introduced into the activity of photo editing. It utterly changed what you could do in photo editing.

What I'm saying in a very long-winded and confused way is that it's difficult to have ideas by means of building an MVP very rapidly. Now, if you have an idea that you think is interesting, it is good to test it rapidly. Part of why I'm confused in my response here is that it's good advice once you have something worth testing. For me, adopting that mindset, and I've lived in it for so long that it's very ingrained in me, it makes me not sit in stillness and in confusion and in contemplation with the ideas long enough for them to be good. Michael Nielsen and I made Quantum Country and when I was trying to think about what to do next, the most obvious or natural idea was "What if we just tried that with lots of other things?".

That idea occurred to me and the pandemic had just struck, so I was feeling a little timid, creatively or emotionally. I wanted something that felt safe and I knew I could do that. I can build a platform that generalizes this thing that we did for this textbook. So I did. And I did it relatively quickly. I did it in a few months. And that wasn't the right thing to do. It wasn't really the right question to be asking. The idea wasn't that strong. Building this highly

general version of it wasn't the right way to test it. I would have been better building more one-offs rather than a self-serve thing that anyone could use. And this comes down to the difference in aim. I'm not trying to build some kind of scalable thing for the world at this moment. I'm trying to build the idea. The prototype is an expression of the idea. Once it arrives at a good place, then maybe there can be some scalable solution. But it's not necessarily at that place. Until it's at that place, there's a lot of thinking and sketching that goes along with the building and prototyping. Part of my confusion here is that often I still need to hear this advice. Often I will just tie myself in knots in theory land. What I really need to do is to have a friend sit me down and say, "Is there a piece of this that you can carve off and build next week?" So you're hearing a lot of tension.

Dwarkesh Patel
Interesting. What was the consequence of shipping Orbit out before it felt ready to scale?

Andy Matuschak
I mean, I learned some things. It was fine. It taught me a lot about where that particular format succeeds and fails in other venues. It was just not a very effective way to find those things out. It was an MVP in the sense that it has very few features and it's very simple. But it was highly general. It's a deployed thing that has infrastructure and has accounts, it has all this stuff that you do when you're building a real thing. That's very different from, "Let me work with this one author and see if I can make it work with this one other book that's very different from Quantum Country to form a specific question or specific theory about, it worked for this text, what's the next kind of text that would be good to test with?". I certainly could have done it much more rapidly.

Dwarkesh Patel
Why do you think that this idea of tools of thought has nerd sniped so many people in Silicon Valley?

Andy Matuschak
It contains this message for technologists that they can potentially be very powerful. That's always tantalizing for people. It also feels very actionable for people in a way that's super misleading. I meet tons and tons of people who tell me that they're interested in tools for thought and 95 plus percent of them are engineers. The problem with this is that building an interesting tool for thought is basically entirely a design problem. Their design ideas are usually not very good, or troubled in a variety of ways. Yet, they can make a thing that solves a problem for them in their lives. That feels very tantalizing or encouraging. It feels like something to get their hands around.

We in Silicon Valley are very, very interested in thought. We are thinking people. People are very interested and engaged with anything that can potentially expand our capacity. That too is tantalizing. What if I could think better? It's also tantalizing because it's meta. There's

all these cliches about people tinkering with their dot files endlessly or tinkering with their blog website, which has two posts on it, but they have to rewrite it because they want to do something else. The new one will have three posts on it before they rewrite it again. Tools for thought also scratch that itch. It's work about the work. This sounds very cynical, by the way. I don't mean for it to be, I'm just trying to earnestly answer the question.

Here's a more optimistic and generous response. Many of us got into computing because computers portray a sense of personal empowerment and possibility. We remember growing up, being locked in our bedrooms at midnight, fooling around. We have this very powerful tool at our disposal and it's opening up these worlds for us. For many people here, that was a formative part of their personal development. Anybody pointing to that and saying we can do more stuff like that is going to be pretty compelling.

Dwarkesh Patel
This was an interesting question from Matt Clancy on Twitter - what are the characteristics of a good crowdfunded research project?

Andy Matuschak
One of the unfortunate things that I've learned in my crowdfunding experience is that there are some dynamics that seem hard to change. One of them is churn rate. Any subscription revenue business model - that's what I have - you lose subscribers every month. In my case, it's about 2%. It's not that large, but it does mean that I need a certain number of new subscribers all the time. One thing I've learned is that the churn rate is surprisingly insensitive to anything I do. I experiment with a variety of things and it hasn't meaningfully changed the churn rate. What does change things is getting more people into the top of the funnel, in other words, marketing. There are some things that have affected the fraction of those people in the top of the funnel who convert. I really hate this way of thinking about it.

In summary, the thing that I've discovered that's sad is that I ended up having to think about this a little bit. I realize that this crowdfunding project only even slightly works, because it's understandable and interesting to others. It's already in a place where there's some results that look promising. It's very easy to imagine other projects that are not broadly applicable. If I were doing marine geology stuff, I probably wouldn't have a big crowd of internet people, not nearly as large or excited. That's one property - this work is very general. It applies to many, many people. It applies to people who have disposable income. If I were doing a research project on writing practices of disadvantaged artists, my audience might not have as much disposable income.

I have already made some progress. That's important. Unfortunately it's probably very difficult to use crowdfunding in the very early days of a research project. I've already chosen a research agenda or direction, and I can express it. Crowdfunding probably applies after the first few stages of research have been completed. There's probably standard grant

advice, where at some point, I'm going to be using this crowdfunding to figure out the next thing, and I won't be able to explain it to anybody. There certainly are seedlings, but you have to have something in flight. I need to be able to say something about my progress with some kind of regularity.

For instance, my wife is working on this study of biological markers of age in association with delirium and traumatic brain injury. To do this, she is signing up patients who show up to the hospital with traumatic brain injury. Once they agree to participate in the study, they agree with the taking of various blood samples and things like that. Recruiting enough patients to get the significance that she requires will take two years or something like this. She can report a little bit of intermediate stuff, but certainly not a monthly update. Right?

Dwarkesh Patel
Yeah, that would be a weird Patreon post.

Andy Matuschak
Yeah, I can't quite report monthly updates either, but there's a cadence that's necessary.

Dwarkesh Patel
Why bother with it at all? I'm sure there's many wealthy individuals who would be happy to single-handedly fund your research. Is there a reason you chose crowdfunding?

Andy Matuschak
Those wealthy individuals are very welcome to reach out and offer to do so. I will say I've been fortunate to have many high net worth individuals as sponsors, but each of them is providing a sponsorship of $100 a month on my Patreon. That is what I get from these people. I'm certainly not getting wild offers for more.

Dwarkesh Patel
I think you're using the wrong tool given the wealth distribution of your audience.

Andy Matuschak
Maybe. There's a couple of ways to interpret your question. One question is, why crowdfund when I could appeal to high net worth individuals? Another version is why crowdfund at all, as opposed to raising grants or talking to philanthropies? Are you mostly focused on the first of those?

Dwarkesh Patel
Yes.

Andy Matuschak
If I'm going to be honest, it's because it has worked. The history of the crowdfunding of this project, like many things in my life, is the result of goading from Michael Nielsen. Early on when we were working on this Quantum Country project, he suggested we set this up and I hemmed and hawed and said, "Yeah, it's going to be a distraction. We don't really need this right now. Let's deal with it later when we have something to show." He's like, "No, no, no, let's just get it started. It's going to take a long time to get enough subscribers." It turned out he was right. The process of building a subscriber base and crowdfunding a project takes a couple of years, at least in my experience. Starting earlier was better.

If that hadn't worked or if we hadn't started early, I probably would have just reached out and asked for individual help and I probably will if it fails on me. I'll say also, when there have been specific projects that I've wanted to do that require, say, hiring people, I have reached out to high net worth friends and they've helped, but in the low five figure, four figure range. And that's great and I'm very grateful. The answer may be a mix. One of the big limitations to crowdfunding is it can't sustain a team or institution. It can barely sustain me. I'm somewhere between a grad student and a junior faculty member. And that's okay. There's a variety of reasons why that's okay for me that are pretty particular to my circumstance, but it certainly wouldn't be okay for everybody. Even for me, it doesn't allow me to support others.

Dwarkesh Patel
Right. It's even more striking because you're pretty well known, especially amongst the audience that would be happy to fund this kind of work. If the LeBron James of independent public research is earning between a grad student and a junior faculty member, it's not a great sign.

Andy Matuschak
It's worth considering that I'm maybe not very good at this. First off, I'm not that successful as a researcher. I object to the LeBron James characterization. It's true that I'm maybe the most successful crowdfunded researcher in tech stuff, and that's kind of weird. In the last couple of years, I've figured some stuff out, but I wouldn't say I've had any spectacular hit publications.

One thing that is true of this is that when I have big publications, I get a lot of new subscribers. There is some kind of market force that could be higher if I were having more spectacular success with my research. It's also true that I systematically avoid marketing it. That's a self-protection thing. I am really worried about the corrosive influence of audience and marketing on honest inquiry. It is very easy to distort my work. It's almost a default to try to make it be something that people would be more likely to like rather than the thing that I actually want to investigate, or to do the boring simple version of it rather than the interesting deep version so I can publish more stuff more often.

One thing that I've chosen not to do, and it's a choice that's definitely cost me financially, is to publish what academics would call minimum viable units of paper. They have a pithier phrase than that. Minimum viable papers. It's very common to take any new marginal insight that is above a particular bar and publish that. I just haven't done that. I've written informal letters to my patrons, "Hey, I figured this thing out this month." If I were an academic, I would have published that as a paper. If I were a marketing-oriented crowdfunded researcher, I would have done some glossy thing and promoted it "Look at this thing I figured out." But actually, I just don't think it's that big a deal and I'd rather get on to the next thing. I have that choice of waiting to publish. That's not really what I'm worried about. Really what I'm worried about is marketing, man. Marketing. It makes it so hard to be honest with oneself, at least in my experience. Not only to be honest, with what I think is interesting and important, but even to be honest about the results. Every paper is, in some sense, a little marketing piece trying to make the case that it's significant, that its results are really exciting, really important. That is really corrosive to discovery. It's true that you need a really strong emotional connection to the work in order to do good work. Part of that emotional connection comes from a sense of excitement of maybe being hot on the tail of something really good. There's a temptation to portray what you found in the best possible light, to downplay its limitations, to take up space and to totalize. All of this is just death for discovery.

Dwarkesh Patel
It is interesting to hear that from somebody who inadvertently and without intentionally trying to do so has done a good job of spreading your material. I've known about you for a long time. I do wonder if there's an element of, if you get to a certain level of quality, trying to market your stuff, not only doesn't help, but probably hurts you. If you can try to think of somebody like Gwern trying to post YouTube shorts of his blog post, it would just be like, "What are you doing, man?" It's just so good that he doesn't need to promote it.

Andy Matuschak
Gwern is an interesting example because there's a simpler failure mode. I still routinely run into people who will tell me, "Oh, I've really liked your work for a while. I didn't know you had a Patreon." That's a simple failure of a certain kind of marketing on my part. Gwern actually has this even worse. I adore Gwern. I have learned so much from him. You can go to his Patreon page and he actually makes public his revenue. He makes a tiny fraction of what I do on Patreon. I think this is inappropriate. Gwern is a much more impactful researcher than I am and he has a much bigger audience than I do. The fact that they aren't converting into patrons is mostly a matter of the way that he talks about it and the way that he presents it. It's not that he needs to market more people to his webpage. I expect he has plenty of traffic and a large audience. It's much larger than mine. There are a bunch of variables about the way you talk about this membership offering. None of us really want to think about them. I've ended up at a slightly more effective part of the space, but I'm pretty sure that there's much more effective ways to do whatever it is I'm doing.

Dwarkesh Patel
Yeah, this is a really interesting problem because I have a Substack where if people choose, they can help contribute to the podcast. It's a broad enough revenue to help pay for certain episodes and traveling. However, in comparison to what I'll be making now that I'm going to be doing ads, it's a small fraction. Some people might say "It's unfortunate that you have to do ads" and maybe listeners will just be finding out for the first time that there was an option on Substack. But you don't want to be in the position where you're asking listeners for money every episode, right?

Andy Matuschak
Yeah, I hate asking people for money. This is a common issue for creative people. I hate it. I really hate it. I probably need to get over this. I do want to make one point, though. I had much more success with my Patreon when I recast it as, "Oh, please subscribe to support my work", like the thing you were describing, to an offering to become a member. "When you become a member, these things will happen." These things need not be terribly substantial necessarily. There's a difference between a tip jar and a membership in people's minds. Becoming a member means something. If you could offer something small, that feels membership-ish, you might get very different results. Gwern has the kind of tip jar vibe. These days, I have a member vibe. My instinct is that if you were to move to "Become a member of Gwern's lab", he would have better results.

Dwarkesh Patel
He has a thing on Patreon where if you donate five bucks or eight bucks, he'll read an entire book and review it.

Andy Matuschak
Yeah, this is crazy. I don't know if anybody's ever taken him up on this.

Dwarkesh Patel
Yeah. That's like valuing his time at a dollar.

Andy Matuschak
Yeah, I don't quite understand this. It's also the case that you'd probably have an easier time asking for subscriptions if you had a larger audience first. You can build the audience for free and then have some bonus offering behind a wall. I feel very conflicted about this actually, maybe you can help me think about it.

I have all these patron essays. It's where most of my writing is these days, because I'm waiting until I can collect enough things for the next big public piece. I have a couple of big public pieces in various stages of flight. I'm writing a lot for patrons and probably much of my audience or people out there don't even know that it exists. One challenge of member only content is even making clear to others that it's there. Often people will try to achieve

this by tweeting or sending newsletters out about this subscriber only content. I just can't bring myself to do it. It feels terrible to say, "Oh, here's a link, but you can't view it." I can't do it. I don't know how you think about this, or if you think about subscriber only material for Lunar Society.

Dwarkesh Patel
I was actually just about to mention this to you. I'm a patron and I got a chance to read all your patron only essays, and they're great. I was thinking while I was reading them that it's really unfortunate that a person might not know they exist. If they're not familiar enough with your work to go ahead and sign up, it's just behind the Patreon. It's a shame that one of the ways to fund public work is to make some of that work less public.

Andy Matuschak
There are better ways to do this. There are design solutions. For instance, if it were the case that my work was mostly all in one place rather than separate places, and the subset of the work that's public was visually and structurally adjacent to the subset of the work that's private, it would be clear that there's additional stuff that's available. Perhaps you can see the first bit of it – Substack has this to get some sense of what it is that you'd be seeing. I've invested like zero effort into figuring out an appropriate presentation of this stuff.

Dwarkesh Patel
Right. Another thing to consider is that a big part of the impact of your writing work is how many people actually consume it. The expected value of that is dominated by the probability it goes viral. For example, you had this really insightful post based on your experience in industry at Apple about the possibilities of Vision Pro and in what ways it's living up to and not. I think that would have just gone huge.

Andy Matuschak
Oh, thanks. I did make it public. I put it on Twitter and it was on the front page of Hacker News. I think you're right. Usually I don't want this stuff to go viral. The primary value that most of it has for people is opening up a window into a particular very unusual kind of creative work that they don't normally get to see the behind the scenes of. And most of it is kind of context laden. It's not really freestanding. And I don't really want to write it as if it could be freestanding. I've occasionally had the experience of one of these things getting widely distributed and then getting all these comments of people being angrily confused about what I'm even talking about. That's kind of discouraging. All of this to say when I want to write something for broad public consumption, I write something for broad public consumption.

Dwarkesh Patel
Okay, I've got some questions from Twitter.

Andy Matuschak
Okay, bring it on Twitter.

Dwarkesh Patel
This is another question from Matt Clancy. Are there other examples of beneficial knowledge work practices that perhaps mostly work because they are former spaced repetition practice where the participants don't realize it?

Andy Matuschak
This is embedded in our working world. For a researcher, when you need to write papers regularly and you're writing those background sections, you're repeatedly explaining the history of a particular line of research and citing the appropriate sources. That is a kind of spaced repetition. When you have students and you're mentoring them in conversation "Oh, in this kind of situation, you really need to remember to do x". That is a kind of spaced repetition. All this is kind of accidental. The doctors have rounds - even when they're not seeing patients regularly, they're still exposed to other patients. There's often a structure in this where while the patient is being presented, you're supposed to be trying to think of what to ask. "What would my differential be?" Before you hear it, there's covert retrieval happening. It's everywhere in our world. It's spaced, and it's repeated.

The thing that differentiates the formal practice that I've been exploring is that it focuses on material that you wouldn't normally have repeated either because you're too early with it to have a consistent practice, or because it's just not firmly tethered enough in anything in your life.

Dwarkesh Patel
This is a question from Ian Vanagas. "What is the optimal amount of effort that should go into a personal website?" I think he might have noticed the amount of CSS that exists on andymatuschak.org, which is very beautiful.

Andy Matuschak
I don't like it. But this is what everybody says about their website, right? It's three years old, that means I want to redesign it, but I will not allow myself to because it feels like a distraction. What's the right amount of effort? There's no general answer to that question. Of course, that's going to be my answer but what can I say about it? What's the job of the website? What's it trying to do? Many people, especially engineers, do themselves a disservice by fretting over their websites unnecessarily, building vast technical infrastructure when really what they want is a place to post markdown files. They're better off getting a ghost installation. The main thing to think about is what is it that you want to put out in the world? What is the ideal form of that thing? And to try to find some way of organizing and expressing that.

We have these common patterns, like a blog or a portfolio. Often people end up forcing themselves into these patterns. People will end up using blogging software to make something that's durable. Very interesting personal websites often come from people who are thinking about that question – the shape of the thing that they want to put out into the world and making something that speaks to it. Often, once you understand the shape of making the thing, it's not that effortful. My website was not an enormous project for me, probably should have been a slightly larger one, given that my income depends on people coming through it.

Dwarkesh Patel
The working notes with the...?

Andy Matuschak
That was a weekend.

Dwarkesh Patel
Really?

Andy Matuschak
Yeah, I feel bad about it because it's made its way into tons of commercial projects now. People are like, "Ah, this is the way to present network notes". I think it's not very good in a variety of ways. I spent like a couple days on it.

Dwarkesh Patel
Wow. Because I thought this is where the question was alluding to – you must have spent months on this.

Andy Matuschak
Nope. It is a little bit like the thing about the mechanic hitting one thing and knowing the thing. I have design intuitions that led me in a particular direction. But there's lots of things I don't like about it. I just haven't allowed myself to spend any more time on it because I just don't think it's important enough.

Dwarkesh Patel
I have a question about your time at Apple before I ask the final Twitter question. Everybody has an iPhone and from the outside, there must be so many different tradeoffs and constraints when a thing like this is being designed. What is the supply of certain components and the cost? What do different consumers want? What features is the R&D team ready to put forward? At your time at Apple, you were responsible for a lot of these cornerstone design features. How is all that information integrated – taking all of these constraints into account and deciding that this is the design? How does that happen?

Andy Matuschak
It's very compartmentalized. None of what you just said was relevant to me. It was all pre-specified. At Apple, you have a little domain that's your own, and the boundaries of that domain are determined by everybody else's little domain. There's a person who's responsible for thermals. Actually, there's a team that's responsible for thermals, and they figure out things like "What is our thermal budget? How much can we have the CPU on and during what kinds of working situations?" I can't argue with that. Those are just my constraints.

Dwarkesh Patel
But aren't those constraints informed by different problems?

Andy Matuschak
It is iterative. We'll run into stuff where there's a thing we really want to do, but we can't pull it off, because it drains too much power. So Hey Siri is an interesting example. To be able to activate a voice command at any time without interacting with the device is great. People prototype that just like having a thing listening in the background and watching for it. But that requires having the main CPU on all the time, processing audio buffers. You simply can't do that – it drains the battery. That attempt led to eventually having this dedicated co-processor that runs at a lower power that's very limited and restricted and it can be on when the main CPU is not on, and it can listen for that sound.

Dwarkesh Patel
Is there a person whose job it is to take all things into account? "I have decided, given the memos from everybody, that thermals, you guys need to work on this, you guys work on that?".

Andy Matuschak
Not exactly. It's a little more push and pull. Some of a team's priorities will be internally determined. The thermals team has its hobby horses, and it knows what it thinks is important. Some of them will be externally determined. There is an executive team that makes ultimate decisions about the main priorities for next year's devices. "Ah, next year, we're going to do this face ID thing to unlock the phone and we're not going to have a home button." If you want to not have the home button, and you want to have the screen go edge to edge, it has all of these impacts like top to bottom on the device. That decision creates lots of necessary work for lots of teams.

Some stuff is kind of handled at a more local level. For instance, the director of iOS apps might decide, we have this problem because the apps were built at the same time as the system frameworks, we end up building our apps using this weird Frankenstein, partially internal framework, partially the public one that our developers use. The internal one is always a little bit different and it's not always maintained reliably. So we have all these

problems about the skew between the two. A big priority for us is going to be to rewrite all the pieces of our apps to only use the public bits so that they could be distributed on the App Store.That's a more local decision rather than at a top level executive team.

Dwarkesh Patel
What I find really interesting about this is that it's possible for a $2 trillion company to integrate all this information to have a cohesive hierarchy where so many different products, so many different trade offs are being made. Does that make you think that over time, these very well functioning tech firms will get bigger and bigger, that they can actually handle the cost of having this much overhead?

Andy Matuschak
Let me first just respond to this observation about the enormity of the company and then we'll talk about the other firms. The reason Apple is able to do this is because of the way they delegate. While there is a very strong command and control structure, and important decisions are made by a small group of people at the top, the individual leaders in various areas at all levels of hierarchy have an enormous amount of latitude. That's the only way that any of this can work. Individual people are given very, very strong responsibility and authority within domains to make decisions. That's how you can have all of these disparate products.

Craig Federighi is head of software at Apple. What does that mean? How can you be head of software? How many platforms do they have? iOS, iPadOS, WatchOS, VisionOS, MacOS. There's also an operating system running in a bunch of the little chips in the cables. All of that is under Craig. What does that mean? In practice, what it means is that there is a set of software concerns that he's super concerned with and he's thinking about day to day. When I was at Apple, I had Craig Federighi in my office talking about gesture-recognizer heuristics with me, because that was something that was hyper salient to him. At the same time, he was basically completely ignoring 95% of software-related decisions. He just fully delegated those things to others.

There's a really interesting Harvard Business Review piece from a few years back about Apple's management structure and how they have different concentric rings of responsibility for any given leader. I don't exactly remember the breakdown, but say there will be 5% of things that you're responsible for – that you have your hands on at all times and you are directly manipulating, controlling. There's a ring outside of that, that's a little bit bigger. Those are the things that you're keeping an eye on. They are salient to you, you're getting reports on them, you are checking in on them, you are thinking about them, you're coming up with ideas and sending them down the chain, but you're not directly controlling them. Then there's a bunch of stuff that you've figured out how to delegate and you want to hear if there's problems. They talk about how that structure's evolved over time. It's now been eight years since I've been at Apple so I'm sure it's practically unrecognizable to me.

Dwarkesh Patel
This is a question from Bazel Halperin on Twitter. “Is the lack of spaced repetition adoption a market failure? Or is a lack of adoption efficient?”

Andy Matuschak
It's probably mostly efficient. In places where spaced repetition, as it stands without substantial novel cultural knowledge that's difficult to transmit and isolate, is valuable, we see a lot of space repetition usage. Among medical students who are highly motivated and have lots of reason to study, the material is shaped in a way that's highly amenable to spaced repetition usage, there's tons of spaced repetition usage. In fact, the med student Anki subreddit is bigger than the Anki subreddit.

Likewise, among language learners, spaced repetition in various forms is extremely common. Duolingo has spaced repetition integrated into it. Spaced repetition is naturally present in the process of immersion learning. Modern spaced repetition tools between the Leitner’s Box and Wozniak's SuperMemo, were both originally motivated by language learning. In language learning, there's a substantial market for spaced repetition. It could be used in a variety of more creative ways. For instance, Russell Simmons has pointed out to me that studying individual vocabulary words on flashcards often misses integrative opportunities. What you really want is to study lots of sentences, or possibly to build up towards that. Duolingo does something like that. People in spaced repetition for language learning subreddits mostly don't. Some of them do, it's complicated. There's edges of the market where you need early adopters to try things that have rough edges. And the early adopters sometimes get cut and bleed a little bit. That's why people aren't rushing into it.

As to why spaced repetition isn't widely used, for instance, to learn quantum physics, it's basically correctly priced. I can use spaced repetition to learn quantum physics a bit faster. It doesn't make it a fait accompli or anything like that. It's not like learning anatomy, where basically if you study the deck, you'll be done. You need some more stuff. I'm working on some of that stuff. You also need an incredible amount of very unusual knowledge that's largely tacit at the moment, in order to use it in that way. That's part of what motivated recording this other video is to show some of that in action. The fact that the market isn't acting on this thing that it can't really act on seems pretty appropriate.

Dwarkesh Patel
That's a good place to tie off that collaboration and this project. This is really interesting.

Andy Matuschak
Thank you so much.

Dwarkesh Patel
This is many hours of just insights and lots of food for thought.

Andy Matuschak
Wonderful. Thank you.

Dwarkesh Patel
Yeah, thanks for coming on.