Appendix I

Collection of Comments on Creativity

By
MIND Research Institute

Table of Contents

MIND Research Institute is a nonprofit, social impact organization committed to transforming education and closing the experience gap for all learners. MIND's flagship program, ST Math, is a PreK-8 visual instructional program that leverages the brain's innate spatial-temporal reasoning ability to solve mathematical problems. ST Math's unique, patented approach provides students with more equitable access to deep conceptual learning.

MathMINDs gives students, teachers and families a different way to experience math. Math is a global, shared, human experience—math is from everywhere, in everything, and for everyone. The more we share that universal experience together, the deeper our appreciation for math will grow.

The Tale of Two Companies

This is adapted from *Creativity and Innovation* by Mihaly Csikszentmihalyi.

Two companies, Company A and Company B, are essentially equivalent. They have the same disposal cash. They have equivalent human talent. They are the same size. They are in the same industry. They are working on the same problems. However, one company produces creative solutions. The other does not. What questions would you ask to figure out which company is producing the more creative solutions?

Chances are, you would ask something along these lines:

- Which company has better data in their field?
- Which company focuses more on research than on product marketing?
- Which company proactively seeks new, relevant, and novel ideas?
- Which company makes it easier to test, fail, and learn?
- Which company offers chances for curiosity and exploration?

The punchline here is that the company that values research enough to seek out original and pertinent ideas that can be readily tested and iterated is probably the more creative one. This is because central to any creative process is testing and iterating. We need to build a culture of expecting and desiring not being right the first time.

Creativity Is Intentional and Effortful

Using the Maker Cycle, creativity requires overt and intentional cycling. You can't just turn it on and force it in the moment. It's also important to take breaks. Sometimes the best way to cycle the engine is to take a break. Breaks and sleep, for example, are an important part of unconsciously and involuntarily consolidating ideas and making connections. Part of creativity seems to involve memory consolidation through the hippocampus that comes specifically with taking breaks from the problem.

This also contributes at least a partial answer to why taking walks can be so creativity-inducing. The walk, being only mildly strenuous, allows the brain to consolidate behind the scenes. A breath of fresh air and a change of scenery can be just enough newness or novelty that the brain is free to do its thing with a boost of new ideas. This opens the mind to make connections you may have otherwise inhibited.

Because of this, we shouldn't try to keep the RPMs on the Maker Cycle sky high all the time. Sometimes, for example, converting a test into insight is far from immediate. That insight may sometimes require data analysis or further reflection.
Creativity seems to involve three mental stages that bounce back and forth between one another.

1. Intense concentration
    a. Conscious effort, extreme struggle, unclear of what to do, sustained confusion
    b. Often prolonged, requiring we change views and challenge assumptions
2. Breaks
    a. Put it aside for a bit. Sleep, rest, talk a walk, or do something else
    b. The key is a brain break - processing without "knowing it"
    c. Boost the brain break with a dose of novelty, even in simple way (seeing something new on a walk)
3. Insight
    a. Associated with feelings of pleasure, but are often incomplete and require more conscious effort to solidify and flesh out.

This implies several components of creativity we must accept:
1. Can't just turn it on in one setting
2. Must fall out of love with the exciting idea
3. Need insight and then to flesh it out
4. Creativity takes time.

Creativity can feel very unreliable and slow. As facilitators, we must embrace this ambiguity and confusion. Creative solutions aren't a straight shot to the end zone. It can even take years to produce the level of creative output necessary to open new paths.

There are lots of types of creativity that we should celebrate when we see it. For example,

Changing our minds is creative.
Expanding our thinking is creative.
Making connections is creative.
Making breakthroughs is creative.
Breaking the status quo is creative.
Solving challenging problems is creative.

Creativity presents itself in so many forms, that it's hard to find the unifying features in them. However, in all cases, creativity relies on spinning the cycle. To do that, we need to focus on the links not the phases.

The Joy of Creativity can be Misleading

Creativity is often very joyful. The insight that comes through the creative engine often produces a feeling of pleasure. It often feels spontaneous and enjoyable. This highlights why learning, as a creative experience, can be very joyful. But the feeling can also trick us. These sparks of insight are often incomplete. It's why we often stop too soon — especially when we experience deceptive clarity. Deceptive clarity is the joyful sense of insight that we didn't earn like when a teacher explains something and it's crystal clear. You leave the room and you've lost your handle on the concept. Your clarity was deceptive. As a result, learning is fleeting. Vidoes, for example, are rife with deceptive clarity — especially when made fun by a great actor.

It's important to embrace the joy of insight and to share that joy. But those feelings do not mean that your idea is done or that creativity has already happened. It simply means that a wonderfully fulfilling moment, within the broader creative process, has happened.

The most hopeful outcome here is that we can all act creatively. It's not reserved for those with some special gift. We can all learn to do it. Creativity is rarely the work of a lone genius and virtually never the result of a single moment. The most creative achievements often stem from long term, grit-like effort in some areas over years and years. The exciting moment of insight that "came out of thin air" needs cultivation and iteration. It needs to be refined by fire. Getting the cycle spinning offers a way to do this.

Embrace those times of elated insight, enjoy them fully, then get back to work and use that excitement to fuel further iteration and refinement.

Should I Use Examples?

Iteration requires insight to attach itself to enough skills or knowledge to do something about the insight. You don't need to know it all in advance — that typically kills creativity. Creative problem-solving requires a lot of learning as you go. But it also suggests that students need some baseline set of experiences or skills to pick up on early in the process. It's hard to be creative without some sort of baseline knowledge.

One of the most common, and contentious, ways to give students some baseline understanding is through examples. Some teachers swear by them. Others swear them off completely because it produces 27 copies of the same thing.

It is true that examples can narrow a field of vision. But, they can also be excellent tools. It all depends on how they are used. Examples that reinforce assumptions tend to narrow the field of vision and we end up seeing 27 copies of the same thing. Examples that break assumptions tend to offer a sense of excitement and freedom to explore possibilities we hadn't thought of. When the latter happens, students don't want to copy. They inherently want to produce something new because they feel room to explore.

For example, if you are offering math games that feel like worksheets, calculations, and math facts and then ask students to be creative and build a math game; you'll probably get worksheets, calculations, and math facts. This is because these experiences fit within existing assumptions of what math is.

Examples are tools.Their value lies in knowing when and how to use them. They can be the right tool in a specific context or not. When deciding when and how to use examples in a PBL challenge, consider"

Does the example reinforce assumptions or define the bar that guarantees success?	Does the example break assumptions that offer freedom to creatively explore?
Does the task and example offer little room for a student to feel a sense of control to offer something unique?	Does the task and example leverage creative expression to leverage our innate desire to do something new?

Test, gain feedback, earn insight, and iterate as you run your applied learning projects so that you eventually zero in on projects and examples that answer "No" to each red question and "Yes" to each green question.

Two Types of Tests

Projects that focus on rapid iteration help take a major step towards building our students' creativity muscles. The key to rapid iteration is rapidly learning. That requires testing ideas and learning from them quickly. This all sounds very similar to the scientific method because it is.

The main difference is that in a classic scientific method project in school you test to gather data then share the results. You either conduct a test once or the same test time and again. As long as you conduct the test and share data, you pass. Testing within the context of the Maker Cycle is about testing to gain insight, then using it to refine the idea toward a goal for which success is not guaranteed.

For example:

- Scientific Method task: People say that low fat butter doesn't taste as good. Do they prefer cookie A with regular butter or cookie B with low fat butter?
- Maker Cycle task: Create a cookie recipe that doesn't use butter at all and tastes better than both cookie A and cookie B.

The primary difference between these two is what you are testing for. Are you testing for insight or testing to verify or to answer a two-option question?

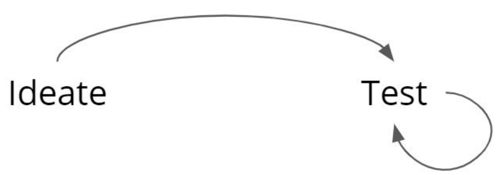
<table>
<tr><th>Test for Insight</th><th>Test to Verify or to Answer</th></tr>
<tr><td>• It's continuous, ongoing, messy, and often simple. The content should change in real-time if possible.</td><td>• A carefully crafted and executed stage on a fixed piece of content.</td></tr>
<tr><td>• The best tests provide real-time and first-hand learning. Often no data analysis necessary</td><td>• The best test provides reliable and replicable results through data.</td></tr>
<tr><td>• The goal is immediate, useful feedback that is actionable and offers quick pivots.</td><td>• The goal is careful post-test data analysis.</td></tr>
<tr><th colspan="2">Examples of Each Type</th></tr>
<tr><td>• Insight
○ Doesn't work, but why?
○ Entrepreneurs</td><td>• Empirical answer
○ Do I have the flu?
○ How "fast" is gravity?
○ Does this work reliably?</td></tr>
<tr><th colspan="2">Common Misconceptions</th></tr>
<tr><td colspan="2">1. Requires a long, initial data gathering and ideation period before you take action.
2. The research approach to testing gives me the best solution.</td></tr>
<tr><th colspan="2">Need</th></tr>
<tr><td colspan="2">1. Get testing barriers out of the way. It's better to iterate a first a first idea than to have the "best" first idea. Students need to practice testing quickly, simply, and often. Get the first idea out of the way and iterate it.

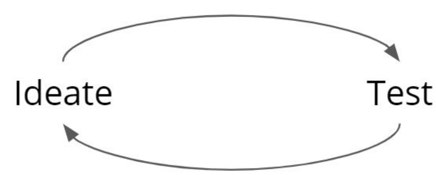
2. Test more quickly and in a way that produces insight. The research approach is great to prove robustness. But, it's often too slow to produce the rapid iteration of insight that mathematical thinking desires.</td></tr>
</table>

A major difference between these two types of tests aren't necessarily on how you test, but what you look to get out of it. In other words, sometimes insight just requires the mindset to look for it. Both tests are good. Don't pit one against the other. We need both. They each have their proper time and place.

Testing Pitfalls

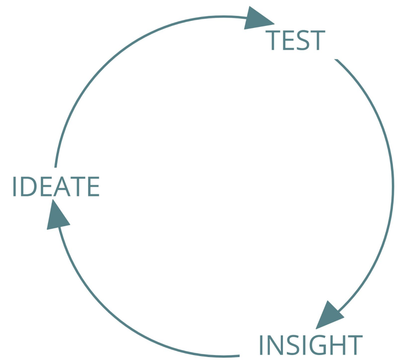
Regardless of whether you are looking for insight or verification, oftentimes people get neither and get stuck in premature loops and lose any chance for true creative output.





In this case, you ideate once — most likely in either a hurry to publish or an effort to avoid confusion. You then test and retest over and over. You keep changing the test until you find a glimmer of data that is sellable. You see this kind of thing all the time when someone is marketing their product based on this "one great study."	In this case, your idea didn't work. Without data or insight, you change your idea. This often happens when your idea didn't work and you changed everything about it. You weren't surgical in what you kept or changed. This happens when, for example, you lose your keys and have no idea where they are. Instead of testing possible locations smartly, you just come up with a possibility seemingly randomly. All the test told you was that your current idea didn't work so you try a totally new one.

By contrast, the first step in productively managing missteps is the Maker Cycle.



In this case, the test taught you something specific. You get a glimpse of what to keep and what to change, and why. You meaningfully iterate. A key aspect of going through this process is that you improve what you have instead of just replacing it entirely.

As a first step in a maker project, I like for students to cycle through the Maker Cycle at least three times. That is, they take their idea and make at least three meaningful iterations to it. One way to practice the Maker Cycle is for students to take something that already exists and, without replacing it, make it better. That is, focus on expanding or nurturing an idea rather than coming up with a fresh one.

The way to gain insight from a test is to get useful and informative feedback. Even with this insight, there's still no guarantee of re-ideation. In order for insight to manifest itself into another iteration, you must have enough baseline knowledge to know what adjustment needs to be made. You can get insight into what's working or not and why and yet have no idea what to do about it. This stops the process of actually solving the problem.

To keep it going you need more baseline knowledge. In the case of the maker projects, our baseline knowledge comes from a combination of the play stage, the Maker Story, the quizlets and the Maker Minis. We get informative feedback through having students play tests with other people in real-time and first-hand.

How to Measure Creativity

Creativity is much like RPMs. In other words, don't unnecessarily delay your progress around the cycle. If you are taking too long to test your idea, you are delaying creativity. If you are delaying the insights gained from good tests you are iterating too slowly and creativity suffers. It may take some time to gain the insights needed. That's fine. Just don't delay that moment any longer than necessary.

Creativity ~ RPMs (revolutions per minute)

The ideal RPMs vary problem to problem, and within this engine it is important to take breaks and let the problem simmer. Even engines are turned off to recharge or refuel. Human creativity is no different. You can't always spin at 7,000 RPMs like a fine tuned Ferrari. The point is that if you delay or hinder one's ability to progress around the cycle, you hinder creativity.

To pile on the good news, highly creative people aren't necessarily superbly brilliant. In fact they often mention not being the smartest in the class or cohort. But they do have an advantage: drive. They can consciously focus their attention on the task at hand with complete absorption on the task/project. They are also generally deeply curious.

Creativity is something we do,
not someone we are.

Notes on Open Problems

The real world is full of open problems. Some of them are ill-defined or outright undefined. Solving these problems requires that we first know what the problem is at its core; not its symptoms or the popular answers.

In the classroom, we often try to model this with open problems. This is a good thing. But, to implement open problems well, we want to understand their goal. The goal of open problems is to build student capacity to solve problems like they'll see in life and to encourage their development for creative thinking — divergent, novel, relevant, etc. In other words, think about a problem before you have it all figured out. You can't just google the answer.

With this goal in mind, we can analyze our implementation. I often see that many of us pose open problems, but reinforce closed thinking. Knowingly or otherwise, we push toward intellectual conformity. Intellectual conformity arises when we want others to love our idea. We hope for immediate universal applause or a "Wow, that's creative" from our teacher. Students tend to exhibit this kind of behavior when their open problem is heavily controlled with a process or a rubric.

Despite our best intentions, we don't do our students any favors when the open-ended problem has to fit within a narrow view of success. Rubrics, grades, and processes can stifle creativity.

Truly open problems don't have closed solution paths.
If they did, we'd already have the solution and it would be closed.

Students need to tackle the uncertain and unknown, finding a way to gauge success on their own. This is as important, or more so, than all other components of the projects. Students must develop their own ability to gauge progress towards or away from their goal.

The evidence is clear that truly creative ideas require us to defy the crowd, in which case we won't get the praise we initially hoped for. In fact, immediate praise is a tale-tale sign of a non-creative idea. To be creative, we must also defy ourselves. We have to feel hazy and unsure, yet push through anyway. Sometimes the most creative ideas seem bizarre, useless, or foolish — even to the one who had the idea in the first place.

Taking away these hazy moments can fight creative capacity-building. Many of our solutions to help motivate students and help them navigate larger problems — rubrics, step-by-step processes, grades, expected evaluation — tend to backfire. As a result, we avoid them entirely and instead level students through the metacognition of the creative process. This doesn't help our students.

Because of this, MathMINDs |Maker offers a series of maker challenges, without grades or rubrics, that are clear and satisfying enough that you know what success feels like but ill-defined enough that students don't know exactly what it takes to make it happen.

We are OK if a student actually moves AWAY from the goal but can quantify why and has a sense of what they might be able to do about it. At this stage, metacognition is more important than completing the challenge.

Notes on Common Maker Strategies

Many of our common maker strategies have some value, but also various pitfalls. In each case, they are tools, not a goal in and of themselves. Each of the concepts below is a tool. How we use it determines if it will be effective.

Brainstorming

Brainstorming offers the chance to generate lots of ideas, often in a group setting. It is a strategy for divergent thinking by suppressing judgement and inhibition.

Some research suggests that cognitive inhibition actually supports creative thought by weeding out irrelevant associations (10). That is, it helps avoid the trap of being stuck on an idea that is doomed. Brainstorming seems to suppress such inhibition. So while it is a tool, it's not a golden one. Creative problem-solving is about goal-directed behavior on fairly complex tasks, and often time comes with significant ambiguity. Without the ability to exercise cognitive control, our minds would go all over the place and we wouldn't make much progress. If we've brainstormed a dozen ideas, how do we choose one? How do we know if that idea is doomed?

One of the reasons for the general outpouring of support for brainstorming is in its design to boost divergent thinking (DT). That is, coming up with divergent ideas rather than being functionally fixed on a couple. And this is entirely valid. Functional fixedness is a true trap.

But, DT is not synonymous with creativity — at least not at the level it once was believed to be. Additionally, the third step in our Creativity Roadmap is specifically designed for this very moment and offers a way to be targeted and intentional in our ideation while at the same time avoiding functional fixedness.
Regardless of how many steps down the Roadmap you've gone, we can still simply measure brainstorming's impact on creativity. In brainstorming, there is no cycling. In fact, we would explicitly not cycle the idea. That hinders a student's ability to spin around the Maker Cycle and thus their creativity.

The worst possible idea cycled ten times is
more creative than brainstorming ten "great" ideas.

In particular, to act creatively, focus on nurturing and improving a single idea as opposed to generating lots of them. It's important for students to fall out of love with good ideas and in love with testing and iterating what they have.

Using the Maker Cycle as a guide, brainstorming suffers in three main ways.

- Brainstorming doesn't filter through informative feedback.
  - In fact, it seeks to intentionally delay informative feedback
- Brainstorming ideas don't run the maker cycle.
  - A cycled idea beats a good idea.
- Brainstorming in a group setting often produces mediocrity.
  - Intellectual conformity is common in a group brainstorm session.
  - The idea selected by the team is often the one with lots of praise — generally one of the least creative ones.

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An initial idea, even a "bad one," is an excellent learning opportunity. We can learn what works, what doesn't, and find clues for how to move forward. This requires going through the Maker Cycle. The more you cycle, the more creativity snowballs getting bigger and bigger as you get rolling and spinning.

Robert Sternberg, in the book *The Cambridge Handbook of Creativity,* points out that brainstorming is a tool and thus has limits:

1. Brainstorming is targeted to groups, often creativity can happen during times of isolation.
2. Brainstorming could delay valid responses to bad ideas and thus those responses may never happen.
3. Brainstorming is a strategy for searching for ideas, not for evaluating them.
4. Brainstorming isn't very specific. It basically says "come up with stuff without rules." Something more specific would be valuable.

Constraints

Constraints, namely resource constraints, are great in that they are efficient. We don't need many supplies. Teachers don't have to buy or store ungodly amounts of dice and cardboard circles. Constraints also model real-world problems such as an astronaut with limited time and supplies or buying a home with limited finances. Scarcity of resources are all around us.

The research shows that resource constraints, especially too early, aren't the right building blocks for developing our creative muscles. These types of problems come better at the end when we already have expertise. Time constraints, for example, become a high stress environment for a novice problem solver, and in exchange they tend to go with their first idea — which we now know is not very creative.

We have to build students up. Resource constraints (time or supplies) aren't always the best way. One big reason for this is that such problems feel unnatural. This tends to narrow a student's thinking.

The best way to use constraints is to broaden thinking or to offer a tantalizingly tricky challenge.

The best constraints expose thinking.
They shouldn't limit it.

We solve this by offering no supplies. The only "supply constraint" is the one you impose on yourself. We don't overtly impose a constraint — either through limited supplies or through a box of flashy and distracting supplies.

If a student needs something, she can get it or build it. She can convert an Amazon box into a game board or cut out custom-made game pieces. This solves a teacher's supply-storage problem without distracting students by some new or flashy thing and without artificially constraining resources.

Collaboration

One of the best things about human communication is that we can talk about a problem before we have the solution. Through each other, we offer informative feedback we would have missed otherwise. Iron sharpens iron.

This is one of the best uses of academic discourse. Through talking it out, we give one another informative feedback that is hard to find in other ways. We are better together than alone.

Collaboration also offers us a division of labor. Neither of us can solve any problem of value on our own. We can't do everything. We don't have the skillset for it and there's not enough time in a day. We need others. No one is an island.

But, large group collaboration often suffers to see these aspects realized. Instead, when everyone owns it, no one does. When there's too many cooks in the kitchen, nothing gets done. We can pass the blame and never take ownership. True problem-solving requires a strong sense of personal responsibility and ownership.

Too often in a group, the best ideas get shot down, the most creative ideas are almost always rejected. Especially in young people, our sense of self-worth is tied to conforming to others and having them like us. As a result, large groups tend to create group-think and produce mediocrity.

We recommend groups of no bigger than two (maybe three) in the MathMINDs | Maker projects. This allows for discourse and feedback without having too many cooks. A group of one is ok, as well, provided that (s)he tests and iterates often. Testing is inherently a social, collaborative experience.

The best collaboration is intermittent and when I have full ownership.
If everyone owns everything, we each own nothing.

Rubrics

Do you see a rubric for how to solve cancer? Do you see a rubric that guarantees we solve world hunger? Me neither. True problem-solving goes beyond the known and into the unknown. <u>Rubrics are too problem-solving as recipes are to cooking.</u> Following a step-by-step process only guarantees success if someone's already used that process with success. Recipes reproduce someone else's creativity. If we are talking about problems that have never been solved, we obviously can't do this.

Rubrics create an environment of expected, pending evaluation. Of course they do. Every certified teacher had to fill them out at some point in her education training. And we all know we can fake our way through them and get an "A". Of course we can. A rubric, by construct, tells us what a teacher wants to see.

This creates convergent thinking. I try to figure out what you want and give it to you. Evaluation of this kind is well known to degrade creative problem-solving. Breakthroughs happen when we violate the norms, the known solutions of the day, the paradigms of the moment. Rubrics train us to act the opposite.

Additionally, rubrics create a guarantee of success. Namely, do what I say and you'll be fine. You CANNOT solve a problem for which success is guaranteed. If you do so, the problem has already been solved. True problem-solving has no clear path. We must stop convincing ourselves that our students are becoming problem-solvers when they work on a project in which the teacher is the gatekeeper of success. When using rubrics in such projects we, again, degrade our students' capacity to truly solve problems.

Finally, you can't issue a rubric for a problem you haven't solved yet either. If you haven't solved it you can't make a recipe that will solve it. In any sort of PBL-like project, loosen the reins. Give students tantalizingly tricky challenges for them to work towards and let them work. If you design them well, intrinsic motivation will offer more learning than our external motivators and controls.

Oftentimes rubrics standardized the means to achieving a particular goal. While it is easy to fall into the rubric mindset, we do want them to begin to navigate the unknown and ambiguous for themselves. To build this capacity, rather than standardized the steps to success, take steps towards building a sufficient foundation and support system for students to find their own means. This is the reasoning behind our role as teachers to cultivate a culture of creativity. We own the learning environment so that the students own their creativity.

Creativity Killers

There are several known creativity killers.

- Extrinsic reasons for why to do it with no intrinsic motivation
    - Real-world, later pay off, good job
    - When the reason is extrinsic it becomes more like coercion than true motivation.
- Expected evaluation
    - this can be grades, rubrics, competition, or expert judging
- Expected reward
    - This can be external (raffle, candy) or even judging
- Intellectually conforming tasks (follow recipe, follow rubric)
    - Standardizing the solution-path takes away room for creative exploration.
- Perfectly-defined problems — like word problems we learned how to game.
- No baseline knowledge to fall back on
    - Even with feedback and insight, there's nothing we can do about it without baseline knowledge. We can get this knowledge in real-time, but experience gives us a lifelong stockpile to pull from.
- Too much over the shoulder surveillance while doing the task

- Fear or strong sense of self — afraid of rejection, tie your sense of worth to positive feedback and praise, mortified of negative feedback

A Glimpse at Step 3 in the Creativity Roadmap

To continue the engine analogy and to pick up with the earlier conversation on brainstorming, it isn't all bad, but it could use a supercharger.

The problem with brainstorming is that it stops short of overtly challenging assumptions. That's step three in the Roadmap: mathematical ideation. The way to mathematically ideate is through exposing, leveraging, and challenging assumptions.

Brainstorming is a strategy for softly challenging an assumption by not giving in to them. But you can also outright and overtly challenge an assumption and see where it takes you. Brainstorming can surely do this, but without metacognition of the larger process many fall short of actually challenging anything. Brainstorming often falls short of calling assumptions out and challenging them.

Mathematical ideation gives a related, but more refined, way to ideate — overtly challenge assumptions as a tool for ideation.

Mathematicians use this strategy in various ways. We find the smallest, simplest assumptions involved and build on them. This is precisely the kind of thinking of *Euclid's Elements* and today's high school geometry class. The waters muddy quickly if the assumptions are too big or too vague. So we strip the problem down to its essential assumptions (often called axioms) and overtly leverage them to build out extremely creative ideas.

For example, here are three assumptions (axioms). What has.

- 4 wheels
- A motor
- Is ground transportation

These examples lead us to an immediate answer of "car." Of course. But, what else fits these axioms?

Electric skateboard, ATV/quad,
go-kart, ...

Now, we've just ideated from car to electric skateboard in no time flat. This is because we didn't ideate out of thin air. This is assumptions-based ideation. We can take it one more step. Now that we know the assumptions, let's intentionally change one and see where it goes.

- NOT 4 wheels
- A motor
- Is ground transportation.

What fits these axioms? All kinds of stuff.

Trike bike, motorcycle, bus, Segway...

And my personal favorite (a kid came up with it), a moving sidewalk at an airport. Again, in a fairly short period of time, we've said that a car, an electric skateboard, and a people mover are all basically the same thing. As far as important components, they vary by how many wheels they have.

We'll expand on these principles more in the next step in the roadmap, but the results so far are clear. We can use strategies much more specific than brainstorming. By stripping to the bare essential assumptions, we get the simplest ideas possible that don't contradict one another. Then use them to ideate. Mathematics education typically waits until a student is a math major to think this way. This is a mistake.

This kind of thinking goes two ways:
1. Find the core assumption and use them to ideate.
2. Challenge an assumption and use that to get out of a rut.

The ultimate punchline is that brainstorming is a great exercise, particularly when paired with this way of thinking. Without this supercharger, brainstorming carries little horsepower. Another strategy to force students to look beyond the obvious is the use of constraints.

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