Inside Our MIND Podcast

Episode 21: Reframing Project- and Problem-Based Learning

Brian LeTendre: [00:00:02] Inside Our MIND is the flagship podcast of MIND Research Institute. We're a neuroscience, education, and social impact organization whose mission is to ensure that all students are mathematically equipped to solve the world's most challenging problems. In each episode of Inside Our MIND, we take a look at the issues and challenges facing education that we're working to address the research, technology and strategic initiatives. Welcome to Inside Our MIND.

Brian LeTendre: [00:00:44] Welcome once again to the Inside Our MIND podcast. I'm Brian LeTendre, the Director of Content and Communications here at MIND. Whether you're a new listener or you've been with us all along, we're happy to have you. You can subscribe to Inside Our MIND on iTunes, Google podcasts, Spreaker, PlayerFM, and iHeartRadio. And if you're listening to us through the embedded player on the MIND blog, remember that you can grab the RSS feed from the blog on mindresearch.org and plug that into whatever podcast app you use. Wherever you listen to us, if you enjoy the show, please rate and review it, which will help more people find us. And if you've got questions, comments, or suggested topics for future shows, you can email us feedback directly at podcasts@mindresearch.org. Today's show features another conversation with Lead Mathematician and Product Director Brandon Smith, discussing project- and problem-based learning. Brandon talks about the similarities and differences between the two, as well as some common misconceptions about them. He also provides guidance on how to get the most out of project- and problem-based learning by increasing student choice, creatively reframing problems, and adding more fun to the process. Without further ado, here is my discussion with MIND's Brandon Smith.

Brian LeTendre: [00:02:00] Well, thank you once again, Brandon, for joining me here on the podcast. How are you doing today?

Brandon Smith: [00:02:04] I'm doing great. Thanks for having me. This is great. I'm excited.

Brian LeTendre: [00:02:06] I'm excited, too, because we really are building on previous conversations that we've had as we get into today's topic. We have talked in the past about addressing the experience gap, about the types of experiences that students are having with mathematics inside the classroom, outside the classroom, and really trying to have a real impact on that. We've talked about getting students dynamically active in their learning and really taking engagement a step further and having those be experiences where they are applying the learning to something as they kind of move forward through that process. Today, we're going to be talking about project-based or problem-based learning, which is certainly, I would say, a buzz word in the sense that it is something that there are a lot of Google searches about. There's a lot of enthusiasm for getting that type of learning happening in the classroom. And so all of the things that we've talked about before kind of lead into that. So maybe a good place to start is, when you hear project-based learning or problem-based learning, where do you take that?

Brandon Smith: [00:03:12] Yeah, so if you're doing project- or problem-based learning, we often use them interchangeably. They're a little different. Problem-based learning—often it has roots in medical scenarios, and playing around with that problem and figuring out what to do. And project-based learning oftentimes has those connotations of larger projects that starts to provide images like when we were a kid doing science fair projects, but taking it a step further. But we oftentimes will bring them together. There's even conferences devoted entirely to PBL, and they will include both problem- and project-based learning. They're very closely related. And I think one of the core aspects that they have in common, is to get students to solve problems that aren't spoon fed in the sense of you don't have the algorithm necessary like in a math class or it's not a worksheet that has 20 questions to solve, that take 30 seconds or five minutes each. It's one problem that takes 30 minutes or a couple of hours or several days, sort of a longitudinal solving experience, which to me is really closely tied with creativity.

Brandon Smith: [00:04:30] And we oftentimes think, "Well, I don't have a creative bone in my body, I'm a math person. Or, I'm not a math person, I like art." And we see math and creativity is completely separated. But to me, creativity really requires that I have some sort of problem to solve. And a project is one way to provide a longitudinal problem. If you take it that way. What that means is creativity, I have to come up with a solution to the problem. And if it's a problem that I've done before, I'm not being creative, I'm just going with my automatic schemas, as we've said. I don't even know that I'm solving it. Creativity to me is very overt. I'm really trying to pay attention to solving a problem I've not done before. I have to come up with a realm relevant idea that has some bit of novelty in it. There's a certain form and function that comes in. So as soon as I think problem based or project based learning, what comes to my mind is changing our framework and understanding of what creativity really is. This take on creativity where you both have to come up with a relevant idea that works or solves some sort of problem and has novelty, is becoming increasingly documented. Some of the examples that people offer are kind of like this. Option one is: imagine you have a paper and a pencil and I give you 30 seconds to draw the first thing that comes to mind.

Brandon Smith: [00:06:00] It might be incredibly artistic if you draw well and it looks cool, and there's definitely some sense of expression. My result will probably be different than yours, but that doesn't—in the literature doesn't really count as creative yet. You need to wrap it around something where you get a sense of what success looks like. So I could say draw the best car for a family of four. Don't worry about existing laws. You're the boss. Do whatever you want. It's a car for a family of four and money is no object. I'll give you five minutes. You now can start to look at two different types of cars and be like, wow, that was really clever because I never even thought about my car being able to convert into a submarine or my car being able to fly. You could come up with so many wild things and you can begin to assess the functionality of that car. So creativity really has a bit of form and function in there. And if we want students to be creative, we need to start giving them these non-routine problems. They have hurdles to overcome, but the goal of it is still clear. And so creative problem-solving is about pushing beyond just getting an answer and pushing into that

metacognition of how do I go about something? I have no idea how to solve. Now I'm becoming incredibly creative.

Brian LeTendre: [00:07:28] And so with that approach, how do you in a classroom as a teacher, try to create the atmosphere, the environment, the opportunity for that type of creativity to occur?

Brandon Smith: [00:07:44] The million dollar question, right?

Brian LeTendre: [00:07:46] Because I'm sure everybody knows what that all sounds amazing, but like how with the time constraints that we have with the tools that we currently have. Like how how do we push on that? How do we get there?

Brandon Smith: [00:07:56] Yeah, I think there's a couple of snags that we run into. And so I'll just share three of them. And we could obviously dive in so much later. But let's just start with three. And then what we can do about them. And it'll help us whether we're doing a science project or an engineering project or using any of the other project-based learning solutions in our schools. Things to keep in mind, especially within that framework and the first one is don't get stuck on just having to be "real world." There is absolutely nothing wrong with a real world problem. Our mission is for students to be able to solve them. But we don't want to just say that it's a real world problem. Just to say it. The implementation of them matters. The big issue with implementation when it comes to real world problems, the first one for me is, solving that real world problem is about ten to one hundred or ten thousand times harder than we think it is because it wouldn't be a real world problem anymore. Right? If there was a simple solution. If there was already a simple solution we probably would have found it. And so if we make all of our projects about solving big, real world problems, we end up doing one of two things. One is we just settle using that problem for a scenario. We say we're solving the water problem. But what kids are actually doing has nothing to do with solving it, at least not in a meaningful way.

Brandon Smith: [00:09:28] Or we take superficial strategies to solve it to the point that we feel good. So we might say, we're going to solve the water problem and we want to come up with one really good solution that we pitch to our local school board and then the project is over. Sounds good. I mean, of course you want to do that. The problem you run into is when you do that, you almost guarantee success no matter what you do. As long as I finish the rubric and I give my presentation to the school board, I get my A. And when you do that, what you're saying is in a way that solving this real world problem is actually pretty easy. Yeah. I follow a rubric and I guarantee success. Creativity is incredibly risky. In other words, remove the guarantee of success. You don't have to be real world to do that. You could have many, many small problems that a student could actually solve and they could gauge whether or not they met that or not. So it can be playful. It can offer creative expression. But if you had a student, for example, create something that was actively used by another student right in front of them, you now are doing real world by creating a solution that has a real-world implication as opposed to just saying I'm solving this big grand problem. So don't be afraid to have many small and lots of problems that a student can actually solve or not. That takes away the guarantee of success.

Brian LeTendre: [00:11:07] Well, to me, as you describe that, when I think about our mission, that goes to the word "equip." And if you are creating these scenarios that have what amounts to be a simple solution, that by just going through the rubric, you can get to the end goal and feel good about that solution that you've created, then you're really not equipping students in that way to actually tackle those real world problems at the end of the day. And so it's kind of like, they don't need to solve the world's problems right now, today, in the classroom. What they need to do is build the skills that will equip them to be able to solve those problems in the real world down the road. And in the classroom, that is something that we can help through these smaller problems, that we can help through these problems that are more fun to engage with, that are going to help build those skills.

Brandon Smith: [00:11:54] Yes. Solving a challenging problem in the real world does not end when I'm finally satisfied that I made some impact. That's a step. But creativity,

especially when you're solving a problem, is gonna go beyond just "I'm excited right now." Real creativity requires me to test and iterate in an actionable and meaningful way. And sometimes the idea that I'm excited about right now is a step in the right direction, but it's just a step. And that's that second issue with a lot of the projects that I've seen is they're almost impossible to test or if they are [testable], they're slow and they're really hard to get testing.

Brandon Smith: [00:12:36] So there is the NASA design challenge, where you create a two-in-one tool. Sounds really awesome. Real world problem. Doesn't sound like a ten or a thousand times harder, but in practice, a student creates it on 3D software. Oftentimes like Autodesk, and they should be able to 3D print it. But schools don't have enough of them to 3D print. One or two of them get printed. Even if I did print the tool, I should be able to walk up to a mock example of a space station and see if my screwdriver or my hammer works. You need to be able to do an actual test, not just a theoretical "what if?" And if we're only designing until we check the box, until you feel emotionally satisfied that I did something "good," I misrepresent what problem-solving is entirely. If I never test, or I test too slowly or it's too arduous or in order to test, I have to fill out a rubric, and these are the five things...the problem is I'm now again turning this into a recipe, and creativity is about breaking out of that. So, rather than having projects that I can theoretically test or sound good to test or talk about, we want to build a desire and a way to actually test. So if you're building something, for example, for a person to actually use, I'm creating a ramp or a door, I can test that really easily. If I start to install the door, I can open it and shut it. I can create real world feedback, not just a theoretical "what if." Real problems are going to require true tests, and so whatever it is that you're working on in your project-based learning environment, you want to begin to ask yourselves, are my students testing this for real in the actual scenario? Or are we kind of softening that? Because in so many of the design processes that we follow, testing becomes down towards the end. I do all of this work and then I test.

Brandon Smith: [00:14:40] And what I'm saying is we want to be testing early and we want to create a culture of "Let's try this out and see what happens." And as long as I can fail differently next time and learn from what I want to keep and what I want to

change, then we will be making much bigger strides toward building student creative capacity, because exactly as you said, we need to be equipping students to actually solve them.

Brian LeTendre: [00:15:03] Right. And it also makes me think about the scale of problems that they're trying to solve in some of these scenarios. And instead of looking at those larger, you know, problems that are kind of disconnected from the students in whatever sort of problem they're trying to solve, maybe even looking at more immediate things that they could be developing resources for or trying to solve for. What are the problems in the classroom we're trying to solve for? What are the problems in our school here that we're trying to solve—what are the things that we can impact here, that we could develop, things that we could test right here, right now? As you mentioned, you develop something that your fellow student right next to you is immediately putting into a testing mode and being able to actually see the impact of that. And so, part of that could be identifying as a class, as a student, as a school, what are some immediate things that we can use as examples here right now in our everyday, you know, environment, in our everyday lives that can provide those opportunities to be creative and also to test and see right now, right here, how those things are having an impact.

Brandon Smith: [00:16:07] Yes. And we need to test to make sure we learn and iterate in a meaningful way. We shouldn't be testing just to verify that we already have the answer. You want to be able to have a problem that a student starts to tackle. You have a sense of what success looks like, but that success isn't guaranteed because if success is guaranteed it's not a problem. It's already been solved because no matter what I do, I'm successful at it.

Brandon Smith: [00:16:30] It has to be something that I don't necessarily or probably don't get right on my first or second or third try. But I'm iterating every time, knowing what I'm keeping and what I'm changing and why. And that's difficult to do if your testing is at the end of your design cycle and you don't get to test often enough. And that's where that whole conversation about the creative engine came into play, was bring testing in, like step two. Don't have testing at the very end. It's right away. And if a

student is still trying to figure out what it is they want to do, that's the time to test, because now I'm not so emotionally invested in my idea.

Brandon Smith: [00:17:12] As soon as you become incredibly invested in your idea, every test, all you're doing is looking to verify that you already have it. And we want students to fall out of love with great ideas and fall in love with great implementation through testing and iterating. And so, if you have any problem, whether it's a "real world" one or not, and your test is late in the game after students have already invested quite a bit of time to get to that point, or if your tests have rubrics that students are supposed to follow, you're gonna get them to comply to a process, but you're not going to get them to build creative muscle.

Brandon Smith: [00:17:50] And the third one of the three was, so often I feel like we use real-world—yes, we want students to be able to solve them, but we bring it in so early to use it as a motivator. And what happens is it starts still feel very serious and paramount because you pitch the problem like how big of a deal this is, like a national disaster. And as soon as the problem feels serious or feels paramount, what you're going to have happen—and all of us do this—is we look for the solution that avoids risk, because the scenario is too important to mess up.

Brandon Smith: [00:18:27] If you want to build creative capacity, you want to develop a student desire to take risks and to fail quickly, and to iterate and then to actually get to a point that they really complete the problem or solve it. If anything that you're doing starts to feel serious enough and you're using that as a motivator, you're going to decrease the likelihood that students are willing to take risks.

Brandon Smith: [00:18:56] The way you can get around that is to lighten the mood. So in particular, the best projects don't have grades and rubrics associated with them. Simply completing it and having somebody actually use it in front of me will be rewarding and enjoyable. There's all kinds of things that we do in life that don't have grades and rubrics, and yet students are still motivated to do them. So if the only way to motivate your students to do the project is with those formal overlays, the issue you're

going to run into is this is probably not a project worth doing. You're either going to be encouraged and to do it autonomously because it's fun and it's engaging and it's challenging and you self-selected to do it. And when that happens, you'll be encouraged to take risks or you're going to have students just comply to a recipe. And so we can't be controlling or molding creativity into a rubricked recipe, create something that's enjoyable enough that I don't need a grade to "motivate".

Brian LeTendre: [00:20:01] Yeah. And again, as I think about the implementation of that in the classroom, you're talking about things like the scale of the problem, the seriousness of the problem, the rubrics and the parameters that we put around the process. All of those things potentially derailing this project-based or problem-based learning. And so now that you've kind of hit on those things, how do we help get through those barriers?

Brandon Smith: [00:20:28] Yeah, I think one important factor or one way to do that, and we kind of do this already with some of our science fairs, is where a student gets to pick their projects. Students have things that they would love to solve or want to work on. We don't have to artificialize those. So you can give students some choice in that matter. It's going to make a huge difference. When they share the idea with you, whatever it is that they're wanting to tackle in their school or in life, make sure that it's something where it feels bite size-ish enough that they actually can assess whether or not they solve that. So, make sure that as they solve it, it's not just, oh, I got I did the project and I got it right even though it wasn't solved. It should go all the way to the point of solving it.

Brandon Smith: [00:21:14] We're doing that—which will come out later—using games and puzzles and stories where you create something for your friends to use. They're going to do it right in front of you. And now you can create little mini-maker challenges that allow you to test against that. So the use of choice, like a science fair project—a lot of schools do that in sixth grade—is really helpful. The problem that you run into with a science fair project is that students pretty much come up with one hypothesis, test it, and then they spend all of their time trying to pitch and defend their scientific process.

There was no problem to solve. You can reframe it. So rather than saying, “Does this type of butter make a cookie taste better than this type of butter?” and you're just using one recipe, you could create a problem. For example, here is a type of butter, I Can't Believe It's Not Butter!®, that maybe doesn't make the cookies taste as good by itself. But I'm going to come up with a recipe that uses that kind of butter, that people will actually like better than my original recipe. Now you have a problem to solve and I can test. I get to be really creative with the recipe that I'm going to use on coming up with a new recipe, if you will. That's so much more powerful than does this type of cookie taste better with this butter or that, because there's nothing for me to test. I'm guaranteed to be successful in that problem, simply because I answered it yes or no and I have some data.

Brandon Smith: [00:22:42] Reframing your science fair questions that students are already self-selecting to tackle, reframe it in such a way that success isn't guaranteed and they have to come up with a solution that wasn't there. You're bumping up your science fair project so much more. And that's something that a lot of schools are already doing. Just reframe it. And you make a big impact.

Brian LeTendre: [00:23:07] So, taking that choice, which is already a good thing, and then reframing it so that you have something that you can actually test...

Brandon Smith: [00:23:12] Yep, makes a big difference. And you're doing this in a lot of different types of scenarios. A lot of schools are. There's all kinds of project-based learning solutions that schools are paying attention to. Maker Education, for example, has quite a few. What we want to remember is that as we're building capacity to creatively solve problems, we're not just trying to train more STEM professionals. We're not just trying to train engineers or designers. We want to build a transferable skill to solve challenging problems. Whether you're an engineer or a designer in the STEM field in general, a politician, an investment banker, a mortgage broker, a realtor, a pastor, a nurse—whatever it is that your life's vocation has for you. Creative problem-solving will be transferable and important to all of those. There is nothing wrong with the processes that we try and get students to go through, but that still feels like a rubric. Do this, do

this, do this, do this. Those sorts of design principles are great, especially if it's already a well-known problem because usually this first step is to define the problem. Real creativity, you do define what you think the problem is. And as you're tackling it, you realize that's not even the right problem anymore. And so it's this really fast iterative cycle. We want to build student capacity to solve breakthrough problems. It's going to become more and more necessary. And in the world of automation, as computers begin to take over more and more of those routine jobs, the transferable creativity is on the rise. And it's up there as the top 21st century skill. It's staying in the very top. It hasn't gone anywhere. A lot of the other skills have been bouncing around. Some of them have dropped off the list from five years ago. And creativity with problem-solving is still up there.

Brandon Smith: [00:25:12] That means it has to be built in a transferable way, not just as an engineer or not just as a science fair project. Whatever projects you're using in your school, allow that student choice. And if you can even reframe it so that success isn't guaranteed and they have a way to test their progress quickly, it will make a big difference. Like that cookie one. I can actually create a recipe. I can cook it. Doesn't take too long. I can try it. I can figure out how to make that recipe better. And I keep testing that recipe. Make it better and better and better. Now I can test, did this new recipe actually get better reviews than the old one? And if it didn't, why not? And I can really work my way through. That is so much more impactful on a student. In order to be creative, it is absolutely necessary that you are intrinsically motivated. And so if you're doing those rubrics, students feel motivated by the external requirement to complete the rubric to get a grade because I'm being evaluated. And as soon as you do that, those are “external motivators”. It's going to kill creativity out.

Brandon Smith: [00:26:23] So if you can even get rid of those extra pieces in the rubric in your science fair and get them to do more testing and iterating, you're going to have a more meaningful learning experience in your in your school and in your classroom.

Brian LeTendre: [00:26:36] I love that because it kind of ties a nice bow on everything that we're talking about. You're taking these things that already currently exist in terms

of a more procedural way of doing things and breaking down some of those barriers, tweaking them enough so that a teacher who is doing some of those things in the classroom, a school who is already doing a science fair, can make some adjustments to what they're doing now, that will turn that into a much more creative process for students. And that is that something that can be taken into the classroom today.

Brandon Smith: [00:27:04] You can use that right now. And we're absolutely not going to leave you hanging in terms of creative problem-solving and project-based learning in mathematics. We're testing a lot of that right now. It's important for us that we don't just release something out. We are testing for effectiveness. Does student behavior actually change those sorts of things? So we're not leaving you hanging in the world of math and creative problem-solving. There's going to be some great stuff on the horizon. But what you can do in the classroom, even if you're not making new content, is right-size the problem so that it's not so paramountly large to solve—so that you can actually solve it. It's fun, it's playful, so that a student decides to do it. Student choice matters and they have a desire and a way to test it quickly. And that clear goal, that reframing of what that project is going to do makes a big difference. But it's not just about one hypothesis. Yes. This works. No, it didn't. Solve a problem and reframing it will be a really powerful way that every teacher can implement, in any project they're already doing.

Brian LeTendre: [00:28:08] Well, I once again appreciate you taking the time to sit down today and talk about something that seems like a familiar topic, but it's great to jump in and sort of give a new way of approaching it and a new way of thinking about it. Now, as you said, there will be much more to come in terms of creative problem-solving. So thanks again for your time and I can't wait to have you on again.

Brandon Smith: [00:28:25] Thanks for having me.

Brian LeTendre: [00:28:26] Thank you for listening to the Inside Our MIND podcast. You can learn more about MIND and find the show notes for this episode at mindresearch.org. You can also follow us on Twitter @MIND_research and on

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