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A Conversation about Failure
Manu Kapur, Adam Jasper, and Amy Perkins

AJ (Adam Jasper) You've said publicly that the architecture studio was a particularly interesting type of educational environment because of its ability to unify things like kinesthetic learning and humanist education.

MK (Manu Kapur) Yes, in the history of the cognitive and learning sciences, until the late 1980s, learning was understood using a computational metaphor: the mind computes things. And if you learn something, it's a change in the long-term memory. And so the whole goal of learning is to change the long-term memory, either the content or the structure of it. But over the years, this account was found to be slightly impoverished in how it explained human behavior, and there was a turn toward the situated view of cognition. If you're learning anything, it gets situated in the kinds of doings you're engaged in; it could be just listening, thinking about something, building something, solving problems, taking notes, or collaborating with somebody. The point is that we act in the world, and we learn through that action.

If what we learn is deeply coupled with the way we learn, when you move into another context where some other kinds of doings are required, you find that even though, from a cognitive standpoint, you have the knowledge and the skills, you're not able to use them. There are many accounts where people demonstrably have the knowledge but can't use it because of this coupling. In traditional schooling people learn a lot of content, but the moment they're thrown into real-world situations they find themselves unable to act in ways that would be seen as competent in any sense.

And so why does this happen? The cognitive account was not able to explain these findings. Situated learning explains that the reason they're not able to act is because the kinds of doings that go on in schools are not the kinds of doings that they need to use the knowledge in.

There followed a conversation around how we then design educational practices and environments so that there is a greater alignment between the doings in education and the doings that people are going to be using. It doesn't have to be a full overlap, but at least if there's an overlap there's a bridge by which one could start to translate or transfer what they've learned in school into action.

Architectural studios were studied as an excellent example of where people are in the moment of doing things, and this doing is multidimensional and complex enough that you can cue and retrieve that information later on. Here the dichotomy

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at the heart of traditional didactic instruction—first you learn the knowledge, then you go and apply it—is completely collapsed.

AJ Is there a classic example of the opposite, of a profession or of a field of study where that decoupling was seen to be particularly extreme or particularly problematic?

MK Abstract mathematics is a perfect example. It's very strict. They always start with formalisms first. Practicing mathematicians don't try to solve problems for which there are already known solutions; they attack new problems. Yet the way we teach kids mathematics is, well, we'll tell you the knowledge, then you try to solve the problem. We lose the opportunity to tap into their prior informal knowledge and intuitive resources to engage them in mathematical practice. One aspect of my own research on Productive Failure does precisely that. [1]

AJ Could you tell us a little bit about Productive Failure?

MK To learn something, you have to be able to see things, and to see something, you need the relevant knowledge, but a novice does not have the knowledge required to see. So how are they going to reach a level of expertise? Productive Failure came about by recognizing that one way to prepare a novice to see is to engage them in activities that are designed for them to fail at solving them correctly. [2] And the purpose of these activities was to afford learners opportunities to design things, to design solutions, to design representations, and to design explanations for the problems that we were giving them, knowing very well that they would not be able to solve them optimally. The goal here is not to be able to get to the correct solution but to design as many ways of thinking about, representing, or solving this problem as you can.

Then the expert comes in and builds on the student's solutions and assembles them into the concepts and ideas he or she wanted to teach in the first place. This is found to be up to three times as effective as learning through traditional instruction with a good teacher. And now there have been hundreds of experiments, and our recent meta-analysis captures this nicely. This started about twenty years ago. Now, twenty years later, a lot of research has gone into it. [3]

From the standpoint of architectural studios, you can think of these mathematics classrooms as mathematical studios, or mathematical practice studios, where you're given a challenging design problem, you invent solutions, you talk to one another, you critique one another, and you build new solutions out of combinations of other solutions. And the teacher goes around facilitating this. In a sense, we're bringing the disciplinarity of mathematics back into the classroom while also solving problems of initial cognition and learning.

1 For a concrete example in math education, see Manu Kapur, "Productive Failure in Learning Math," *Cognitive Science* 38, no. 5 (2014), 1008–22, here 1011, https://doi.org/10.1111/cogs.12107.

2 Manu Kapur, "Productive Failure," *Cognition and Instruction* 26, no. 3 (2008), 379–424, here 414–15, https://doi.org/10.1080/07370000802212669; Manu Kapur, "Examining Productive Failure, Productive Success, Unproductive Failure, and Unproductive Success in Learning," *Educational Psychologist* 51, no. 2 (2016), 289–99, here 289, 296, https://doi.org/10.1080/00461520.2016.1155457.

3 Tanmay Sinha and Manu Kapur, "When Problem Solving Followed by Instruction Works: Evidence for Productive Failure," *Review of Educational Research* 91, no. 5 (2021), 761–98, here 762, https://journals.sagepub.com/doi/10.3102/00346543211019105.

AP (Amy Perkins) A mathematical problem has an ultimate answer, and you're giving students a chance to do something beyond what they understand currently in order to get closer to it. Is it important that there is a correct answer?

MK That's a very relevant question. I don't think designing for Productive Failure rests on any need for there to be a correct answer. The reason I chose mathematics was because that's where the most resistance comes from. It doesn't rest on the fact that there is a correct answer or not. What it rests on is disciplinary criteria. As a community, you have criteria to assess what has gone into the performance. For example, you can say that this is an excellent piece of writing, and as experts you can talk about what makes this writing excellent. Experts and communities of experts in that domain tend to recognize that there are some features of writing that one could characterize as very good writing as opposed to not so good writing or really terrible writing. It's the same thing in other domains. You don't have a correct answer to what's being designed, but you have meta-criteria that allow you to evaluate the results.

AP When you looked at architectural education as part of your research, did you study the role of critique specifically?

MK If critique happens both formatively and summatively, that's when it's the most powerful. Formative critique in a studio setting is very informal, and you get peer critique as well. Learning from multiple perspectives and peers by spontaneously or intentionally getting and giving critique or feedback is very powerful, especially when it comes in the formative stage as you're developing solutions. It's the same with Productive Failure. As you're inventing solutions, if your peers say, "Oh, I don't understand that, have you considered something else?" it might lead to something new or improved. Formatively, that's powerful and has a strong impact on development and learning.

In summative critique, like a PhD defense, you stand up after four years and tell people in thirty minutes what you did, and then people critique you for an hour. In that sense, it is also a common component of scientific and disciplinary communities. This kind of discourse is part of the identity you develop as a professional person; it's a rite of passage. It's just that people get really nervous. Sometimes students don't understand the purpose of it. Some think the critics are too harsh. They don't understand that we are bringing students into this community of discourse where we sometimes ask harsh questions just to see how you will react, not necessarily because there's something wrong with your work or terrible with your work. By the time I see my students' final defense, I've cycled through ten such presentations

and seen the growth from day zero, so they've gone through a lot of formative critique and feedback by the time they reach their defense.

AP It makes me wonder whether the defense or the summative final critique exists in order to be able to prepare for it with the formative critique, but the defense itself doesn't necessarily have a pedagogical benefit ...

MK I used to play football. You train and train and train, but ultimately you've got to play the match, right? Likewise, you can train for a race, but then you've got to run the race, and the possibility of failure is part of the motivation. It's part and parcel of how professional communities are designed. If there's a change within those communities as to whether they're going to reexamine or rethink how they formally enculturate people into their community as professionals, then by all means ... But this is not just a feature of architectural education by any stretch of the imagination; it's a feature of almost every walk of life.

AJ One of the characteristics of students undergoing a crit is adrenaline. You are almost physically involved in their movements.

MK We tend to think that learning should be easy. We should be having fun. We should be feeling good about ourselves; there should be no anxiety, no frustration, and no struggle. And all of this is not true. These are not monotonic functions. If you have too little anxiety, learning doesn't happen. If you have too much anxiety, learning doesn't happen.

But you've got to have been in that zone where there's a bit of stress, there's a bit of anxiety, there's a bit of butterflies, there's a bit of struggle, and there's a bit of frustration. But there should also be resources in the environment that can help you navigate through that. It's like learning to collaborate, learning to feel these things and these kinds of emotions and learning to deal with them, repurpose them, or navigate through them in productive ways. That's also part of learning, independent of what you're trying to learn. And this aspect of learning and growth is not something that we design explicitly for in traditional instruction, but it's equally important. Because how are you going to learn to manage your struggles, frustrations, anxieties, and butterflies if the first time you have to do that is at the end?

AJ It does seem that there are many idiosyncratic elements of architectural education that are also to do with the historical shaping of architecture as a profession and its attempt to make itself autonomous from engineering and the fine arts. This has led to teaching practices that are, in some ways, quite experimental and innovative. It's very normal in an architecture studio to have small groups working completely collaboratively in a range of

media, making physical models, making drawings, and discussing. There's everything from advanced illustrative techniques to simply pointing and talking. It's tempting to see how they could be generalized, but then there's also a tendency to create quite hermetic and sometimes totally weird private jargon amongst architects, and I wonder about those two in parallel. Is there a relationship between the robust, multimodal nature of architectural education on the one hand and the almost esoteric language that wraps around it on the other?

MK It would not be unreasonable to see that happen in communities that rely on robust exploration, multimodal exploration, and collaboration, especially if these communities are trying to carve out a niche against the backdrop of historically dominant discourses and communities. So, it is certainly something that one could see emerging in architectural education.

Yes, I think from a learning standpoint, or from a growth standpoint, engaging in collaborative, open design, multimodal design, and discourse is, on the one hand, a very good initial learning environment, but it is also hard from a cognitive standpoint, because you have to coordinate many inputs, make sense across multiple features and phenomena, and integrate discussions and feedback. So there has to be some element of just-in-time, suitably surgical support, feedback, or structuring of that environment. It's not like free play, but it has to combine with it, and maybe in these sessions of feedback with experts you go on this exploration or exploitation loop, and then you have to come back and converge, and then you go out again. Back in the '60s and '70s, there was a big push toward discovery learning—letting people discover things on their own. Well, it doesn't work. Because if it's not sufficiently constrained and structured, even lightly, people go on wild goose chases that have nothing to do with what you're actually trying to teach them.

Therefore just leaving students in that open space could also be a recipe for disaster. And I think the point that the architectural studio example makes is that in its design there are these kinds of structurings that are implicit in how it's run. Thus conceived, architectural practice provides a pedagogical analog for architectural education. Lee Shulman has this concept of signature pedagogies, the idea that certain domains or disciplines—such as law, engineering, professional education—have signature practices that result in signature pedagogies. [4]

AJ Amy, I have a question for you about this, because you've gone through the full nine yards of architectural education and in a number of contexts. What's the function of boredom in a studio? Because I know that there are alternating moments

4 Lee S. Shulman, "Signature Pedagogies in the Professions," *Daedalus* 134 no. 3 (2005), 52–59.

of intense attention placed on students and then lots and lots of extended periods where perhaps they're simply bored.

AP It's a good question. I think boredom can be really productive because you end up getting bored of your own work and going and seeking out these moments of exchange with the other students. But recently there's been a tendency in studios to overwork students to the point where there's no boredom. You can't get bored because there are so many tasks piling up, one on top of the other. It was interesting what you were saying about this stress being a way of learning ...

MK But not that kind of stress. There is good stress and bad stress. Prolonged stress, if you have no time to think, is negative. I tend to think of boredom as an important aspect. There's a productive idleness, which may have some different functions. Zoning out can also be useful because you relax your mind, you go to other places, and you come back to the task at hand. We need to give people the space and time to be a little bored and idle so that they can come back and deal with the same content in a more productive way. Research shows that there are benefits to idling and just thinking about something that has nothing to do with the task at hand, that it has benefits for innovation and creativity. We need to give our students more time to be productively idle and bored. Instead of packing the curriculum with an ever-increasing load of content, we should perhaps stop to think that sometimes less is more.

AP How important do you think it is to inform students of the pedagogy before implementing it?

MK A body of research suggests this, but it isn't being practiced. I run a course that is part of the Science in Perspective program at ETH Zurich; it's called "The Science of Learning from Failure." I get students from all departments—bachelor's, master's, PhD—and semester in and semester out they are surprised that this is what research on learning is suggesting. And when students understand the science behind learning and teaching, they are quick to notice how current practice falls short and how and why advances in the learning sciences could enhance teaching and their own learning.

AJ How should we train teachers in higher education institutions? Because normally, in higher education, we don't.

MK Normally, we don't. But you know the sad story: even when we train teachers for high school, they still teach the way they were taught. So, training itself is only one component. Knowledge of what makes good teaching and what makes good learning is only one component of the bigger puzzle. We are creatures of habit, and sometimes experiences make bad habits.

So, we need to redouble our efforts at bringing more higher education faculty into teaching conversations and starting to examine their own teaching practice as a scientific exercise. Part of the goal of the Future Learning Initiative, which I direct at ETH Zurich, is precisely this, and it is heartening how many departments and professors came on board to collaborate on teaching and learning. *5*

5 Future Learning Initiative, https://www.fli.ethz.ch/.

AJ It seems odd to try to teach architecture in the same way that we teach law or physics.

MK If you want to build a building, it has to obey all the basic laws of physics and chemistry. Those fundamental laws do not change. But how you embody those laws and principles in a design can create a huge design space. Learning and teaching models are like those designs. The universality is in the fundamental mechanism. So, whether you're learning math or architecture, your perceptual mechanisms, sensory mechanisms, and encoding mechanisms don't change based on what you're learning, but how these mechanisms are then designed so that they create powerful learning in that domain is something of a discussion that we need to have. The design has to be customized and also has to take into account the discipline, the nature of the discipline, and the cultural practices of the discipline. All that has to come in, and that forms the design. But certain fundamental things about learning mechanisms are universal.