

Fostering Self-Direction through Design, Technology, and Research (DTR)

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Thank you for the wonderful introduction, Jonathan. I am thrilled to be here today, and even more thrilled that you are here today, because I think there is a deep, under-explored connection between the inner world of the researcher (which has been my focus), and the outer world of the researcher (which has been, some of your focus at AI2).

By the end of this talk, I hope to paint a picture of why developing technologies to support research tasks is just one side of the equation, and why we need to think more about the person who is doing the research

It'll take us a few steps to get there, so I ask for your patience as I build the argument.

With that, I'm excited to share what we've been doing in the Design Technology and Research (DTR) program — and how it's become a space for students to learn to direct their research, and their selves.



So, what is DTR? DTR is a learning community in which we use independent research as a vehicle for students to learn how to self-direct complex work, and to learn about themselves as people. Already, notice that our mission isn't to train students to become academics, or to simply produce new knowledge.

Students enroll in DTR as a course. They take it over multiple quarters to deepen their learning and advance their research. Even though it's a course, really a community, and all students in DTR, regardless of seniority, lead their own research project from day 1. Research projects are broadly in the area of human computer interaction and in human-AI interaction.



In DTR, we teach students how to work with themselves, so that they have more effective models and processes for thinking about complex problems. Students frequently externalize their thinking on the board, and receive coaching on not only the work itself but on how they are approaching their work.



Students learn how to lead their own projects, to formulate plans for next steps and present them to peers and mentors. They learn how to recognize risks and obstacles, and devise strategies for overcoming them.

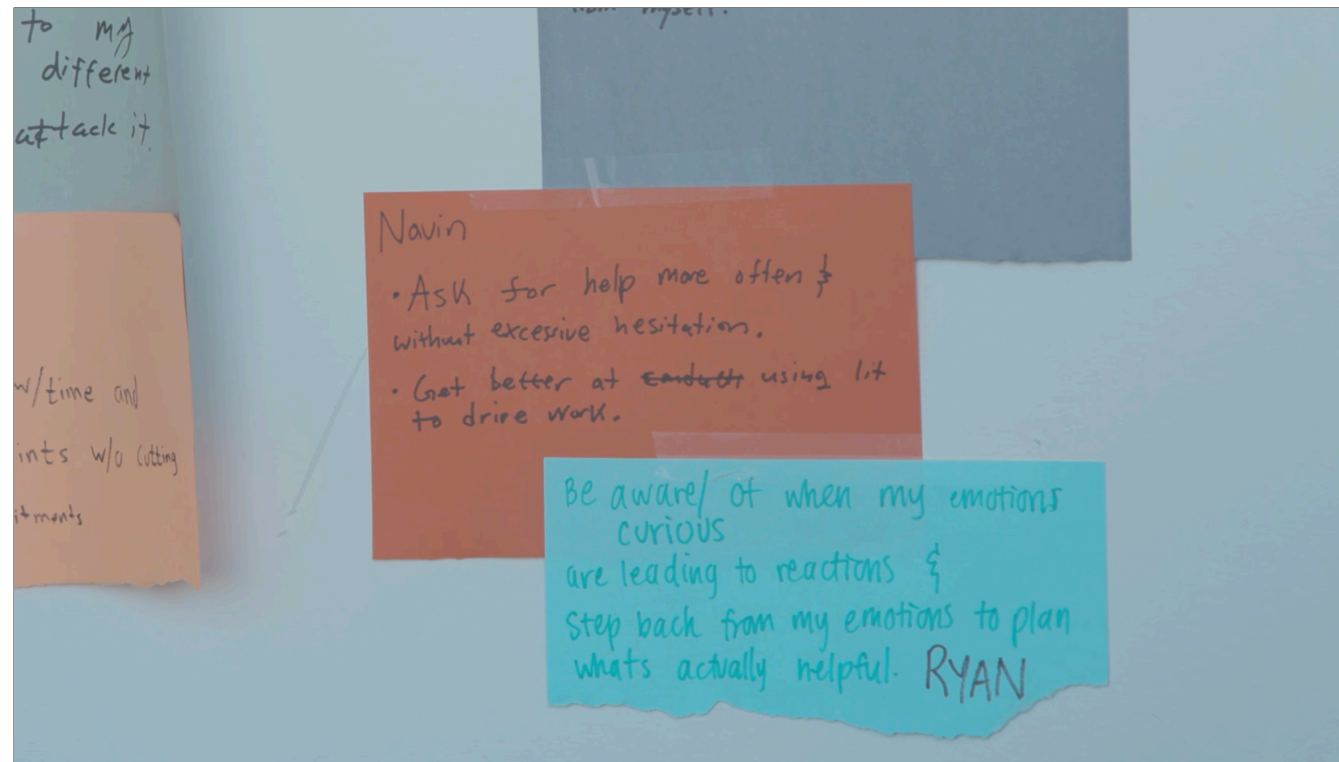


Students learn to not only rely on themselves, but to learn from others. They learn that self-directing complex work relies on a supportive community, and that self-direction requires learning to serve yourself, learning to serve others, and learning to allow others to serve you.



We learn also to take time to breathe, that learning and growing requires us to be able to slow down, find center, and engage with presence.

We also take time to talk to one another each week, about our practice, our struggles, and our growth.



We learn to reflect on our metablockers, or what prevents us from doing what we want to do and growing into who we want to be.



And we make time to talk about all this, focusing not just on project progress, but on personal growth, and how we learn to work with ourselves as we grow.



DTR is a lot of things, but I think it's first and foremost, a community. It's where we come together to work and learn, yes, but also where we come to belong, and to be with one another. It's a community where students learn to lead, and lead everything —- including this art-a-thon that brought us together one quarter.

Outcomes (11 yrs)

- ❖ 176 students (152 UG, 11 MA, 15 PhDs) who led 70+ research projects.
- ❖ 50% women!
- ❖ 73 undergraduate research grants
- ❖ 30 papers + extended abstracts; 7 winners at major ACM Student Research Competitions
- ❖ Many DTR undergraduates placed at Apple, Google, Microsoft, Meta, Amazon, OpenAI; others have founded their own companies.



And in 11 years, in my own studio at Northwestern, we have now hosted...

Success beyond Northwestern

- ❖ Founded Agile Research University (ARU) to support 70+ faculty at universities across the world using the Agile Research Studios model (even in the humanities!)
- ❖ Produced the DTR documentary, *Forward*
See: <http://forward.movie>
- ❖ DTR annual letters to start deeper conversations on mentoring and learning
See: <http://dtr.northwestern.edu/letters>

Forward

A film about learning and growth.

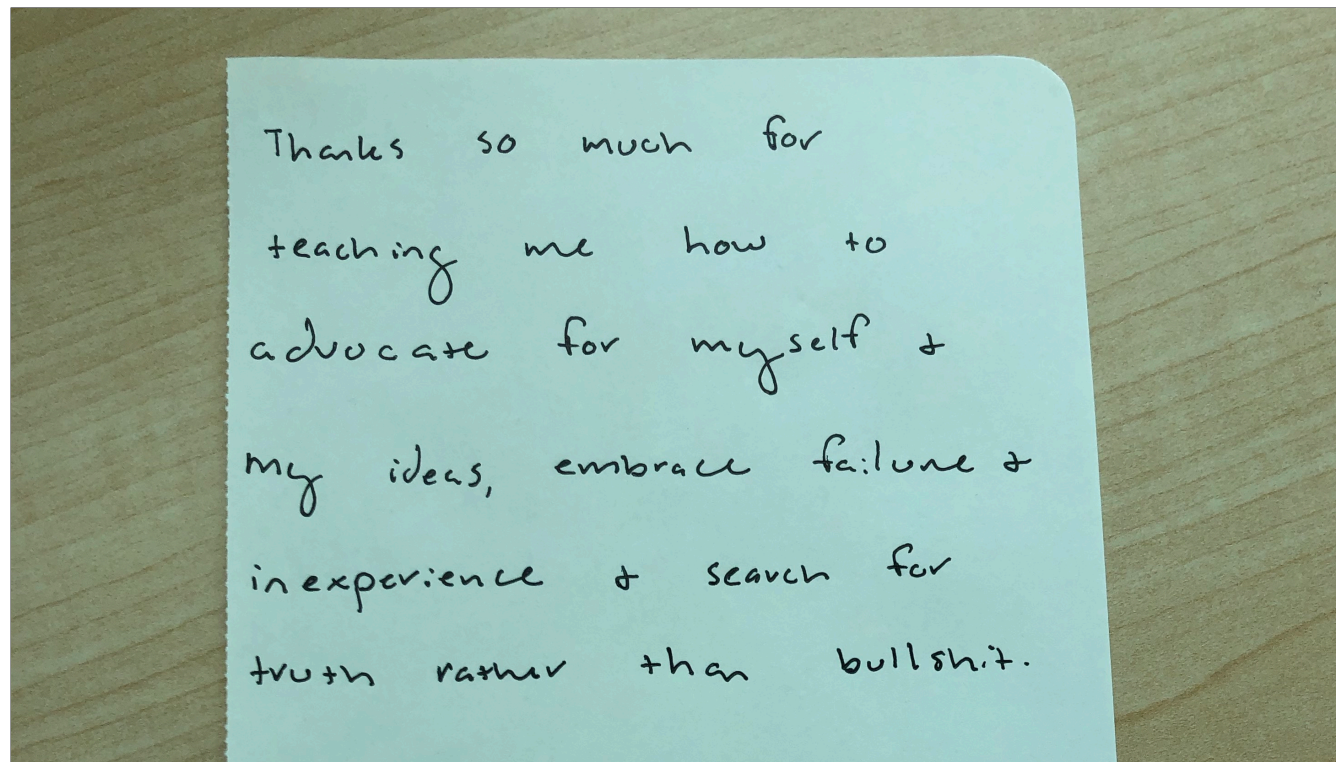
Watch Trailer

Watch Film

DTR pioneered a new model for research training and student learning, that we call agile research studios. I have since founded the Agile Research University program, where we have supported 70+ other faculty around the world who use our model to support their students back home.

In 2022 we released the DTR documentary, *Forward*, to further share our culture of learning and growing.

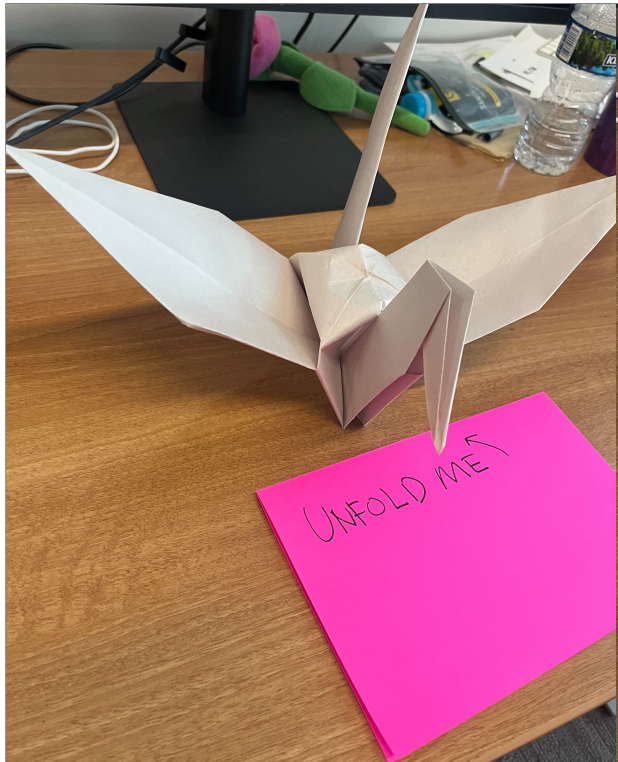
I also began to write annual letters to initiate dialogue on learning and growing, and the challenges we all face, as students and educators.



Beyond these outcomes, what we really did, and what I will get to later in this talk, is finding a way to use research training as a vehicle for students to learn about themselves, and to grow as people.

Quote: Thanks so much..

Notice that the most important thing here is not about producing research, but about creating a space where someone can see themselves differently, as they engage with their work and themselves differently.



Hi Haq!

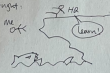
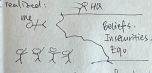
Thank you! for how much you genuinely care about & pay attention to not just our work, but our development as researchers & as people.

As undergrads, we've found home in OTR. It means more than we can say. Thank you for making OTR available to us. It's more than a class or research experience - it shaped our perspectives & helped us see new ways of being.

I came in trying to impress, I'm leaving trying to understand. DSC taught me that beyond doing shit fearfully as if it makes meaning, we can do a path incrementally & deliberately towards it. This has replaced "no fluster, no, no broken hearts. This territory goes uncharted." (Uncolored). I've learned to hold onto my values when everything's loud, to push (oh) when I believe in something - not because I'm supposed to - & to care for myself & those around me while doing it. I never expected to be given the tools to see, test, & sharpen even my most ingrained "flaws" - my stubbornness, my worst, strongest instincts - & hold them with both honesty & compassion.

Thank you for providing the space to discover the warmth & richness inside me. With clarity, you helped me see who I was - & who I could be. In witnessing you building a living ecosystem so kind, robust, & full of heart like OTR, I started to believe I could build the world that I wish to see. I feel safe to have always had an amazing mentor to have my hand on I stepped into research. Thank you for everything I couldn't have asked for a better 2 years.

People say that "it's a tough style of mentoring." However, no matter how much I tried to prepare myself, I certainly didn't expect to get kicked off a metaphorical cliff.

I thought:  I realized: 

(Until OTR, I had no awareness of how I was forming myself or how closed off I was from the world. I came in needing desperately to prove myself, telling myself that I *NEED* to get somewhere. It never occurred to me that a gentler approach was even possible, let alone effective. You taught me to pay attention & help me become more perceptive of the wonderful world around me. Thank you for giving me tools to become more self-aware & be able to reflect more meaningfully on what it means to be true to myself.)

Best wishes to Haq! & OTR.

I've learned to hold onto my values when everything's loud, to push (eh!) when I believe in something — not because I'm supposed to — & to care for myself & those around me while doing it. I never expected to be given the tools to see, test, & sharpen even my most ingrained "flaws" — my stubbornness, burnout, flaky flaky instincts — & hold them with both honesty & compassion.

Thank you for providing the space to discover the warmth & weirdness inside me. With clarity, you helped me see who I was — & who I could be.

How does a space for research training enable this kind of learning and growth? And what does this kind of personal growth have to do with doing research?

And if they are not just related, but deeply symbiotic and intertwined as I will argue that they are, what does that imply about how we support researchers, both in the design of research training programs, but also, when we create technologies that support researchers?

Rest of the talk

- ❖ Structuring research training
 - ❖ Deepening research practice
 - ❖ Fostering self-direction

For the rest of the talk, I will walk you through how we went from structuring a new learning environment for research training, to deepening our research practice, to fostering our self-direction, both in research, and in life.

In particular, I will highlight how personal growth and deep engagement in research are inseparable from one another.

At the end of the talk, I will more broadly argue for technological developments that go beyond supporting research tasks to fostering one's self-directed research practice.

[PAUSE FOR QUESTIONS]

Structuring research training



I want to start by talking about how we structure research training

Students need regulation skills

- ❖ **Regulation skills:** cognitive, metacognitive, motivational, and emotional skills for reaching a goal *[Jarvela & Hadwin. 2013]*
- ❖ Independent research requires regulation skills including **planning** and **seeking help** to overcome challenges.
- ❖ Students lacking these skills are confined to rote tasks, or can struggle to make progress.

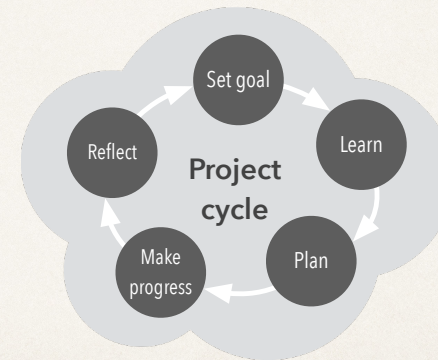
What we found is that if you really want students to become self-directed so they can conduct independent research, they are going to need regulation skills.

Regulation skills are

And the thing is that regulation skills are really hard to learn, and we do a terrible job of teaching them! Bang your head. There is got to be a better way.

Agile Research Studio (ARS) [Z. et al.]

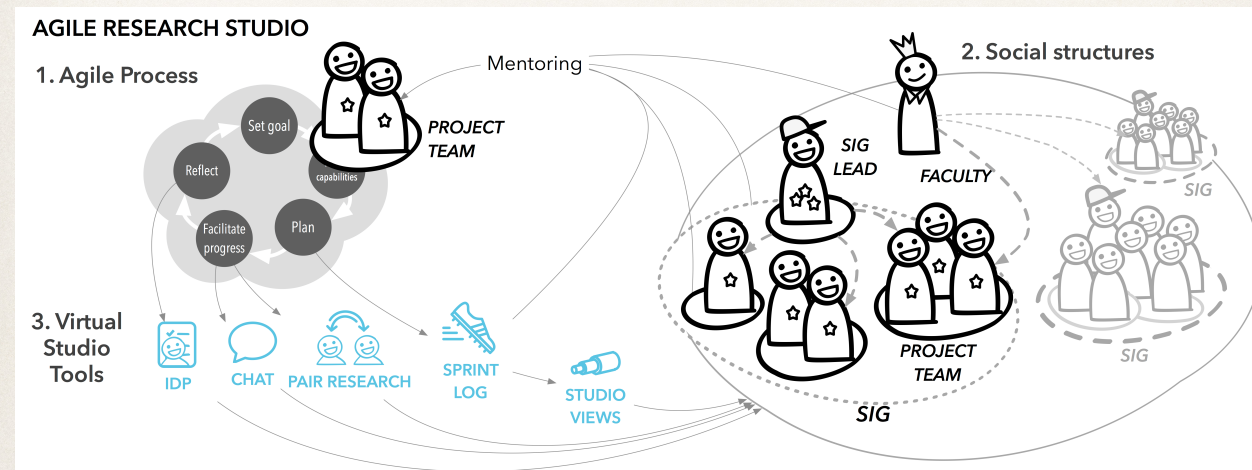
- ❖ Model for research training in a learning community
- ❖ All students, regardless of seniority, conduct independent research and receive authentic research practice.



To help with students learning regulation skills, we created Agile Research Studios as a new model for research training in a learning community.

In this model, all students, regardless of seniority, conduct independent research and receive authentic research practice. By authentic research practice, I mean that students drive the self-directed learning cycle, where they set goals for their project, learn what they need to learn, make a plan, do the work, and reflect on what they have done and learned to plan again.

Agile Research Studio (ARS): a socio-technical model for developing regulation skills

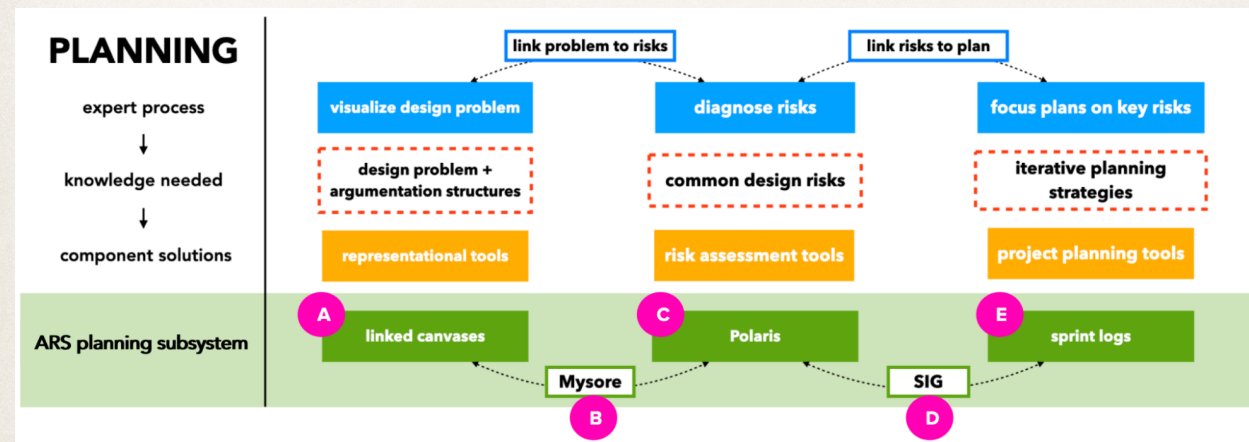


[Z., Easterday, Gerber , Rees Lewis, Maliakal, CSCW 2017]

ARS provides a socio-technical model with processes, social structures, and tools that work together to help students develop regulation skills.

I will get into some of the details of it in a minute, but what I want to highlight for now is that we fundamentally reconfigured the roles and relationships of student researchers and mentors, and created technologies that facilitate that reconfiguration.

ARS: planning [Maliakal, 2023]



To present the ARS model, i will first describe how ARS supports students learning to plan research work.

Here is a diagram of what it looks like to build a planning practice within ARS. For us, planning isn't simply: figure out what your tasks are for the week. It's a process of learning to represent and visualize your existing understanding, diagnosing risks, and then focusing plans on those key risks.

We created entire subsystems, sociotechnical configurations, for each of these sub-skills, and for students to connect these skills, so that they can actually link their problems to risks, and link risks to plans.

Together, these subsystems provide a way for students to deepen their practice of how THEY DRIVE their research, so that they are not just doing research tasks that are given for them, but wholly responsible for self-directing their inquiry.

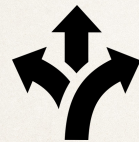
Planning Strategies

- ✦ assessing risks and aligning risks to plans
- ✦ using effective representations for thinking about problems and solutions
- ✦ building at the appropriate fidelity
- ✦ prioritizing important features and research questions
- ✦ moving on despite uncertainty or imperfect knowledge.

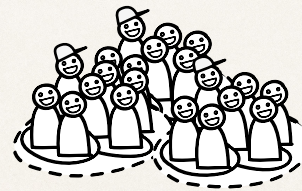
we found students developing regulation skills in planning

ARS: Help & Collaboration

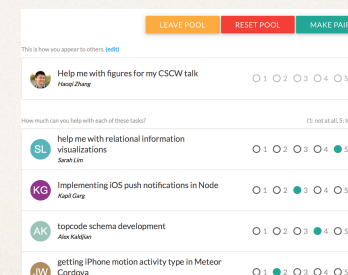
Process:
Distributed help



Social structure:
Studio meeting

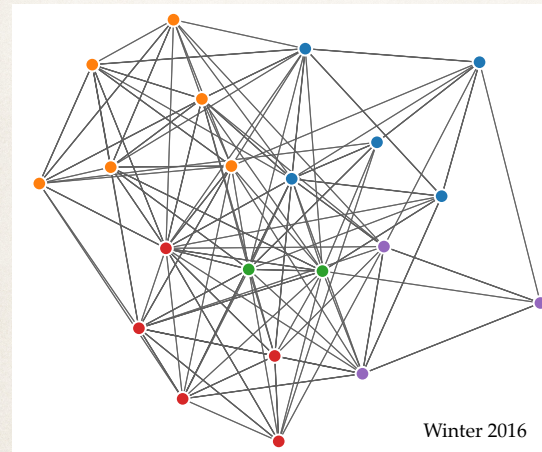


Studio tool:
Pair research



[Miller, Z., Gilbert, Gerber]

Help & Help-seeking



*"I can ask for help and that everyone asks
for help and it doesn't make them stupid
to need help."*

What you see in the graph on the left is that students were very willing to help others, both within SIGs and across SIGs.

But what's really compelling is to see shifts in students' help-seeking dispositions.

Summary: Structuring Practice

- ❖ Develop regulation skills for research planning and help-seeking across structured interactions
- ❖ Extends the scale and capacity of a community to produce and learn

Deepening Practice

At first glance, DTR might still seem like ordinary research mentorship — helping students plan, help-seek, and regulate. Maybe we do it better, but it's still largely as you may expect.

But in actuality, there is a lot going on under the surface than meets the eye.

Developing regulation skills for building a self-directed (research) practice

Cognitive skills

- ✦ representing problem and solution spaces
- ✦ assessing risks
- ✦ critical thinking and argumentation
- ✦ core design, research, and STEM methods

Metacognitive skills and dispositions

- ✦ planning: forming feasible plans and planning effective iterations
- ✦ help-seeking: leveraging resources; seeking help; communication skills
- ✦ reflection: awareness of one's own skills, abilities, and metacognitive blockers

Emotional regulation and disposition toward self and learning

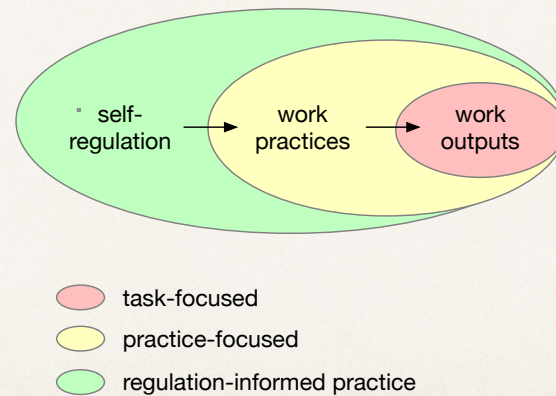
- ✦ emotional regulation: understanding one's fears and anxieties
- ✦ disposition: dealing with failure, embracing challenges, embracing self-direction

First of all, there are actually lots of regulation skills to learn.

Not easy to be really good at any of them.

All kinds of scaffolds can help, but good coaching really matters.

Challenge #1: understanding and address the gaps in students' practice and regulation is **really complicated**.

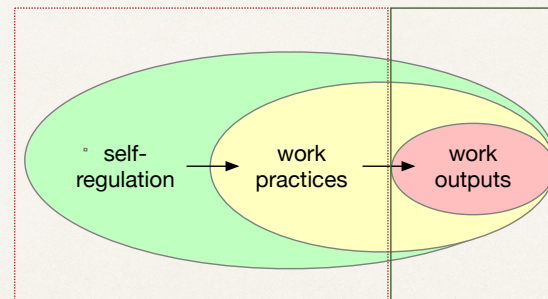


A core challenge is that understanding and addressing the gaps in students' practice and regulation is really complicated.

We understand that students' work outputs aren't everything -- and that really, if we want students to grow, we need them to learn better work practices, and even more so, better ways of regulating their work and learning.

Challenge #1: understanding and address the gaps in students' practice and regulation is **really complicated**.

not enough attention here mostly here



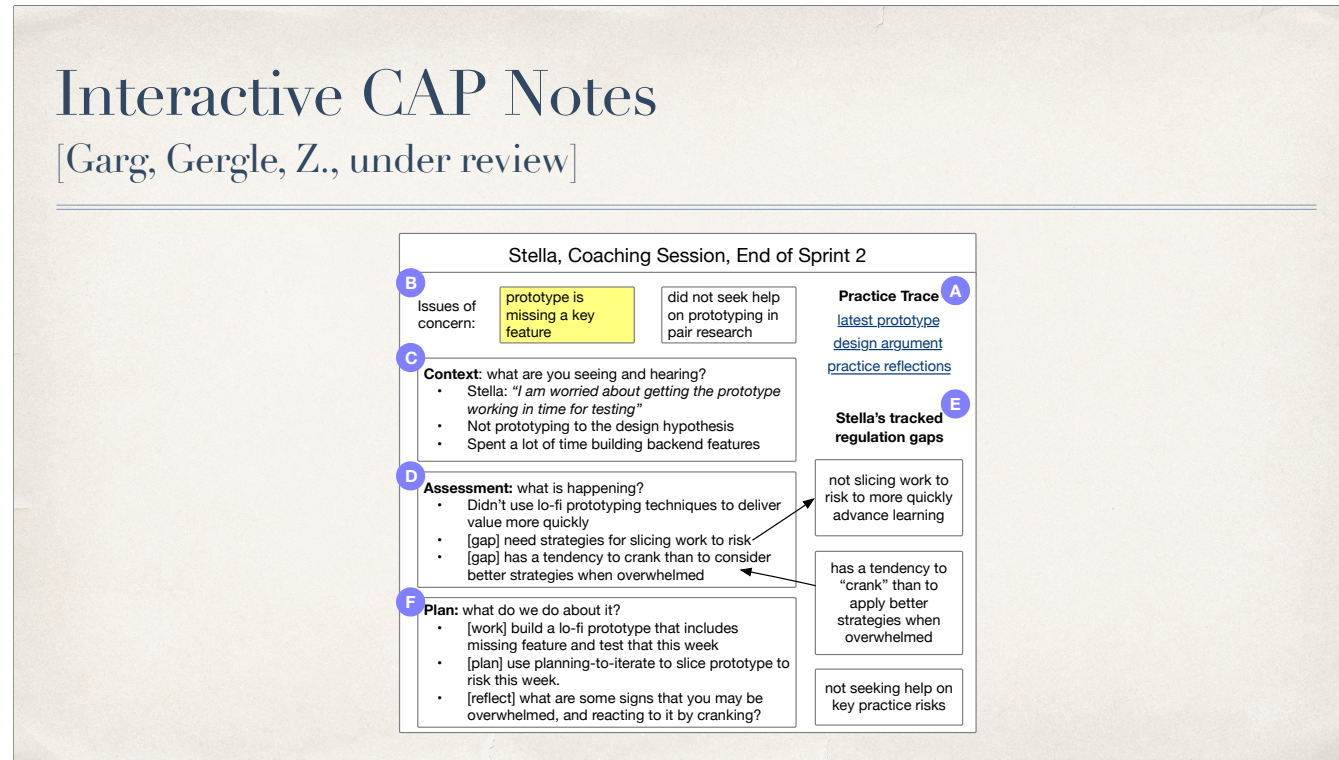
- task-focused
- practice-focused
- regulation-informed practice

However, this is often not what we end up focusing on in project-based learning environments. A lot of effort is spent on understanding students' work output, and there is often little focus on understanding a student's practice and regulation.

This makes it really unlikely that students can get good feedback on how they are approaching the work, even when those are actually the desired learning outcomes.

Interactive CAP Notes

[Garg, Gergle, Z., under review]

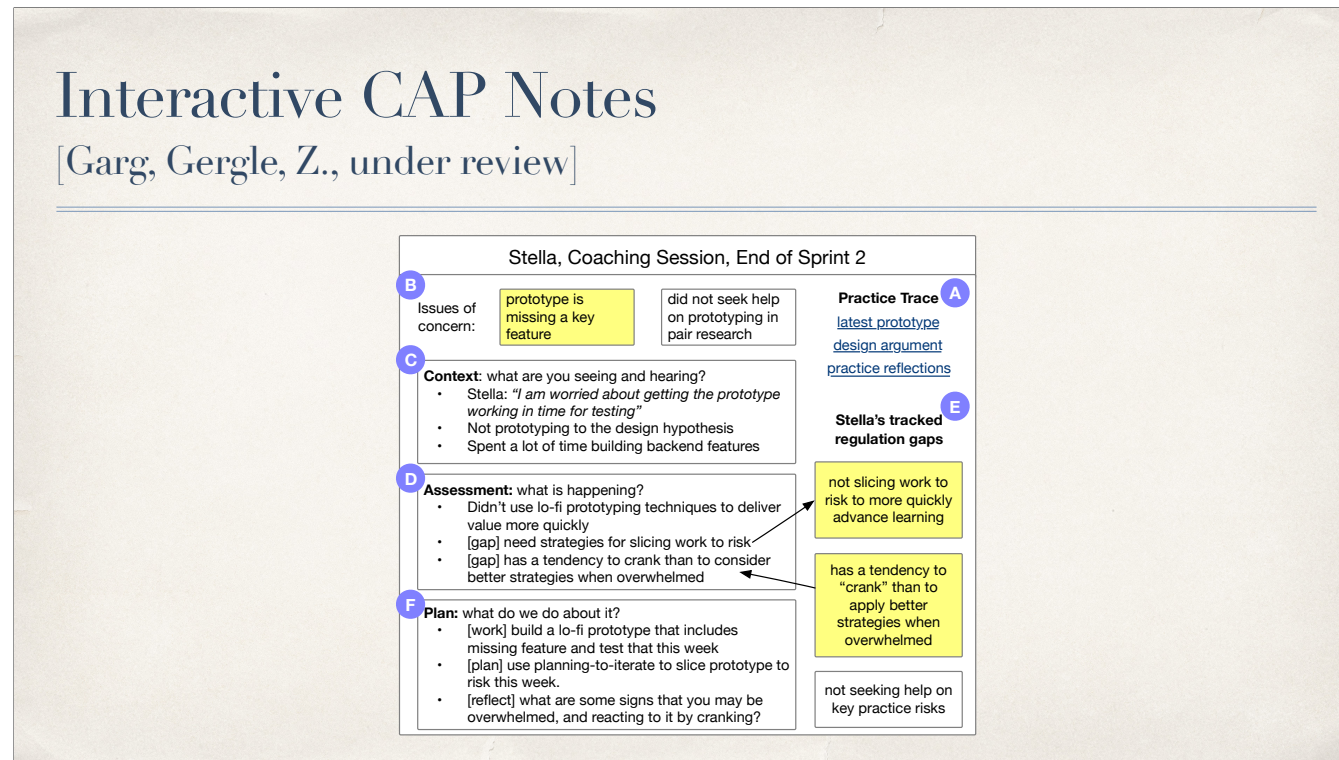


To address this, we developed a mentoring practice and tool called CAP notes, where coaching focuses on understanding and addressing issues in students practice and regulation, instead of just their work output.

During a coaching session, a coach still notes practical issues of concern, such as recognizing in this example, that Stella's prototype is missing a key feature. But instead of telling Stella to just fix it, the coach tries to understand, why is this happening in the first place? How is Stella's way of practicing and regulating, leading to this?

Interactive CAP Notes

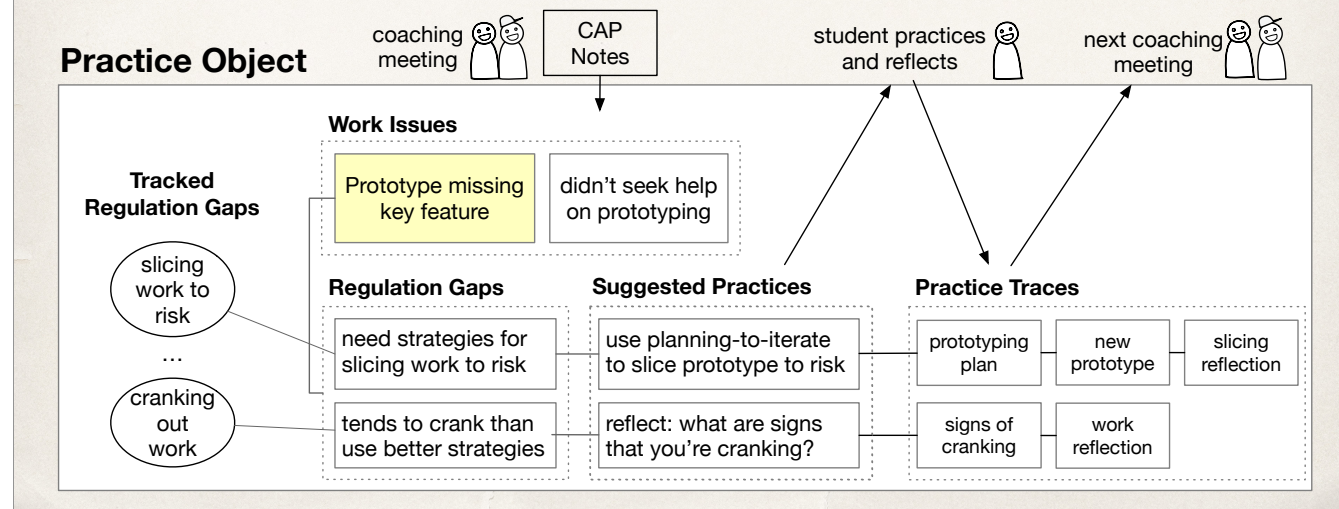
[Garg, Gergle, Z., under review]



And what the coach finds from really digging into it, is that Stella really lacks effective strategies for slicing work to risk, and that she often prioritizing delivering software than thinking about how she can more effectively deliver research learning each week. We find also, that Stella tends to over crank when she is overwhelmed, which often leads her to overwork, and to produce work that is ineffective.

So what this process and tool, a coach focuses on building a rich model of students' regulation behaviors and practices, and on addressing regulation gaps that they discover, and not only on advancing the work output.

Practice Objects for tracking practice and regulation [Garg, Gergle, Z., under review]



To make this possible, we created practice objects, which are computational representations that capture how a student's regulation and practice evolves over time.

[Example]

This gives us a way to work with students on their underlying patterns, rather than just addressing one work issue after another across weeks.

By addressing the same underlying regulation gaps across weeks, which gives us a way to engage in a regulation informed practice.

Creating space for learning about regulation

- ❖ See students and build strong relationships
- ❖ Hold space for reflection, sharing, and acceptance
- ❖ Recognize that patterns + beliefs recur, and can be quite sticky
- ❖ Value developing regulation skills over production
- ❖ Problematize how students approach problems and look at themselves (see “Interruption, Discord, and Drama” in 2025 DTR letter)

Beyond providing computational supports, what really shifted in us is that we no longer see self-regulation as just a skill to be built. Instead, we see regulation as a doorway into seeing students more clearly, and for students to see themselves more clearly.

To do that, we make an effort to.. [SLIDE — don't say too much...]

Challenge #2: Seeing and acting on the *good* of engaging in research

- ❖ Dancing with not knowing
- ❖ Re-examining phenomenon
- ❖ Re-examining beliefs and worldviews
- ❖ ...

see: “The Good” and
“Beyond Production” in
the 2024 & 2025
DTR annual letters

These goods are largely not about producing research,
but about how we engage with it, deeply.

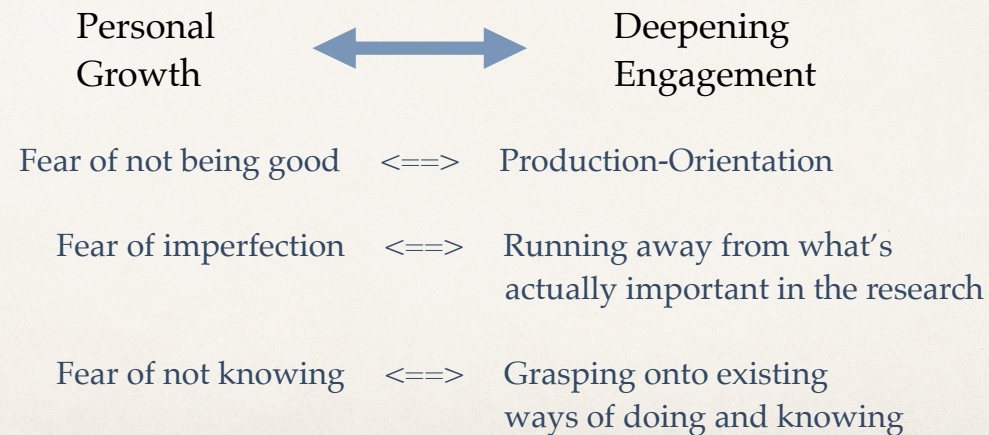
In addition to learning regulation skills, we have focused also on the challenge of helping students to engage more deeply in research.

As examples, what I value about engaging deeply in research is that it can give us the opportunity to learn to dance with not knowing, to intensely re-examine phenomena, and to see into our deeply held beliefs and worldviews, that may limit our ability to see the world clearly.

These goods connect us to the scientific tradition, and they are largely not about producing more papers, but instead, are valuable ways to engage in research in their own right.

If you are interested in learning more, please refer to these essays in the 2024 and 2025 DTR annual letter.

Learning to engage deeply in research



So how does one learn to engage more deeply? This is a complicated question, but a partial answer is, that we need to understand what gets in the way of engaging deeply, and work with that.

And here we see that personal growth is intricately tied to our ability to engage deeply, because for example, when we fear we are not good, it's easy to slip into a production-oriented mindset, as a way to prove our own worth.

Our fear of imperfections can lead us to run away from what's actually important in the research, and our fear of not knowing can lead us to grasp onto existing ways of doing and knowing, than to explore new ways of investigating that may be more effective.

So what we really did in DTR is to use our learning ecosystem to create space for students to have this kind of growth, both because it's valuable for their persons, and because it then enables them to engage more deeply in their research.

Until DTR, I had no awareness of how I was tormenting myself or how closed off I was from the world. I came in ~~me~~ needing desperately to prove myself. telling myself that I **NEEDED** To get somewhere! It never occurred to me that a gentler approach was even possible, let alone effective. You taught me to pay attention & help me become more perceptive of the wonderful world around me. Thank you for giving ^{me} the tools to become more self-aware & be able to reflect more meaningfully on what it means to be true to myself.

And when you do this, you can get some really transformative growth in students.... [QUOTE]

This note really struck me, because for her and all of us: How can we engage deeply in research, if we can't see the beautiful world around us? How can we seek new knowledge with open eyes?

Summary: deepening practice

- ❖ Coaching regulation by facilitating students seeing themselves and working with their patterns
- ❖ Understanding that personal growth and engaging deeply in research go hand in hand

To summarize, I shared with you in this section how we deepened our research practice, by focusing our efforts on coaching regulation by facilitating students seeing themselves and working with their patterns.

We also developed an understanding of how personal growth and engaging deeply in research can go hand in hand, and how you often can't have one without the other.

[PAUSE HERE, ANY QUESTIONS?]

Fostering self-direction

For the last part of my talk, I want to talk about self-direction, and why I think that's so important to research.

What is self-direction?

A good starting place may be to ask, what does it mean for one to self-direct their work and life?

What does that entail, and what skills or mindsets may be pertinent to it?

What is self-direction?

Core Concepts	Description	Examples of Related Concepts
Self-regulation	Cognitive, motivational, emotional, metacognitive, and strategic behaviors for reaching desired goals and outcomes (Zimmerman, 2000; Järvelä & Hadwin, 2013)	Metacognition; mindset; planning; socio-emotional learning; intrinsic motivation; self-determination theory; autonomy supportive
Self-knowing and being	Understanding oneself and learning to live up to values one endorses (Brewer, 2009).	Narrative identity; life stories; self-actualization; introspection; virtue; dialectical activities
Aspiration	The transforming of oneself into another, desired self (Callard, 2018).	Becoming; identities and aspirational selves

Core theoretical concepts on three facets of self-direction:
self-regulation, dialectical understanding, and aspiration.

And by first approximation, I think we can describe three aspects of self-direction:

- We have already talked about the value of self-regulation, as a way to effectively drive towards one's own goals, which can include the need to learn and grow in the face of new challenges and situations.
- We have also talked about the value of self-knowing, by which I mean understanding oneself and learning to live up to values one endorses
- And implicitly we have touched on the idea of aspiring, that is, the idea of transforming oneself into a more desired self, perhaps by acquiring and endorsing values that one doesn't yet hold.

Already, we see that self-direction is not just about cognition (small part); it's about freedom. Freedom in how we see, how we think, how we move.

DTR uses research as a vehicle for fostering self-direction

Cognitive skills

- ✦ representing problem and solution spaces
- ✦ assessing risks
- ✦ critical thinking and argumentation
- ✦ core design, research, and STEM methods

Metacognitive skills and dispositions

- ✦ planning: forming feasible plans and planning effective iterations
- ✦ help-seeking: leveraging resources; seeking help; communication skills
- ✦ reflection: awareness of one's own skills, abilities, and metacognitive blockers

Emotional regulation and disposition toward self and learning

- ✦ emotional regulation: understanding one's fears and anxieties
- ✦ disposition: dealing with failure, embracing challenges, embracing self-direction

I've learned to hold onto my values when everything's loud, to push (ok!) when I believe in something — not because I'm supposed to — but to care for myself & those around me while doing it. I never expected to be given the tools to see, test, & sharpen even my most ingrained "flaws" — my stubbornness, burnout, flimsy instincts — & hold them with both honesty & compassion.

Thank you for providing the side me. With clarity, you

Thanks so much for teaching me how to advocate for myself & my ideas, embrace failure & inexperience & search for truth rather than bullsh*t.

Congrats!

Until DTR, I had no anchor off I was from the world. — myself. telling myself that I ~~NEEDED~~ to get somewhere. It never occurred to me that a gentler approach was even possible, let alone effective. You taught me to pay attention & help me become more perceptive of the wonderful world around me. Thank you for giving ^{me} tools to become more self-aware & be able to reflect more meaningfully on what it means to be true to myself.

Viewed this way, DTR is a research learning community for which self-direction is central. DTR students come to see themselves more clearly, and learn to engage in research more deeply.

What they gain is not only cognitive, or even, only these skills — what they gain is a window into who they are as people, and who they can become from there.

Implications for Ai2

- ❖ The research we produce will always be bound by our (lack of) self-direction.
- ❖ Technologies for achieving research tasks can be tremendously helpful, but achieving these tasks do not equate to:
 - ❖ regulating one's self-directed research practice
 - ❖ deepening one's engagement in research
 - ❖ ...or the freedom to move

So while I recognize that your work is different than mine as an educator, what I've been highlighting so far in this talk is that the research we produce will ...

In other words, if we are not inwardly free — if our curiosity and direction are bound by unexamined patterns — our research cannot be outwardly free either. It will reproduce the limits that we haven't yet noticed, or have neglected, within ourselves.

Implications for Ai2

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- ❖ Technologies for achieving research tasks can be tremendously helpful, but achieving these tasks do not equate to:
 - ❖ regulating one's self-directed research practice
 - ❖ deepening one's engagement in research
 - ❖ ...or **the freedom to move**

Moreover, while technologies....

In other words, accelerating research is not the same as accelerating self-direction. Our work will always reflect the limits of our own agency — not the power of our tools.



So when I first saw this article from Dan, Eric, and others a few years ago, I was very excited. It's a powerful vision: having an ecosystem of research tools for scientific discovery that can suggest, reason, and even hypothesize, is just incredible.

But it also made me wonder: what rests on a system — and what rests within us? [LONG PAUSE]

I think AI systems can scaffold inquiry, and in fact, ya'll are proving it can. But as research increasingly relies on such systems, we'll need to pay even more attention to what must remain within us — such as our direction, reflectiveness, and FREEDOM.

Total Freedom



J. Krishnamurti

What we call happiness or ecstasy is, to me, creative thinking [...] When thought, which is emotion, which is action itself, is unimpeded in its movement, is not compelled or influenced or bound by an idea, and does not proceed from the background of tradition or habit, then that movement is creative [...]

When there is this creative thinking, which is infinite movement, then there can be no idea of a limitation [or] conflict.

"To be a true human being", Total Freedom

This question of FREEDOM is at the core of what we are talking about. Krishnamurti, for instance, describes it as follows: [QUOTE]

If we take him seriously, freedom isn't the absence of external limits — it's the absence of internal compulsion. And that raises a question: even if AI overcomes our cognitive bounds, what about the emotional, institutional, or habitual patterns that bound us still, and that continues to shape what we're willing to ask and see?

In AI research we worry about model alignment — but the same question applies to us. How are we align with our own freedom to inquire? How do we see beyond our own loops, and come to see the world through fresh eyes?

A vision for Ai2: AI for fostering **self-direction** in research and beyond

How can AI help to foster our self-direction, as researchers and as people?

If our research reflects our own capacity for freedom, then perhaps the next frontier for AI2 isn't just building systems that can reason, but building systems that can help us become more self-directed researchers and persons.

How can AI help to foster our self-direction, as researchers and as people? How could it help us cultivate the very capacities we most need as researchers, such as the courage to dance with not knowing?

A vision for Ai2: AI for fostering **self-direction** in research and beyond

How can AI help to foster our self-direction, as researchers and as people?

How would that transform how we approach the world's problems, and ourselves?

And if it could do that — if AI could help us learn how to move freely — how might that transform how we approach the world's problems, as we come to see ourselves differently?

Perhaps the deeper question isn't whether AI can help us solve the world's problems — but what kind of people are we becoming, as we try.



CYBERLEARNING: Agile Research Studios: Scaling Cognitive Apprenticeship to Advance Undergraduate and Graduate Research Training in STEM

RITEL: Situated Practice Systems: Supporting Coaches and Students to Develop Regulation Skills for Design, Research, and STEM Innovation

thank you

dtr.northwestern.edu/letters
forward.movie
agileresearch.io
dtr.northwestern.edu

I am here this afternoon :)

Want more? UW DUB tomorrow @ noon:

Computational Ecosystems: Advancing Human Values Through Integrative Computing and Changing Practice



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slides+readings: haoqizhang.com

thank you all, and thanks to the NSF for supporting this work.

I hope you all find the following links helpful, and feel free to contact me if you need anything. I especially recommend the DTR annual letters, if you are interested in learning more about how we approach research and learning.

I am here this afternoon, and I am giving a more expansive talk about my and my students' work at UW tomorrow.

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DTR and Agile Research Studios

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