Coaches teach in design reviews.

How do I teach?

What do I teach?

pedagogical knowledge

content knowledge
pedagogical content knowledge (PCK)

What pedagogical techniques do I use to teach this specific content?

How do I teach?

What do I teach?
Goal: support a broad, integrated perspective

Make visible the (tacit) design pedagogical content knowledge coaches’ use in design reviews when guiding students to develop as design thinkers.

(How) Features of design review structures

Design PCK “sits at intersection”

(What) Learning goals and awareness of student capabilities (conceptions, misconceptions, habits of mind)

(What) Ways to represent design thinking as a form of inquiry

(How) Relevant teaching strategies
Pedagogical Knowledge

How do I teach?

Cognitive Apprenticeship
(Collins, Brown & Holum, 1991)

&

Teaching as Improvisation
(adaptive, no script)
(Sawyer, 2011)
Pedagogical Knowledge

Cognitive Apprenticeship
- modeling
- articulating
- scaffolding
- bounding*
- coaching
- reflecting

Teaching as Improvisation
- breaking 4th wall
- denial
- driving
- yes-&
Content Knowledge

Conceptual Know-that & Procedural Know-how

What do I teach?
Content Knowledge

Conceptual (design judgment)

- aesthetic
- coherence
- (un)predictability
- feasibility
- interactivity
- novel

Procedural (tasks*, management)

- Problem framing,
  Doing research, Idea fluency, Deep model,
  Balanced trade-offs, Focused diagnostics,
  Valid tests, Iterative, Reflective practice
- Time, complexity & risk management
- Multiple perspectives
- Suggest, don’t tell *(Crismond & Adams, 2012)
## Selected dataset

<table>
<thead>
<tr>
<th>Discipline (Learner level)</th>
<th>Longitudinal video subset</th>
<th>Learners</th>
<th>Coaching Dialogue</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choreographers (Seniors)</td>
<td>First, Second &amp; Third (final) Review</td>
<td>Elena &amp; Anita</td>
<td>Learners being reviewed as individuals</td>
<td>Group sessions with multiple coaches and working prototypes (performances)</td>
</tr>
<tr>
<td>Industrial Design (Juniors)</td>
<td>First, Second &amp; Looks Like Review</td>
<td>Todd &amp; Sheryl</td>
<td>Learners being reviewed as individuals</td>
<td>One-on-one sessions with sketches and prototypes</td>
</tr>
<tr>
<td>Mechanical Engineering (Seniors)</td>
<td>Conceptual Design Review &amp; Final Design Review</td>
<td>Robot Fish Team</td>
<td>Learners being reviewed as a team</td>
<td>Formal and informal presentations with working prototypes</td>
</tr>
</tbody>
</table>

- Maximize variation
- Longitudinal; Substantive dialogue
- Undergraduates; Instructor as coach
<table>
<thead>
<tr>
<th>Scaffolding articulation</th>
<th>Breaking the 4th wall to create a teaching moment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME: What prevents the fish from taking a nosedive?</td>
<td>CHOR: Ideas are generative, right?</td>
</tr>
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<td>CHOR: What does the title have to do with your piece?</td>
<td>ID: Put this in scale</td>
</tr>
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<td>ID: Now explain that…</td>
<td>ME: So why did you not stay on schedule?</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Driving for meaning and guidance</th>
<th>Combination repertoires to let the student figure it out</th>
</tr>
</thead>
<tbody>
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<td>Student, ID: Do I need my prototype to function?</td>
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<td>Student, CHOR: Can I ask a general question about tempo?</td>
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<td>Student, ME: We have a question</td>
<td>ME: You’re putting a pretty large moment on that servo</td>
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<tr>
<td>Coach, ID: Always do something safe</td>
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Ask yourself:

Does this resonate?
• As a coach
• As a student
• As a researcher
Scaffolding articulation: What does the title have to do with your piece?

CHOR, 2nd Review, Mia to Anita

Mia: When you told us your title you said what it meant and so I wondered what the title has to do with your piece…is it the tension, is it the spatial juxtaposition or the relationship…[scaffolding to direct attention to lack of coherence between aesthetics and title]

Anita: Would you like me to talk about it?

Mia: Yeah, because I’m just gonna tell you, my students won’t know what that means…[encouraging articulation of reasoning]

Anita: …first of all there is a definition for this…very gestural and articulate…very precise…has something to do with the hands and the hands are something that I’m working with…the word ‘purlicue’ and the way you write it and the way the letters are formed and the way you say it on your tongue…it has that rounded flowy-ness…it sort of fits into the aesthetic that I have in my head…
Driving (bounding) for meaning and guidance: Do I need my prototype to function?

ID, Looks Like Review, Sheryl to Gary

Sheryl: Mm-hmm. Um, I guess my last question then is when I do that, do I need to make it more of a prototype? So if I pick up the table, do I need a function for it to actually lock there? [takes control to direct coach to task for situated guidance – on managing complexity/scope]

Gary: I wouldn't, that's too difficult. I would – [modeling reducing complexity]

Sheryl: Can I just not do that? [Laughs] Just say, "Look, it moves."

Gary: I would say that. I'd say, "Listen," and you lift it up and someone puts in your four sections, someone like your, a demo –

Sheryl: A buddy?

Gary: Yeah, buddy to help you out on this and don't let anyone else touch this, watch this for me. So, it looks like it's functional but it really isn't, so you need to explain that – [modeling risk management]
Breaking the 4th wall to create a teaching moment: Ideas are generative, right?

I think you’re in – you’re your situation, your optional situation right now is that you started with an idea that generated movements and generated your staging and everything. Um, and I think that what happens is we work and then we create something and that thing speaks, and I don’t think it’s necessarily saying like straight your ideas that generated it… seeing women like half-dressed in underwear, I like I don’t understand what you’re trying to tell me and I don’t go to the place that you started from. And I’m not advocating for you pushing your piece in the direction of the ideas you started from, because ideas are generative, right.

…But the piece is maybe calling for that to happen. So you just get to decide, like do I kinda stick and like, and like go into like I want it to be like this, and make changes and push it more towards an original idea or do you flow with like what is happening and go, you know, I can let go of some of my preconceived notions and follow the flow.

…So I think it’s really hard to step away from your work and just ask it, you know, kinda like, well, what are you doing, already, work, and how can I help bring that to fruition. Because I think it – for me, I think it has a different title than, than how you’ve got it right now.
Breaking the 4th wall to create a teaching moment: So why did you not stay on schedule?

ME, Final Debrief ("loose script")

...schedules in the back of your book are red, right?...Why did you do that?" [break 4th wall – "loosely" scripted teaching moment, scaffolded articulation – time management]

...Okay. So that's an – actually, a good reason. If you recognize the complexity of the different phases and you adjust for that, then that's a good idea. [Yes &, complexity management, iteration]

...we underestimate things...Especially things we haven't done before. [Yes &, complexity management]

All right, so what – the three things – you're exactly right. The schedule went red...I didn't grade on your schedule being red, because I anticipated that and I want to make this point because I want to give you the best service I can for your next job. That's really where I'm going with this. An engineer has responsibilities for three things – in industry. One is technical performance. If you don't get technical performance, you don't have anything you're out of a job, right? That's the same way here. You had to have some minimum technical performance to continue. Secondly, what's – next most important is schedule, and thirdly, is cost. And schedule is the second most important thing because if we stay on schedule or, or ahead of schedule, you contain your costs.... [modeling, time management, feasibility, cost]
Combination repertoire to let the student figure it out: He’s gotta discover that

Gary: But keep in mind, though, if you have just one center axis, you sure you're not gonna have to have a second axis? Because what happens is this is going straight through here – [coaching, focused diagnostic – feasibility]

Todd: Wow.
Gary: - what can really – you're already locked in.
Todd: Will I be?
Gary: Well, what we’ll see, get a pencil and ah, ah, see, that's what I'm thinking's gonna happen. [modeling, deep model]

Alek: It's not gonna spin with the dowel. Not with the angles.

Gary: He’s gotta discover that. [break 4th wall, coaching, suggest don’t tell]
Todd: I think it will. Um, we’ll see.
Alek: But if you're wanting it to sit flush and you're wanting it to spin, you can get one or the other.
Todd: I don’t know why it wouldn’t…
Gary: You, you just need to go through it. This will be good experience for you. [suggest don’t tell]
## Scaffolding articulation

- **ME:** What prevents the fish from taking a nosedive?
- **CHOR:** What does the title have to do with your piece?
- **ID:** Now explain that...

## Breaking the 4th wall to create a teaching moment

- **CHOR:** Ideas are generative, right?
- **ID:** Put this in scale
- **ME:** So why did you not stay on schedule?

## Driving for meaning and guidance

- **Student, ID:** Do I need my prototype to function?
- **Student, CHOR:** Can I ask a general question about tempo?
- **Student, ME:** We have a question
- **Coach, ME:** You’re gonna need an O-ring
- **Coach, ID:** Always do something safe

## Combination repertoires to let the student figure it out

- **CHOR:** Is it a subway?
- **ID:** He’s gotta discover that
- **ME:** You’re putting a pretty large moment on that servo arm
These coaches have a common repertoire

Of teaching techniques – used in many combinations
- Used in all contexts (no driving in CHOR)
- Predominant: Scaffolding and coaching; breaking 4th wall, Yes &, driving
- Adapt to situation at hand (student’s needs) or design phase (reduction in modeling)
- Limited or enabled by review structure

Of conceptual knowledge for judging design decisions
- Same codes, differences in emphases (aesthetic, feasibility, interactivity)

Of procedural knowledge from task to project management strategies
- Focused diagnostics as entry point – diagnosing elements of designs and connecting features of solutions to early framings
- Suggest don’t tell – draw attention to problematic situation, encourage student to experiment and make own informed decision (intrinsic shared value?)
Make design PCK visible, make the “system” visible

Make visible – teaching strategies
• Cognitive apprenticeship & Improvisation codes
• Help students make conceptual connections, see fallacies in thinking
• Create opportunities to reflect on tacit knowing
• Guide while enabling decision making

Make visible – what coaches worry about
• Meeting performance goals of aesthetics, feasibility, coherence
• Performing focused diagnostics, iteration, reflection
• Managing time, risk, complexity

Make visible – coach’s design thinking as a form of inquiry
• Conceptual and procedural knowledge coding schemes
• Connections between these

Make visible – salient features of design review structures
• *Breaking the 4th wall* to create a teaching moment similar across structures
• *Scaffolded articulation*: Formal presentations & informal individualized one-on-ones structures
• *Student bounding*: Informal one-on-one settings, but not restrictive – attribute of student?
• Informal one-on-one and group-on-one settings, as well as scripted teaching lessons, may support collaborative interactions or co-designing (via Yes &)

Design PCK
Linking to practice

Design coaches or instructors – experts & newcomers
• Language for noticing and sensemaking of own practice
• Language for collaborative learning and knowledge sharing
• Repertoire – just-in-time teaching as a situated practice
• Visibility as authentic professional practice

Students
• Language for noticing and sensemaking of own practice (design as a form of inquiry)
• Language to recognize inefficient habits of mind and difficulties, and the ways coaches try to help them overcome these difficulties
• Visibility of coach’s support in facilitating their voice as a designer
Questions?

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### Cognitive Apprenticeship

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
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<tbody>
<tr>
<td>Modeling</td>
<td>A coach makes their thinking about their (expert) performance visible to the student, demonstrating the target task while thinking out loud about their process.</td>
</tr>
<tr>
<td>Articulating</td>
<td>A student makes their thinking about their performance visible to the coach.</td>
</tr>
<tr>
<td>Scaffolding</td>
<td>A coach makes their thinking about a novice's/student’s future performance visible to the student – e.g., directing the student towards a subset of the task as a suggested next step or as &quot;homework&quot; to be done in the future.</td>
</tr>
<tr>
<td>Bounding*</td>
<td>A student makes their thinking visible to the coach by directing the coach towards a subset of the problem they want guidance on (role reversal of scaffolding).</td>
</tr>
<tr>
<td>Coaching</td>
<td>A coach makes their thinking about a novice's/student’s past performance visible to a student – e.g., providing feedback on the student's performance on a target task.</td>
</tr>
<tr>
<td>Reflecting</td>
<td>A student compares their process (e.g., during articulating to an expert's process (e.g., from modeling)).</td>
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### Teaching as Improvisation

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<tr>
<td>Breaking the 4th wall</td>
<td>A coach, as the expert, takes control of the interaction to communicate an important point to the student such as a concept or “ground rule” that has intrinsic value for the coach or the field of inquiry.</td>
</tr>
<tr>
<td>Denial</td>
<td>A coach/student rejects what another has introduced into the dramatic frame (e.g., opposite of Yes &amp; code). This may be confrontational and involve an abrupt switch from the student to the coach. Students may feel their contributions are not valued.</td>
</tr>
<tr>
<td>Driving</td>
<td>A coach takes control of the interaction (verbally or through tone, body language, etc.), not letting others talk or contribute. The coach’s expertise is often the main reason for this kind of shift in conversation; however, students could also drive.</td>
</tr>
<tr>
<td>Yes &amp;</td>
<td>A coach has an affirmative reaction to a student’s assertion or work, allowing a coach-student collaboration to emerge and flow. Typically, the coach accepts a students’ assertion as valid and revoices this to the student(s), building on the assertion. In the context of design reviews, this may occur among coaches as well as students.</td>
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Adams, Forin, Chua & Radcliffe – Making design PCK visible: Design thinking knowledge codes

<table>
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<tr>
<th>Design Judgment</th>
<th>Task strategies</th>
<th>Process management strategies</th>
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<tr>
<td><strong>Aesthetic:</strong> Artistic (visual, auditory, sensory) appeal or a sense of beauty – e.g., authenticity or “realness”, simplicity/purity, aesthetics of form (shape, geometry, color, texture, symmetry, repetition, organic/formal, variation, negative space, tension, etc.)</td>
<td><strong>Problem framing:</strong> Coach encourages/exhibits problem-framing behaviors to help the student comprehend important features of the problem; discourages behaviors such as treating design as well-defined and prematurely attempting problem-solving.</td>
<td><strong>Complexity management:</strong> Coach encourages and/or exhibits strategies for managing complexity (e.g., scope of work, feasibility within a timeline).</td>
</tr>
<tr>
<td><strong>Coherence &amp; Essence:</strong> Achieves coherence (cohesion, integration, completeness as a system) and essence (a personality, philosophy, passion).</td>
<td><strong>Doing research:</strong> Coach encourages/exhibits doing research behaviors to help the student learn about the problem or how the system works; may discourage behaviors such as skipping doing research and building solutions immediately.</td>
<td><strong>Risk management:</strong> Coach encourages and/or exhibits strategies for anticipating and addressing (e.g., playing it safe, meeting deadlines, ways to communicate designs in a persuasive manner).</td>
</tr>
<tr>
<td><strong>(Un)Predictability:</strong> Creates drama or stimulates an unexpected, unpredictable, or counterintuitive experience. In the ID and CHOR context, this code was an aesthetic principle; in the ME context the opposite of this code, predictability and certainty, was a feasibility principle.</td>
<td><strong>Deep modeling:</strong> Coach encourages/exhibits deep drawing or modeling to help the student inquire into how ideas work, function, or could be made; discourages behaviors such as superficial drawings or models that can’t support inquiry or wouldn’t work if built.</td>
<td><strong>Time management:</strong> Coach encourages and/or exhibits strategies for managing time to help students complete tasks within a prescribed timeframe.</td>
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<td><strong>Feasibility:</strong> Feasible or possible to achieve: easy to afford, easy to realize/manufacture, technologically feasible, and feasible within the constraints of the human body.</td>
<td><strong>Balance tradeoffs:</strong> Coach encourages/exhibits strategies for helping students judge options and making decisions that acknowledge both benefits and tradeoffs; discourages behaviors such as attending only to pros of favored ideas and cons of lesser approaches.</td>
<td><strong>Multiple Perspectives:</strong> Coach encourages and/or exhibits plurality of perspectives including disagreements and agreements.</td>
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<td><strong>Interactivity:</strong> How users interact with or experience a design: ergonomics, practical, easy to use, multi-functional, fun, and engaging.</td>
<td><strong>Valid experiments:</strong> Coach encourages/exhibits conducting valid experiments to help students substantiate design decisions; discourages behaviors such as doing few or no tests on prototypes, or running experiments that cannot provide useful information.</td>
<td><strong>Suggest don’t tell:</strong> Coach encourages students to exercise and develop design judgment under ambiguous circumstances.</td>
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<td><strong>Novel:</strong> Unique, evolutionary, opens up new markets or meets a future need.</td>
<td><strong>Focused diagnostics:</strong> Coach encourages/exhibits focused diagnosis to help students identify and attend to problematic aspects, and proposing ways to improve, fix, or build on them; discourages behaviors such as unfocused and non-analytical diagnosis of designs that cannot provide useful information for improvements.</td>
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