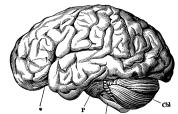


1

How to Teach All the Things (including Shiny and the Tidyverse)



From Novice to Expert

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2


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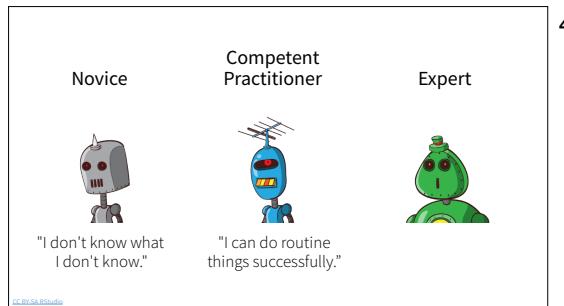
Research on how people acquire skills led Patricia Benner to develop a five-stage model of the cognitive changes people go through on their way from being a complete novice to being an expert. We're going to simplify that model to three stages:

3


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A **novice** doesn't even know what they don't know. You can usually spot novices because they work primarily by blindly repeating and then tweaking things in the hope that they'll work, by using jargon incorrectly (or not at all), or by asking questions that don't make sense.

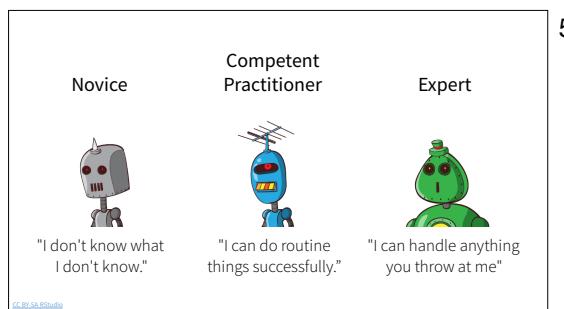
"I don't know what I don't know."



4

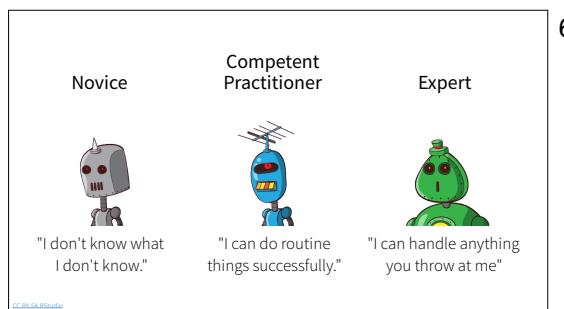
A **competent practitioner** can do routine things reliably: in everyday terms, they can drive across town or make dinner. However, they may need to look up details that they don't use very often.

Most of us become competent in most of the things we do regularly, and don't bother to progress beyond that. Despite what pop sci gurus like Gladwell would have you believe, ten thousand hours of practice isn't going to make you an expert: most of us have probably spent that much time writing, and yet most of us wouldn't consider ourselves expert writers.



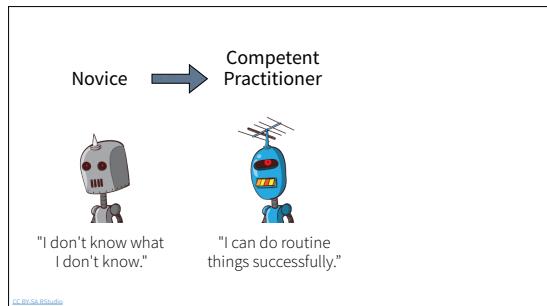
5

This brings us to **experts**. They seem able to solve common problems at a glance, but can also figure out the one-in-a-million cases that would baffle the “merely competent”. They’re also usually much better at working backward from effects to causes, i.e., at diagnosis and debugging. And crucially, they are also often unable to explain their reasoning: you’ll often hear experts call things “obvious” when they’re anything but.



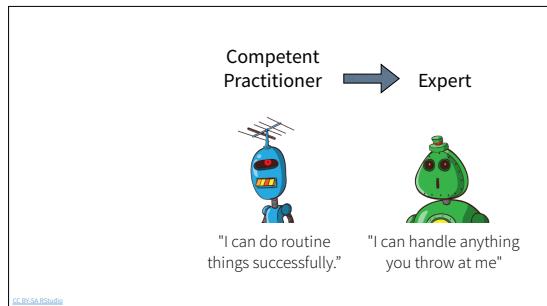
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Your learners will usually be somewhere on the left of this diagram, and will want to be closer to the right. As we'll see, it's probably not possible to get them all the way in a single course, much less a single workshop...



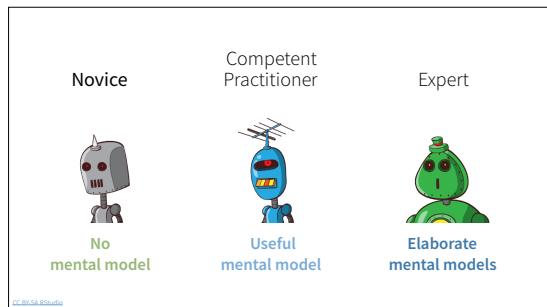
7

...but you can almost always get someone on the road from novice to competent with as little as an hour or two of instruction. This is what this workshop attempts to do: introduce you to a few fundamental concepts, show how to use them, and point you at next steps.



8

Getting someone from competent to expert is harder in a classroom setting. At this level, the most effective approach is mentoring or coaching spread out over weeks, months, or even years, but case studies and critiques can give competent practitioners insight into experts' thought processes, which in turn can help them check their own understanding.

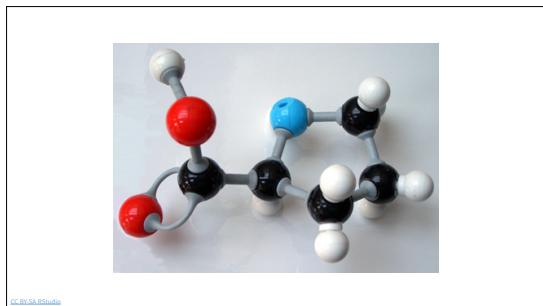


9

From a cognitive standpoint, the main difference between novices, competent practitioners, and experts is the nature of their **mental models**.

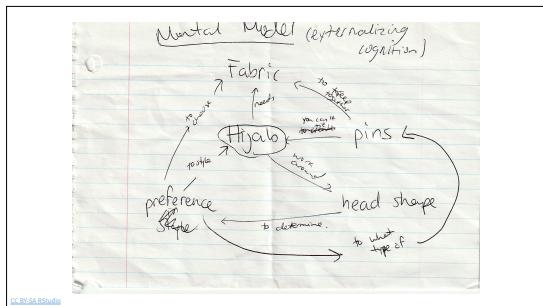
- Novices don't have one, or are just starting to assemble one.
- Competent practitioners have one that includes common cases.
- Experts have more elaborate models with more links between ideas.

Our goal when teaching novices is therefore **not** to give them lots of



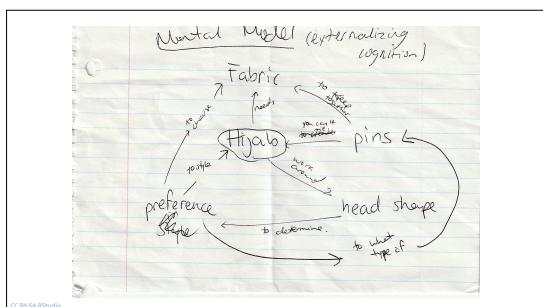
10

Here's a mental model you may all be familiar with from high school science classes. Atoms are balls of different colors, and bonds are sticks or springs. Every single thing about this is wrong, but it's still very useful, because it allows novices to organize what they know and make predictions that actually work.



11

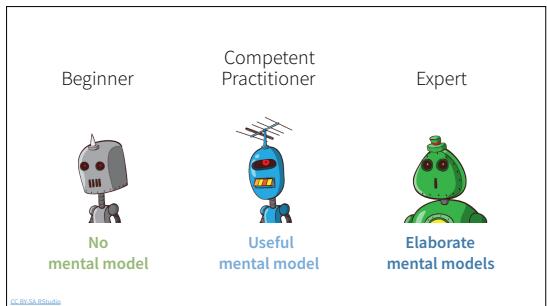
Here's another mental model that was drawn by a participant in a workshop one of us taught that shows the factors at play in tying a hijab. Do you have a narrow face or a round one? How does your preferred style affect your choice of fabric and pins? Again, there's a lot that isn't here (like whether your hair lies flat or is curly), but it's an actionable approximation to the truth, and that's all most people require most of the time.



12

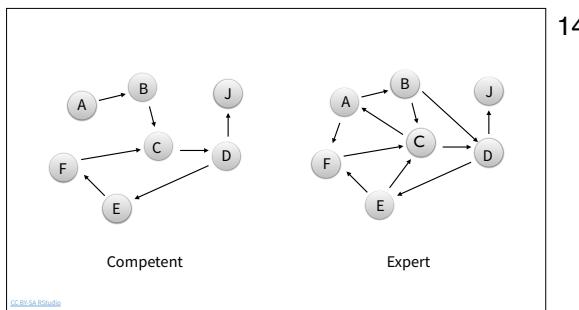
A diagram like this is called a **concept map**. One of the most important things about it is that it shows relationships as well as ideas. This matters because our brains are actually very bad at forgetting things. What happens instead is that we lose our ability to recall them. When we're teaching novices, it's therefore important to emphasize the links just as much as the concepts themselves, because without the links, the knowledge might as well not be there.

Note that the order in which you **draw** and the order in which you **teach** need not be the same – in fact, they usually aren't – but a good lesson will follow the links from concept to concept.



Let's return to our three learners. How can mental models help explain the difference between them?

- The novice doesn't (yet) have a working mental model.
- The competent practitioner has one that covers most common cases.
- The expert's has more nodes, but crucially, also has more links.



Here's why this matters. To get from A to F, a competent practitioner has to reason her way through B, C, D, and E (and possibly backtrack out of J). An expert, on the other hand, might have a direct link from A to F that lets them solve the problem in a single step. This is what we mean by intuition, and it's also why experts are often so bad at explaining their reasoning: there wasn't any.

To make a graph

```
ggplot(data = survey) +
  geom_points(mapping = aes(x=disp, y=mpg))
```

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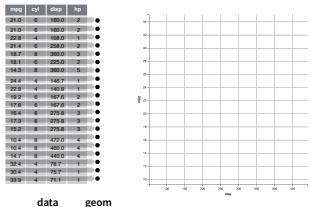
And here's what that looks like in action. Someone who had been using ggplot2 for a while would probably type this in without thinking about it.

To make a graph

16

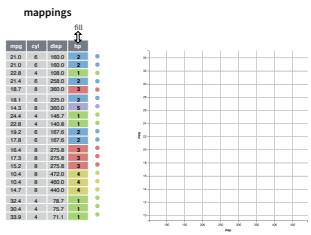
1. Pick a **data** set
2. Choose a **geom** to display cases
3. **Map** aesthetic properties to variables

But in doing that, they're relying on a mental model that has several key concepts, which in turn relate to each other in important ways.



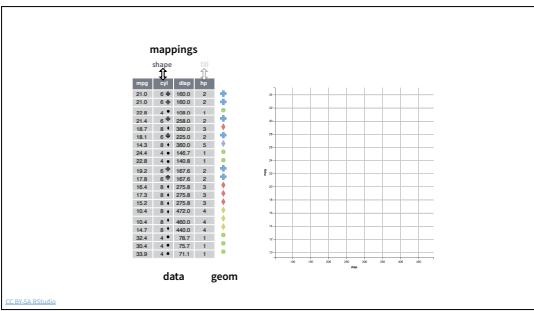
17

You need to understand that the properties of your data can be selected and turned into geometry.



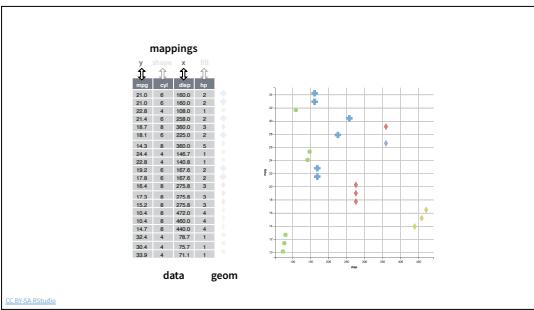
18

You need to understand how multiple properties can be mapped to different aspects of what the library is going to draw for you, like color...



19

...or symbol...



20

...or x and y position. Once you have that model in your mind, the library becomes “obvious”.

Create a Concept Map

21

1. Draw a concept map for the features of ggplot2 just shown. Remember that (labelled) links are just as important as concepts.
 2. Compare your concept map to your neighbor's. Where did you agree and disagree?