Investigating Student Use of Representation in Quantum

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Notation Key:

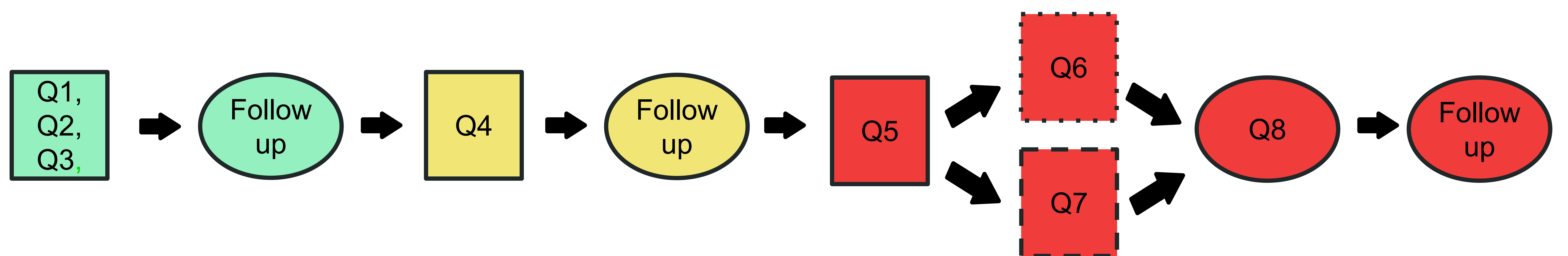|	
Spinor	$\chi = \frac{3}{5} \cdot \chi_+ - \frac{4}{5} \cdot \chi_-$
Dirac	$|\psi\rangle = \frac{3}{5} \cdot |+\rangle - \frac{4}{5} \cdot |-\rangle$
Matrix	$\chi = \frac{3}{5} \cdot \begin{bmatrix} 1 \\ 0 \end{bmatrix} - \frac{4}{5} \cdot \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

Meta-Representational Competence:

"...[describes] the full range of capabilities that students (and others) have concerning the construction and use of external representations"
diSessa, Sherin (2000)

Question: When would you choose a bar graph vs a pie chart?

Semi-Structured Interview Protocol (IM)

Q1, Q2, Q3, → Follow up → Q4 → Follow up → Q5 → Q6 / Q7 → Q8 → Follow up

CG

So when you were choosing the matrix representations like basis and stuff, in my opinion, that's super, super similar to picking a coordinate system… because sometimes, for example, if you picked a good basis to work in, you know, all your stuff will fly out really easy.

If you're trying to like. Open like… a phillips screw, with like a butter knife or something like that. It's way harder, you know. But then you try to butter your toast with a phillips screwdriver. That might not work.

PS

Okay. So I think I could go back and like maybe like interpret that (points at Q5) to get my A B it cause writing like this is makes sense.

When changing basis I would prefer to use matrix notation, I guess in general I would prefer it because then I just like, understand exactly what's going on and I can like, I just like make the distinctions…

Which Notations CG mentioned regarding…

Clarity	Aware of one's own progress in notation use	Abstractability
"Likeability"	Able to "step back" and weigh options to decide	Visualizability
Useful in Calculations	which notation system is best	Hierarchy

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Special thanks to:

Sam Gisi, Kristen Rodenhausen, Jessica Searl, and Megan Wawro

References:

[1]diSessa, Sherin (2000). "Meta-representation: an introduction"

[2]Wawro, Watson, Christensen (2020) "Students' metarepresentational competence with matrix notation and Dirac notation in quantum mechanics"