

QMAT slides from Steve G.

What is the point of the quantum post test (QMAT[†])?

- Traditional measures of assessment often do not explicitly address (faculty developed) course learning goals.
- Not meant to replace a traditional final exam.
- Compare conceptual learning by students with more traditional assessments (exams)
- Compare student learning in quantum mechanics from semester to semester.

[†]Quantum Mechanics Assessment Tool

What areas of student difficulty are targeted?

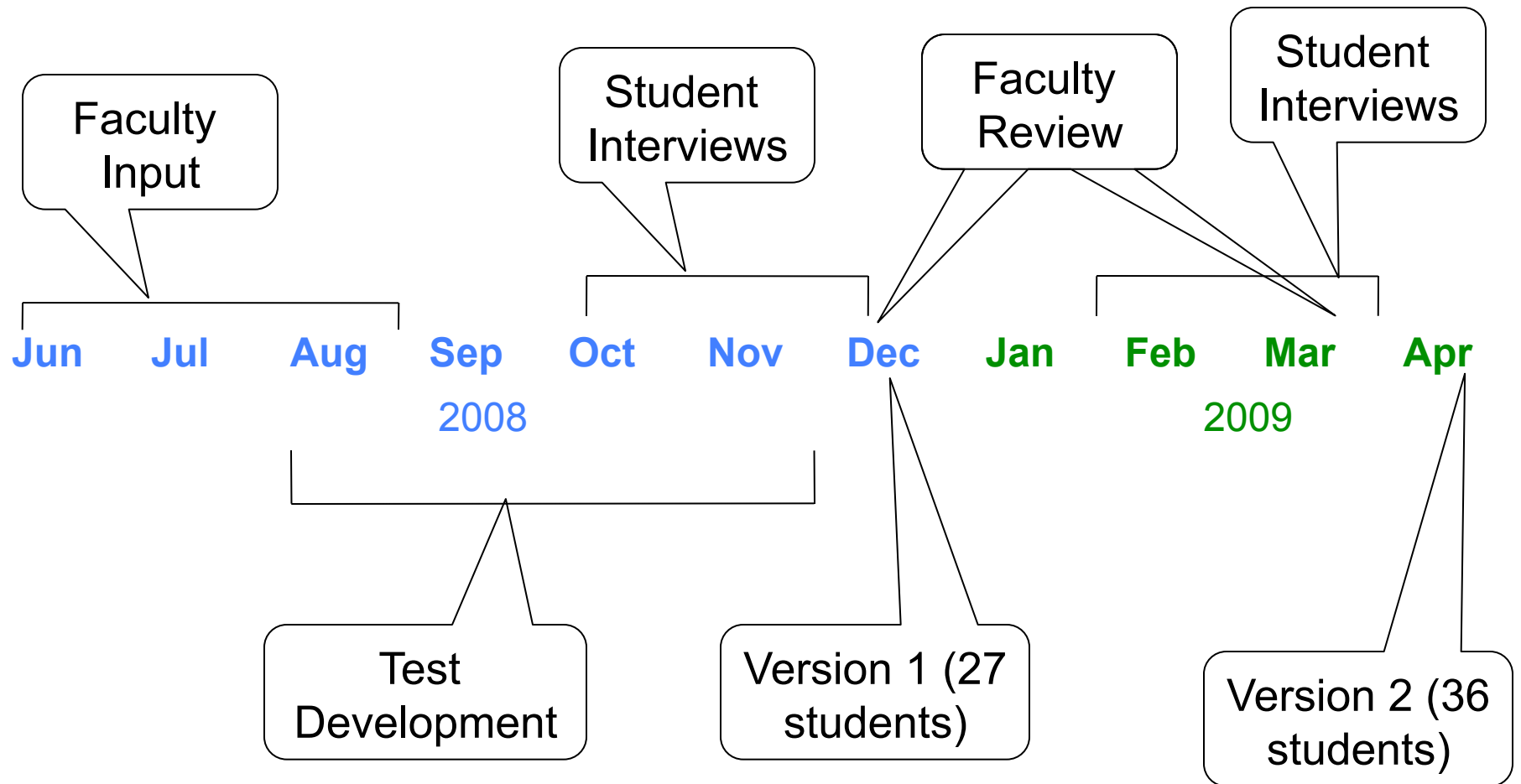
- Time dependence of a quantum state
- The form of the wave function
- Probability and probability density
- Meaning of quantum operators

How was the QMAT developed?

- Student learning difficulties were collected from in-class questions, homework help sessions, tutorials, and student interviews.
- Four questions were drawn from earlier work[†]
- New questions were developed by the STF and by the faculty working group
- Questions were reviewed by faculty and tested on students at various levels (including graduate students).

[†]QMCS developed by Sam McKagan

QMAT development timeline



Faculty Involvement in QMAT Development

Paul Beale [†]	Andreas Becker	Tom DeGrand	Oliver DeWolfe
Mike Dubson [†]	Noah Finkelstein	Steve Goldhaber [‡]	Chris Greene
Anna Hasenfratz	Ed Kinney	Kathy Perkins [†]	Steve Pollock [†]
John Price	Chuck Rogers	Kevin Stenson	Eric Zimmerman

[†]QMAT review committee member

[‡]SEI Science Teaching Fellow

Example QMAT Question

Consider a particle in a 1D, infinite square well with width a , centered at $a/2$. The normalized energy eigenstate wave functions are $u_n(x)$ with energies E_n ($n = 1$ is the ground state).

The particle starts in a state given by

$$\Psi(x, t = 0) = \left(\sqrt{\frac{4}{5}}u_1(x) + \sqrt{\frac{1}{5}}u_2(x) \right) .$$

Average

85%

a) You make an energy measurement on this system and find the maximum possible value for the energy. **What is the state of the system after this measurement?**

32%

b) After the energy measurement, you make a position measurement. After this position measurement, you immediately re-measure the energy. **At this point, what value(s) could you get for energy?**

25%

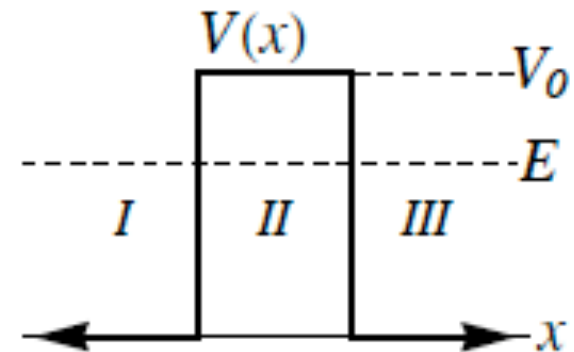
c) **Does your answer to part b depend on how long you wait between the position and energy measurements? Explain.**

42%

Learning Goal: Measurement Formalism

Example QMAT Question

Suppose a particle of mass m and total energy E has a potential energy function, $V(x)$ shown to the right. Note that in region II, $E < V_0$. What is the general 1-D solution to the time independent Schrödinger equation in this region (region II)? Where possible, define any constants in terms of E , V_0 , and m .



Average
60%

Learning Goal: Simple solution to differential equation. Problem represents simple tunneling example.

Example QMAT Question

Is the following statement true for all operators, \hat{O} ? **Explain briefly why you agree or disagree.**

A system which is in an eigenstate of \hat{O} will stay in that state until disturbed by measurement.

Average
46%

Learning Goal: Understand time development