

## Week 6 Video 2

Visualization

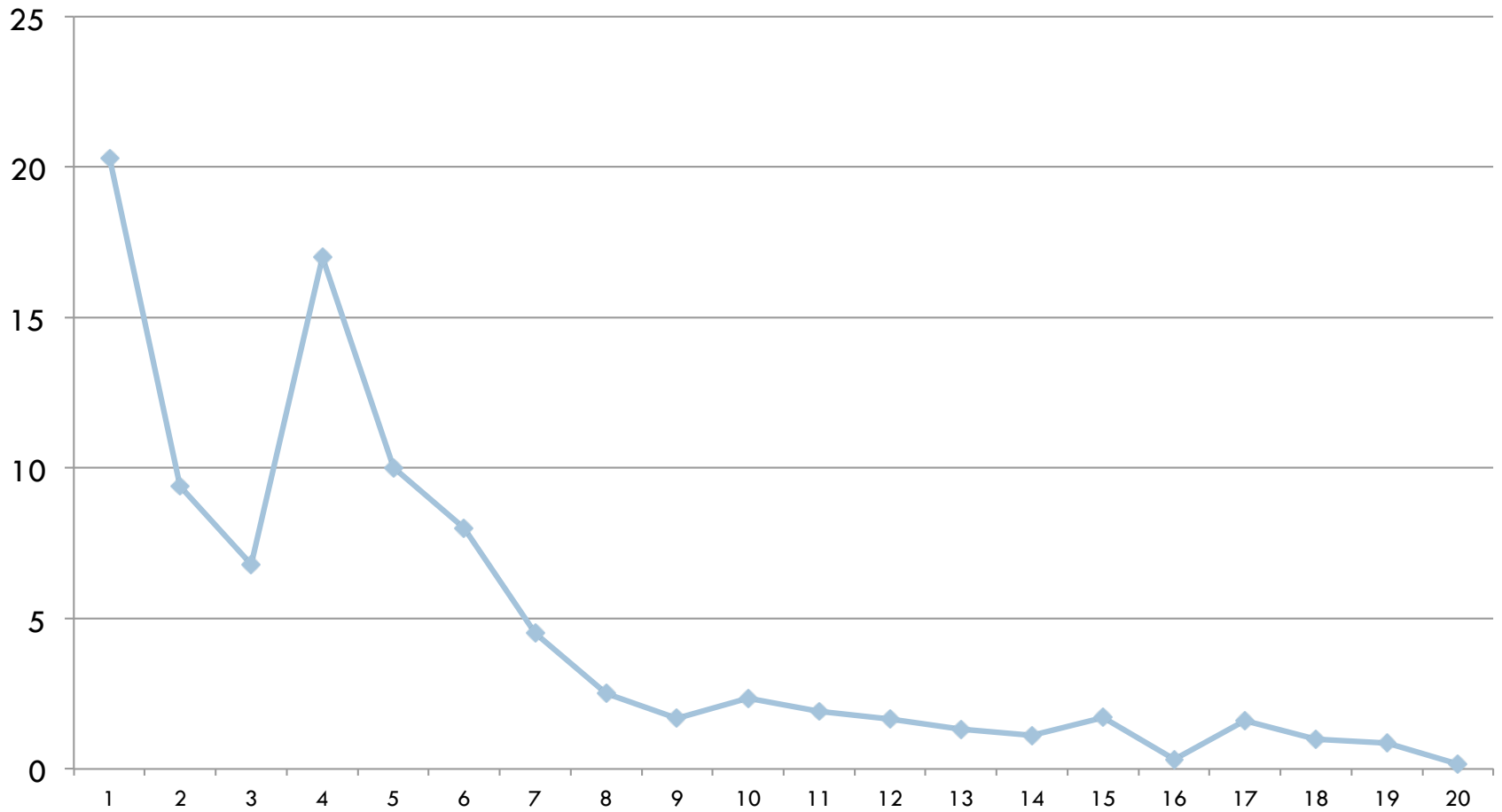
Moment-By-Moment Learning Graphs

# First...

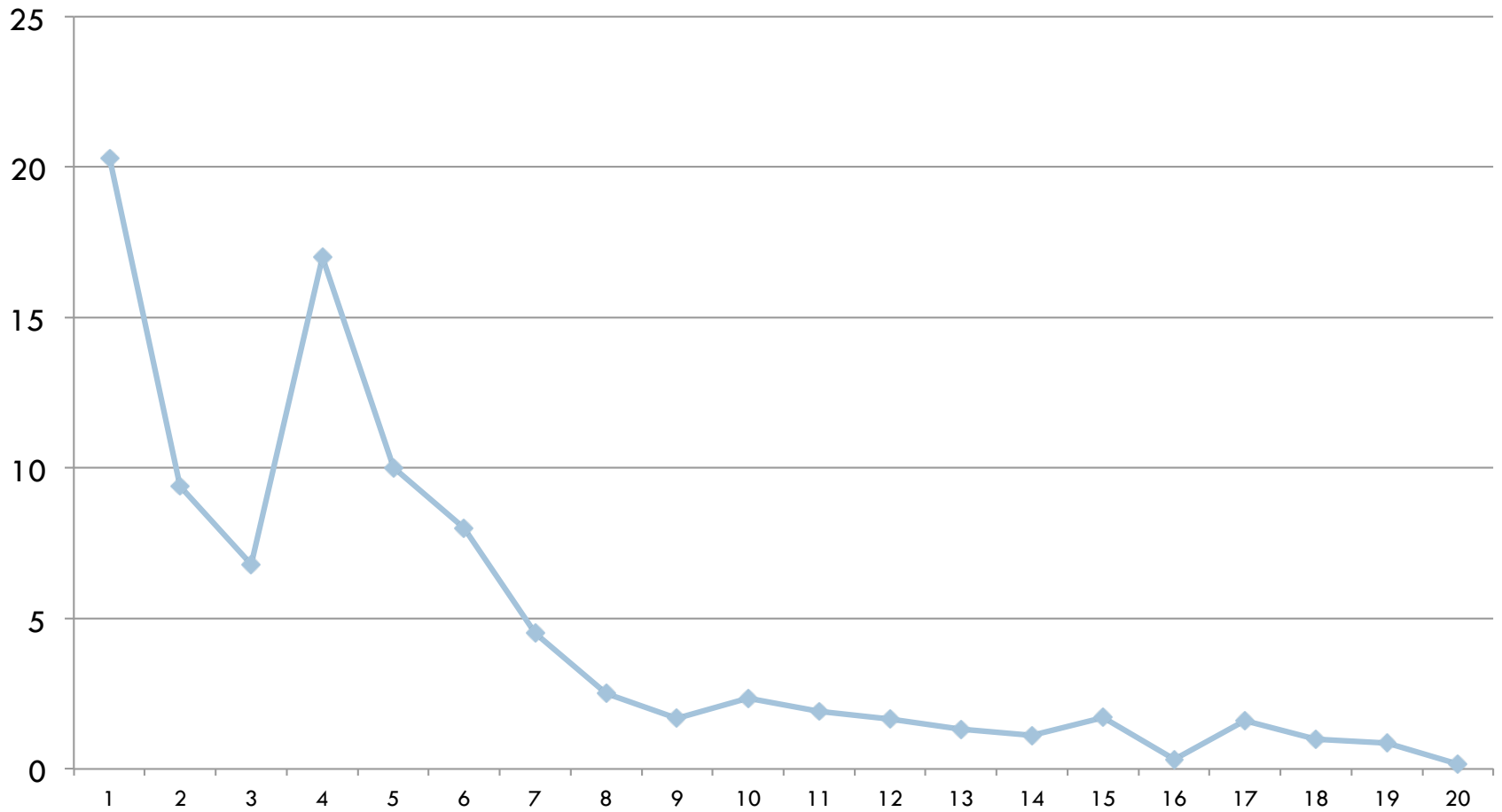
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- I'd like to start with an observation about learning curves

# They shouldn't be called learning curves



# They should be called performance curves



# They should be called performance curves



- Because they show the relationship between performance and time
- You can infer learning from them...
- But they aren't curves of learning

# This was fine for decades...

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- Until folks actually wanted to graph learning over time
- Then it became really annoying

# Moment-By-Moment Learning Graphs (MBMLG)

- (True learning curves, but we can't call them that)

# Based on the Moment-By-Moment Learning Model

- Baker, R.S.J.d., Goldstein, A.B., Heffernan, N.T. (2011) Detecting Learning Moment-by-Moment. *International Journal of Artificial Intelligence in Education*, 21 (1-2), 5-25.
- Discussed in mathematical detail in week 4





# Moment-By-Moment Learning Model

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- Gives us moment-by-moment assessments of learning

# Can be used to create a Moment-by-Moment Learning Curve

- X axis: Opportunity to practice skill
- Y axis: Moment-by-Moment learning assessments

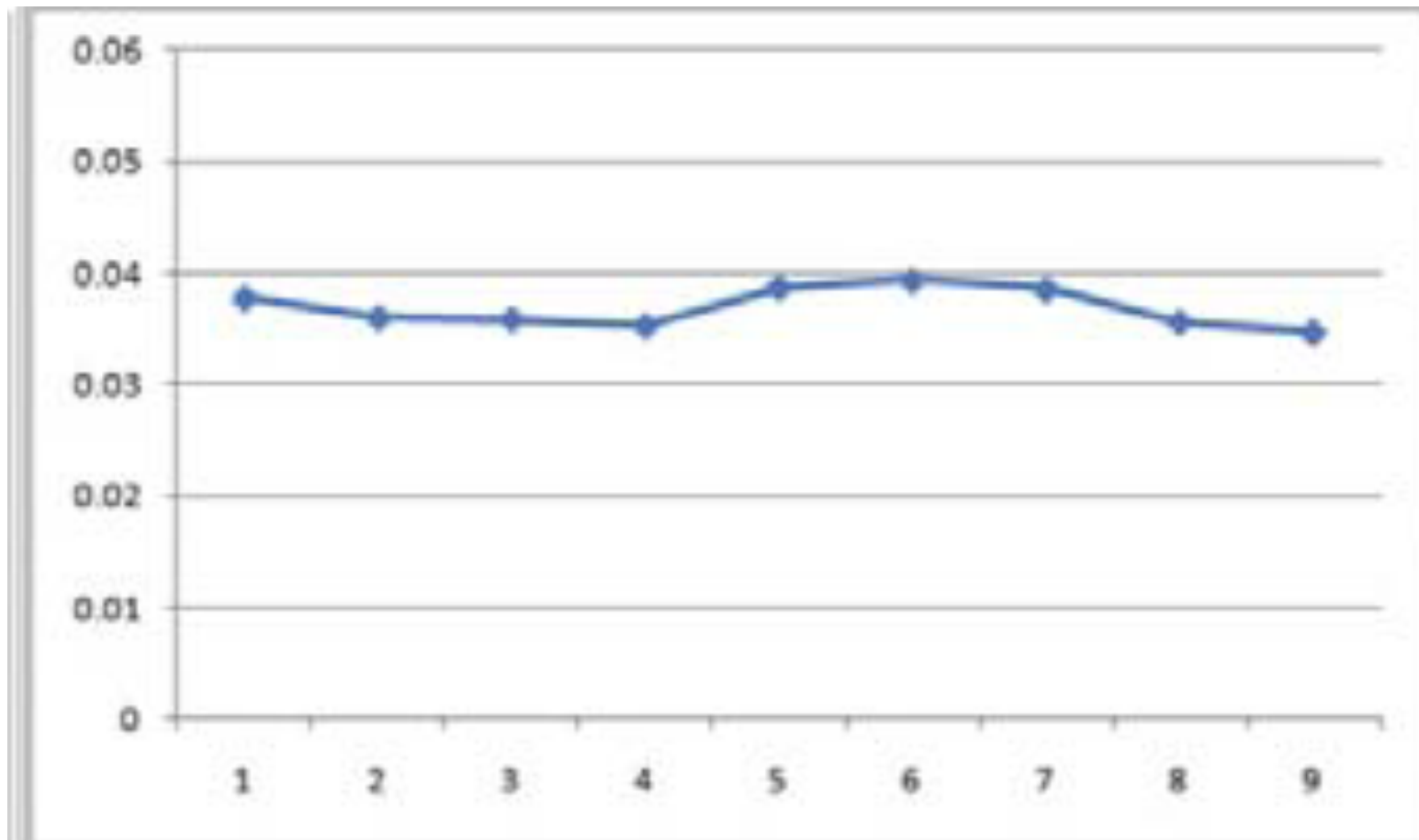
# Moment-by-moment learning curves

- Are meaningful to interpret for individual students
- Much harder to do this with traditional learning curves
  - ▣ Accuracy = 0 or 1
  - ▣ Time is noisy

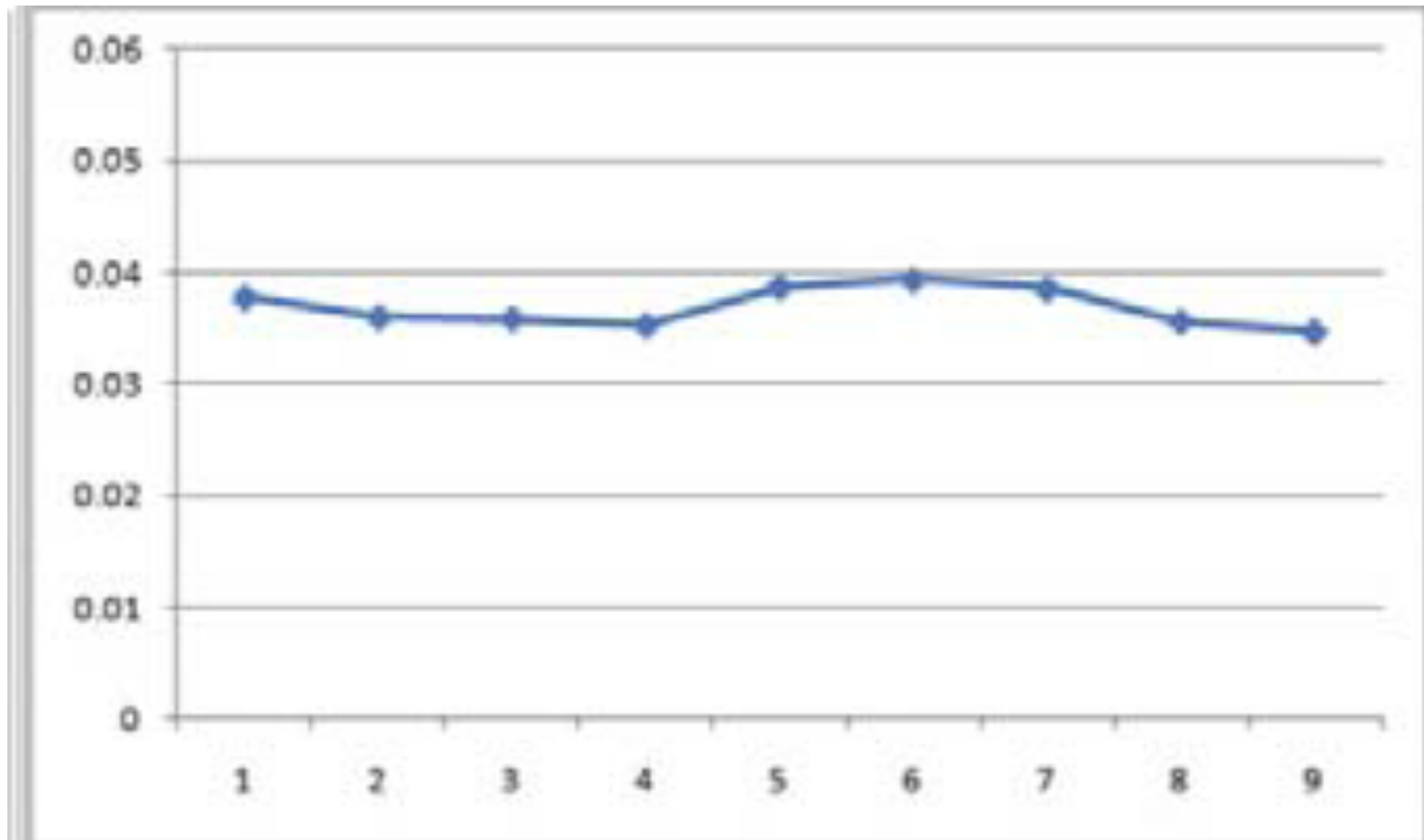
# Let's look at a few graphs



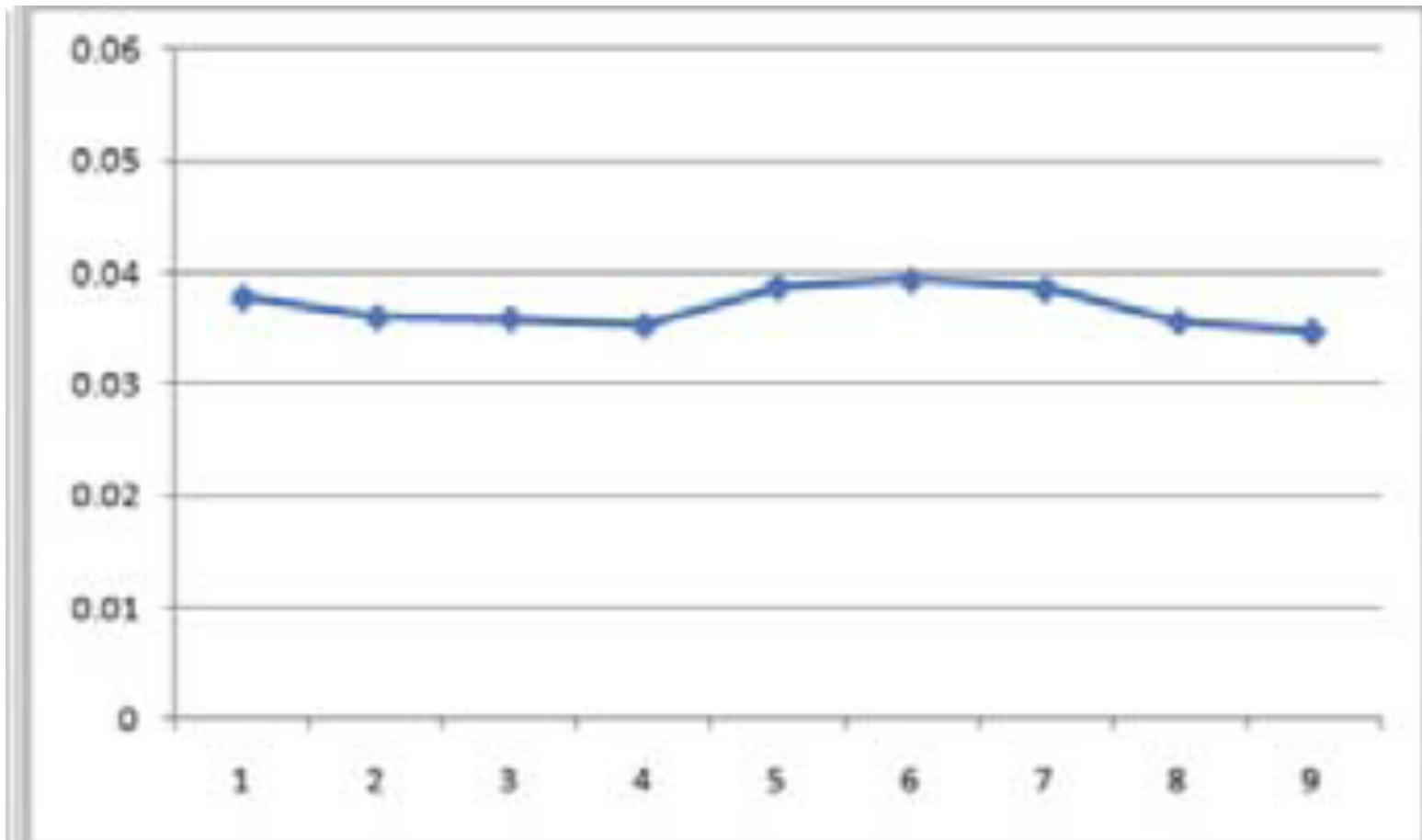
# What might this MBMLG mean?



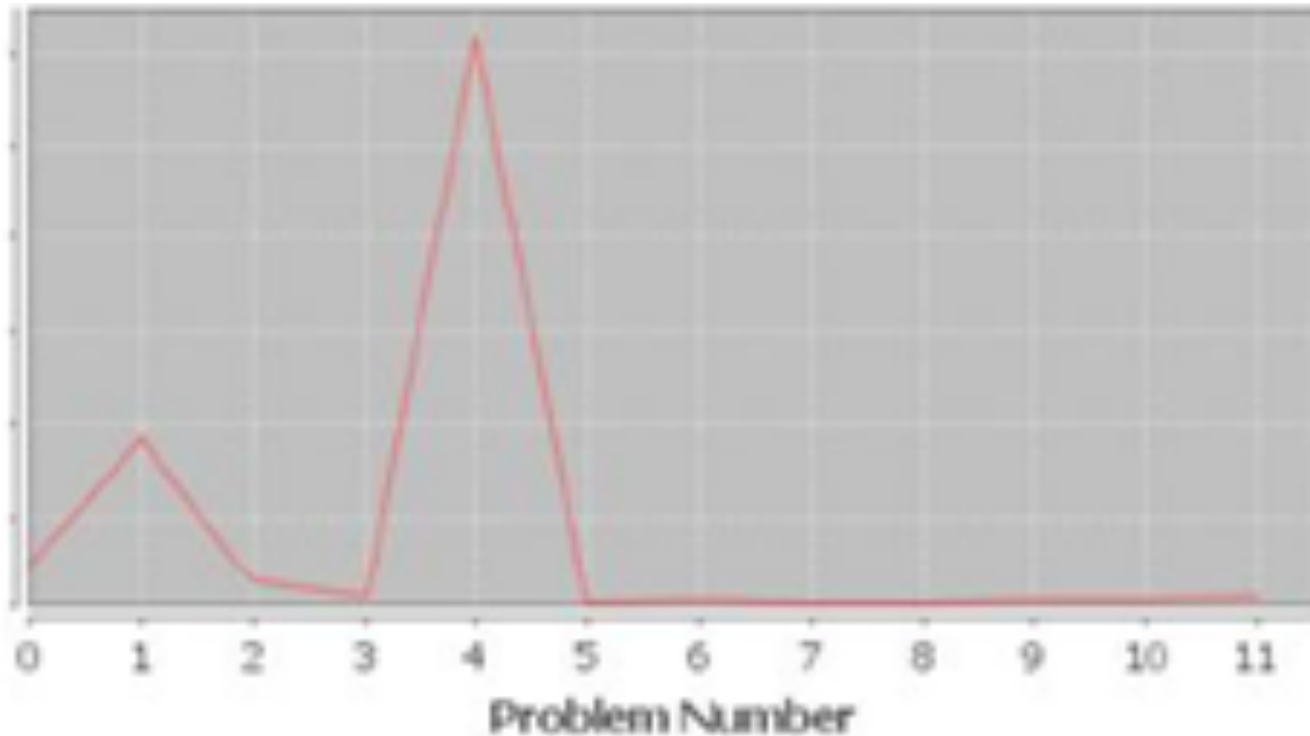
# Insert Pause-Continue Quiz Here



# Steady learning

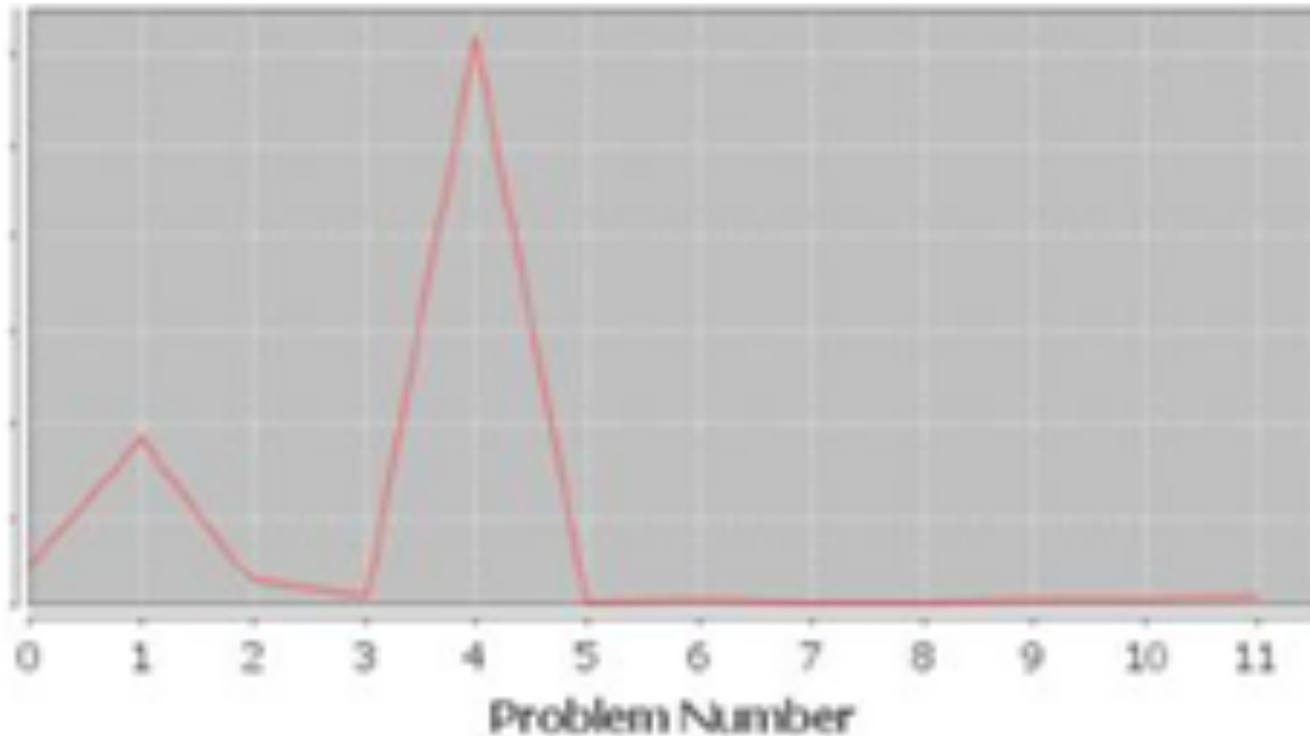


# What might this MBMLG mean?

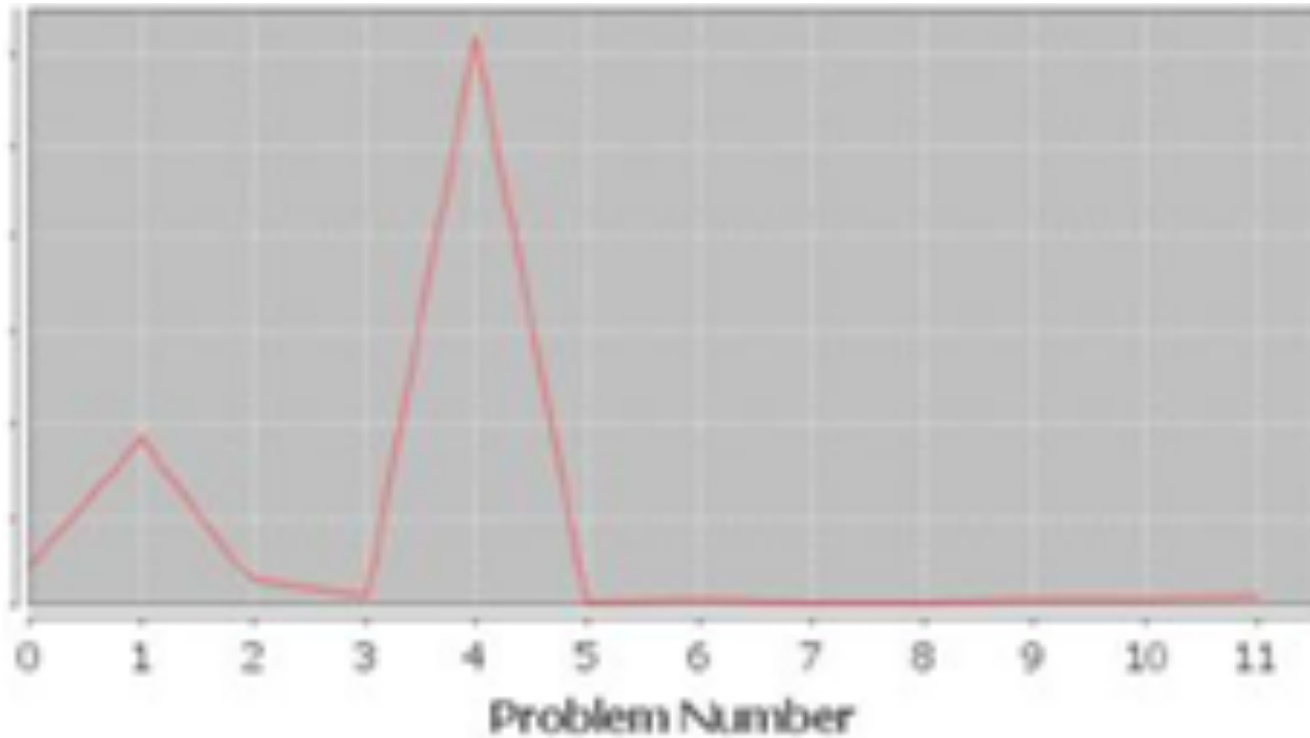




# Insert Pause-Continue Quiz Here



# A Eureka moment



# What would that model correspond to

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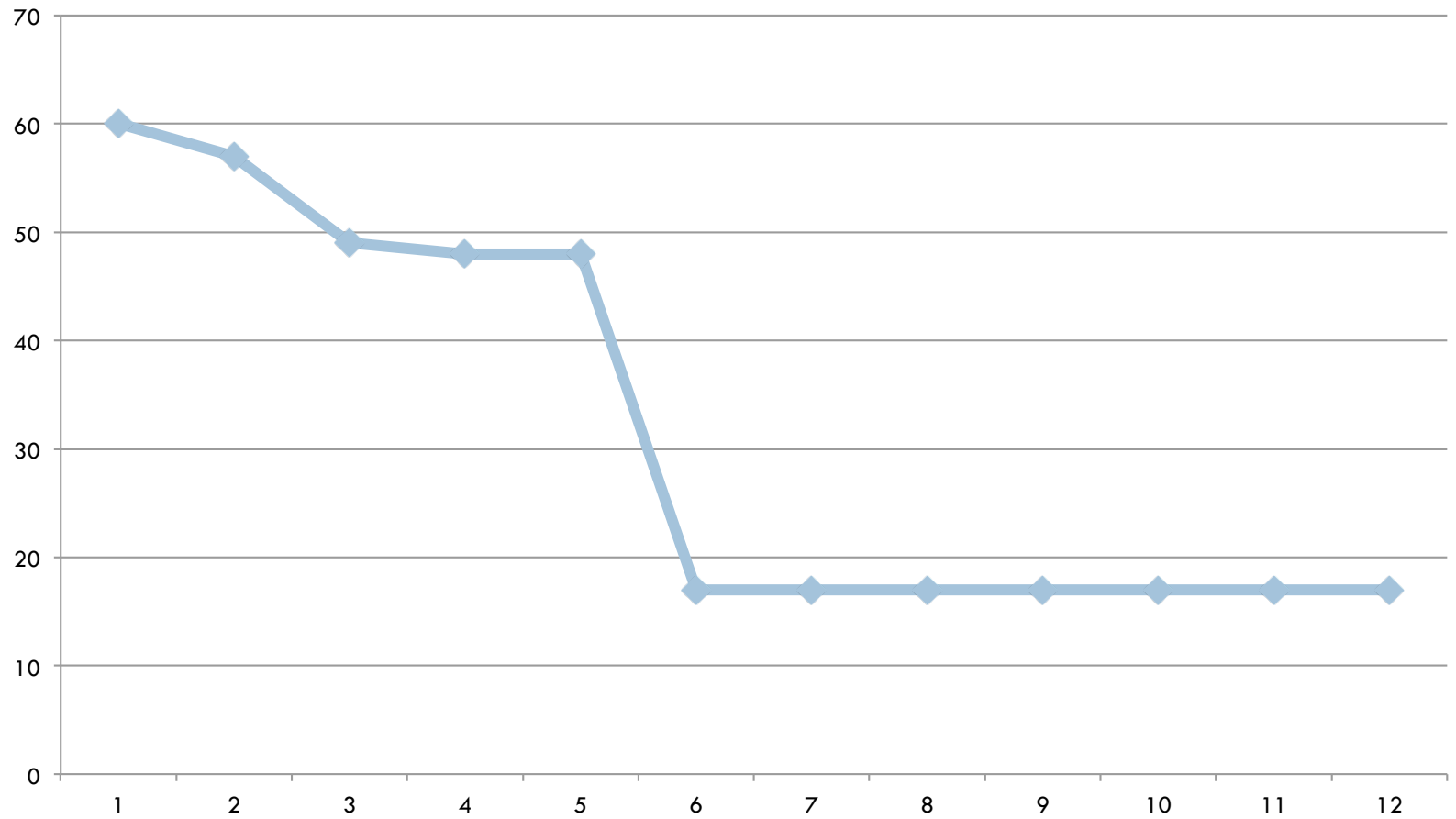
- In a traditional learning curve?

# Insert Pause-Continue Quiz Here

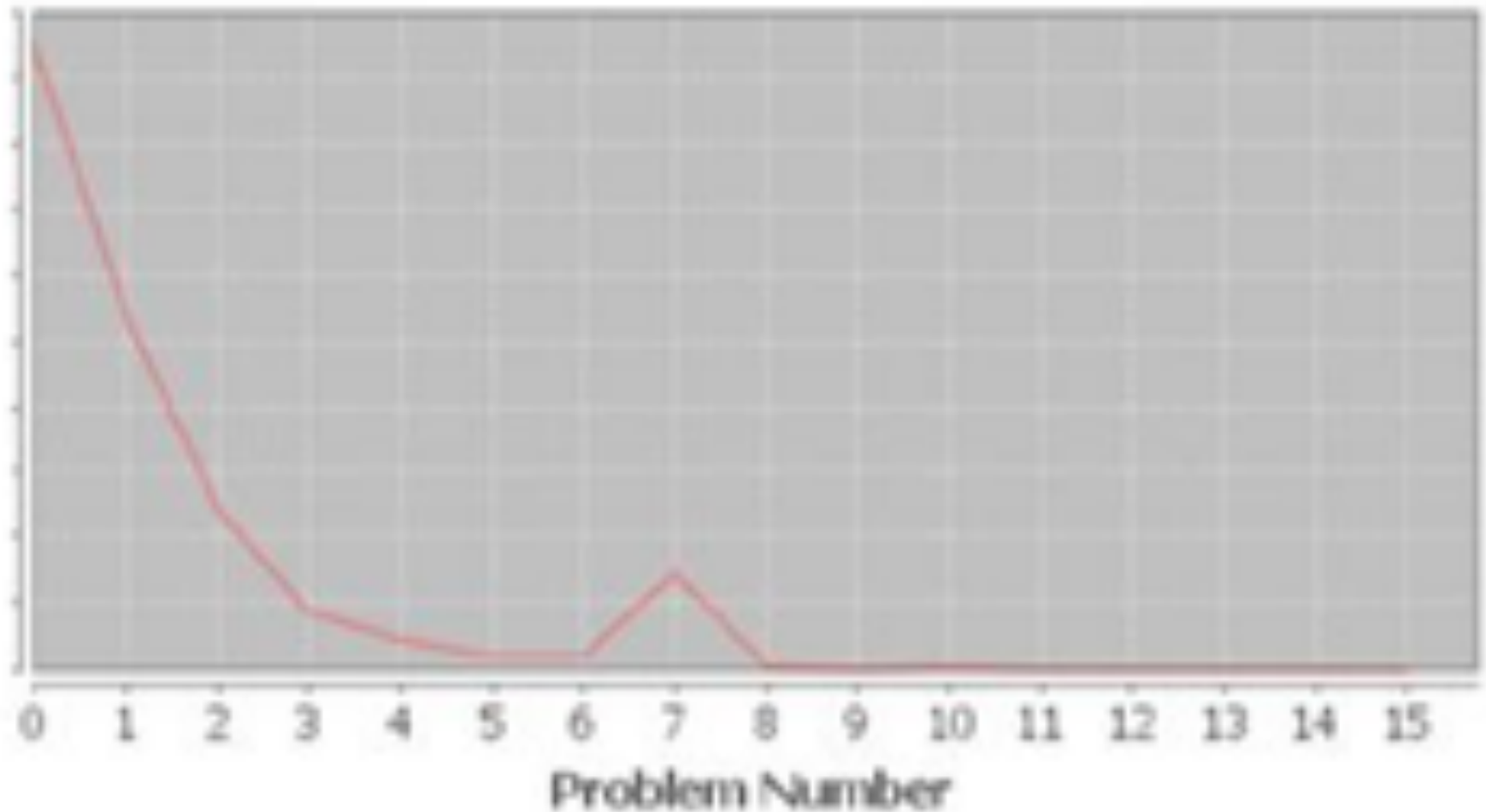
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- What would that model correspond to in a traditional learning curve?

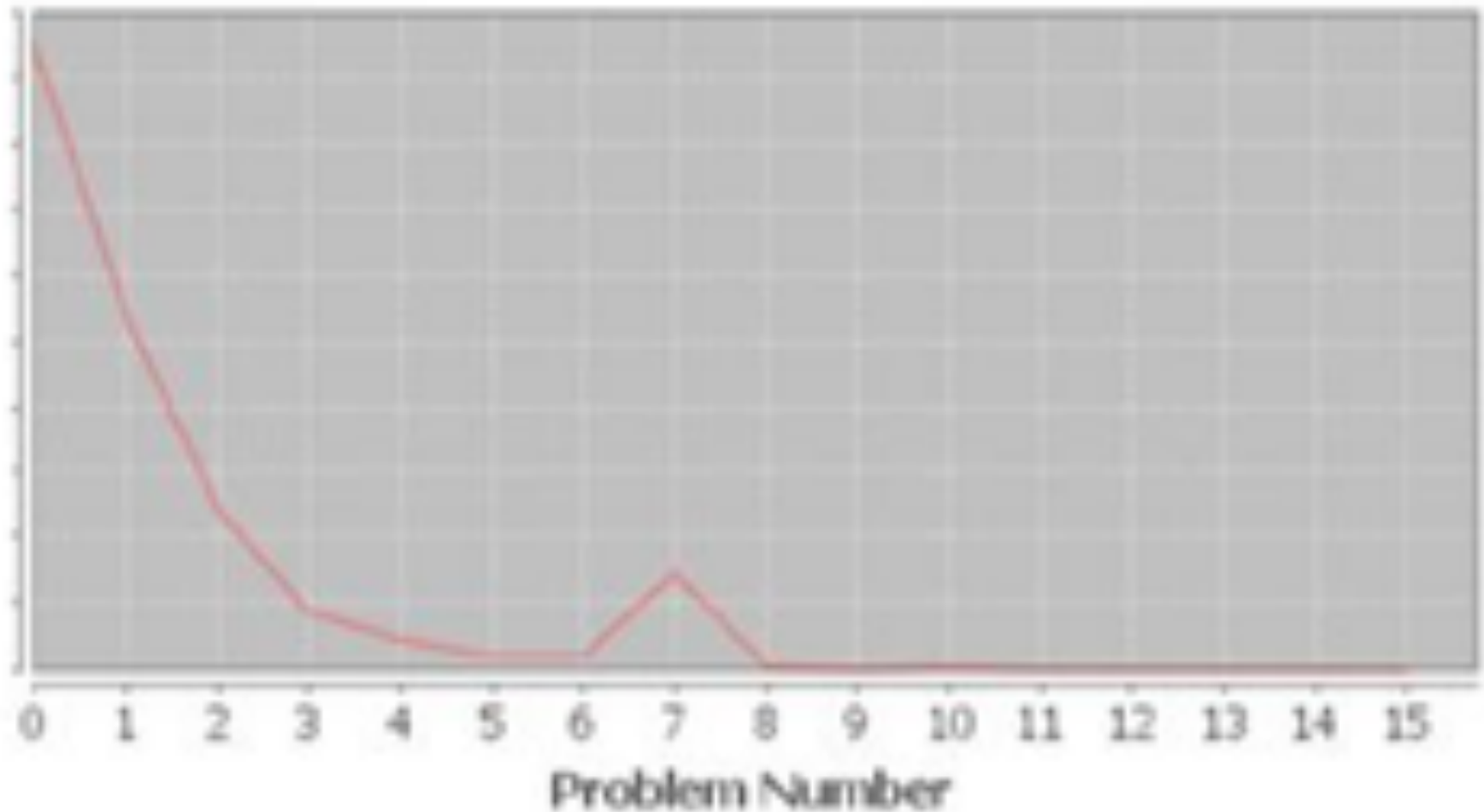
# A Eureka Moment



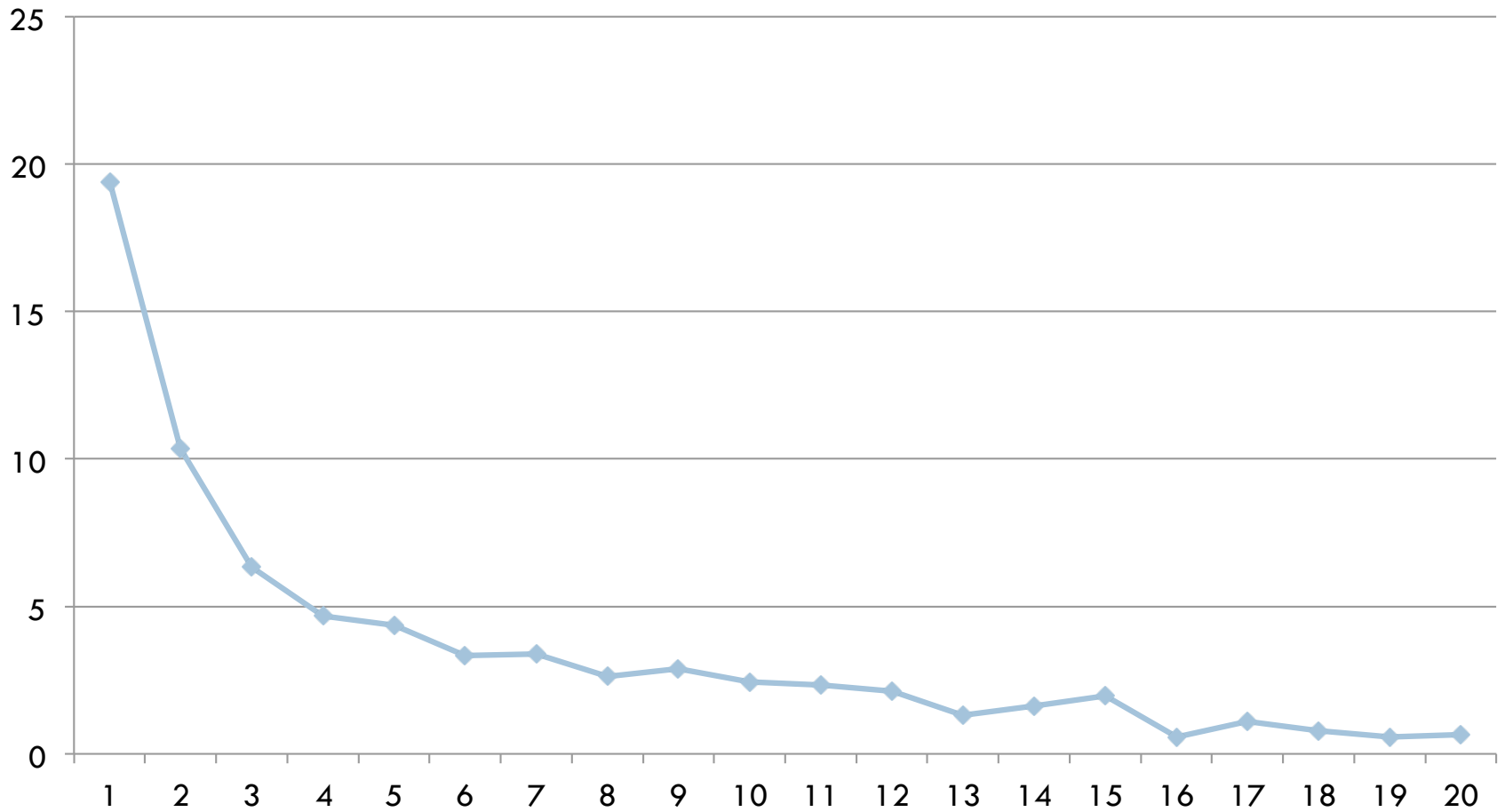
# What might this graph mean?



# Insert Pause-Continue Quiz Here

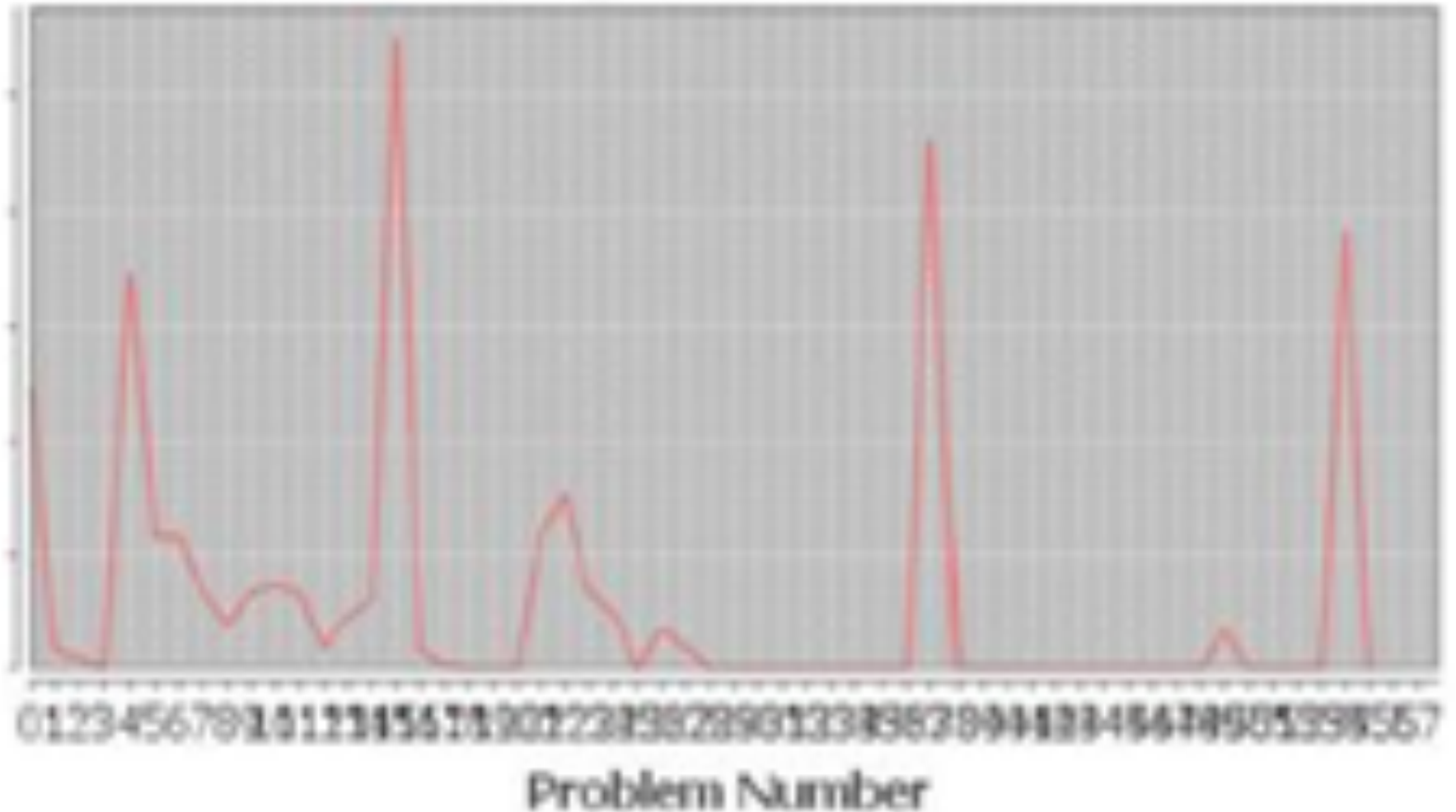


# Corresponds to learning curve

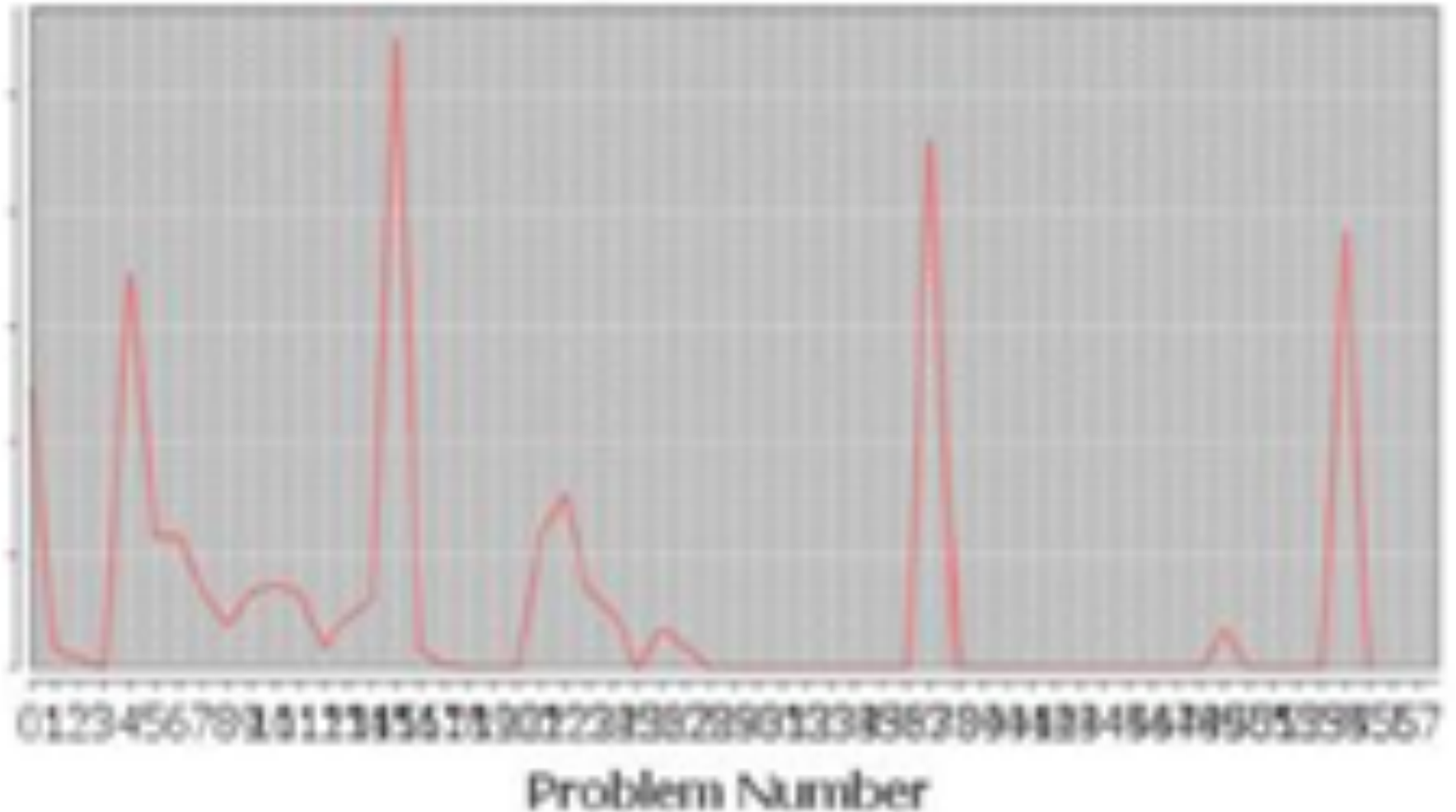




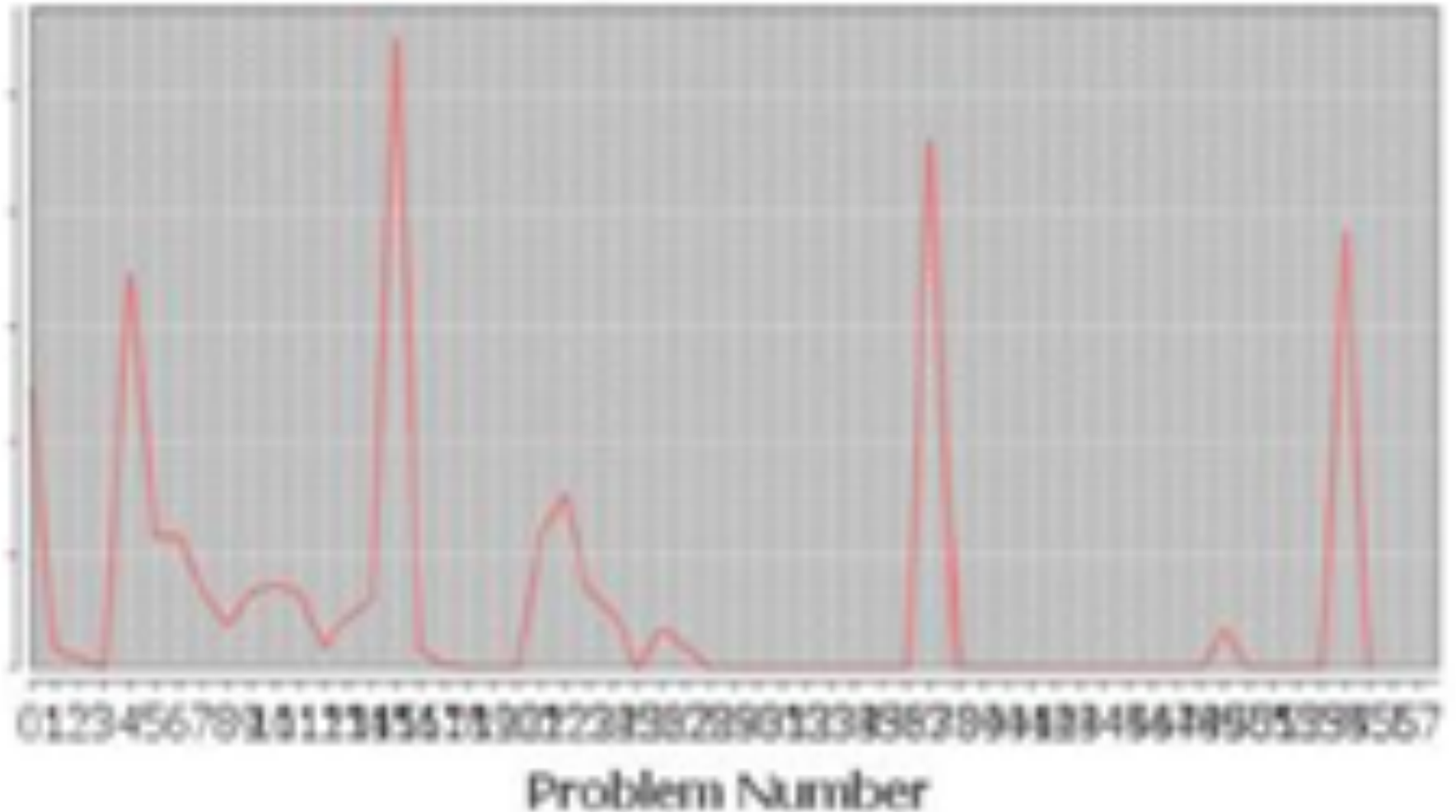
# What might this graph mean?



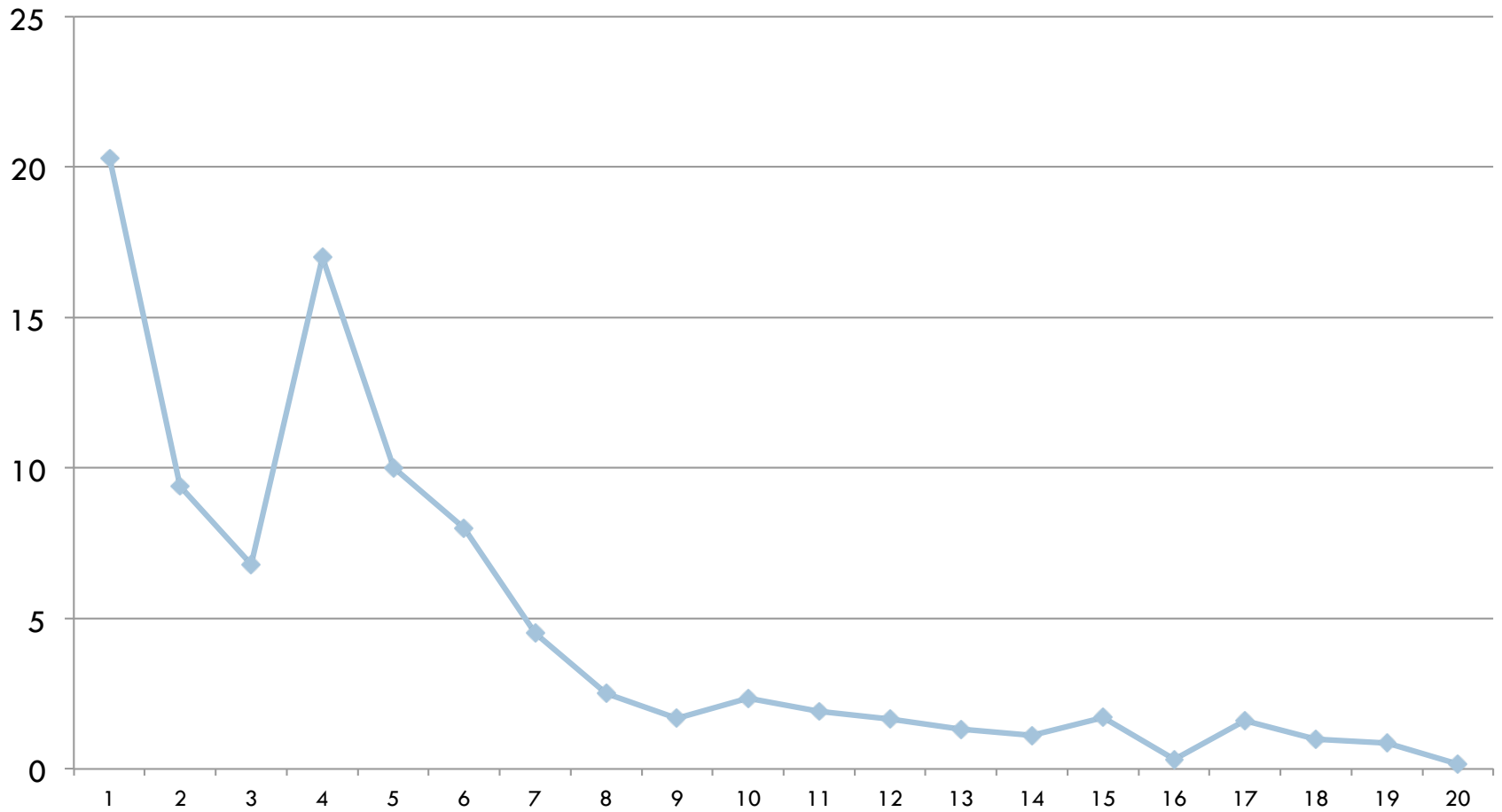
# Insert Pause-Continue Quiz Here



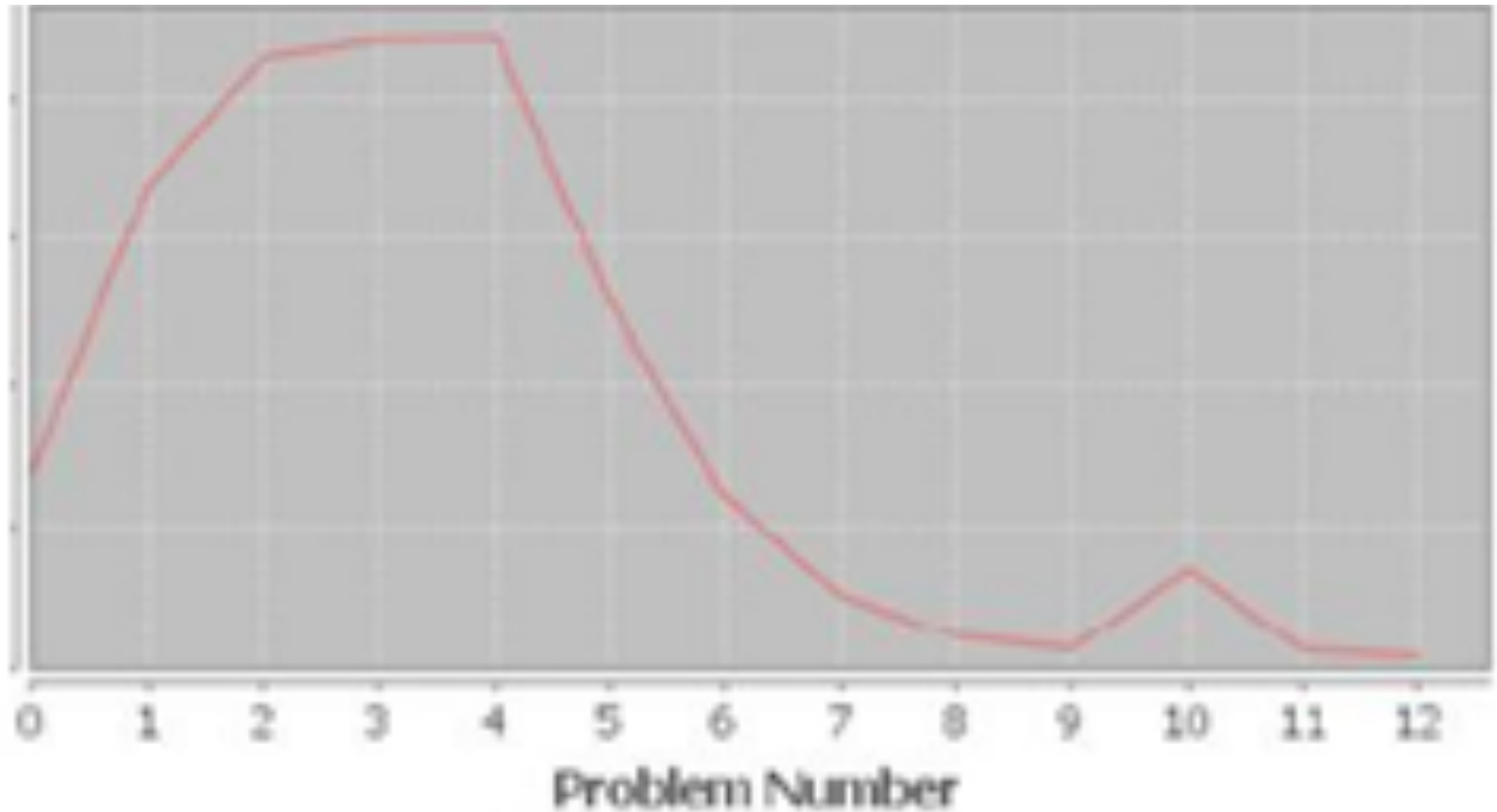
# Multiple skills treated as a single skill



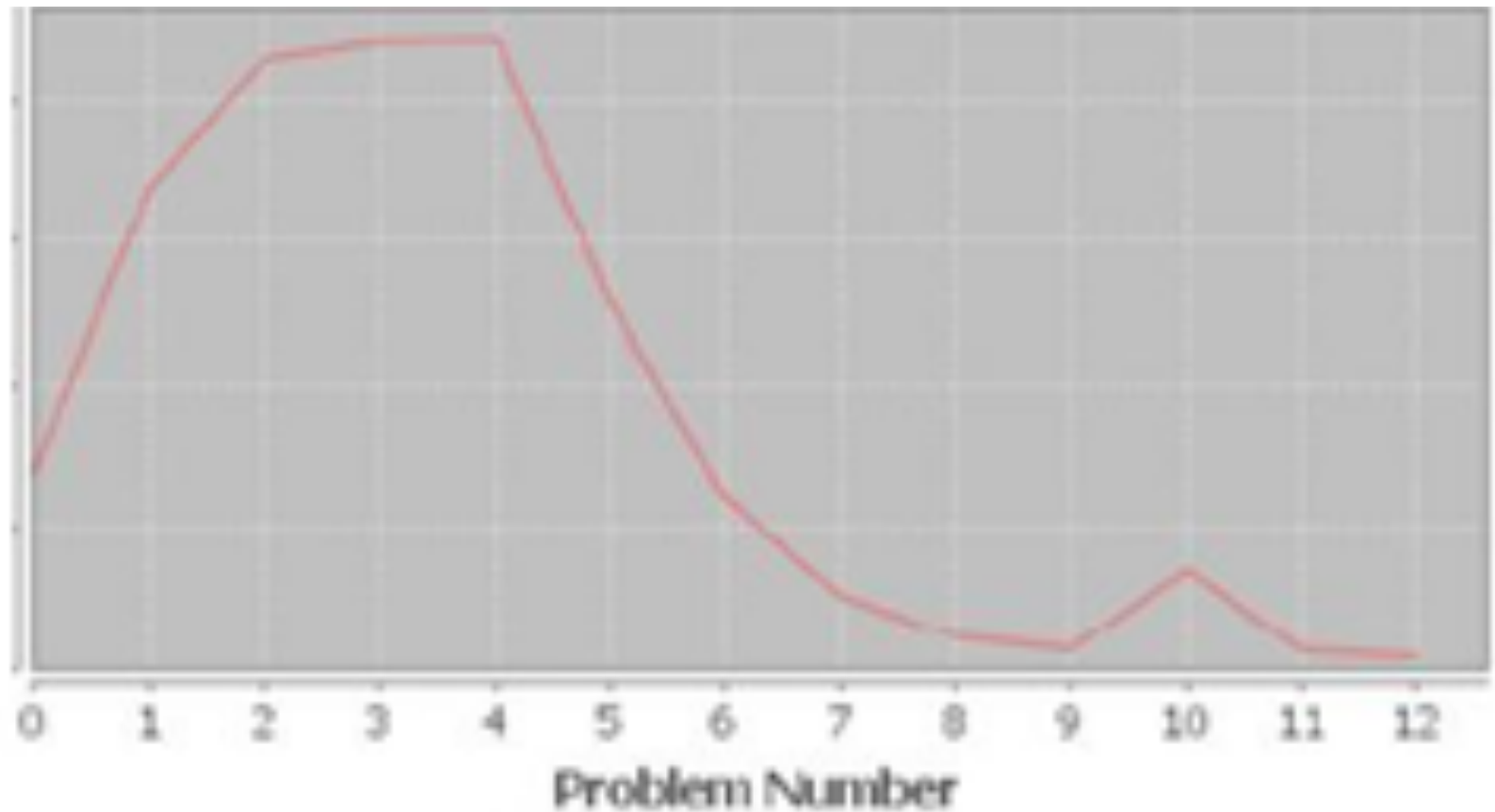
# Corresponds to (several)



# What might this graph mean?

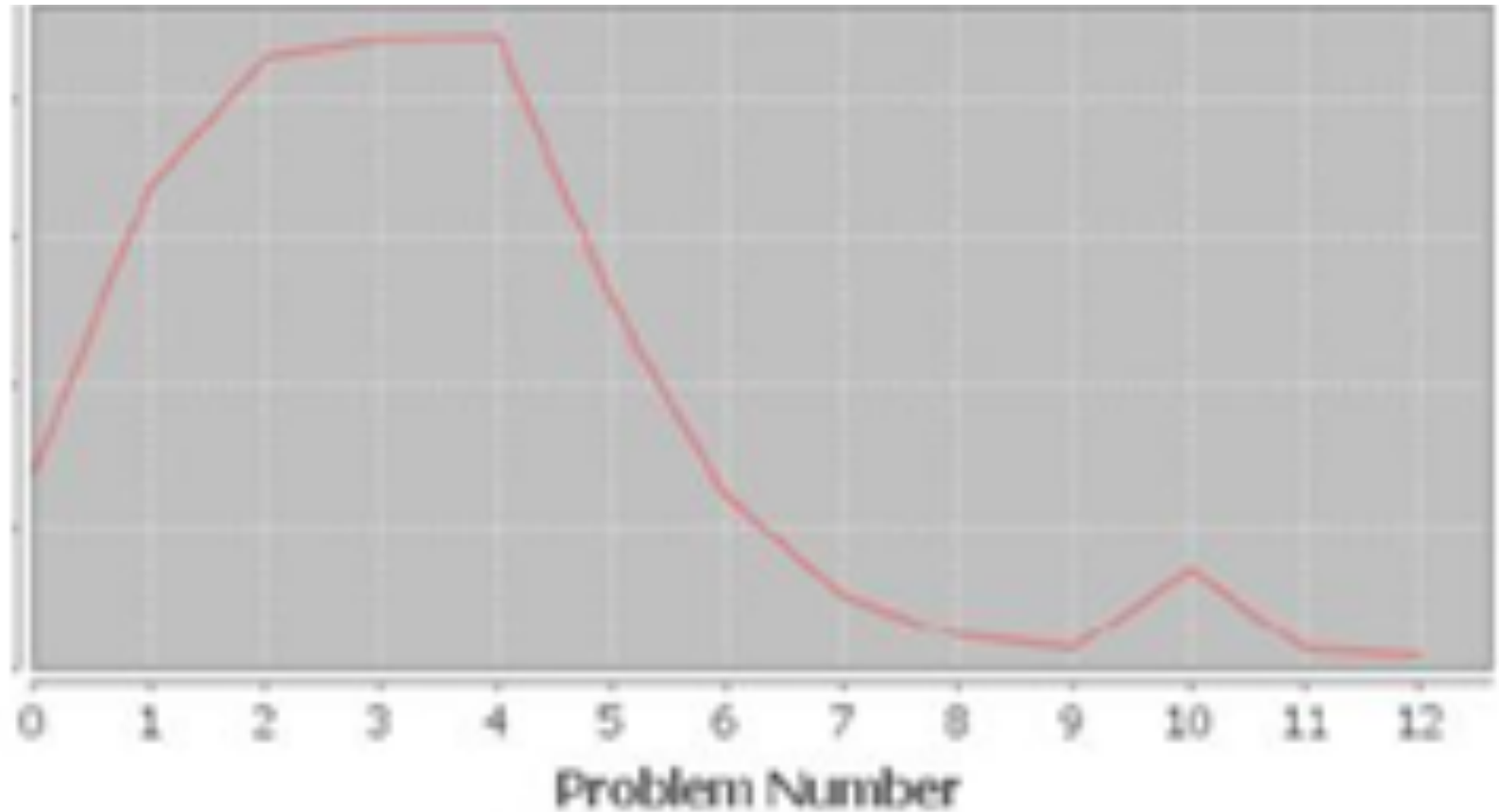


# Insert Pause-Continue Quiz Here

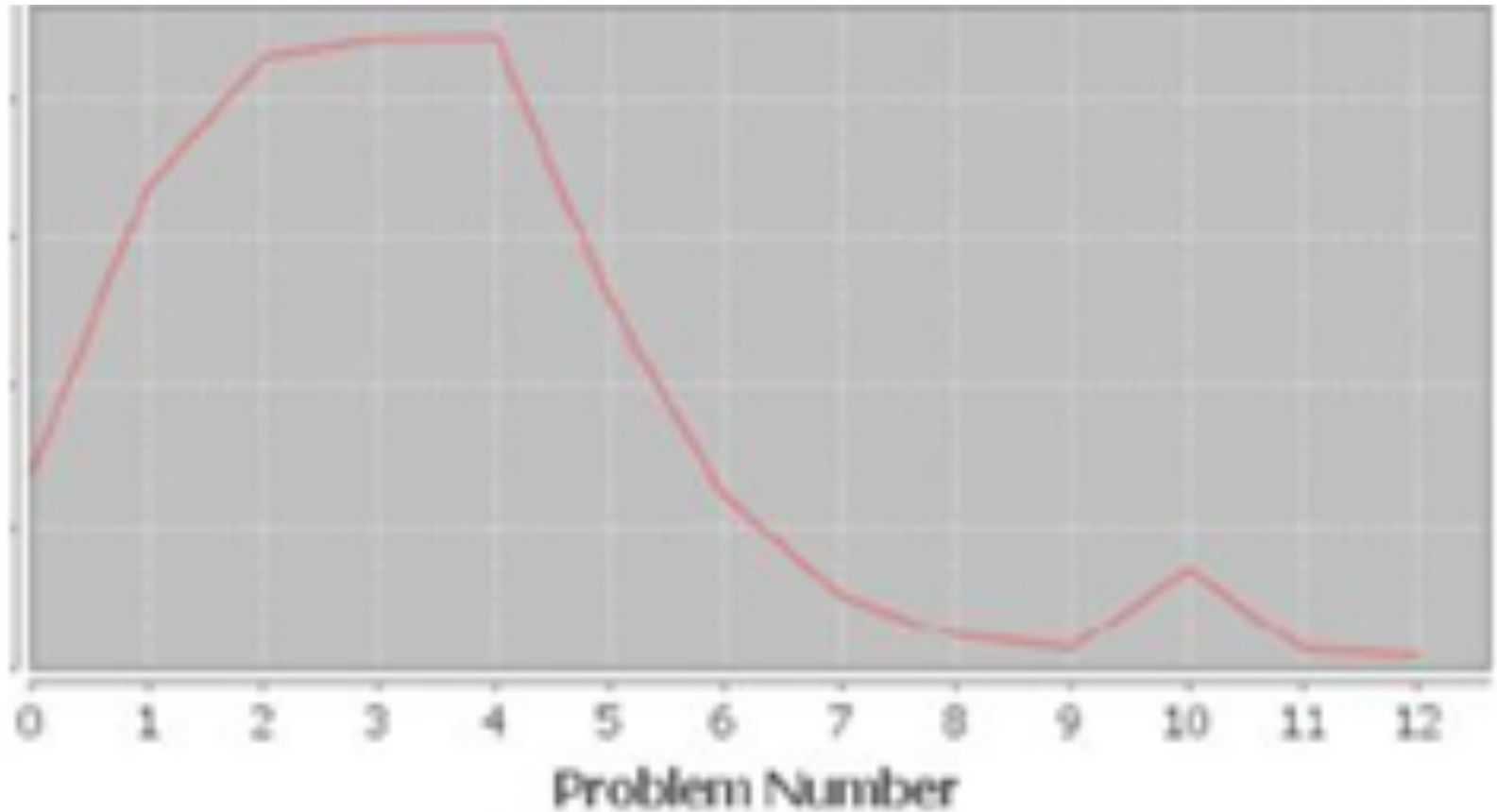


It's still a mystery to me...

(post your ideas on the forums!)



(It turns out to be quite common)





# Uses

- To study relationships between learning trajectories and learning outcomes
- Baker, R.S.J.d., HersHKovitz, A., Rossi, L.M., Goldstein, A.B., Gowda, S.M. (in press) Predicting Robust Learning With the Visual Form of the Moment-by-Moment Learning Curve. To appear in the *Journal of the Learning Sciences*.

Table 4 – The correlation between a student’s proportion of a specific visual form of the moment-by-moment learning curve across skills, and their performance on the four learning tests. Statistically significant findings (controlling for false discovery rate) are highlighted in dark gray; marginally significant findings are highlighted in light gray.

Curve form	Test	r	F	p	q
pct single spike	Post-test	0.075	0.400	0.529	0.374
	Transfer test	-0.036	0.095	0.759	0.446
	PFL test	-0.139	1.402	0.240	0.253
	Retention Test	-0.094	0.636	0.428	0.330
pct close multi-spike	<i>Post-test</i>	<i>-0.247</i>	<i>4.610</i>	<i>0.035</i>	<i>0.056</i>
	Transfer test	-0.094	0.634	0.429	0.330
	PFL test	-0.035	0.085	0.771	0.446
	Retention Test	0.045	0.142	0.708	0.446
pct separated multi-spike	Post-test	-0.134	1.301	0.258	0.253
	Transfer test	0.011	0.008	0.927	0.492
	PFL test	-0.113	0.916	0.342	0.311
	Retention Test	0.063	0.285	0.595	0.399
pct plateau	<b>Post-test</b>	<b>-0.377</b>	<b>11.786</b>	<b>0.001</b>	<b>0.006</b>
	<b>Transfer test</b>	<b>-0.276</b>	<b>5.847</b>	<b>0.018</b>	<b>0.036</b>
	<b>PFL test</b>	<b>-0.272</b>	<b>5.663</b>	<b>0.020</b>	<b>0.036</b>
	<b>Retention Test</b>	<b>-0.515</b>	<b>25.647</b>	<b>0.000</b>	<b>0.000</b>
pct immediate peak	Post-test	0.092	0.601	0.441	0.330
	<i>Transfer test</i>	<i>0.214</i>	<i>3.399</i>	<i>0.069</i>	<i>0.098</i>
	PFL test	0.017	0.021	0.886	0.490
	<b>Retention Test</b>	<b>0.347</b>	<b>9.725</b>	<b>0.003</b>	<b>0.011</b>
pct immediate drop	<b>Post-test</b>	<b>0.317</b>	<b>7.930</b>	<b>0.006</b>	<b>0.020</b>
	Transfer test	0.167	2.035	0.158	0.183
	<b>PFL test</b>	<b>0.285</b>	<b>6.286</b>	<b>0.014</b>	<b>0.036</b>
	Retention Test	0.206	3.152	0.080	0.102

# Uses

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- To analyze individual students' learning

# Uses

- To study which learning material most promotes learning
- Gowda, S., Pardos, Z., Baker, R.S.J.d. (2012) Content Learning Analysis Using the Moment-By-Moment Learning Detector. *Proceedings of the International Conference on Intelligent Tutoring Systems*, 434-443.

# Next lecture

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- Heat Maps, Scatterplots, and Parameter Space Maps