ACTIVE LEARNING

CSE 216 – RENJIE ZHAO-5/30/2019

HOW COMPUTER HELPS LEARNING

- STUDENT – TEACHER INTERFACE
  - COGNITIVE TUTORS
- STUDENT – COMPUTER INTERFACE
  - CHALLENGE: ONLINE EXPERIMENTS & EDUCATIONAL GAMES

COGNITIVE TUTORS: TECHNOLOGY BRINGING LEARNING SCIENCE TO THE CLASSROOM

STUDENT – TEACHER INTERACTION

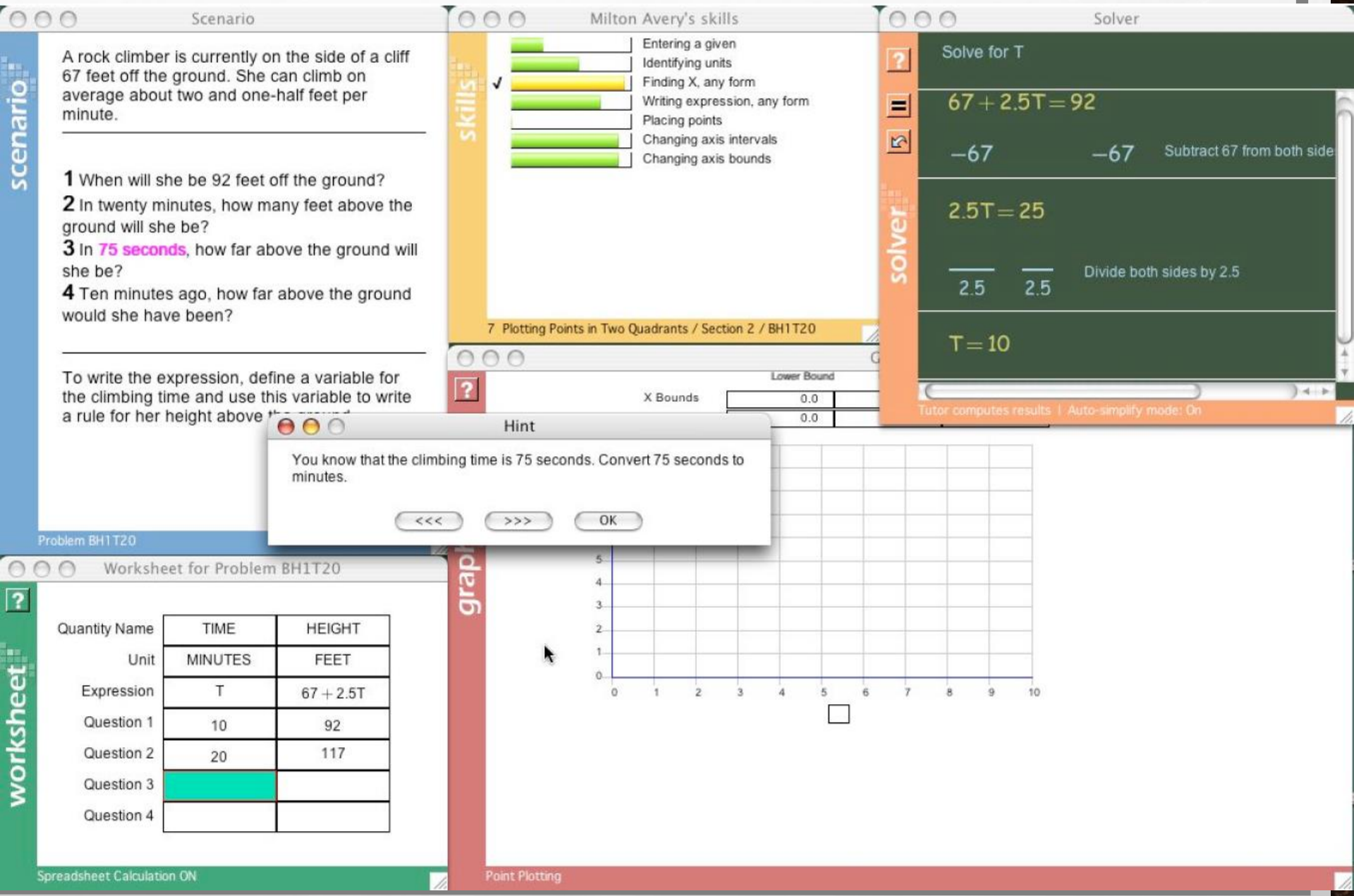
Q: WHAT KIND OF TUTOR WAY IS MOST EFFECTIVE?

- ONE TO ONE
- WHY TEACHER TO CLASS?
  - EFFICIENT
- THEN HOW TO COMBINE?

WHAT IS COGNITIVE TUTORS:

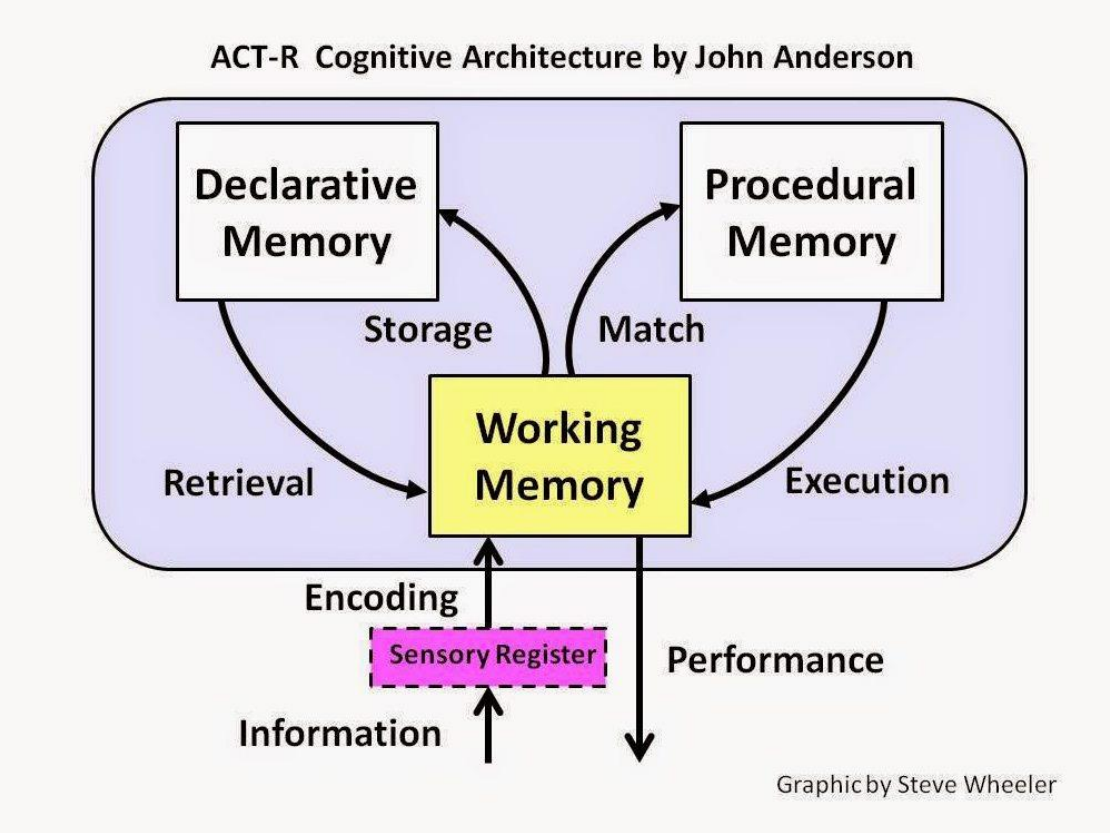
A kind of educational software	
Learning by doing	Personalized, step-by-step guidance

Principal tasks	
Monitoring performance	Monitoring learning


Scenario
A rock climber is currently on the side of a cliff 67 feet off the ground. She can climb on average about two and one-half feet per minute.
1 When will she be 92 feet off the ground?
2 In twenty minutes, how many feet above the ground will she be?
3 In 75 seconds, how far above the ground will she be?
4 Ten minutes ago, how far above the ground would she have been?
To write the expression, define a variable for the climbing time and use this variable to write a rule for her height above
Problem BH1T20
Milton Avery's skills
Entering a given
Identifying units
Finding X, any form
Writing expression, any form
Placing points
Changing axis intervals
Changing axis bounds
7 Plotting Points in Two Quadrants / Section 2 / BH1T20
Solver
Solve for T
67 + 2.5T = 92
−67 −67 Subtract 67 from both side
2.5T = 25
2.5 2.5 Divide both sides by 2.5
T = 10
Tutor computes results | Auto-simplify mode: On
Lower Bound
X Bounds
0.0
0.0
Hint
You know that the climbing time is 75 seconds. Convert 75 seconds to minutes.
<<<
>>>
OK
Worksheet for Problem BH1T20
Quantity Name TIME HEIGHT
Unit MINUTES FEET
Expression T 67 + 2.5T
Question 1 10 92
Question 2 20 117
Question 3
Question 4
Spreadsheet Calculation ON
Point Plotting

ACT-R THEORY

- ADAPTIVE CONTROL OF THOUGHT—RATIONAL



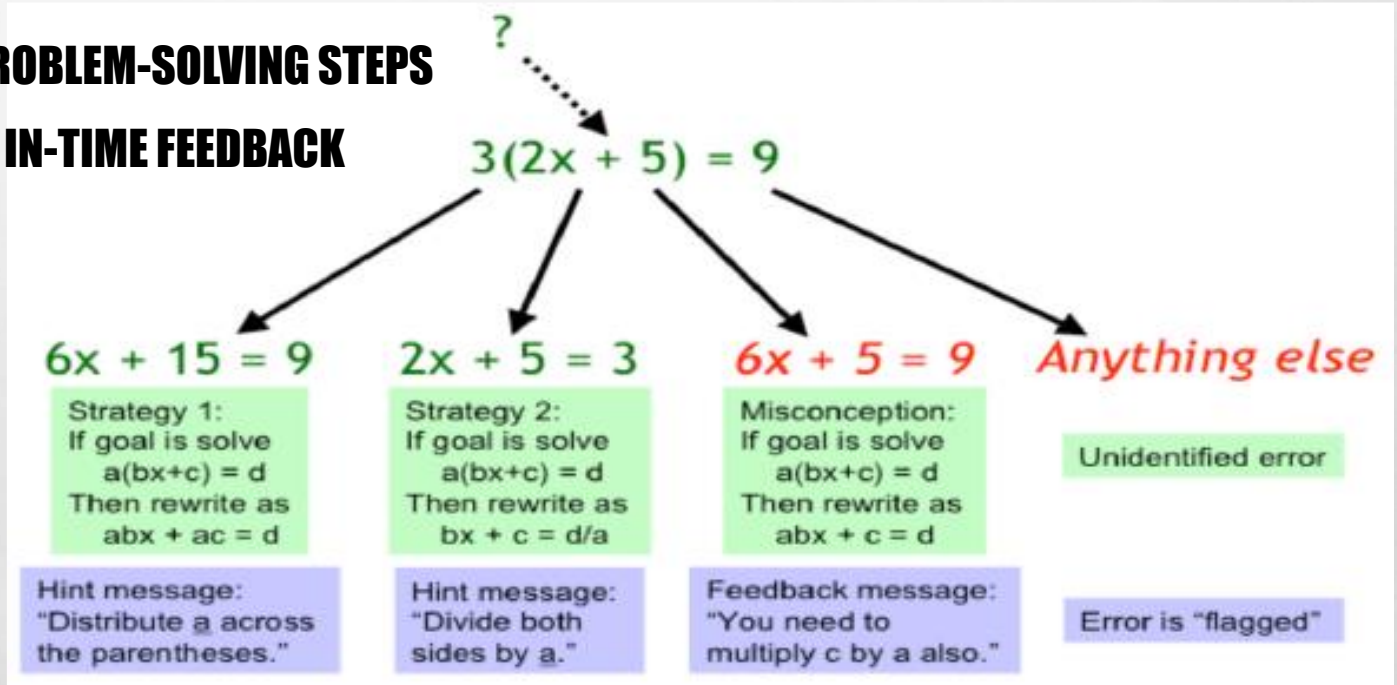
Ref: https://www.teachthought.com/learning/theory-cognitive-architecture/

PRODUCTION RULE

Production Rules in English	Example of its application
1. *Correct production possibly acquired implicitly* IF the goal is to find the value of quantity Q and Q divided by Num1 is Num2 THEN find Q by multiplying Num1 and Num2.	To solve "You have some money that you divide evenly among 8 people and each gets 40" find the original amount of money by multiplying 8 and 40.
2. *Correct production that does heuristic planning* IF the goal is to prove two triangles congruent and the triangles share a side THEN check for other corresponding sides or angles that may congruent.	Try to prove triangles ABC and DBC are congruent by checking whether any of the corresponding angles, like BCA and BCD, or any of the corresponding sides, like AB and DB, are congruent.
3. *Correct production for a non-traditional strategy* IF the goal is to solve an equation in X THEN graph the left and right sides of the equation and find the intersection point(s).	Solve equation $\sin x = x^2$ by graphing both $\sin x$ and x^2 and finding where the lines cross.
4. *Correct but overly specific production* IF "ax + bx" appears in an expression and c = a + b THEN replace it with "cx"	Works for "*2x* + 3x" but not for "*x* + 3x"
5. *Incorrect, overly general production* IF "Num1 + Num2" appears in an expression THEN replace it with the sum	Leads to order of operations error: "x * *3 + 4*" is rewritten as "x * *7*"

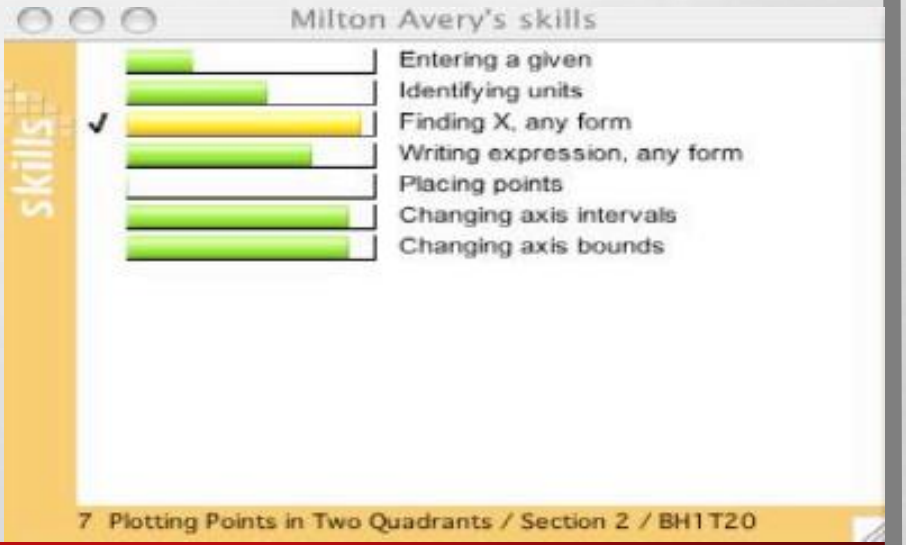
PERFORMANCE MONITORING

- **MODEL TRACING**
  - TRACE PROBLEM-SOLVING STEPS
  - PROVIDE IN-TIME FEEDBACK



PERFORMANCE MONITORING

- KNOWLEDGE TRACING
  - TRACK ACQUISITION OF PRODUCTION RULES
  - ADAPT THE PACING OF INSTRUCTION TO INDIVIDUAL STUDENT NEEDS

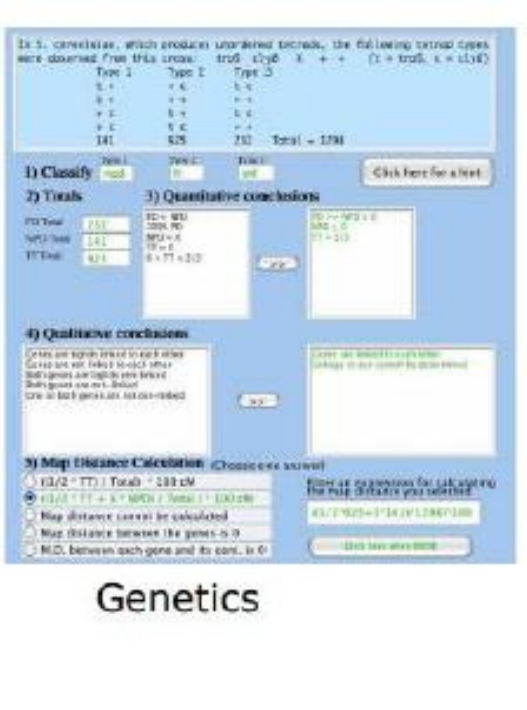


DISCUSSION

- OTHER THEN COGNITIVE TUTOR ALGEBRA. WHAT ELSE WOULD BENEFIT FROM COGNITIVE TUTORS? HOW WOULD YOU PERFORM MODEL TRACING AND KNOWLEDGE TRACING IN THESE DOMAINS? (GROUPS OF 2-3, 1 MIN)

PERFORMANCE KNOWLEDGE
LEARNING BY DOING

- BEGINNER PROGRAMMER COURSES
- TEMPLATE BASED; CODING ALGORITHMS (SORTING)
  - MODEL TRACING: DIFFERENT ALGORITHMS
  - KNOWLEDGE TRACING: GIVE HINT BASED ON THE ERROR PART



Genetics

From last year slide.

DESIGN PRINCIPLES AND METHODS

- PRODUCTION SET
- PROBLEM SOLVING
- MINIMIZE WORKING MEMORY LOAD
- IMMEDIATE FEEDBACK

DISCUSSION

- RECALL THE FIELDS FROM LAST DISCUSSION, PICK [ ]. HOW TO PERFORM THIS PRINCIPLES? (GROUPS OF 2-3, 1 MIN)
  - PRODUCTION SET
  - MINIMIZE WORKING MEMORY LOAD
  - IMMEDIATE FEEDBACK
  - PROBLEM SOLVING

EXAMPLE: REDUCING WORKING MEMORY

- **Q: WHAT ARE THE MOST EFFICIENT SCENARIOS FOR THIS THREE FORMS?**

Story Problem: As a waiter, Ted gets $6 per hour. One night he made $66 in tips and earned a total of $81.90. How many hours did Ted work?

Word Problem: Starting with some number, if I multiply it by 6 and then add 66, I get 81.90. What number did I start with?

Equation: $x * 6 + 66 = 81.90$

EVALUATIONS

- 15%-25% BETTER PERFORMANCE ON STANDARDIZED TEST
- 50%-100% BETTER PERFORMANCE ON PROBLEM SOLVING & REPRESENTATION USE
- STUDENTS ARE FOUND MORE ENGAGED IN LEARNING

DISCUSSION

- **DO YOU THINK THESE RESULTS ARE GOOD PARAMETERS TO CHECK? ANY ELSE? (GROUPS OF 2-3, 1 MIN)**
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DISCUSSION

- BY COMPARING WITH HUMAN TUTORS DO YOU THINK THERE ARE DRAWBACKS OF COGNITIVE TUTORS? HOW TO DEAL WITH THEM? (GROUPS OF 2-3, 1 MIN)

- **ON-DEMAND SOLUTION SENSITIVE HINTS**
  - Most of the times, students tend to look at the answers when they are stuck on a certain problem If hints are available, students will tend to use it early on rather than putting an effort into working thorough the problem
- **CREATIVITY**
  - I am critical of this approach because I think it underestimates the power of creativity.

From last year slide.

DISCUSSION

- DO YOU THINK CURRENT MOOC PLATFORM FOLLOWS THE SIX DESIGN PRINCIPLES? IF YES, HOW DOES IT PERFORM? IF NO, HOW CAN YOU CHANGE IT BETTER? (GROUPS OF 2-3, 1 MIN)

FROM YOUR COMMENTARIES

"One thing I wish this paper focused more on is the connection of this whole idea of cognitive tutor to MOOCs, to expand this idea on a larger scale and provide education that caters to the specific characteristics of an individual to a wide range of audiences. *I believe this system has potential to be used in MOOCs, since they seem to be scalable*. It would have been interesting to see this system being discussed in the context of online classes." —KASITSAK CHUPONGSTIMUN

"Web app based platforms such as Mastering by Pearson College Physics, and *Coursera typically follow this idea*. Student have chances to solve simple problems immediately after the instructors demonstrating the theories. These system is able to perform knowledge tracing and model tracing in a timely manner. In contrast, other platforms such *as Duolingo and DynEd, focus on providing secondary language study services followed the design idea of declarative knowledge*, where there are a huge amount of learning involved with memorize and get familiar with verbal knowledge." —Chen Chen

OPTIMIZING CHALLENGE IN AN EDUCATIONAL GAME USING LARGE-SCALE DESIGN EXPERIMENTS

STUDENT – COMPUTER INTERACTION

Q: WHAT KIND OF FIELD DO YOU THINK THAT GAME CAN HELP FOR EDUCATION?

- TYPING PRACTICE
- KINDERGARTEN LEARNING
- MODEL DESIGN

BATTLESHIP NUMBERLINE

- AWARD WINNING LEARNING GAME
- ESTIMATION ABILITY AND NUMBER SENSE
- GRADE 4-8

HTTPS://WWW.YOUTUBE.COM/WATCH?V=-Q71IULTLNU

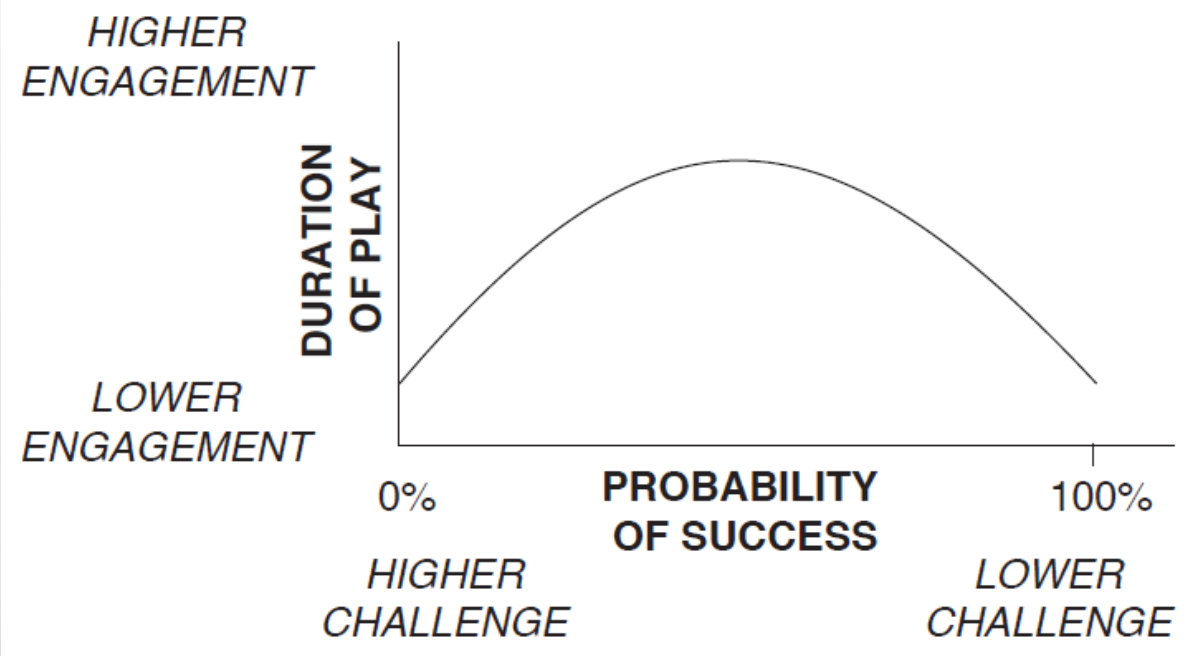
HTTPS://WWW.BRAINPOP.COM/GAMES/BATTLESHIPNUMBERLINE/

WHY FOCUSING ON CHALLENGE FOR ONLINE EDUCATIONAL GAMES?

- ENGAGEMENT : TOTAL TIME & LEVELS
- CHALLENGE : TANGIBLE AND INTANGIBLE REWARDS

THE INVERTED-U HYPOTHESIS

- **APEX ENGAGEMENT/ CHALLENGE**



HOW TO STUDY CHALLENGE?

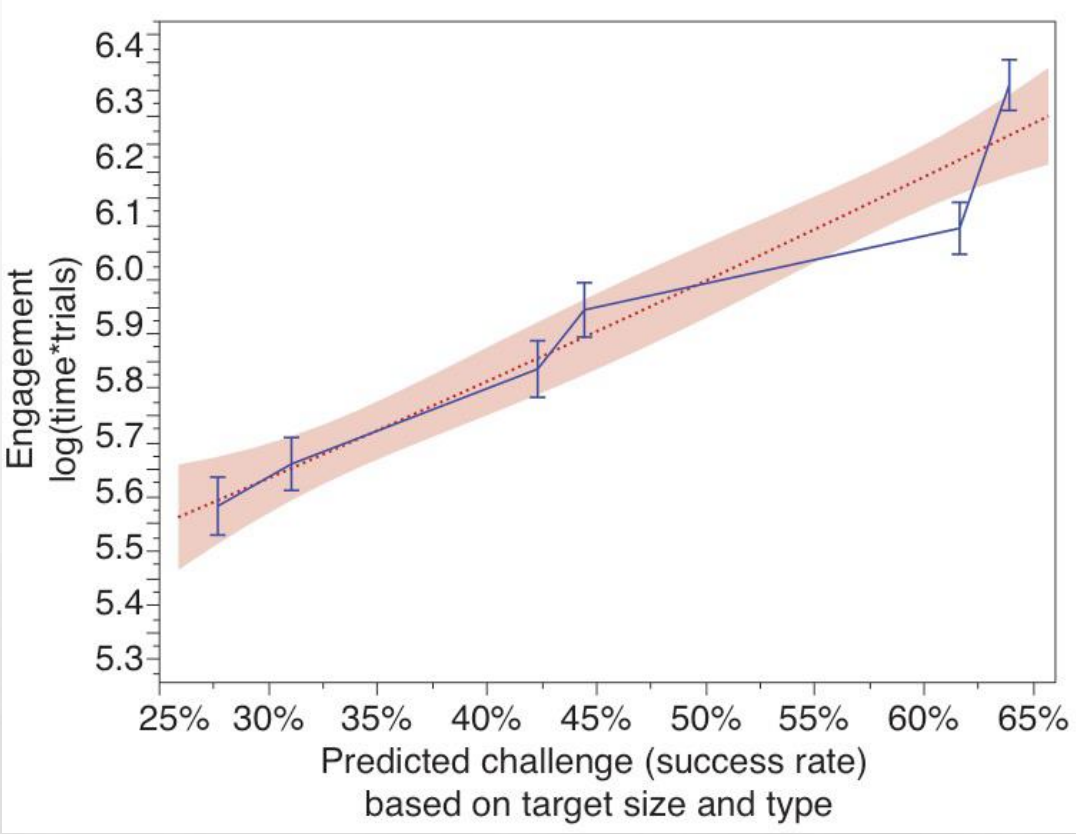
- VARIOUS MODELS OF EASY AND HARD VERSIONS OF THE GAME
- THE EFFECT ON ENGAGEMENT?

THE EXPERIMENT: VARIABLES

Between-subject experiment	10,500 sessions
Challenge	Success rate of each configuration
Engagement	Duration of play → Log(trials x time)

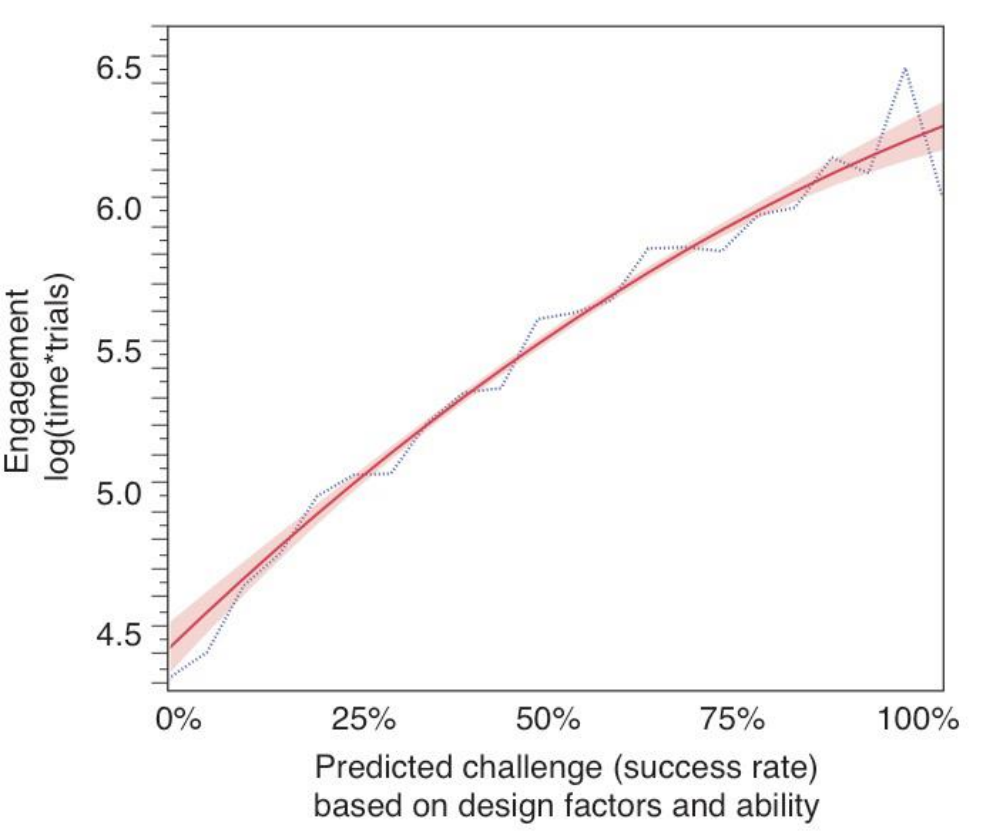
RESULTS

- LINEAR RELATION



RESULTS

- LINEAR RELATION



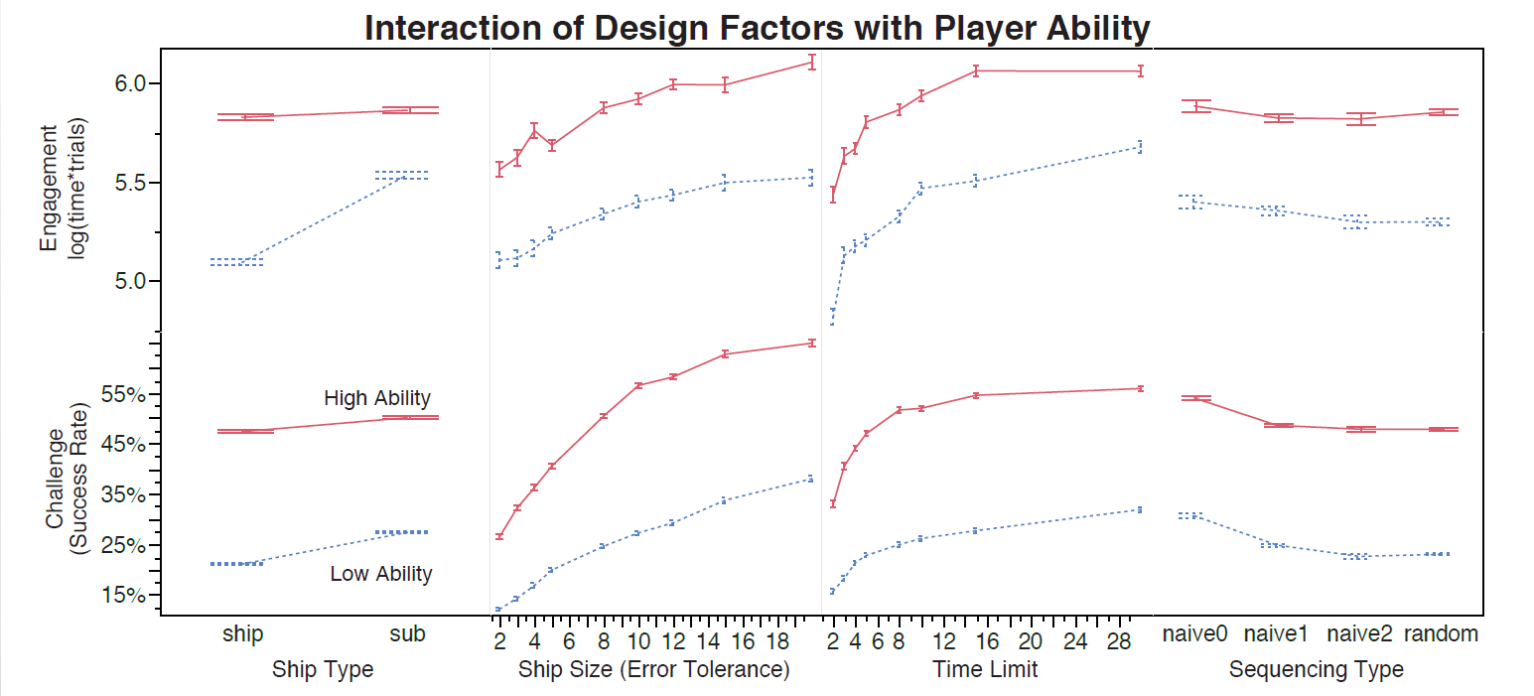
DISCUSSION

- DO YOU THINK THIS RESULT CONVINCIBLE? IF YES, WHY? IF NO, WHAT DO YOU THINK IS BETTER? (GROUPS OF 2-3, 1 MIN)

Q: IS IT A GOOD TABLE?

Targ. Size	N	Total Trials	Total Time	Accur-acy	Success Rate	React Time
3%	3462	12.6 (13.1)	60.9 (54.1)	78.8% (26.5)	29.2% (25.2)	6.8 (5.8)
5%	3479	14.6 (14.4)	66.5 (55.5)	79.5% (26.0)	43.3% (30.3)	6.6 (5.6)
10%	3537	17.0 (15.8)	71.6 (55.4)	79.6% (25.6)	62.8% (34.1)	6.3 (5.6)

Q: IS IT A GOOD FIGURE?



HYPOTHESES AND DESIGN IMPLICATIONS

- **EFFECTANCE MOTIVATION:** BY SUCCESS
- **EXPERTISE:** FIRST LEVEL AS EASY AS POSSIBLE
- **FEEDFORWARD:** LET PLAYER ABLE TO VALUE THE SUCCESS AND FAILURE
- **CLOSE GAME:** MOTIVATION INCREASE WHEN NEAR TO THE END

DISCUSSION

- DO YOU THINK RELATIONSHIP BETWEEN ENGAGEMENT AND CHALLENGE IS A GOOD POINT TO RESEARCH FOR? IF YES, WHY? IF NO, WHAT DO YOU THINK IS BETTER? (GROUPS OF 2-3, 1 MIN)

THANKS!