Hint Systems May Negatively Impact Performance in Educational Games

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Online educational tools can scale to reach massive numbers of students.
Only 28% of all students in the US are in post-secondary institutions

U.S. Department of Education National Center for Education Statistics, 2010
Educational video games can be used as tools to teach at scale.
Motivation has a strong impact on academic achievement
Most MOOCs have completion rates under 13%

http://www.katyjordan.com/MOOCproject.html
Educational video games can increase motivation in online learning environments.
How can we design hint systems to support struggling students?
Hint systems have been successful in other interactive learning environments.
Asking for help has negative connotations in game environments

Andersen et al. CHI 2012
Hint systems are a component of many successful commercial games.

If you find yourself stuck on a puzzle, a **Hint Ghost** will give you a hint in exchange for a **Play Coin**.
Can we design hint systems to reduce the negative connotation of asking for help?
Refraction
Studied two hint system properties:

Hint Presentation

Hint Content
Hint Content

Abstract Hints

How can you make $\frac{1}{4}$ with the splitters you have?

Concrete Hints

To get $\frac{1}{3}$ split the laser using:
Study Design

Concrete Embedded

Concrete Earned

Abstract Embedded

Abstract Earned
Collected Data on BrainPOP
Satistical Analysis

• Data is non-normally distributed
• Factorial analysis of four hint conditions
  – Binomial logistic regression
  – Align Rank Transform procedure and ANOVA
• Pairwise comparisons with baseline
  – Wilcoxon rank sums
  – Kruskal Wallis
• Report p-values and effect sizes
Question: how do hints impact student engagement?

Hypothesis: concrete hints will be more engaging than abstract hints

Metric: time played
Earned hints improved engagement

- Median Time Played (sec)

  - Earned: $p<0.0001$, $\eta^2=0.001$
  - Embedded: $p<0.05$, $r=0.01$
Result:
Earned hints improved engagement
**Question:** how do hints impact performance?

**Hypothesis:** all four hint systems will improve student performance

**Metric:** level completion rate
Students with hints completed fewer levels than those without hints

Median Levels Completed

Baseline Earned Embedded

p<0.005, r=0.01
**Question:** how do hints impact performance?

**Metric:** failure rate on introductory levels
All hint systems negatively impacted performance on introductory levels.
**Question:** how do hints impact performance?

**Metric:** failure rate on evaluation levels
All hint systems negatively impacted performance on evaluation levels.

Median Failure Rate

- Embedded: n.s.
- Earned: n.s.
- Concrete: n.s.
- Abstract: p<.001, V=0.02
- Baseline
Result:
All hint systems negatively impacted student performance
Question: how were the hint systems used?

Hypothesis: students will use concrete hints more often than abstract hints

Metric: hint view rate
Embedded hints were viewed more often than earned hints

$p<0.0001, \eta^2=0.05$
**Question:** how were the embedded hints used?

**Metric:** hint view rate in each embedded hint level
Students viewed embedded hints on more difficult levels.
Question: how were the earned hints used?

Metric: number of hints saved on each game level
Median Number of Earned Hint Saved

Number of Hints Saved

Level Number

Concrete

Abstract
Results:
Embedded hints were viewed more often than earned hints

Concrete hints were viewed more often than abstract hints

Students viewed embedded hints on more difficult levels

Students hoarded earned hints
Implications

• Hint systems do not uniformly improve performance

• Scaffolding learning may be more effective

• Hints may need to be more personalized
Hint systems should be designed carefully in systems that teach at scale
Thank You!

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