Evaluation of “Dragoon”: A Systems Modeling Intelligent Tutoring Tool

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Purpose and Goals

- To evaluate Dragoon-based instruction
  - To what extent does Dragoon impact learning of domain content and skills in authentic classroom settings?
  - How do students perceive the features and use of the system?
“Dragoon”

- Systems modeling intelligent tutoring tool
  - Novel technologies necessary to build a comprehensive assessment and instruction system
    - Domain customization, automated interactive testing, and feedback
  - Helps students learn computer-based systems modeling and dynamics
    - Model construction, and by interacting with specific systems, concepts, and principles.
“Dragoon” Authoring Mode

Problem Title: zebra and lion population growth
Units: years
Start Time: 1900 seconds
End Time: 2050 seconds
Integration Method: Eulers Method
URL for Image: http://i00.i.aliimg.com
Node to adjust: --Select--
Direction of adjustment: --Select--

Problem Statement:
Assumptions:
Lessons Learned:
“Dragoon” Instruction, Assessment, and Feedback Mode
The models you made in Levels 1, 2 and 3 predicted that the lion population would increase indefinitely. Clearly, that won't happen because lions will starve to death where there are too many of them for the amount of grassland they occupy. Ecologists use "carrying capacity" to refer to the maximum population that can be supported by a given habitat. The model below assumes that the death probability rises as population increases until the death probability equals the birth probability when the population equals the carrying capacity.
“Dragoon” Instruction, Assessment, and Feedback Mode

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<tr>
<th>time (years)</th>
<th>Zebra Population</th>
<th>Lion Population</th>
<th>Zebra Births</th>
<th>Predation Events</th>
<th>Zebras Killed</th>
<th>Zebra Survival Rate</th>
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To reset sliders, close and reopen window.

- Zebra Birth Probability = 0.3
- Probability of Zebras Killed = 0.45
- Zebra Carrying Capacity = 700
- Size of Range = 100
- Lion Birth Probability = 0.5
- Lions Fed per Zebra Killed = 0.742
- Initial Zebra Population = 200
- Initial Lion Population = 20
3 Studies: Overview

- Study 1: Physics
  - Usability Test
  - AP Physics

An object starts at rest and falls from a building that is 56 meters tall. Graph its velocity and position from 0 seconds to 4 seconds. Use 9.81 m/s² for the acceleration due to gravity. Choose the positive x-axis to start at 0 meters so that the ground is at zero.
3 Studies: Overview

- Study 2

  - **Field Test**
  
  - **Purpose:** compare Dragoon to baseline instruction over a longer period of instruction
  
  - **Physiology (Energy Balance, Blood Glucose Homeostasis)**
3 Studies: Overview

• Study 3
  ✓ Field Test
  ✓ Replicate study 2 within a new domain and new context
  ✓ AP Biology: Ecology (population dynamics)
Study 2: Physiology Sample

- 95 total participants (Physiology students)
  - 45 treatment (Dragoon, 2 classes)
  - 50 control (2 classes)
- Majority 10th graders (72%)
  - Most enrolled in geometry math class (60%)
  - Nearly all Dragoon and control students (95%) had never taken a programming class
  - No experience programming outside of school (97%)
Study 2: Design and Procedure

• Content: physiology and systems modeling

• 5 day implementation window (55 minute class periods)
  
  ✔ Pre and posttest on first and last day
    
    ✤ Consisted of 5 questions about energy balance and homeostasis
    
    ✤ Short essays, mathematical derivations, interpretations, and concept mapping
  
  ✔ Intervention day 2, 3, 4
    
    ✤ Dragoon: teacher introduced systems modeling, researcher introduced Dragoon, students collaborated on Dragoon problems
    
    ✤ Control: teacher introduced systems modeling, students collaborated on equivalent workbook problems
Study 2: Results

• Pretest

✓ Mean score for Dragoon group was 1.69 (SD=1.58) out of a maximum score of 6.

✓ Mean score for control students was 1.16 (SD=1.04); reliably lower (p<.01)

• Posttest

✓ Mean score for Dragoon students was 4.53 (SD=1.71), out of a maximum score of 10

✓ Mean score for control group was 3.59 (SD=1.52); significantly lower (p=.006)
Study 2: Results Continued

• Pretest scores between the two groups were significantly different

• ANCOVA (pretest score as covariate)

  ✓ Dragoon group performed reliably better than the Control group \((p=.029)\) with a medium effect size \((d=0.47)\)
Study 3: AP Biology Sample

• 59 total participants (AP Biology students)
  ✓ 41 treatment (Dragoon, 2 classes)
  ✓ 18 control (1 class)

• Majority 10th graders (58%)
  ✓ Remainder in 11th (35%) and 12th (7%) grade
  ✓ Most enrolled in trig/pre-calculus (73%); remainder (27%) in calculus
  ✓ Some of the students (34%) had taken programming classes
Study 3: Design and Procedure

- Content: ecology; population growth, predator-prey relationships

- 6 day implementation window (100 minute class period – block schedule)
  
  ✓ Pre and posttest on first and last day (40 mins each)
  
  ✓ Comparable forms covering 5 population dynamics question:
    
    ✓ Open-ended, graph completion and analysis, graph interpretation, conceptual population growth, concept mapping
Study 3: Design and Procedure Continued

- Intervention day 1, 2, 3

✓ Dragoon: researcher introduced systems modeling, researcher introduced Dragoon, students first worked individually, and later collaborated on Dragoon problems in pairs

✓ Control: teacher introduced systems modeling, students first worked individually, and later collaborated on workbook problems in pairs
Study 3: Results

• Average Inter-rater reliability .82 (Cronbach’s alpha)

• Pre-test scores between two groups not statistically different

• ANCOVA (pre-test score as covariate)

  ✓ Dragoon group (M=31.00; SD=6.00) performed significantly better than the Control group (M=24.00; SD=6.96)

  ✓ The difference was reliable (p=.029) with a large effect size (d=1.00)
Additional Findings

• Students enjoyed working collaborative (dyads, groups) more than individually while working with Dragoon.

• Students liked the feedback; would have liked it to be even more explicit.

• Teachers and students agree that tool can be more intuitive.

• Teachers and students agree that they learn from Dragoon.