The Impact of a Story-Based Lesson on Student Learning and Attitudes

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Abstract

Recent work by Stephen Klassen draws attention to specific structural elements that are thought to give stories their explanatory power in the context of physics. In this paper we report results of a study based on Klassen’s pioneering work but in the context of evolution. A mixed-method research study was conducted over two semesters at a Midwestern university to determine if a story developed from the story of an evolutionary model of industrial melanism over the course of a three day lesson would result in improved student understanding of the concept of natural selection.

The study involved a direct comparison of two different versions of the unit: one presented the history of research on industrial melanism (IM) as a story, the other did not. The episode was chosen because it incorporates past scientists’ investigations on IM as a strategy to mitigate misconceptions. Learning gains were monitored by means of the Concept Inventory of Natural Selection (CINS), used as a pre- and post-assessment. Semi-structured interviews were also conducted with a subset of the participants in an effort to understand their experiences with and attitudes toward the lesson. Results demonstrate that the story version yielded significant learning gains, and significant decreases in some misconceptions. In addition, participants expressed positive attitudes to the lesson’s format as a mystery in reference to inquiry teaching.

Teaching & Learning Evolution

- National & State Science Education Standards
  - Important to understand biology from evolutionary perspective
- Evolution is Difficult for Students to Learn
  - Alternative conceptions compound difficulties
- Stories are a powerful form of communication
  - (Press, Miles & Cottrell, 1999)
- Suggests a role for stories to teaching evolutionary biology

Research Background and Gap

- Story construction
  - Stephen Klassen’s work
- Story structure
  - 10 narrative elements
    - Not a formula
    - Identify deficiencies
- Provides
  - Standard structure
  - Consistent way to evaluate
  - (Klassen, 2009)
- No empirical studies evaluating Klassen’s approach
  - This study fills gap
- Purpose: to test efficacy of story approach
  - Two versions of the Mystery Phenomenon Lesson
    - Traditional approach
    - Story approach
  - Both use Klassen’s 10 narrative elements
  - Evaluate learning outcomes and student experiences

Research Context

- Participants
  - BIOS 1700 for future elementary teachers
  - Fall semester 2013 n=44; 15 interviews
  - Traditional Approach
  - Original PowerPoint scripts
  - 3 sections (aggregated)
  - Spring semester 2014 n=40; 14 interviews
    - Story Approach
    - Modified PowerPoint scripts
      - 3 sections (aggregated)
    - Same instructors for both semesters
- Worldview
  - Pragmatist
  - Good fit with mixed methods
  - Not to test for quantitative or qualitative research paradigms
  - Focus on combination that best fits research goals
  - (Sawatzky, 2010; Johnson & Trainor, 2009)
- Theoretical stance
  - Constructed learning theory
  - Learners construct own knowledge
  - Participants active in own learning
  - Learning takes place in context
  - (C eron & O’Malley, 1993; Linn & Sowinski, 1977)

Data Collection and Analysis

- The Mystery
  - Rapid increase of dark form of moth in areas downstream from manufacturing centers
  - Unique example of natural selection: reliable visual imagery and bird predation as agent of selection
  - (Rudge, 2009; Fulford, 2010)
- The Mystery Phenomenon Lesson
  - Explicitly discusses past scientists’ ideas
  - Responses to misconceptions
  - Student-centered approach
  - Science content and HSS learning objectives
  - 3 class periods (2 hrs, 20 min. each)
  - Multiple components
    - PowerPoints wrapt
    - Discussions
    - Activities
    - Workshops
  - (Klassen, 2009; Fulford, Cusick, & Howe, 2010)
- Quantitative
  - Quasi-experimental
  - Non-equivalent design
  - Instrument
  - Concept Inventory of Natural Selection (CINS)
  - Pre and post test
  - Participant scores
  - Explanatory coherence
  - Misconceptions
  - Inferences
  - Descriptive statistics
  - Inferential statistics
  - (Klassen, 2009; Anderson, Polanski, & Anderson, 2002; Brous; & Rodgers, 2012)
- Qualitative
  - Semi-structured interviews
  - Coding
    - 1st round emergent coding
    - Questions
    - 2nd round
      - Prior codes
    - Content questions
  - Theme development
  - Inferences
  - (Stake, 2009; Stake & Tenkasi, 2018)

Q1 Results: Learning Impacts

What differences in learning outcomes do the concept inventory (CINS) scores reveal in both approaches?

- Graph One: The story approach group had statistically significant gains from pre to post-test, and the difference in gains between traditional approach and story approach group was statistically significant.
- Graph Two: The story approach group had more unique display positive gains, including statistically significant gain.
- Graph Three: The story approach group had a statistically significant amount of participants move from a failing to a transferable score.

Q2 Results: Misconceptions

What alternative explanations, as identified in the CINS and the interviews, are participants using in both approaches?

- CINS
  - Participants in both groups displayed the same misconceptions based on:
    - Lamarckian ideas
    - Origin of variation
    - Darwinian ideas
    - Trial and error
    - Differential survival
    - Other ideas
    - Variation inherited
    - Change in population
  - Results align with other studies
- Interviews: 3 types of misconceptions
  - Same as CINS
  - Hybrid answers: correct statement w/ incorrect one
  - Variation example
  - C3 stated that variation was “different” but the eye color, different skin, different protein
  - C3 also stated that variation happened between different species.
  - Concept of species
    - Origin of variation example
    - C13: “two different species coming together and mating, successfully mating is what I was referring to”

Q3 Results: Story-Based Lessons

What are the similarities and differences in participants’ experiences, as revealed in the interviews, in both approaches?

- Mysteries equal inquiry
  - Majority of each group:
    - T4: “So I think it’s always helpful when you’re presented with a mystery or something you actually think about and go through the inquiry process, and use critical thinking…”
- Inquiry as future teachers
  - T1: “I think the advantage there is the inquiry part of it… with young children, you can just give them facts and expect them to understand something… but if you set them explore why things are happening… I think it will help them learn cause they’ll come to it on their own…”

Q4 Results: Stories

What do the interviews reveal about the participants’ awareness of the story and its narrative elements in the story approach?

- The story structure
  - Klassen’s structural components (narrative elements)
  - All were described by the story group

Limitations and Implications

- Improvements
  - Improvement of ML report
  - Explicitly discuss other common misconceptions
  - Review area of random mutation and species
- Future Research
  - New parts of lessons
  - minimum narrative elements vs. all
  - Mysteries vs. stories

Conclusions

- Q1 - Improved learning outcomes: CINS scores, explanatory coherence gains
- Q2 - Decline in common misconceptions explicitly discussed in lesson
- Q3 - Mysteries are considered inquiry
- Q4 - Mystery phenomenon considered a story: Basic structure & narrative elements recognized
- Method for empirically testing efficacy of stories

References

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- Rudge, Cassidy, Fulford & Howe, 10.3102/0013189X033007014
- Evans, Johnson, & Rudge, 2004.