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 poster 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 Midwest university to determine if a story developed from the history of research on 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 this 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

  (AAAS, 1993: NGSS Lead States, 2013)
- Evolution is Difficult for Students to Learn
  - Alternative conceptions compound difficulties

  (Alters & Nelson, 2002: Nehm & Reilly, 2007)
- Stories are a powerful form of communication

  (Reiss, Millar & Osborne, 1999)
  - Suggests a role for stories for 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's10 narrative elements
  - Evaluate learning outcomes and student experiences

Research Context

- Participants
  - BIOS 1700 for future elementary teachers
  - Fall semester 2013 n=41; 15 interviews
    - Traditional Approach
    - Original PowerPoints/scripts
    - 3 sections (aggregated)
  - Spring semester 2014, n=46; 14 interviews
    - Story Approach
    - Modified PowerPoints/scripts
    - 3 sections (aggregated)
- Same instructors for both semesters

- Worldview
  - Pragmatist
    - Good fit with mixed methods
    - Not tied to quantitative or qualitative research paradigms
    - Focus on combination that best fits research goals

  (Feilzer, 2010; Johnson, & Onwuegbuzie, 2004)
- Theoretical stance
  - Constructivist learning theory
    - Learners construct own knowledge
    - Participants active in own learning
    - Learning takes place in context

  (Driver & Oldham, 1986; Leech & Onwuegbuzie, 2009)

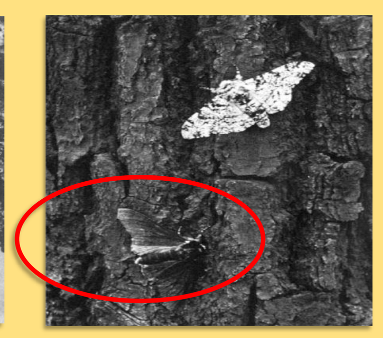
Data Collection and Analysis

- The Mystery
  - rapid increase of dark form of moth in areas downwind from manufacturing centers
  - unique example of natural selection: relatable visual imagery and bird predation as agent of selection

  (Majerus, 2005; Rudge, 2000)
- The Mystery Phenomenon Lesson
  - specifically chosen
  - explicitly discusses past scientists' ideas
    - resemble misconceptions
  - student-centered approach
    - science content and NOS learning objectives
  - 3 class periods (2 hrs. 20 min. each)
  - multiple components
    - PowerPoints w/script
    - discussions
    - activities
    - worksheets

(Rudge, 2004: [2]Rudge, Cassidy, Fulford & Howe, 2014)

Lichen-covered tree
Biston betularia[a]



Soot-darkened tree
Biston carbonaria[b]

[a] http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/E/Evolution.html
[2b]http://www.liv.ac.uk/researchintelligence/issue38/hitchhiking.htm

The Intervention

The Mystery Phenomenon Lesson

- Quantitative
  - quasi-experimental
  - nonequivalent design
- Instrument
  - Concept Inventory of Natural Selection (CINS)
  - pre and post-test
  - participant scores
  - explanatory coherence
  - misconceptions
- Inferences
  - descriptive statistics
  - inferential statistics

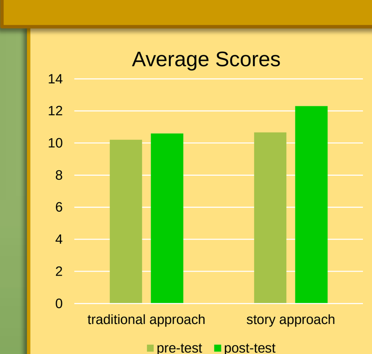
(Shutt, 2009; Anderson, Fisher, & Norman, 2002; Evans, & Anderson, 2013)

- Qualitative
  - Semi-structured interviews
    - coding
      - 1st round
        emergent coding
        all questions
      - 2nd round
        a priori codes
        content questions
  - Theme development
  - Inferences

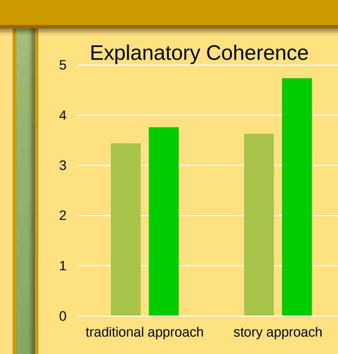
  (Saldaña, 2009;Tashakkori & Teddlie, 2008

Q1 Results: Learning Impacts

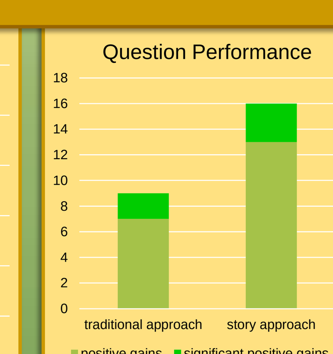
What differences in learning outcomes do the concept inventory (CINS) scores reveal in both approaches?



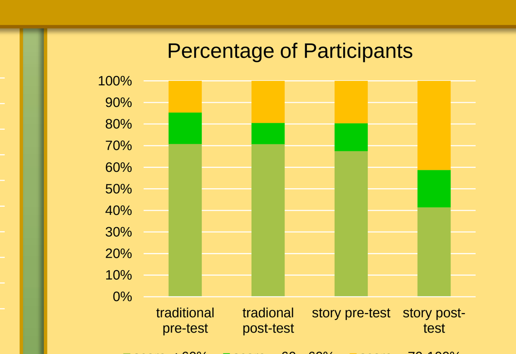
Graph One



Graph Two



Graph Three



Graph Four

- ***Graph One** and **Graph Two**: The story approach group had statistically significant gains from pre to post-test, and the difference in gains between traditional approach and story approach groups was statistically significant.*
- ***Graph Three**: The story approach group had more questions display positive gains, including statistically significant gains.*
- ***Graph Four**: 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
      - Variation
      - Differential survival
    - Other ideas
      - Variation inherited
      - Change in population
  - Results align with other studies
  - Story group had statistically significant declines in 2 of 4 explicitly discussed misconceptions. Traditional group had declines in 1 of the 4.

- Interviews: 3 types of misconceptions
  - Same as CINS
  - Hybrid answers: correct statement w/ incorrect one
    - Variation example
      - C3 stated that variation was "different traits…like eye colors, different skin colors…"
      - 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: Mystery Phenomenon Lesson

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't just give them facts and expect them to understand something, …, but if you let 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 Mystery Phenomenon as a story
  - The entire story approach group agreed
  - Stories have specific structure
    beginning – middle – end
  - Other components
    - human agency
    - resolution to problem

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

Limitations and Implications

Limitations
- CINS instrument
  - 2 alternative conceptions Semi-structured interviews
  - Only treatment group were asked about stories
- Long-term retention of gains
  - Not considered due to time constraints
- Quasi-experimental design
  - Generalizability limited

Implications
- Improvement of MP lesson
  - Explicitly discuss other common misconceptions
  - Review ideas of random mutation and species

Future Research
- New pair of lessons
  no/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

Alters, B.J., & Nelson, C.E. (2002). Perspective: teaching evolution in higher education. *Evolution, 56*(10), 1891-1901. Doi:101554/0014-820(2002)056[1891:PTEIHE]2.0.CO;2
American Association for the Advancement of Science (1993). Project 2061 Benchmarks for Science Literacy. Oxford University Press. New York.
Anderson, D.L., Fisher, K. M., & Norman, G. J. (2002). Development and evaluation of the conceptual inventory of natural selection. *Journal of Research in Science Teaching*, *39*(10), 952-978.
Driver, R., & Oldham, V. (1986). A constructivist approach to curriculum development. *Studies in Science Education, 13*(1), 105-122.
Evans, P. L., & Anderson, D. L. (2013). The conceptual inventory of natural selection a decade later: development and pilot testing of a middle school version leads to revised college/high school version. Paper presented at 2013 Annual International Conference of the National Association for Research in Science Teaching. Rio Grande, Puerto Rico.
Feilzer, M.Y. (2010). Doing missed methods research pragmatically: implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research 4*(1), 6-16. Doi: 10.1177/1558689809349691
Klassen, S. (2009). The construction and analysis of a science story: a proposed methodology. *Science & Education, 18*, 401-423.Kubli, F., (2001). Can the theory of narratives help science teachers be better storytellers. *Science & Education*, *10*, 595-599.
Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: a research paradigm whose time has come. *Educational Researcher 33*(14), 14-26. Doi: 10.3102/0013189X033007014
Leech, N.L., & Onwuegbuzie, A.J. (2009). A typology of mixed methods research designs. Quality and Quanity. 43, 265-275. doi 10.1007/s11135-007-9105-3
NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*: *Evidence of Common Ancestry and Diversity and Natural Selection.* Achieve, Inc. on behalf of twenty-six states and partners that collaborated on the NGSS.
Nehm, R.H. & Reilly, L. (2007). Biology majors' knowledge and misconceptions of natural selection. *BioScience, 57*(3), 263-272.
Reiss, M.J., Millar, R. & Osborne, J. (1999). Beyond 2000: science/biology education for the future. *Journal of Biological Education, 33*(2), 68-70. doi:10.1080/00219266.1999.9655644
Rudge, D.W. (2004) The Mystery Phenomenon: Lesson Plans. In D. Metz (Ed.) *Proceedings of the Seventh International History, Philosophy and Science Teaching Group Meeting* (pp 773-811). IHPST: Winnipeg, Canada.
Rudge, D.W., Cassidy, D.P., Fulford, J.M. & Howe, E.M. (2014). Changes observed in views of nature of science in a historically based unit. *Science & Education*. *23*(9), 1879-1909.
Saldaña, J. (2009). *The Coding Manual for Qualitative Researchers*. Los Angeles, CA. Sage Publishing.
Shutt, R. K. (2009). *Investigating the Social World: The Process and Practice of Research. 6th Ed.* Los Angeles, CA: Pine Forge Press. Sage Publications, Inc.
Tashakkori, A., & Teddlie, C. (2008). Quality of inferences in mixed methods research: calling for an integrative framework. In Bergman (Ed.), Advances in Mixed Methods Research. Thousand Oaks, CA. Sage Publications.