Effects of a Historical Story on Student Understanding of NOS

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Abstract

Science educators have identified that Nature of Science (NOS) is essential to improve students' science literacy. Numerous empirical studies suggest that incorporating the history of science (HOS) into class by means of an explicit reflective approach is one way to promote students' NOS conceptions. In view of these findings, we developed a unit using an interrupted story technique to depict the discovery of the structure of DNA featuring Rosalind Franklin's neglected role to help students learn both science content and NOS. Our study design compares an experimental group (story used) with a control group (no story used). The SUSSI (a well known instrument to study NOS) was administered pre- and post- instruction during both terms to assess the impact of this lesson on students understanding of the NOS. Semi-structured interviews were conducted to further clarify students' responses. The results show that most of the participants in the experimental group made significant gains in their understanding of two aspects of NOS targeted by the intervention ((1) creativity and imagination, and (2) social and cultural influences). Several interviewees in the experimental group specifically mentioned that the story helped them to better understand these two aspects of NOS. The current study provides additional support for using historical narratives to improve students' NOS understanding.

Statement of Purpose

Our study examined whether and how incorporating a historical story associated with the discovery of the structure of DNA with reference to Rosalind Franklin's perspective would affect undergraduates' of understanding of several specific issues associated with NOS.

Research Background

Nature of Science (NOS)

- NOS is referred to a host of general issues associated with the process of science.
- NOS is essential to improve students' science literacy (AAAS, 2009).
- Students and teachers have difficulty understanding issues associated with NOS.

History of Science (HOS)

- Teaching science with the history demystifies the process of science and provides students contextualize settings for learning NOS concepts.
- HOS has been rarely used by science teachers because of the lack of HOS knowledge and integrated approaches.

Historical Story

DNA is a central topic in biology courses because it is crucial to an understanding of modern genetics.

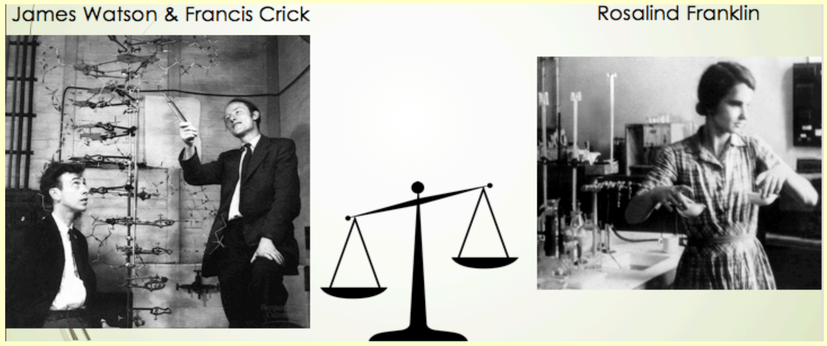
We developed a two-class lesson that draws attention to the story of discovering the structure of DNA and Rosalind Franklin's role in the process to help students learn both science content and the NOS (Dai & Rudge, 2018).

Our study relies on a specific definition of what a story is in terms of 10 narrative elements that must be presented (Klassen 2009).

The story is shared in two parts. Each part is shared by means of an interrupted narrative, with students being given explicit opportunities to reflect on targeted aspects of the NOS, both individual and in follow-up class discussions.

Research Design

- BIOS 1120 for non-major college students.
- 212 participants from a flipped introductory biology course
- Same instructors for both semesters
- Fall 2017 – Control group
  - Learned about the discovery of the structure of DNA in the absence of the story
  - n=124; 13 interviews
- Spring 2018 – Experimental group
  - Learned about the discovery of structure of the DNA using the interrupted story
  - n=88; 14 interviews; 7 females & 7 males



Data Collection and Analysis

- Research protocol approved by HSIRB
- The SUSSI (Student Understanding of Science and Scientific Inquiry) instrument was used to assess the impact of the lesson on students' NOS views (Liang et al. 2008).
- The SUSSI was administered pre- and post- the genetic unit during both terms.
- Semi-structured Interviews were conducted to further clarify students' responses to the assessment instruments.

Result 1: Creativity and Imagination

Part One of the historical narrative, sharing the discovery of the structure of DNA as it is typically portrayed as the result of Watson and Crick's work, promotes students' understanding of the role of creativity and imagination in science.

Pre-assessment: "Most often scientists do not use their imagination/creativity in science. This is because science is a logical field." – Student 6

Post-assessment: "The process of science involves creativity and imagination because creativity inspires questions and experiments. A person has to be creative in order to come with a way to experiment their hypothesis." – Student 6

Result 2: Society and Culture

Part Two, which retells the story from the perspective of Rosalind Franklin, promotes students' understanding of the role of social and cultural factors in science.

Pre-assessment: "Science is supposed to be apart from society and culture, with a methodical, logical way of doing things." – Student 2

Post-assessment: "Society and culture do affect research. Both society and culture affect a person's interpretations of data. Society may also dismiss or ignore research that doesn't fit in with their ideals (like that of most early women scientists)."– Student 2

Result 3: Gender Equality?

In the experimental group, all female interviewees believed that women scientists today still do not have equal rights. They related the Rosalind Franklin's example to their own family issues, work experiences, and male-only stereotype in society. In sharp contrast, three of 7 male interviewees indicated they believed the gender issue has declined dramatically since the 1950s, and that men and women scientists nowadays are generally treated as equals.

Female: "Guys just think they're more dominant than women and I think they're a little more confident too, which society probably made them that way, but I'll be like, oh, you're better and so women are just thought of as like having the children and like staying at home and cooking and stuff." – Student 7

Male: "I think they [men and women] are being equal because the main opportunities, back then wasn't the same, like for the woman, they didn't get that much, so, you know, back then, women weren't allowed to vote. Now, women can vote now and women can run for president." – Student 12

Conclusions

1. Students in the experimental group made significant changes between pre- and post-assessment in their understanding of two aspects of NOS including creativity and imagination, and social and cultural influences on science, in scientific investigations.
2. Most interviewees in the control group specifically mentioned that the historical story associated with discovering the structure of DNA helped them made changes in understanding the two aspects of NOS.
3. There is a significant difference between the opinions from male and female participants in the experimental group about whether gender inequality still persists in the modern world.

Implications

1. This research addresses a gap about the effectiveness of historical narratives for improving students' NOS views.
2. It provides insights on how to incorporate HOS into science class explicitly and reflectively.
3. It also gives science teachers effective instructional materials to teach NOS using a narrative based on the history of science.

References

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