Science Literacy Skill Development: Performance and Perceptions of Undergraduates

by

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Introduction

- At its core, science literacy is:
  - A general understanding of scientific concepts/processes, and the ability to utilize that knowledge in real-world situations. (DeBoer, 2000)
- Science Literacy is much more than simply knowing scientific concepts; but making informed decisions (NRC, 1996)
- Having a scientifically literate population is important for solving global challenges such as food insecurity and climate change.

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What is Science Literacy?

- A Test of Scientific Literacy Skills (Gormally, Brickman, & Lutz, 2012)
- Instead of focusing on content knowledge, this measure evaluates students' ability to use scientific literacy skills to solve problems/make decisions.

9 Scientific Literacy Skills:

- Identify valid scientific argument
- Conduct an effective literature search
- Evaluate use and misuses of scientific information
- Understand research design
- Create an appropriate graph from data
- Read/interpret graphical representations of data
- Solve problems using quantitative skills
- Understand and interpret basic statistics
- Justify inferences, predictions, and conclusions

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AEE 204N: Science Literacy and Policy in the 21st Century

- **General Education, Integrative Studies Course**
- Focus on **both Scientific and Social Sciences** to develop content knowledge and critical thinking skills
- **Teaching Methods:** lecture, case studies, discussions, reading scholarly articles

- **Example activities:**
  - Critical analysis of food advertising campaign
  - Develop a policy recommendation concerning ag issue
  - Interviewing/educating the public on various ag topics

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Research Objectives

1. Measure undergraduate students' change in science literacy, (comprised of 9 skills) as a function of the course.
2. Explore student perspectives regarding their scientific literacy (related to the 9 skills).

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Methods

- 13 undergraduate students- Fall ‘18
- **Quantitative:** Pre-/post-test measuring 9 science literacy skills
  - 28 questions, multiple choice
  - Paired samples t-tests on each skill and total science literacy
- **Qualitative:** 2 student focus groups (n=6 & n=7)
  - Conducted after the final exam, led by graduate student/TA
  - Open & Axial coding of transcripts for each of the 9 skills
  - Selective coding for entire transcripts

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Skill 1: Identify a valid scientific argument

Pretest M	Postest M	p
66.7	79.5	.20

1. **Practical Interpretation of Science**
   a) "I think a lot of our life, science comes into whether we realize it or not, so whether it's our food choices, or our medical choices, or even our political choices."
2. **Battling Misconceptions**
   a) "I think right now... there's so many misconceptions in the world. Being able to decipher between the [issues] is important for not only agriculture but for everyone."

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Skill 2: Conduct an effective literature search

Pretest M	Postest M	p
58.5	70.8	.07

1. **Critical Thinkers**
   a) "I think it's also important to look at cherry picking. So, if they took specifics from the data to make their certain points seem better than it really is. And again, personally for me, it comes back to just questioning everything."
2. **Awareness of time/effort involved**
   a) "I'm not by any means efficient with it. It takes me a lot of time to deduce if it's unbiased or if it's credible information, it takes me a little time to do that but I do have the skillset to identify most biased or non-scientific sources."

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Skill 3: Evaluate use and misuse of scientific information

Pretest M	Postest M	p
59.0	79.5	.02*

1. Pick your Battles
    a) "...I think we have to pick our battles and know that we may not be able to reach everybody but know we can relay at least some scientific knowledge to a majority of people instead of just focusing on a couple people who we think are oblivious and push all of our knowledge onto..."
2. Gullibility of the Public
    1. "It kind of goes with the herd idea of once this comes out and people start following it and believing it, other people that don't research it or even look it up or even understand what's actually truly going on will just follow 'cause they don't want to be left behind..."

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Skill 4: Understand elements of research design and how they impact scientific findings/conclusions

Pretest M	Postest M	p
53.8	71.2	.05*

1. Avoiding Bias
    a) "Knowing the decisions you're making as a scientist and when you're writing those papers can influence things. Making sure that you're… making the right graph. That can eliminate some of the bias from the reader…"
2. People Complicate Bias in Science
    a) "…science is basically set up to be non-biased but it's just people have opinions about science. Two people can read the same scientific article and get two completely different results or two completely different reactions out of it."

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Skill 5: Create appropriate graphs from data

Pretest M	Postest M	p
38.5	46.2	.72

Skill 6: Read and interpret graphical representations of data

Pretest M	Postest M	p
53.8	69.2	.01*

1. Construction of Graph Components
    a) "Definitely have to look at everything. You have to look at the titles, you have to look at the key, what color are they using, is it years, is it time, how different are they? You just have to take in everything …"
2. Utility of graphs for readers
    1. "One thing I noticed about color is they will use red. People associate with bad….Your brain automatically associated those numbers with something bad.
    2. "I think it was the very first thing we learned, correlation does not equal causation. That was a very big theme throughout the course."

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Skill 7: Solve problems using quantitative skills, including statistics

Pretest M	Postest M	p
46.2	66.7	.01*

Skill 8: Understand and interpret basic statistics

Pretest M	Postest M	p
69.2	61.5	.42

1. Critical Thinkers
   a) "I would say the actual calculation of that hasn't changed. I've always been able to calculate that sort of stuff. Interpreting that stuff has been enhanced but the actual skillset of doing those tasks has not."
2. Application of Statistics to Other Disciplines
   a) "I will say though that statistics is probably the most applicable math I've ever used in my entire life. I will never ever use calculus ever again. Well, statistics … yeah. We use it in this class which I thought was pretty impressive to see [since] we were taking an Ag science …"

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Skill 9: Justify inferences, predictions, and conclusions based on quantitative data

Pretest M	Postest M	p
76.9	69.2	.50

1. **Communicating with Public**
   a) "... for educating others, I didn't have the numbers for it, or a good explanation why ... But especially after this course, I feel like I have the confidence to be like, there's this source, and this source, and here's some numbers, and some fun thoughts, and there you go. I feel I can actually communicate the science of it a lot better to other people."
2. **Influence of Prior Knowledge/Experience**
   a) "Okay. So from what I know, and from what I've been taught in these aspects, I think it should turn out this way, or it would turn out this way."

Results Summary

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Skill	N	Pretest M	Postest M	t	*p*	*d*	Qualitative Themes
Skill 1: Identify a valid scientific argument	13	66.7	79.5	1.33	.20		Practical Interpretation of Science Battling Misconceptions
Skill 2: Conduct an effective literature search	13	58.5	70.8	1.98	.07		Critical Thinkers Awareness of time/effort involved
Skill 3: Evaluate use and misuse of scientific information	13	**59.0**	**79.5**	**2.55**	**.02***	**.72**	Pick your Battles Gullibility of the Public
Skill 4: Understand elements of research design and how they impact scientific findings/conclusions	13	**53.8**	**71.2**	**2.11**	**.05***	**.61**	Avoiding Bias People Complicate Bias in Science
Skill 5: Create appropriate graphs from data	13	38.5	46.2	.37	.72		Construction of Graph Components Utility of graphs for readers
Skill 6: Read and interpret graphical representations of data	13	**53.8**	**69.2**	**2.89**	**.01***	**.55**	
Skill 7: Solve problems using quantitative skills, including statistics	13	**46.2**	**66.7**	**2.89**	**.01***	**.58**	Critical Thinkers Application of Statistics to Other Disciplines
Skill 8: Understand and interpret basic statistics	13	69.2	61.5	-.82	.42		
Skill 9: Justify inferences, predictions, and conclusions based on quantitative data	13	76.9	69.2	-.69	.50		Communicating with Public Influence of Prior Knowledge/Experience
Total Science Literacy	13	**58.8**	**70.0**	**3.24**	**.007***	**.59**	**Growth of Skills** **Self Efficacy** **Critical Thinkers**

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Conclusion/Implications

- Significantly improved science literacy (59%-70%) pre-post
  - Most improved in areas of:
    - “Evaluate use and misuse of scientific information”
    - “Understand elements of research design and how they impact scientific findings/conclusions”
    - “Read and interpret graphical representations of data”
    - “Solve problems using quantitative skills, including statistics”
  - Still not ‘proficient’ for college level science literacy

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Conclusion/Implications

- Broad qualitative themes:
  - Growth of Skills
    - Articulated the development of their science literacy skills
  - Self Efficacy
    - Increased confidence in their science literacy skills
  - Critical Thinkers
    - Overarching ‘skill’ which students cited as having increased

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Total Science Literacy	13	**58.8**	**70.0**	**3.24**	**.007***	**.59**	Growth of Skills Self Efficacy Critical Thinkers