Building young scientist confidence: Integrating peer-review and publication in science research projects

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The Question

It has been known for many years that the way scientists approach “doing science” is not fully reflected in classroom practices or by the curriculum standards and assessments for K–12 science education (1, 2,3). Specifically, the role of disciplinary literacy skills (reading, writing, revising and using literature) within scientific inquiry are emphasized much differently in the scientific field compared to the classroom. For scientists, communicating one’s work is not just a critical output of their research, but an integral part of the entire process from initial observation to hypothesis development, design and revision of methodologies, results interpretation, and finally, the dissemination and revision of findings. Thus, it is not known how younger scientists perceive the role of disciplinary literacy practices, specifically the role of the primary literature, within science and how their views align with contemporary understandings of STEM disciplinary literacy and scientific inquiry. This study explores the experience and perceptions of students who have engaged in peer review and publication of their STEM research projects through the Journal of Emerging Investigators. We hypothesize that after the publication experience, students will express more advanced ideas of disciplinary literacy practices and also express enhanced self-efficacy and confidence in pursuing research.

Our Approach

Figure 1. The Journal of Emerging Investigators (JEI) is a free open access journal open to middle and high school students to publish their work. JEI connects middle and high school students with graduate students and post-doc scientists within their field who mentor each student through the publication process.

Data Collection & Analysis

Figure 2. Disciplinarity within Science Inquiry. Of the six statements, a greater proportion of students respond “strongly agree” in the post-survey compared to the pre-survey in 4 of the statements. This demonstrates a positive trend in better understanding the role of disciplinary literacy.

Figure 3. Identity in STEM. Overall, students demonstrate increased perceptions of belonging and identity after the peer-review and publication process. However, post-survey responses indicate that students have lower perceptions of the significance or importance of their research projects.

Discussion & Conclusions

The dimension of “Disciplinarity within Science Inquiry” shows the least gains in the post-survey responses. Our past work concurs with the survey results and suggests that students view the publication process as a personal outcome more so than an integrated part of doing science. Although, students do acknowledge that writing helped them understand their research better. Students report greater gains in all “Identity in STEM” statements, except the two statements regarding the impact or importance of their research. Considering our past data, this may be because the peer-review process encourages students to make careful conclusions that are supported by evidence, which may lead students to better understand the limitations of their work. Across all dimensions, there were greatest gains in confidence and self-efficacy following the peer-review and publication process. Research has shown that confidence and identity is associated with continued interest and retention in STEM; thus these results are promising regarding long-term value of engaging in publication of research projects (7,8).

Although preliminary, these results could inform the how and why disciplinary literacy practices should be incorporated in the classroom.

Future Directions

We are continuing to collect survey results for the next year and we will analyze questions within each dimension to understand changes more clearly. We also plan to examine demographics, type of research, and type of mentor to determine if any of these variables impact potential learning gains.

Findings:

For each statement, the % of students who agreed or strongly agreed to the statement is shown. Lighter bars represent pre-survey responses (n=59); darker shaded bars represent post-survey responses (n=64).

- **Disciplinarity within Science Inquiry**
  - 31.25% vs. 62.50%
  - 65.63% vs. 75.00%
  - 62.50% vs. 75.00%
  - 75.00% vs. 81.25%
  - 75.00% vs. 87.50%
  - 75.00% vs. 87.50%

- **Identity in STEM**
  - 54.07% vs. 41.56%
  - 44.07% vs. 26.56%

**References**

4. PUBLICATION IS IMPORTANT BECAUSE IT HELPS A SCIENTIST SHARE HIS OR HER SCIENCE WITH A BROADER AUDIENCE
5. PEER REVIEW IMPROVES THE COMMUNICATION OF THE SCIENCE PRESENTED
6. PEER REVIEW CAN GIVE SCIENTISTS DIFFERENT WAYS TO UNDERSTAND THEIR SCIENCE
7. PUBLICATION IS IMPORTANT BECAUSE IT HEALS A SCIENTIST SHARE HIS OR HER SCIENCE WITH A BROADER AUDIENCE
8. PUBLICATION IS IMPORTANT BECAUSE THE SCIENCE IN A PAPER COULD BE USED BY ANOTHER SCIENTIST TO HIS OR HER PROJECT
9. WRITING ABOUT MY RESEARCH HELPS ME UNDERSTANDING THE SCIENCE BETTER
10. MY RESEARCH WILL HELP TO SOLVE A PROBLEM IN THE WORLD
11. I HAVE A STRONG SENSE OF BELONGING TO THE COMMUNITY OF SCIENTISTS
12. I HAVE COME TO THINK OF MYSELF AS A SCIENTIST
13. I FEEL LIKE I BELONG IN THE FIELD OF SCIENCE
14. THE FINDINGS OF MY RESEARCH PROJECT AND PAPER GAVE ME A SENSE OF PERSONAL ACHIEVEMENT
15. MY FINDINGS ARE IMPORTANT TO THE SCIENTIFIC COMMUNITY
16. MY RESEARCH WILL HELP TO SOLVE A PROBLEM IN THE WORLD
17. I FACED CHALLENGES IN COMPLETING MY RESEARCH PROJECT
18. I WAS ABLE TO OVERCOME CHALLENGES POSED BY MY RESEARCH PROJECT
19. I AM CONFIDENT THAT I CAN GENERATE A RESEARCH QUESTION TO ANSWER
20. I AM CONFIDENT THAT I CAN FIGURE OUT WHAT DATA/EXPERIMENTS TO COLLECT FOR A RESEARCH PROJECT
21. I AM CONFIDENT THAT I CAN CREATE EXPLANATIONS FOR THE RESULTS OF MY SCIENCE
22. I AM CONFIDENT THAT I CAN USE SCIENTIFIC LITERATURE AND REPORTS TO GUIDE MY RESEARCH
Demographics

### Race

#### Pre-Survey

- American Indian or Alaska Native: 1.59%
- East Asian: 23.81%
- Southeast Asian: 6.35%
- Black or African American: 1.59%
- Native Hawaiian or Pacific Islander: 0.00%
- Other, please specify: 3.17%
- Prefer not to answer: 0.00%

#### Post-Survey

- American Indian or Alaska Native: 1.59%
- East Asian: 23.94%
- Southeast Asian: 2.82%
- Black or African American: 38.03%
- Native Hawaiian or Pacific Islander: 1.41%
- Other, please specify: 7.04%
- Prefer not to answer: 1.41%

### Gender Identity

#### Pre-Survey

- Male: 65.08%
- Female: 0.00%
- Non-binary: 28.57%
- Prefer to self-describe: 6.35%

#### Post-Survey

- Male: 57.97%
- Female: 4.35%
- Non-binary: 36.23%
- Prefer to self-describe: 0.00%

### Location of Research

#### Pre-Survey

- Public school: 36.37%
- Charter school: 0.00%
- Private school: 26.17%
- Home school: 5.05%
- Other, please specify below: 11.62%

#### Post-Survey

- Public school: 36.23%
- Charter school: 0.00%
- Private school: 16.45%
- Home school: 9.52%
- Other, please specify below: 11.09%
Confidence, Identity and Self-Efficacy in STEM

### Post-survey comments from student authors

<table>
<thead>
<tr>
<th>Comment</th>
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<tbody>
<tr>
<td>JEI has been a great experience that made me even more enthusiastic about research, so my decision to continue research in college has been strongly influenced by this opportunity.</td>
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<tr>
<td>I think JEI has encouraged me to continue scientific research and try to publish my work more often.</td>
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<tr>
<td>I think submitting my paper to JEI has made me more motivated to pursue science.</td>
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<tr>
<td>I plan to be a veterinarian and a researcher. Yes JEI has influenced my plans because it has made me realize how important research is to me.</td>
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<tr>
<td>I was wondering if I should do research after I graduate college and JEI gave me more confidence in thinking I could do this.</td>
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<tr>
<td>Absolutely. I plan on going into biomedical engineering, and this research project was what skyrocketed my interest in the field. Going through the publishing process showed me that this is what I really want to do, and that it can benefit other people in the scientific community too.</td>
</tr>
<tr>
<td>Writing this paper and submitting it to JEI has helped me feel more confident in my abilities as a scientist.</td>
</tr>
<tr>
<td>I would like to study social and political sciences. I have always been fascinated by history. I believe that the experience that I gained from JEI will give me more confidence to possibly pursue scientific research at the university.</td>
</tr>
<tr>
<td>I would like to pursue a degree in astrophysics. JEI has helped me gain confidence in my research and explore a lot more deeper into my field than before. I am interested in doing research in the future so JEI gave me the ability to explore the process of research and publication as a high schooler.</td>
</tr>
<tr>
<td>Yes, I was skeptical to study a science degree but after this experience, I completely fell in love with it.</td>
</tr>
<tr>
<td>Yes, it has! My confidence in doing academic research before was extremely low. It seemed like such an unreachable goal. But publishing my work in JEI has boosted that confidence immensely. The research I conducted was primarily independent and having other scientists approve it has made me confident in pursuing academia, doing independent research and taking risks!</td>
</tr>
<tr>
<td>JEI helped me develop the confidence I need to succeed as a researcher.</td>
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