Supplemental Material

Turner *et al*.

Supplemental materials for
Student perceptions of authoring a publication stemming from a course-based undergraduate research experience (CURE)
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This supplement contains the following:

Interview script

To what extent do students perceive they have benefited from their publication in the CURE?
Please describe how, if at all, you benefited from being a co-author on the CURE publication.

I'm interested in how students use the publication to get ahead or to achieve specific goals. Are there any (other) ways that you have used the publication from the CURE to achieve specific goals?
- How did you know how to use your publication to achieve these?

To what extent have you listed the publication as an accomplishment (have you listed it anywhere online)? Please explain.
- How did you know how to list the publication?

To what extent have you talked about the publication for professional or academic-related reasons? Please explain.

To what extent did you share about the publication with people in your personal life? Please explain.

What is your career goal?

How, if at all, has the publication resulting from the CURE influenced your career choice?

How, if at all, has the publication resulting from the CURE moved you closer to your career goal?

Has the publication motivated you to pursue similar research experiences outside of science?

Are there any drawbacks you can think of to getting a publication as a freshman from a CURE such as your experience?

Have there been any drawbacks to you being an author of the publication? Please explain.

To what extent do students perceive they deserve authorship on the publication in the CURE? What factors do students consider when they think about co-authorship?

Describe what you think a student needs to contribute in order to be a co-author on a scientific paper?

You were listed as a co-author on the publication resulting from the CURE. How would you rate the extent to which you feel you earned your position as a co-author on the manuscript? Please explain.

Many journals say that all authors have to intellectually contribute to a project in order to be a co-author.

- What does it mean to you to intellectually contribute to a research project?
- To what extent do you feel that you intellectually contributed to the CURE research project?

Describe your role in the CURE research project.

Describe your role in the preparation of the manuscript.

Did you read the manuscript before submitting it for publication?

Did you send in comments about the manuscript before publication?

How thorough were your comments?

To what extent were your comments incorporated into the manuscript?

How well can you describe/present the published CURE study to a scientific audience (now)?

Have you gone back and read the publication once it was published?
- If yes:
  o How many times?
  o For what occasions did you re-read the article?
  o Will there be any other instances in the future that might prompt you to read it?
- If no:
  o Why not?

As the CURE was taking place during that semester, did you see your experiments actually contributing to and resulting in a publication?

To what extent were students primed to recognize the benefits of a publication and how did such priming affect how they leveraged the publication?

When in your life did you first hear or learn about research publications?

How did you learn about research publications?
- If learned about publications prior to the CURE:
  o How did your prior knowledge about publications influence your enthusiasm about the publication?

To what extent do you perceive publications are useful?
- If student perceives the publication to be useful
  o When did you first learn publications were useful?
    ▪ If prior to the CURE:
      - How did your prior knowledge about the usefulness of publications influence your enthusiasm about the publication?
      - Did you then feel or know that you were going to get one?

Did you conduct any research prior to coming to college?
- If yes: How did your prior experience influence what you aimed to get out of the CURE?

Have you published any other articles (besides the CURE publication)?
- If yes
  - Which publication was first? CURE publication or others?
  - If the CURE publication was first, how, if at all, has that publication affected the extent to which you were able to publish the others? Or leverage your other publications to achieve your goals?
- If no
  - How, if at all, will the CURE publication affect your future publishing?

Final coding rubric

Theme	Description of theme	n (%) (n = 16)
Potential benefits		
Built a professional profile	Student describes putting a publication on their CV or resume or mentions that they have used or will use their publication to gain a scholarship, research position, job, or to get into graduate/professional school. This includes if a student shares the publication/networks with individuals in their professional circles, presumably to gain status or to advance further in the field. Additionally student may perceive that down the line the publication could be helpful for the tenure and promotion process or for grant funding.	15 (93.75)
Built social support	Student describes that they use the publication to strengthen their personal relationships or to gain social status among peers, or simply to share to result in celebration with others in their personal life.	16 (100)
Increased ability to do research or publish in the future	Student describes that publishing gave them confidence in their ability to publish in the lab. Student may mention they thought it was impossible to publish as an undergraduate or that it was just incredibly rare that undergraduates can publish and describe how the CURE publication has changed this.	12 (75)
Experience in the process of research and conducting experiments	Student describes building competency in skills/techniques from experiments that led to publication. They may mention that they feel more comfortable or are more familiar with doing research in a lab setting.	14 (87.5)
Increased experience in the process of publishing	Student describes that they gained experience in writing, communicating science, became more familiar with the peer review process and/or gained an increased understanding of ethics as it relates to publishing.	13 (81.25)
Influenced career direction	Student describes that engaging in the process of publishing gave them clarity in their career goals. For some students this means that they wanted to pursue a career in research and for others it means they know they don't want to do research.	15 (93.75)
Increased belonging to the scientific community	Student describes that being an author made them feel like they are a part of the scientific community. This code also includes students who described an	7 (43.75)

	increase in self-esteem in being a scientist or feeling more recognized by the scientific community.	
Developed personal pride	Student mentions that publication is viewed as a personal accomplishment they are proud of.	7 (43.75)
Appreciation for research and science	Student mentions the publication gave them an appreciation for science and research.	6 (37.5)
Helped students to see the big picture of research	Student describes the publication allowed them to see the big picture or connect the dots on their experiments and the project as a whole.	6 (37.5)
What student perceives is needed for authorship		
Conception and design of study	Student mentions developing of research questions and the design of the study/experiments; planning the project and experiments; constructing hypotheses or contributing ideas that have to do with the conception or study design.	2 (12.5)
Data collection/experimentation	Student mentions engaging in the collection of data or conducting of experiments.	14 (87.5)
Data goes into figure of paper	Student mentions data goes into a figure of the paper.	4 (25)
Data analysis	Student mentions the need to analyze the data.	5 (31.25)
Data interpretation	Student mentions data interpretation.	2 (12.5)
Putting in time and effort	Student mentions needing to participate or to put in substantial time or effort into the project.	5 (31.25)
Deep conceptual understanding	Student describes needing to fully understand aspects of the project or why they are doing what they are doing.	6 (37.5)
Explicitly states intellectual contribution	Student simply states you must intellectually contribute or must put in intellectual effort.	2 (12.5)
Substantial idea	Student mentions the need to contribute a thought that changes the narrative of the project (however, if the idea has to do with the conception or overarching design of the study, then this is coded as 'conception and design of study').	2 (12.5)
Write part of the manuscript	Student mentions contributing writing to the manuscript.	16 (100)
Critically revise the manuscript	Student mentions critically revising the manuscript or making a substantial change to the draft of the manuscript.	0 (0)
Read and/or provide minor edits on the manuscript	Student mentions reviewing the manuscript and providing minor feedback/revisions that did not require intellectual investment in the project itself.	3 (18.75)
Approve the manuscript	Student mentions approving the manuscript or being aware of what is in the paper before it's published.	2 (12.5)
Troubleshooting	Student mentions troubleshooting an experiment.	1 (6.25)

Intellectual contribution definition		
Asking questions to learn and develop their own understanding	Student describes actively thinking and questioning to learn and understand what they were doing.	2 (12.5)
Asking questions to challenge or further the research project (substantial idea)	Student describes actively thinking and questioning with the intent to push the project forward; providing a substantial idea.	6 (37.5)
Formulations ideas about the research question or experimental design (conception and design)	Student describes coming up with the research question or hypotheses or designing the experiments.	11 (68.75)
Write parts of the manuscript (e.g. intro/discussion)	Student mentions writing the manuscript.	6 (37.5)
Do experiments and collect data	Student mentions doing the experiments or collecting the data.	10 (62.5)
Understand the project	Student mentions to understand the project.	3 (18.75)
Data analysis	Student mentions to analyze the data or data analysis.	3 (18.75)
Data interpretation	Student mentions interpreting data or figuring out what the data means or is saying.	2 (12.5)
Troubleshoot experiments	Student mentions troubleshooting an experiment or figuring out why an experiment isn't working.	5 (31.25)
Edit the manuscript	Student mentions editing or providing comments on the manuscript.	1 (6.25)
Review the manuscript	Student mentions reviewing the final manuscript.	1 (6.25)
Approve the manuscript	Student mentions to approving the final manuscript.	1 (6.25)
Based on your level of experience	Student mentions that intellectual contribution is based on your personal level of experience and knowledge at the time of the project.	1 (6.25)

Survey questions

Please select the major that is closest to yours. If you have more than one major, please choose all that apply.
- ☐ Biology
- ☐ Business
- ☐ Chemistry
- ☐ English
- ☐ Geosciences
- ☐ Physics
- ☐ Psychology
- ☐ Sociology
- ☐ Other (please describe)

What is your GPA (on a 4.0 scale)?

How long have you attended college while pursuing your undergraduate degree?
- o 1 year or less
- o 2 years
- o 3 years
- o 4 years
- o 5 years or more
- o I have graduated with my undergraduate degree

Did you have any research experience prior to enrolling in the CURE?
- o No
- o Yes (please describe)

Did you pursue and engage in undergraduate research following the CURE?
- o No
- o Yes (please describe)

What is the total number of primary research articles that you have currently submitted or published in peer-reviewed journals?

List your primary research articles published in peer-reviewed journals below (articles you have been included as authors). You are more than welcome to simply paste the citation from Google scholar or Pub Med.

Name

How old are you?

I most closely identify as
- o   Woman
- o   Man
- o   Other (please describe)

I most closely identify as
- o   American Indian or Alaska Native
- o   Asian
- o   African American or Black
- o   Hispanic, Latinx, or Spanish Origin
- o   Pacific Islander
- o   Caucasian or White
- o   Other (please describe)

I most closely identify as
- o   Heterosexual
- o   Lesbian
- o   Gay
- o   Bisexual
- o   Transgender
- o   Queer
- o   Intersex
- o   Asexual
- o   Other (please describe)

The language you spoke at home when you were growing up
- o English
- o Spanish
- o Other (please describe)

I most closely identify as
- o An international student
- o Not an international student

What is your best guess for the yearly income of the household in which you grew up?
- o Low income (less than $25,000)
- o Middle-low income ($25,000 - $49,999)
- o Middle income ($50,000 - $99,999)
- o Middle-high income ($100,000 - $199,999)
- o High income ($200,000 or higher)
- o I do not have any idea

What is your parent or guardian's highest level of education? If you have more than one parent or guardian with differing levels of education, choose the higher of the two.
- o Less than high school completed
- o High school diploma or GED
- o Some college but no degree
- o Associates degree (AA or AS)
- o Bachelor's degree (BA, AB, or BS)
- o Master's degree (MA, MS, MEng, MEd, MSW, or MBA)
- o Higher than a Master's degree (PhD, MD, or JD)

Do you have anyone in your immediate family who has a Master's or Doctoral degree in science?
- o Yes
- o No

What are your plans following graduation? Where are you headed next?

What are your career goals?

Figure SM1. Individual students' contributions to the CURE research project and manuscript

CURE Activity	Individual CURE Students															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Identify CRISPR targets within target gene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
In vitro synthesis and validation of guide RNAs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Microinjection of guide RNAs and Cas9 into zebrafish embryos	✓	✓			✓	✓	✓			✓						✓
Analyze microinjected zebrafish embryos and score for phenotype	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Infer developmental defects and correlate observed defects to the target gene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Analyze off-target/on-target scores, protein modeling of identified mutations, and more	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Prepare figures, abstract, and posters for research exposition and/or manuscript	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Draft/write parts of the manuscript					✓											✓
Review, provide feedback, and approve the manuscript	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓