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Activity

Writing Children's Books to Increase Engagement in Non-major Introductory Chemistry Courses

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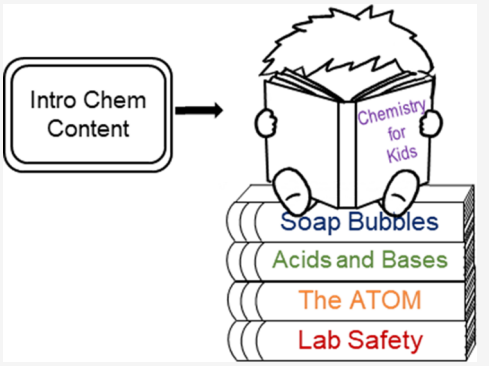
ABSTRACT: To increase student interest and engagement in introductory chemistry courses for non-science majors, we incorporated a children's book project based on the chemistry discussed in class. Students were given agency in topic, target age range, and book format to encourage creativity, to integrate student interest and major, and to challenge communication skills. Postactivity surveys provide positive student impressions of the project. Recommendations for implementation are included.



KEYWORDS: *General, Interdisciplinary, Communication, Writing, Non-major Courses, Student-Centered Learning, Public Understanding*

INTRODUCTION

One of the challenges of teaching a Chemistry course to non-science majors is increasing their interest and engagement in Chemistry and in course content. Increased engagement has a positive impact on overall course grades and increases learning of course material.[1,2] Incorporating projects and creative learning activities into the chemistry curriculum has been shown to increase interest, engagement, and learning. Preparation of videos,[3] music videos,[4] infographics,[5] and open-ended, student-directed projects[6] are some examples that have been incorporated successfully into Chemistry courses. These unique assignments increase student interest and enthusiasm for the topics as well as improve student understanding of course material.

Some unique assignments specifically challenge students to write or prepare media for a targeted audience. These can focus on workplace readiness[7] and encourage improving science communication for the general public.[8−10] The authentic assessments with specific target audiences use a constructivist pedagogical approach by asking students to connect new knowledge from the classroom to prior knowledge and experience.[11] Incorporating real-world relevance encourages the students to engage with the activity and build communication skills relevant for future employment.

Over the past five to ten years, there has been an increased interest in science-themed children's literature and books on topics in STEM fields that are available for a wide variety of ages.[12] These children's books and materials are accurate in their content, creative in their delivery, and written at an age-appropriate level for the target audience.[7] The Baby University series includes topics such as Quantum Mechanics and Organic Chemistry for babies and young toddlers ages 0−3,[13] and children aged 4−6 are engaged by picture books such as Ada Twist, Scientist by Andrea Beaty.[14] In addition to fact-based STEM books such as National Geographic Kids Series, early chapter books incorporate STEM into adventure and mystery story lines for kids ages 6−10, including The Magnificent Makers book series by Theanne Griffith.[15] A series of comic books called "Kids' Chemical Solutions: The M.C. Detective Agency" by Colleen Kelley provides an additional, unique format for kids ages 8 and up to learn about Chemistry.[16] There are also many options for fun, at-home STEM and STEAM experiments to engage children in Chemistry, Physics, and Math including the Awesome STEAM Activities for Kids 11 book series.[17]

Children's literature has been incorporated in K12 education to increase student interest in STEM and increase teacher comfort in teaching science topics when introducing a new STEM topic.[17−22] In higher education, however, students can be challenged to create a STEM-themed children's book. One

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such example was highlighted in Brouet and Hupp's 2013 paper where their non-major chemistry students prepared a children's book about a specified topic (ozone depletion) to a specific target age group.[23]

Here, we describe a children's book writing activity that was incorporated into in-person and virtual non-major introductory chemistry courses. Students were given agency to choose their topic and target age. The goals of this project were to increase student engagement in chemistry and to challenge student creativity in communication to a unique audience.

COURSE INFORMATION

The children's book learning activity was incorporated into two non-major chemistry courses in either in-person or online modality. "Chemistry! Better Things for Better Living" with no laboratory component has approximately 105 students in non-science majors including Education, Communications, Journalism, Applied Engineering, and History. "General, Organic, and Biochemistry 1" (GOB1) with a laboratory component enrolls approximately 50 students who are Mid-Level Education, Occupational Safety and Environmental Health (OSEH), and Allied Health majors. 15−30% of the students in these courses had declared an education major, and some GOB1 classes had up to 25% OSEH majors. In online modalities, "Chemistry! Better Things for Better Living" was taught in an asynchronous modality and "General, Organic, and Biochemistry 1" was taught in asynchronous modality with a synchronous laboratory component.

Both courses were organized into topical modules to directly connect chemistry concepts to real world topics or questions.[23−25] Modules included: Should the US use nuclear power as an energy source?, How do cleaning products work?, Why should not you microwave food in some plastics?, and How does sunscreen work? Course outcomes related to this activity include:

- Describe how selected chemicals and reactions are significant to the world around you.
- Explain natural phenomena encountered outside the classroom using chemical principles.
- Nurture an appreciation for thinking, speaking, and acting like a scientist.

ACTIVITY

Students in non-major, general education introductory chemistry courses were challenged to prepare a children's book that incorporated a chemistry topic in an age-appropriate manner. The activity was introduced midsemester (week 8 of 15) and was due at the conclusion of the semester. (Example course schedules are provided in the Supporting Information.) Students were required to include accurate content and were given agency with flexibility of chemistry topic, target age range, illustrations, and book format which could include an illustrated book, fact-based book, or narrative that incorporated chemistry topics. Student autonomy in choice of topic was particularly important to increase student motivation for activity completion and to raise student interest.[26−28] Many students chose topics closely related to their major and field of interest, enabling them to incorporate topics or content from their major coursework. The most common book topics included Atoms, Soap, Safety, and Acids and Bases although some students focused on more unique topics of Sunscreen, Electromagnetic Spectrum, Plastics, or Brewing Beer. Several students majoring in Occupational Safety and Environmental Health highlighted laboratory safety protocols which were discussed in the first week of lab. As a significant population (10−30%) of the courses were composed of early education or midlevel education majors, students were able to apply their knowledge of early childhood literature to a topic in chemistry. Example images from student books in Figure 1 highlight the diversity of topics and student aesthetic.

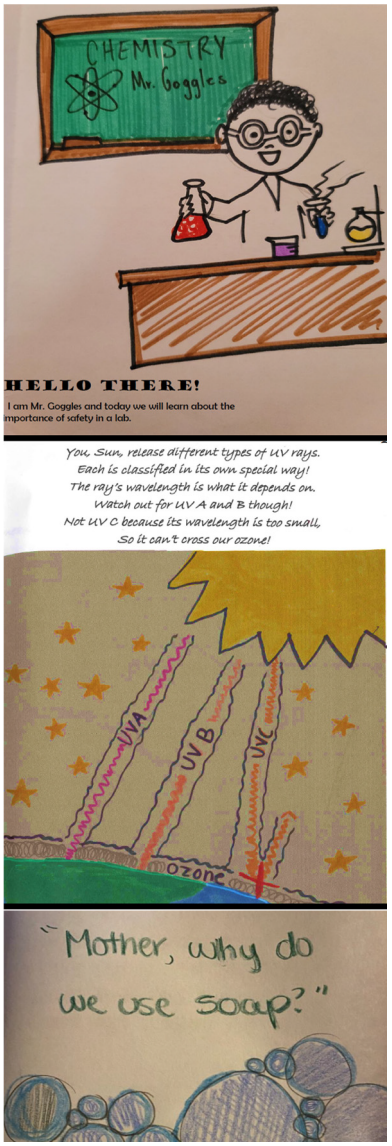

Figure 1. Selected pages from student-prepared children's books. Top to Bottom: "Safety in the Lab" page 2, "Thanks for everything you do but you're very harmful too" page 4, and "Mother, why do we use soap?" cover. Complete book examples can be found in the Supporting Information. Included with permission from the students.

All the student-prepared books focused on topics that were discussed in class, and most students chose topics discussed in the first half of the course which already had been covered when the activity was introduced (for example, atoms, safety, soap, and acids/bases). However, some students interested in topics that were listed on the course schedule waited to complete their children's books until after that topic had been discussed (for example, sunscreen and plastics).

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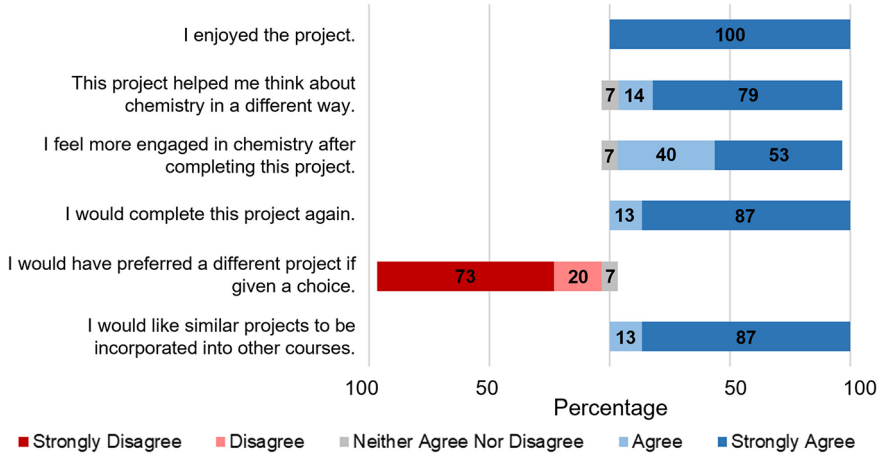

Figure 2. Student perceptions of the children's book project. Percent response to 5-point Likert questions about the children's book project incorporated into non-major courses (n = 15). Data is plotted as a response percent histogram centered on "Neither Agree Nor Disagree" response. Percentages are rounded to the nearest integer and included in each category with responses. Categories not included had zero responses.

Table 1. Student Perceptions of Children's Book Project in Free Response Questions

Question	Themes	Responses
What did you like about this project?	Creativity (66.7%)	I liked that it offered creativity and the ability to connect with my major.
	Fun (26.7%)	Fun and able to be creative.
	Display understanding in unique way (13.3%)	It was a break from actual classroom chemistry and it got our brains thinking about chemistry in a creative way.
What did you find challenging about this project?	Creativity (25%)	Being creative is not my strong point but with a little more push I figured out what to do.
	Age-appropriate wording (41.7%)	Coming up with a topic but also making it simple enough for the age range that I wanted [to target].
What did you dislike about this project?	Nothing (60%)	I did not dislike anything about the project.
	Amount of time/work (10%)	It was a lot of work.
	Artistic Ability (10%)	My artistic ability.

Variations of the activity were included in different general education, non-major introductory chemistry courses with in-person and virtual modalities. Student impressions of the activity from virtual courses were collected after the book was submitted using an IRB-approved survey.

■ ASSESSMENT OF STUDENT WORK

Books were assessed on accuracy of chemistry content and depth of understanding (40%), terminology and phrasing (20%), originality and creativity (20%), and overall presentation (20%) with a rubric out of ten points (Supporting Information). The average score for submitted children's books was 87.0 ± 10.5 with a median score of 85. The criteria where student books were more frequently rated less than exemplary were accuracy and depth of content and originality and creativity.

Most student-prepared books contained information that was factually correct with appropriate terminology and phrasing when describing chemistry facts. However, some students struggled with demonstrating a depth of understanding of the topic, providing just a couple of chemistry facts within the story. For example, a book about atoms that correctly defines subatomic particles and relative atomic location but does not include any examples or correlation to identity or reactivity would display a lack of depth of the topic. Another example would be a book about plastics and health hazards that does not include a molecular explanation or analogy of polymers or additives. The lack of depth in the books could indicate a surface level understanding of the book topic chosen; however, it could also be an artifact of students attempting to simplify books for younger children. Incorporating scaffolded assignments and/or book drafts could improve incorporation of more chemistry in the books and demonstrate student understanding of the chosen topic.

Some students were very creative in their illustrations, story, and text including generating rhyming text, and it was common for students to anthropomorphize atoms and molecules or create characters that interacted with the chemistry in some way. However, some students did not demonstrate as much originality and creativity. For example, alphabet books that included a chemistry-related word for each letter without additional explanation or content would be rated acceptable or needs improvement in creativity and accuracy and depth of content.

We supplied several examples of children's books from target age groups to help students without early childhood literature experience distinguish between the different levels. This set of examples should be carefully curated as when an example alphabet book was included, we saw an increase in submission of alphabet-themed children's books. In the courses that offered the extra credit project, 25−40% of students enrolled in the course submitted a children's book and there was no correlation between final course grade and completion of the children's book. While we did not explicitly assess learning gains associated with writing children's books about a specific topic, we collected student perceptions of the activity.

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STUDENT PERCEPTIONS

Students who prepared a children's book in the online courses were asked to complete an IRB-approved online survey (Qualtrics) to provide feedback about the activity and its impact on their understanding, engagement, and interest in chemistry topics. Fifty eight percent of students who submitted a book completed the survey (Supporting Information), which included four questions about their project and its preparation and three free response questions about what was liked, disliked, and what students found challenging about the project. Students were also asked seven 5-point Likert questions about their perceptions of the project and basic demographic information. While the responses provide student feedback and enable us to include student voices in this paper, the results do not provide statistically significant responses due to the low response rate.

As shown in Figure 2, all survey respondents (n = 15) indicated they enjoyed the project (100% strongly agree), would complete the project again (87% strongly agree), and would like similar projects to be incorporated into other courses (87% strongly agree). When asked what students liked about the project, 67% of students mentioned creativity and 13% mentioned displaying understanding in a unique way (Table 1). Interestingly, 25% of students also found creativity to be one of the most challenging aspects of the project and 42% found finding age-appropriate language to be difficult (Table 1).

Students also agreed that the project helped them think about chemistry in a unique way (79% strongly agree), and they felt more engaged after completing the project (53% strongly agree). Some students indicated that the project was a lot of work; however, 60% indicated they did not dislike anything about the project. When asked if they would have preferred a different project if given a choice, 93% of respondents indicated they would not. Writing children's books is a unique project that challenges student creativity and communication to increase student enthusiasm, engagement, and interest in chemistry topics.

INSTRUCTOR REFLECTION AND RECOMMENDATIONS

After incorporation of the project in several courses, we have compiled recommendations for instructors who are interested in including a similar project in their course. In future iterations of the project, we would recommend incorporating the project as a requirement for the course and including scaffolded assignments and/or peer review to assist depth of content and improve target age range estimation, which are aspects of the project which were particularly challenging for students and where they asked for the most guidance. Partnering with faculty in the education department(s) who specialize in children's literature could provide opportunities for peer review with education majors and specific, helpful feedback to enhance the project and improve the quality of the books.

This project can be combined with a STEM outreach activity or a service learning project where students can share books with or read books to younger children. While there are significant logistical challenges to students visiting schools for in-person readings, it would be possible to partner with local schools to send books to the school for students within the target age group to read, record videos of students reading books, and share with multiple schools and/or libraries or partner with a local library for a STEM book reading event.

Students can share their work with the campus community. After one semester, several students presented their children's books at an on-campus conference for research and creative work and received feedback from faculty and students from multiple disciplines. Similar events or local conferences could be an opportunity for students to present their work.

Additionally, high quality children's books can be published by working with a publisher or by self-publishing, providing avenues for student-focused scholarship in the classroom environment.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available at https://pubs.acs.org/doi/10.1021/acs.jchemed.3c00068.

Activity prompt and age appropriate guidelines (PDF; DOCX)

Grading rubric (PDF, DOCX)

Survey instrument (PDF, DOCX)

Example course schedules (PDF)

Examples of student work (PDF)

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Notes

The authors declare no competing financial interest.

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