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Exploring College Students' Perceptions of Biologists

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ABSTRACT

This study examined how and to what extent undergraduate students' conceptions of biologists changed over a year-long introductory biology sequence featuring case studies of diverse scientists, collaborative activities, and laboratory experiences. Using a modified Draw-a-Scientist Test (DAST) tailored as 'Draw-a-Biologist,' students completed drawings and written descriptions at the beginning and end of each semester, with follow-up interviews. Students shifted from intelligence as a defining characteristic to qualities like perseverance and problem-solving, aligning with a growth mindset. Multi-scene depictions and outdoor settings increased over time, reflecting broader perspectives on biologists' work. Gender-neutral language was common, reducing the focus on gender roles. These results highlight the importance of discipline-specific prompts, longitudinal approaches, written responses, and interviews for understanding students' perceptions. Educators can foster inclusivity and challenge stereotypes by featuring diverse role models, explicitly connecting science to teamwork, and engaging students in authentic scientific practices.

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Biologist; conception; Draw-a-Scientist Test (DAST); gender; stereotype; undergraduate

Introduction

Historically, the stereotypical image of a scientist has been that of a white male in a lab coat, working alone in a laboratory, and surrounded by scientific tools such as microscopes and test tubes. This stereotype begins in early childhood and persists in adulthood (Chambers, 1983; Ferguson & Lezotte, 2020; Miller et al., 2018). While more students in recent decades identify scientists as female, these stereotypes persist (e.g., Miller et al., 2018), even among college students (e.g., Thomas et al., 2006). Teaching approaches that help to continue reducing these stereotypes include highlighting scientists from different backgrounds (Metzger et al., 2023; Schinske et al., 2015), modeling positive attitudes toward scientists (Quita, 2003), and implementing inquiry-based activities (Miele, 2014), including team-based problem solving (Espinosa et al., 2019) and authentic scientific experiences (Ambrosino & Rivera, 2023).

One common method for examining students' perceptions of scientists is the Draw-a-Scientist Test (DAST), developed by Chambers in 1983 and inspired by Mead and Métraux (1957). Across decades of research, which have primarily focused on children, DAST drawings frequently reflect stereotypical images, though modest shifts have occurred, such as increased representation of women and a reduction in the 'mad scientist' stereotype (Ferguson & Lezotte, 2020; Miller et al., 2018). When studied, college students hold similar perceptions (Thomas et al., 2006), although biology majors and graduate students depict fewer stereotypical features than non-majors (Miele, 2014; Rosenthal, 1993). Pre-service teachers, a population more frequently studied than other majors, often depict scientists in traditional lab roles and tend to portray male and white scientists despite predominantly female participation (McCarthy, 2015; Meyer et al., 2019; Moseley & Norris, 1999; Quita, 2003; Rubin et al., 2003). Discipline-specific studies reveal similar stereotypes, though context matters: biologists were often

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depicted as solitary lab workers (Sheetz, 2023), entomologists outdoors (Reed & Hoback, 2024), and ecologists more often in field settings than geneticists or generic scientists (Jordan & Duncan, 2009).

Our study examines discipline-specific conceptions by asking students to ‘Draw a Biologist’ at the start and end of two sequential courses—organismal biology with fieldwork and cell biology with lab projects. Both courses emphasized problem-solving, diversity, and collaboration, and we conducted interviews with students across both to gain deeper insight. This study examines how undergraduate students’ conceptions of biologists change over a year-long introductory sequence and how instructional practices may influence those changes.

Methods

Research Design

To investigate how undergraduate students conceptualize biologists, we administered a survey at the beginning and end of two sequential introductory biology courses: organismal biology and cell biology. Students drew a biologist and completed short written descriptions. We analyzed changes in coded features using normalized gains and conducted follow-up interviews with students who took both courses with the same instructor to explore their reasoning in more depth. All procedures were approved by the university’s IRB, and participation was voluntary and anonymized.

Participants

We collected data at a residential, science-focused college within a large public R1 university in the United States. Our focus was on two sequential introductory biology courses: organismal biology and cell biology. The sections that participated in this study were taught by the same female instructor. Organismal biology enrolled 26 students (15 females and 11 males; based on university records), with 24 completing both surveys; cell biology enrolled 40 students (28 females and 11 males), with 39 completing both. Most were lower-division students majoring in biology or related fields. Eleven students enrolled in both courses with the same instructor, and seven participated in follow-up interviews. Interviewees were first- or second-year biology majors; five identified as female and two as male.

Instructional Context

Both courses employed a flipped classroom model in which students learned foundational concepts through online modules and applied those concepts during laboratory and class sessions in teams of four.

Organismal biology course. In organismal biology, students examined topics such as evolution, ecology, and genetics through case studies, data analysis, and lab activities. About one-third of the class periods featured case studies portraying working scientists via either photographs or videos, with all but one showing outdoor fieldwork, and half focused on female scientists. Inquiry-based lab activities either introduced or reinforced lecture topics and ranged from indoor exercises to sessions at the university museum and outdoors.

Cell biology course. Cell biology involved a larger class size and additional lab sessions. About one-third of class periods focused on real science case studies, with most highlighting women scientists engaged in field and lab work. The laboratory consisted of a semester-long project identifying fish species from sushi restaurants using various laboratory techniques. The steps required precise measurement, and often did not work the first time, so students frequently problem-solved to fix their approach. Halfway through the semester, students viewed and reflected on the video *Naturally Obsessed* (Rifkind & Rifkind, 2009), which follows a mixed-gender research team as they navigate dilemmas in their research projects.

Surveys

During class, students completed a Draw-a-Biologist survey during the first and last weeks of each course. The survey asked them to draw a biologist at work. We used a modified version of the DAST

template (Chambers, 1983), replacing ‘scientist’ with ‘biologist’ and obtained the template from the PEAR Institute (Partnerships in Education and Resilience, PEAR, 2008). The survey included the following instructions:

1. Close your eyes and imagine a biologist at work. In the space below, draw what you imagined.
2. Describe what the biologist is doing in the picture. Write at least 2 sentences.
3. List three words that come to mind when you think of this biologist:
4. What kinds of things do you think this biologist does on a typical day? List at least three things:

We analyzed survey data using a mixed qualitative–quantitative approach. Students’ drawings and written responses were coded for six broad categories reflecting common themes in Draw-a-Scientist research: gender cues, work setting, stereotypical characteristics, community and collaboration, problem-solving traits, and multiple conceptions of scientific work. Codes captured the presence or absence of features in drawings and short-answer responses and were informed by prior DAST literature (e.g., Chambers, 1983; Finson et al., 1995; Mead & Métraux, 1957) and iterative review of the survey data (see [Supplementary Material 1](#)).

To examine changes over time, we compared the proportion of students whose responses included each coded feature at the beginning and end of each course. We used normalized gains (Hake, 1998) to estimate the magnitude and direction of change within each course (see [Supplementary Material 2](#)). Because gains were generally small, we emphasize overall patterns rather than individual values in the Results.

Interviews

We conducted 20-minute semi-structured interviews with a subset of students ($n=7$). Interviewees discussed the similarities and differences among their four drawings, including possible reasons for these changes (see [Supplementary Material 3](#) for interview questions). To analyze the interviews, we qualitatively identified the recurring coding themes, such as problem-solving, perseverance, collaboration, or work setting. Interviews were used to validate the survey codes (see [Supplementary Material 1](#)), contextualize survey patterns, and provide insight into how course experiences influenced students’ perceptions.

Results

Normalized gains from pre-course to post-course surveys were generally small, except for decreases in male depictions ($g=-0.21$) for organismal biology ([Figure 1](#)) and, for cell biology ([Figure 2](#)), an increase in perseverance ($g=0.49$) and a decrease in intelligence ($g=-0.22$).

Gender

We used pronouns from the student responses to the short-answer questions to identify whether the drawn biologists were male (he/him/his), female (she/her/hers), or gender-neutral (they/them or no pronouns). At the beginning of organismal biology, 17% of responses contained female pronouns, 42% contained male pronouns, and 38% contained gender-neutral pronouns. At the end of the course, the use of male pronouns decreased by 13%, marking the largest change for this course ($g=-0.21$). In cell biology, about half of the students used gender-neutral language in pre- and post-course surveys, with a 5% increase in the use of male pronouns. Hair length patterns, which have historically been used to identify gender (e.g., Miller et al., 2018), generally aligned with pronoun use. That is, across all drawings, one student drew a biologist with long hair and used male pronouns, and another student drew a biologist with short hair and used female pronouns. For all testing phases, about half of the students who drew long hair used general-neutral language.

Setting

We identified whether the biologist was drawn in an indoor or outdoor setting ([Figure 3](#)). Nearly three-quarters of the students drew the biologist indoors for both courses. Drawing a biologist

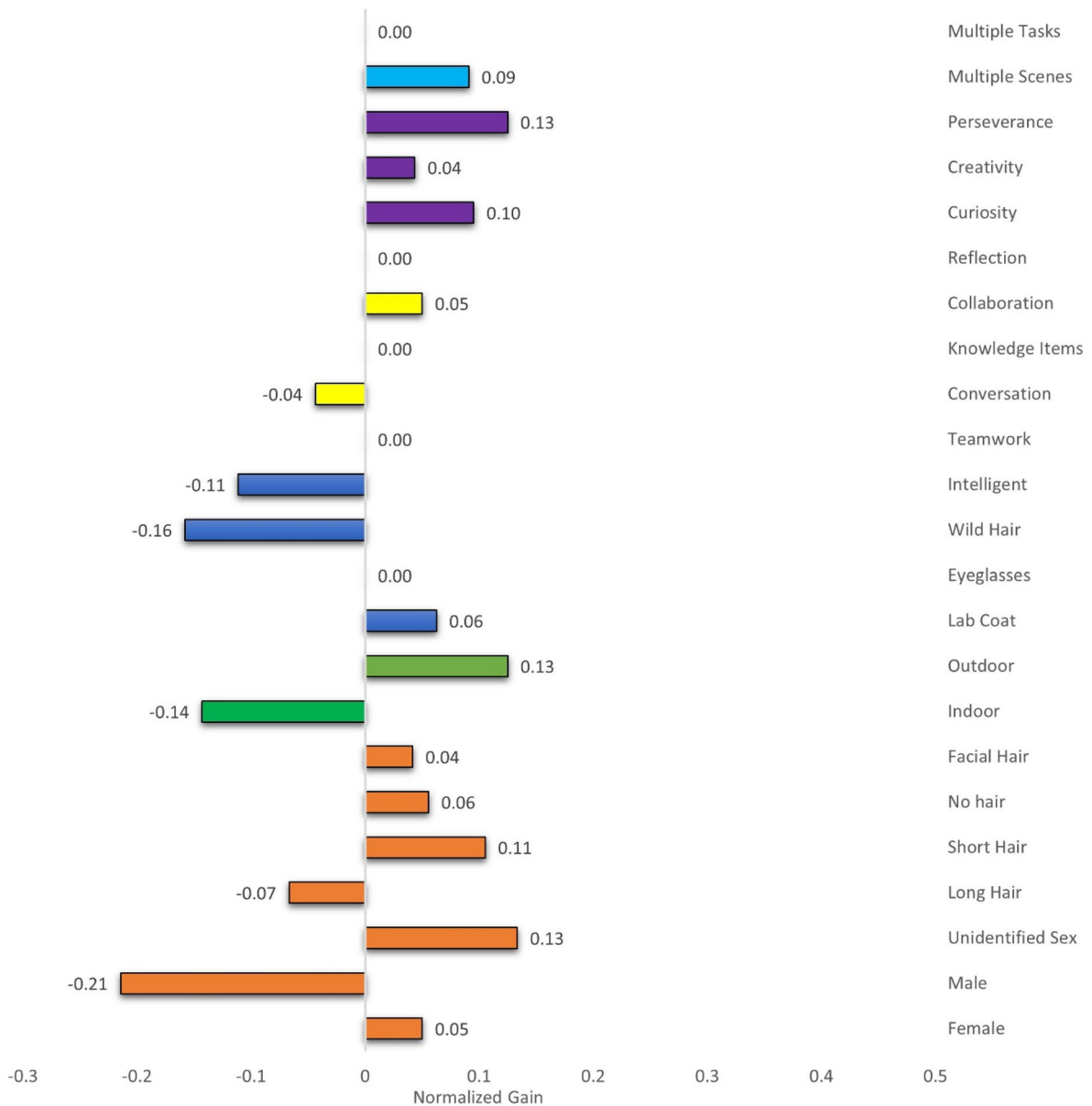


Figure 1. Normalized gains for the organismal biology course. Different colors represent each category. Negative gains indicate that the code appeared less often by the end of the course, positive gains suggest that the code appeared more often by the end of the course, and no bar (a gain of zero) means that there was no difference between the pre- and post-course surveys.

outdoors slightly increased. Interviewees frequently noted that biologists work in a range of environments. For example, Charlie reflected: ‘I guess over the course of the semester, we did like a lot more research to like open my eyes to what they actually do.’

Stereotypes

Stereotypical depictions of biologists included elements like lab coats, eyeglasses, and wild hair (Figure 4). In both courses, about one-third of students drew lab coats and eyeglasses, with a slight drop to about one-quarter by the end of cell biology. Wild hair was relatively rare in both courses, with 21% drawing it at the beginning of organismal biology and dropping to 8% by the end, marking the second-largest change in organismal biology.

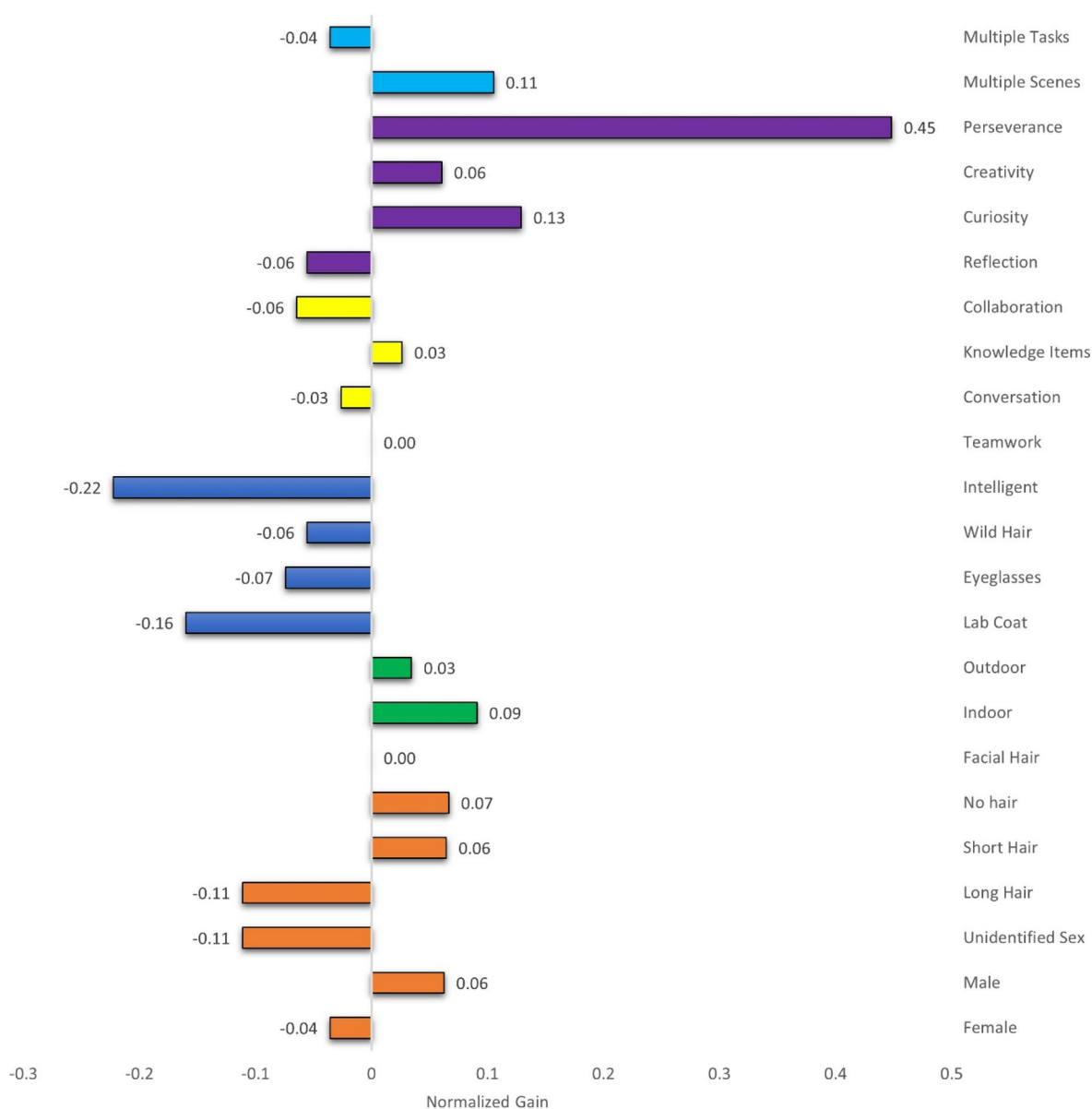


Figure 2. Normalized gains for the cell biology course.

Intelligence was also categorized as a stereotype due to its association with a fixed mindset. In organismal biology, a quarter of students initially described biologists as intelligent, a figure that decreased by 8%. In cell biology, though, the percentage of students describing biologists as intelligent fell from 31% to 15%, yielding the second-largest change ($g = -0.22$).

Community

The percentage of drawings depicting teamwork (Figure 5) was relatively low in both courses. Around 15-21% of students described collaboration as a biologist's trait across both courses, with a small gain in organismal biology and a drop in cell biology. A couple of interviewees described biologists working collaboratively. Taylor, for example, explained that the drawings began to incorporate collaboration because 'we did like look at case studies every day and that was again hands-on way of taking up information but we also did work together.'

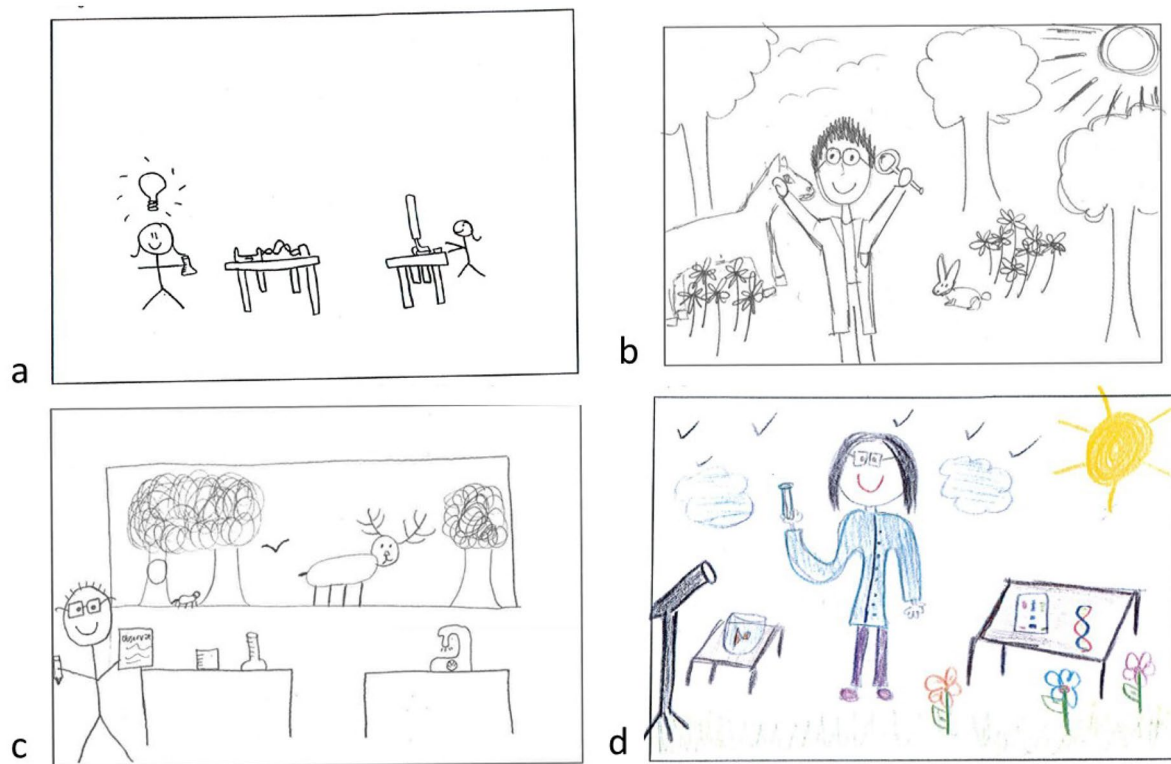


Figure 3. (a) Illustrates the absence of outdoors (coded as indoors; cell biology post-course survey), and (b) shows outdoor scenery (outdoors; organismal biology post-course survey), (c) boxes with outdoor scenery represented windows (outdoors; organismal biology post-course survey from interviewee Charlie), and (d) is a drawing with outdoor scenery and lab equipment (outdoors; cell biology pre-course survey).

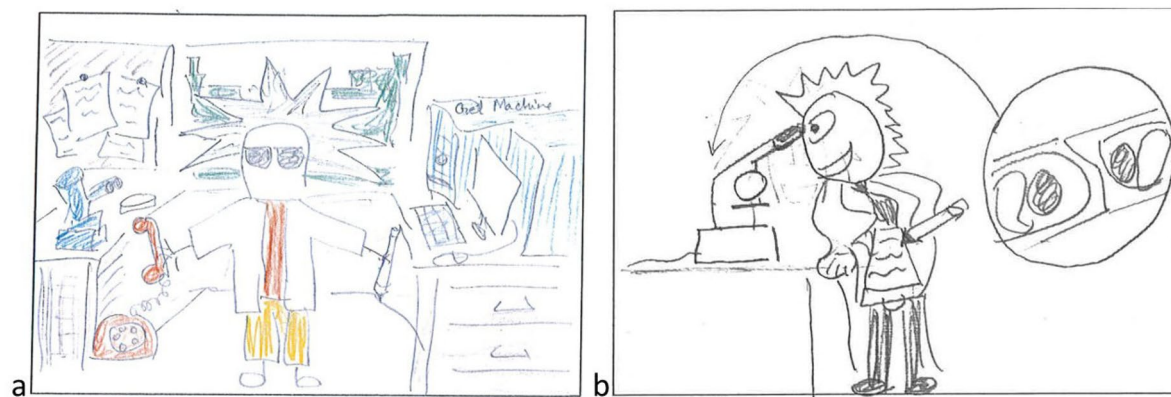


Figure 4. (a) Shows the presence of stereotypes, including lab coat, eyeglasses, and wild hair (cell biology post-course survey). (b) Shows the presence of wild hair (organismal biology pre-course survey).

Problem-Solving

Drawings indicating reflection (Figure 6) remained relatively low in both courses. Across the biology sequence, references to curiosity, creativity, and perseverance in written responses consistently increased. Curiosity was initially mentioned by 4% at the start of the organismal biology sequence and gradually rose to 21% by the end. Perseverance went from not being mentioned to being used by 13% of students at the end of the organismal biology course. In cell biology, 44% of students described it in the pre-course survey, and an additional 15% did so in the post-course survey, resulting in the greatest change ($g=0.49$; double the second-largest value). In describing what a biologist does on a

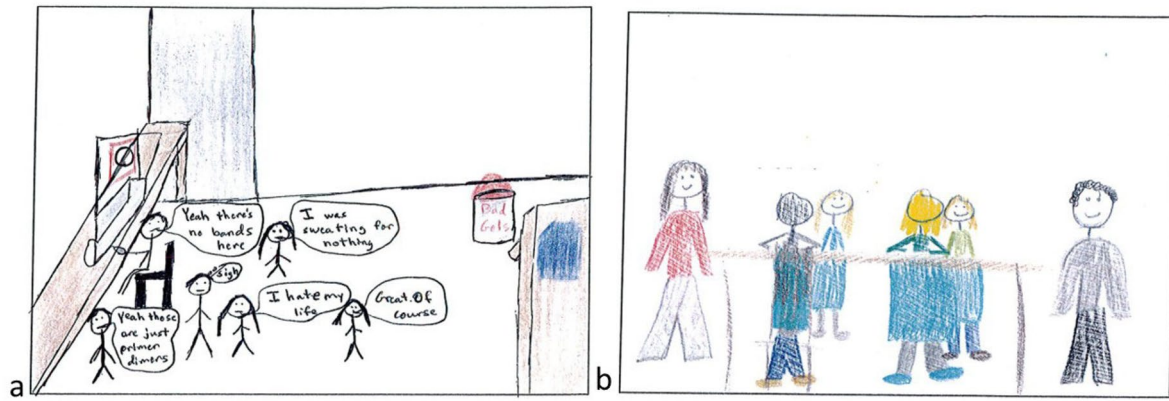


Figure 5. Drawing examples with more than one biologist in a drawing. (a) Illustrates teamwork and conversation (cell biology post-course survey). For (b), the student explained that 'we are all biologists. [Instructor] and [Undergraduate learning assistant] are teaching, and we are beginner biology students learning' (cell biology pre-course survey).

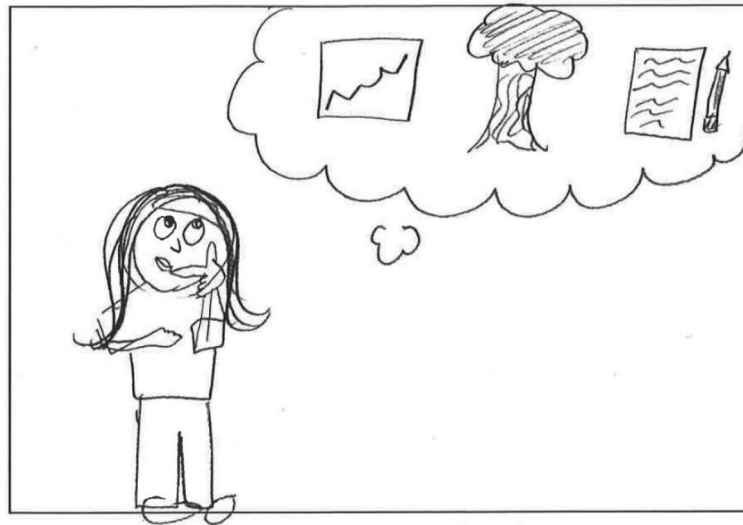


Figure 6. Reflection was represented by either a hand drawn near the mouth or a thought bubble (organismal biology post-course survey).

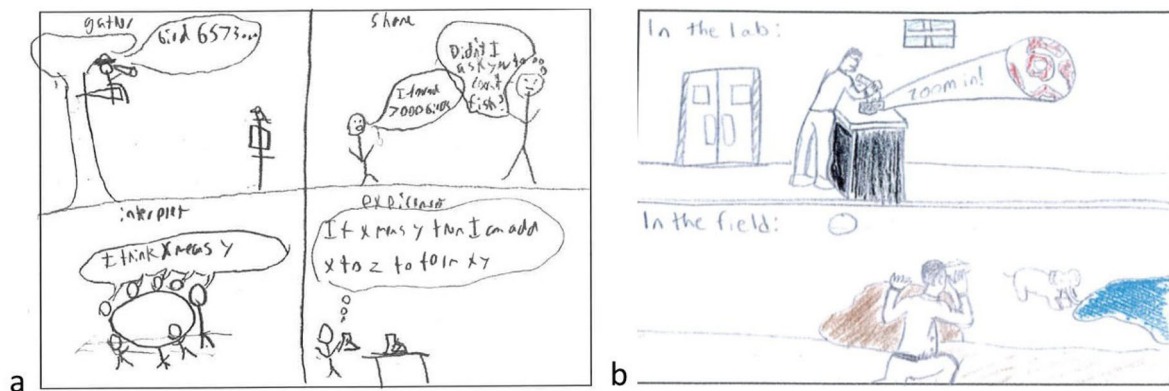


Figure 7. Example of drawings having 'multiple drawings.' (a) Shows biologists in different settings performing different tasks of a scientific process (organismal biology post-course survey). (b) Depicts a biologist in the lab and one in the field (cell biology post-course survey).

typical day, one student at the end of the course explained: ‘(1) goes through 5 stages of grief daily, (2) laughs off her failure, (3) secretly loses sleep over failure.’

Multiple Conceptions

Students increasingly depicted multiple scenes, often drawing both lab and fieldwork (Figure 7). When asked what a biologist does on a typical day, most students describe scientific practices, such as a biologist ‘examines species in the field, documents findings, connects with other biologists to compare findings.’ Just over a quarter of students described different types of research instead: ‘She may look at cells under the microscope or research different disorders, or she could work to find new ways to help endangered species.’ Interviewees similarly emphasized the diversity of biological work, frequently describing both field and laboratory tasks.

Discussion

This study examined undergraduate students’ conceptions of biologists during a year-long introductory biology sequence that focused on team-based learning and the representation of diverse biologists. Our findings suggest that biology majors beginning their college careers may not hold stereotypical views of biologists to the same extent as younger students, as previously observed (Thomas et al., 2006). Moreover, we found small shifts in students’ depictions of biologists, such as increased use of multiple settings and problem-solving elements. We examine these findings in more detail below.

Gender

Our findings revealed small shifts in students’ use of gendered language when describing biologists. At the beginning of the year in the present study, students described male biologists twice as often as female biologists, reflecting persistent stereotypes previously observed across ages (Miller et al., 2018), including in college (Meyer et al., 2019; Miele, 2014). However, at the end of organismal biology, more students used female pronouns and gender-neutral language. These findings may be attributed to showing diverse representation in science (Schinske et al., 2015) and possibly the influence of female instructors (Ambrosino & Rivera, 2023; Reed & Hoback, 2024).

The high percentage of gender-neutral language may suggest that some students are moving away from assigning a specific gender to biologists. Trends toward using more gender-neutral language have been seen in other recent DAST studies (e.g., Sheetz, 2023). This shift reflects broader trends toward gender-inclusive language and reduced emphasis on traditional gender roles (Remigio & Talosa, 2021).

Multiple Conceptions and Work Settings

The increased presence of multi-scene drawings at the end of both courses suggests that students developed a more flexible and dynamic understanding of biologists’ work environments. Drawing multiple scenes resulted in a slight increase in outdoor drawings by the end of both courses. In organismal biology, nearly half of the students drew an outdoor setting. Conversely, most studies on college students’ drawings of scientists show few or no outdoor settings (e.g., McCarthy, 2015; Rubin et al., 2003), including when biology majors were asked to draw a biologist (Sheetz, 2023). The exception was when biology majors in a teaching program were asked to draw different scientists: the ‘scientist’ and ‘geneticist’ were often depicted similarly in lab roles, while most ecologists were drawn wearing outdoor clothing and binoculars (Jordan & Duncan, 2009). Interviews suggest students drew outdoor settings more frequently due to fieldwork and related case studies in the organismal class, as seen in previous research (Miele, 2014; Rosenthal, 1993). Despite this shift, over two-thirds of drawings still depicted lab work, suggesting that perceptions of scientists working indoors remain strong, consistent with findings from other studies (Ferguson & Lezotte, 2020; McCarthy, 2015; Sheetz, 2023).

Stereotypes and Problem-Solving

A notable shift in students' conceptions- especially in cell biology- was a decrease in references to intelligence and a strong increase in problem-solving and perseverance. The reduction in intelligence and the increase in perseverance as defining characteristics of biologists indicate a shift from a 'fixed mindset' that views intelligence as an inherent trait to a 'growth mindset' (Dweck, 2006). This may be due to students participating in a semester-long project that involved repeated challenges requiring troubleshooting and persistence (Esparza et al., 2020).

However, despite this shift in students' views of perseverance, references to 'collaboration' in their responses remained consistently low, ranging from 15% to 21% throughout the study. Similarly, the number of drawings depicting teamwork or collaborative settings also showed little change within each class. The concept of teamwork is rarely drawn by children (Ferguson & Lezotte, 2020) or college students (e.g., Rubin et al., 2003; Sheetz, 2023). This consistency may partly reflect the instructions given, as students were specifically asked to draw a biologist, which may have led them to focus on an individual rather than a team. Additionally, while collaboration was a central feature of the classroom and lab environments, students rarely mentioned it in their free responses.

Teaching Implications

Our findings suggest some practical strategies for educators aiming to broaden students' perceptions of scientists. Similar to how we framed it for our students, incorporating DAST (or DABT) as both a pre- and post-activity allows students to visualize their conceptual growth and encourages reflection on how their views have changed. If a pre-activity is not feasible, asking students to consider how their drawings might have looked at the beginning of the course may suffice and encourage reflective thinking (Miele, 2014).

Educators can also use follow-up discussions or case studies to highlight scientists from varied backgrounds and career paths, showcasing how diverse perspectives have enhanced our knowledge. For example, as more women have entered the field of ornithology and as research from tropical areas gained recognition, the study of female bird song has expanded significantly (Benedict & Wilkins, 2022).

Finally, emphasizing problem-solving and collaborative work in class can foster a deeper understanding of scientific inquiry as an iterative, community-oriented process (Von der Mehden et al., 2023). To strengthen these connections, educators could explicitly discuss how teamwork and perseverance are essential in real-world science. Incorporating dialogic conversations and culturally relevant examples can further challenge stereotypes and foster a more inclusive understanding of science (Rodriguez, 1998). By incorporating case studies, teamwork-based projects, and diverse role models, educators can create a classroom environment that supports a more representative and inclusive image of science (Finson, 2003; Mason et al., 1991; Miele, 2014).

Conclusion

By following students across a year-long biology sequence, this study provides new insights into how undergraduate perceptions of biologists change over time. By using discipline-specific drawings, multi-scene depictions, written responses, and reflective, team-based activities that emphasize perseverance, educators can challenge stereotypes and foster a broader, more inclusive understanding of scientific work while advancing science education and workforce diversity.

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Ethics statement

Michigan State University Human Research Protection Program approved all components of this research investigation (survey research IRB # x16-1386e; interview research IRB # X17-589eD). Participation was voluntary, and all responses were anonymized. The survey was an in-class activity and part of their participation grade. Interviewees were provided with free coffee at a coffee shop as an incentive for their participation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the findings of this study are not openly available but are available from the corresponding author upon reasonable request. Data are secure on a password-protected, university-approved cloud storage server.

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