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Translating climate research into children's books: science communication learning in an undergraduate geoscience course

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Abstract. This study evaluates a children's book assignment in an upper-level undergraduate climate science course in which students translated peer-reviewed climate research into illustrated books for young audiences. The project examined whether this format supported science communication skills, audience awareness, and sustainability competencies often
10 underdeveloped in content-heavy science courses, while also exploring students' experiences with generative AI tools for image creation. A mixed-methods design was implemented across two cohorts of EENV-242: Climate and Global Change at Susquehanna University. Pre- and post-project surveys measured changes in student understanding, confidence, and engagement, and were analyzed using descriptive statistics, independent-samples t-tests, and Cohen's d. Student reflections were analyzed thematically to identify patterns in learning, communication challenges, audience awareness, and AI use. The
15 largest gains were in science communication, particularly students' confidence creating visuals that communicate science and combining text and images to tell a compelling story. These effects were statistically significant and replicated across cohorts. Agreement that storytelling effectively communicates complex scientific topics also increased, while climate attitude and understanding items showed ceiling effects due to high pre-project scores. Reflections most often emphasized audience awareness and translation decisions, suggesting that students were not simply simplifying climate science but
20 rebuilding explanations around the needs of young readers. AI tool use appeared less frequently, suggesting that image generation functioned as a normalized part of the creative process rather than the central learning outcome. Together, these findings suggest that children's book assignments can help students practice the difficult work of translating complex science for non-specialist audiences, while providing a widely applicable framework for audience-centered communication across climate, geoscience, and other STEM courses.

25 **1 Introduction**

Teaching climate change in higher education often requires more than building scientific understanding. Students must also work with information that is technically complex, politically charged, and emotionally weighted, conditions that compound the usual challenges of disciplinary instruction. Climate literacy frameworks make this expectation explicit (USGCRP, 2024; OECD, 2025). Wiek et al. (2011) identify systems thinking, anticipatory thinking, and strategic action competencies as core

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30 to sustainability education. These capacities require students to apply knowledge across disciplinary boundaries and communicate it for real-world use. The conditions of climate instruction frequently work against that goal. Climate content is often conveyed in undergraduate courses through technical models, dense datasets, and disciplinary language that can feel abstract to students and impenetrable to non-specialist audiences (Brownell et al., 2013). At the same time, students carry the emotional weight of the subject. Climate anxiety is a documented feature of how young people engage with this material 35 (Hickman et al., 2021; Ogunbode et al., 2022), and educators are increasingly called on to design learning experiences that account for the emotional dimension rather than ignore it (Finnegan, 2024).

Storytelling is one way to bridge the gap between technical understanding and audience-centered communication. Narrative structures help organize complex information, make scientific ideas relatable, and re-center attention on what an audience actually needs to know (Dahlstrom, 2014; Negrete & Lartigue, 2010). For students, building a narrative around a scientific 40 concept forces them to identify what is essential, distill it into accessible language, and decide what to leave behind (Stocklmayer & Bryant, 2012). Recent work suggests that the vividness and emotional grounding of a story shape how audiences engage with science, and also how well they retain it (Fischer & Thies, 2026). The literature on narrative in science communication, however, has focused almost entirely on audience effects. What happens to the student who produces the narrative is less well understood.

45 Children's books impose constraints that more conventional writing assignments do not: limited length, age-appropriate vocabulary, a reliance on visuals to carry meaning, and an audience that, for example, cannot be expected to know what a carbon molecule is or how a warming ocean affects ecosystems. These constraints require students to make deliberate decisions about what to emphasize, what to omit, and what to illustrate. Peters (2024) frames children's books as both science communication products and pedagogical tools, drawing on examples from research-based outreach and an 50 undergraduate course in which students wrote and illustrated science picture books. Peters, along with related case studies (Hughes et al., 2015; Walsh et al., 2024), establishes that the format can produce both useful community resources and durable learning gains for students.

Assignments of this kind sit within two established pedagogical traditions. Authentic assessment holds that learning gains are largest when students produce work that resembles real-world tasks and carries real-world consequences (Wiggins, 1990; 55 Gulikers et al., 2004; Villarroel et al., 2018). Project-based learning emphasizes sustained inquiry, iterative development, and the creation of a public-facing product. Recent meta-analyses report that PjBL produces consistent gains in conceptual understanding, motivation, and 21st-century skills across STEM contexts, with notable effects on achievement and creativity outcomes (Zhang & Ma, 2023; Kwon & Lee, 2025). The persistent question for climate and geoscience communication education is less whether these approaches work than how they can be integrated into content-heavy science courses where 60 communication skills are often valued but not explicitly taught (Liverman & Jaramillo, 2011; Brownell et al., 2013; Zhang & Jenkinson, 2024).

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Generative AI complicates and enriches this picture. In 2025, surveys of UK undergraduates found that 92% were using generative AI in some form, up from 66% the year before, and that 88% had used AI for assessments (Freeman, 2025). The pedagogical question is no longer whether students will encounter these tools but how their use can be structured into learning. Recent literature on generative AI in higher education calls for empirical work on specific creative integrations rather than general discussion of policy or use (Bond et al., 2024; Yan et al., 2023). Image generation in science communication assignments is one such underexamined integration. For students using AI-generated illustrations, the task is not simply to produce images, but to evaluate whether those images are scientifically accurate, age-appropriate, and representative of the people and places connected to the science. Systematic review evidence suggests that representational bias and content inaccuracies are common concerns in AI-generated educational images (Alon et al., 2026), while design pedagogy increasingly treats the evaluation and curation of AI outputs as a core learning task (Hwang & Wu, 2025). That evaluative work remains a central part of the student's task

This project grew out of a recurring pattern in our upper-level climate and global change course at Susquehanna University, one that reflects a broader disconnect in undergraduate climate science education. Climate literacy frameworks emphasize communication and real-world applications (USGCRP, 2024; OECD, 2025), yet climate curricula often emphasize content mastery while giving less attention to communication training, leaving students underprepared to translate climate science for public audiences (Bowen et al., 2025; Klapp & Bouvier-Brown, 2021). In our course, students arrived with strong content knowledge and motivation. Most could describe the carbon cycle, name major climate feedback mechanisms, and parse peer-reviewed sources related to climate change, but felt less prepared to explain those ideas to a non-specialist audience. Visual communication represented a related gap: while images are central to communicating climate science, formal training in visual communication was largely absent from their prior coursework (Brownell et al., 2013; Zhang & Jenkinson, 2024). The children's book assignment was designed to address these gaps by requiring students to translate technical climate content for young readers through both texts and visuals. In doing so, it targeted the science communication and visual literacy skills that undergraduate geosciences programs identify as important but less frequently teach explicitly (Brownell et al., 2013; Zhang and Jenkinson, 2024).

In this study, students translated peer-reviewed climate research into illustrated children's books across two cohorts of an upper-level climate and global change course. This study has two aims: (1) to assess how the assignment supported students' science communication skills, audience awareness, and engagement with climate content; and (2) to examine how students perceived and reflected on the role of generative AI in the creative process.

2. Project context and methods

2.1 Setting and participants

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This study was conducted at Susquehanna University in EENV-242: Climate and Global Change, an upper-level undergraduate course taken primarily by juniors and seniors in the natural sciences. The same survey instrument was administered across two cohorts: spring 2025 (n = 21 pre-project, n = 17 post-project) and spring 2026 (n = 34 pre-project, n
95 = 30 post-project).

2.2 Assignment structure

Students selected a peer-reviewed climate research article focused on an impact of climate change to our natural world and translated its key findings into an illustrated children's book. We asked for three connected products: a narrative that simplified scientific ideas into age-appropriate language, illustrations to support the story, and a written reflection on the
100 challenges and ethical considerations of translating science for a non-specialist audience. Each book also included an educator and parent guide that explained the underlying science, cited the original journal article, and pointed readers to additional resources (see assignment and sample books in SI). To reduce the barrier posed by limited visual art experience among science majors, students were able to use generative AI tools for image creation. Students who chose not to use AI created illustrations through other means, including hand drawing, digital illustration without AI assistance, and Canva-
105 based digital collages. The assignment concluded with a public sharing of student work. Depending on cohort and term logistics, this took the form of a release event, a tabling event with community attendees, or recorded video presentations to be distributed to local educators.

2.3 Data sources

This study was conducted under IRB protocol (#20250305_34), approved by the Susquehanna University Institutional
110 Review Board. The research was ruled exempt, as it involved established educational practices in a commonly accepted educational setting and was determined to involve no more than minimal risk to participants under 45 CFR §46.104(d)(1). All students provided informed consent for use of their de-identified survey responses and reflections in research. Data were collected from three sources. Pre- and post-project surveys assessed changes in student understanding, confidence, and engagement across 19 items rated on a five-point Likert scale. Reflective essays submitted at the conclusion of the
115 assignment provided qualitative data on student learning processes, challenges, and experiences with AI tools. Surveys and reflection prompts can be found in Supplementary Information.

2.4 Analysis

Survey data were analyzed in R using descriptive statistics and independent-samples t-tests (R Core Team, 2025). Because survey responses were anonymous, pre- and post-project comparisons could not be matched by individual, so group-level
120 means (M) and their corresponding standard deviations (SD) were compared. Effect sizes are reported as Cohen's d, with benchmarks following Cohen (1988): small $d < 0.5$, medium 0.5–0.8, large > 0.8. The two cohorts were analyzed separately

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and in combination.

Table 1. Codebook for thematic analysis of student reflections. Codes are ordered by prevalence and consistent with the order in Fig. 3.

Theme	Definition and inclusion criteria
Audience awareness	Student adapts language, tone, or framing for children or non-specialist readers. Includes explicit reflection on simplifying jargon, meeting readers where they are, or translating scientific concepts for a lay audience.
Understanding & learning gains	Student reflects on improved understanding or retention of climate science through the translation process. Coded when the student attributes a learning gain to the act of simplification itself, not to course content in general.
Ethical tension & decision-making	Student reflects on tradeoffs between scientific accuracy and accessibility, or on responsibility for deciding what audiences are told. Includes grappling with what to include, omit, or simplify without misrepresenting the science.
Storytelling & emotional connection	Student discusses narrative structure, character, emotion, or illustration as tools for science communication. Coded when the student reflects on the function of story or imagery, not merely the act of writing one.
Personal disposition & career aspiration	Student reflects on identity, confidence, or anticipated future application of science communication skills. Includes connections to honors research, career plans, or a broader sense of purpose as a communicator.
Action-oriented & hopeful messaging	Student reflects on strategies to ensure the book emphasizes solutions, agency, or positive outcomes rather than fear. Coded when the student describes a deliberate choice about tone, not a general preference for optimism.
Engagement & motivation	Student describes enjoyment, pride, or creative investment in the assignment. Distinguished from general positive affect by specificity: the student names what they enjoyed or felt proud of.
AI & tool use	Student discusses AI image generators or design software in practice. Includes technical limitations (style consistency, image quality), access constraints (free trial limits, update instability), and ethical concerns about AI-generated art.

125 Reflective essays were coded using a hybrid deductive-inductive thematic approach informed by Braun and Clarke (2006). The lead author, also the instructor of record, developed the codebook from two sources: the study's research questions, which generated a set of predetermined codes, and patterns she identified across the full set of reflections during grading, which generated the inductive codes (Table 1). This approach is consistent with directed content analysis, which applies theory-driven codes through documented decision rules and applied with interpretive flexibility (Hsieh & Shannon, 2005;

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130 Krippendorff, 2018). A co-author then applied the codebook to a subset of 19 de-identified reflections in Taguette (Rampin & Rampin, 2021). Prior to independent coding, the lead author and co-author coded three reflections separately, compared their decisions, and resolved disagreements by consensus to calibrate shared interpretation. The 19-reflection subset produced 153 coded passages.

To extend the analysis to all 52 reflections, we developed a rule-based automated phrase-pattern procedure with assistance 135 from Claude (Anthropic, 2026; Model: Sonnet 4.6), a large language model. Regular-expression patterns for each code were derived from inspection of the 153 human-coded passages, reviewed by the lead author, and refined iteratively before implementation. The procedure flagged matching sentences in each reflection. Validation against the human-coded subset produced strong aggregate agreement: total instance counts matched within 1% (154 automated vs. 153 human-coded; Spearman $\rho = 0.952$, $p < .001$ across the eight codes) and moderate file-level reliability (Cohen's $\kappa = 0.474$, 73.7% raw 140 agreement; Landis & Koch, 1977). Aggregate code frequencies for all reflections are from the automated procedure. Analytic memos documented coding decisions throughout, supporting reflexivity given the lead author's dual role as instructor and researcher (Creswell & Plano Clark, 2017). Complete coding rules, validation statistics, and reproducibility notes are available in Supplementary Information.

3. Results

145 **3.1 Student learning outcomes**

Pre-project survey scores on climate understanding and attitude items were consistently high across both cohorts, with combined means ranging from 4.71 to 4.85 on a five-point scale. Students in this course agreed that climate change is real, that it affects natural and human systems, and that communicating about it matters. There was very little room left to move them upward on those items. The items where students had room to grow were primarily the skills and confidence items, and 150 those are where we saw the largest changes.

Two items showed statistically significant pre-to-post differences across the combined sample, and both were in visual communication (Fig. 1). Confidence in creating visuals that communicate science increased from a pre-project mean of 3.31 (SD = 1.10) to a post-project mean of 3.98 (SD = 0.94), a medium-to-large effect ($d = 0.65$, $p < 0.01$). Confidence in combining text and images to tell a compelling story increased from 3.71 (SD = 0.90) to 4.26 (SD = 0.71), also a medium-to-155 large effect ($d = 0.68$, $p < .001$). Both findings replicated across the two cohorts when we analyzed them independently.

A third item reached significance in the combined sample. Agreement that storytelling is effective for communicating complex scientific topics increased from 4.26 (SD = 0.78) to 4.57 (SD = 0.68), a small-to-medium effect ($d = 0.43$, $p < 0.05$). The effect was stronger in 2026 ($d = 0.55$, $p = .034$) than in 2025 ($d = 0.31$, $p = .350$). Students entered the course reasonably

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convinced of storytelling's value, so this is a shift in conviction among an already-receptive group rather than a first exposure
160 to the idea.

The other surveyed items showed small-to-medium positive trends that did not reach statistical significance (Fig. 1). The item asking whether it is important to communicate climate change to children increased from 4.70 (SD = 0.46) to 4.83 (SD = 0.38; d = 0.30, p = .140). Climate attitude and understanding items entered the course at means above 4.7 and showed minimal movement (changes < 0.1), consistent with ceiling effects in this motivated population. These patterns are
165 consistent with assignment-related growth on measures with room for change but cannot be confirmed at conventional thresholds in samples of this size.

Figure 1. Pre- and post-project mean scores on Likert items grouped by domain, combined cohort (n = 55 pre, n = 47 post). Circles indicate pre-project means; squares indicate post-project means. Connecting lines reflect the direction and magnitude of change; green

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170 lines and squares indicate statistically significant differences and gray lines indicate non-significant differences. Cohen's d values are reported to the right of each item. * p < .05, ** p < .01, *** p < .001.

The post-project survey included four retrospective self-assessment items asking students to evaluate the project's contribution to their learning (Fig. 2). These items had no pre-project counterpart and are reported descriptively. Across the combined sample (n = 47), 95.7% of students agreed or strongly agreed that the project improved their ability to explain
175 complex scientific topics to a general audience (M = 4.51, SD = 0.59). In the 2026 cohort, agreement on this item reached 100%. Agreement that the project helped students understand the ethical challenges of simplifying scientific information was also high (M = 4.38, SD = 0.61; 93.6% agree or strongly agree). The retrospective item with the widest variation between cohorts concerned confidence reading peer-reviewed research: 70.6% agreement in 2025 versus 90.0% in 2026 (combined 83.0%, M = 4.21, SD = 0.83). The 2026 cohort reported higher means on all four retrospective items than the 2025 cohort, a
180 pattern that may reflect cohort characteristics, refinements to the assignment between years, or sample size differences.

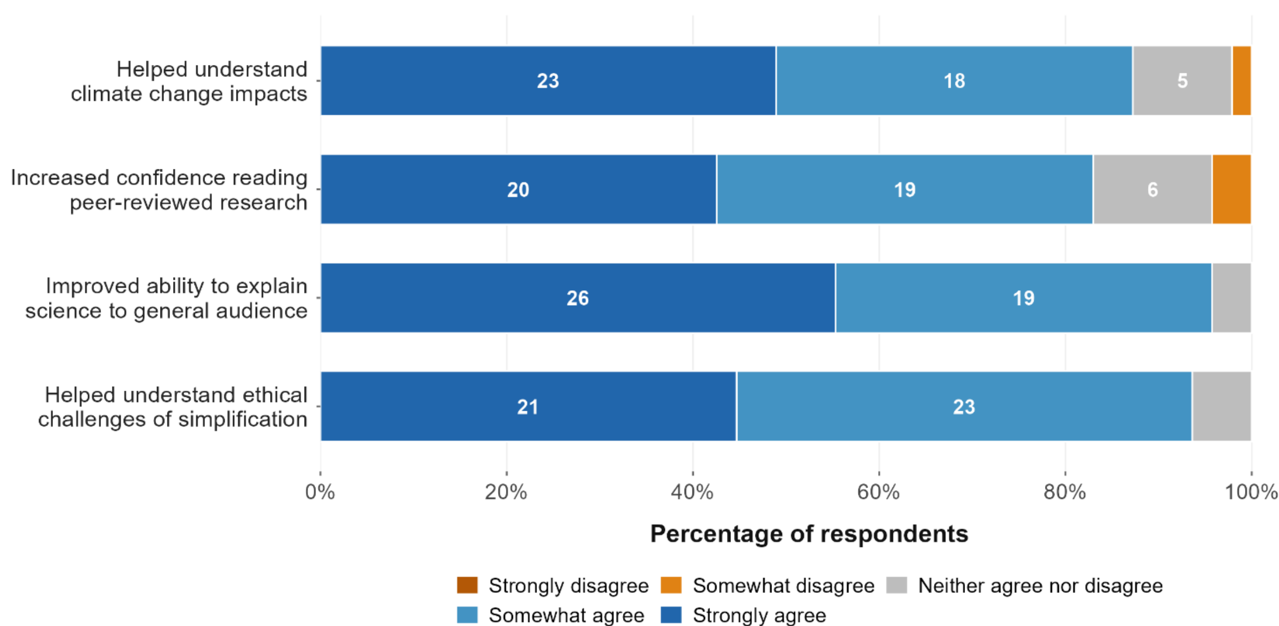

Figure 2. Student agreement with post-project retrospective self-assessment items, combined cohort (n = 47). Bars show the percentage of respondents selecting each response option; numbers within segments indicate response counts. Items reflect student-perceived learning gains following completion of the climate change children's book assignment.

185 Across 52 reflections, coding identified 415 coded instances across the eight themes (mean 8.0 per reflection; Fig. 3). The two dominant themes, both directly reflecting the core learning outcomes the assignment targeted, were audience awareness and bridging the gap (128 instances across 88% of reflections) and understanding and learning gains (99 instances across

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83%). Roughly half the cohort engaged with ethical tension and decision-making about what to simplify (50%) or storytelling and emotional connection (46%). Action-oriented and hopeful messaging appeared in 33% of reflections, personal disposition or career-relevant identification with science communication in 35%, and engagement and motivation in 29%. Quotations, presented in Table 2, illustrate how students engaged with the dominant themes.

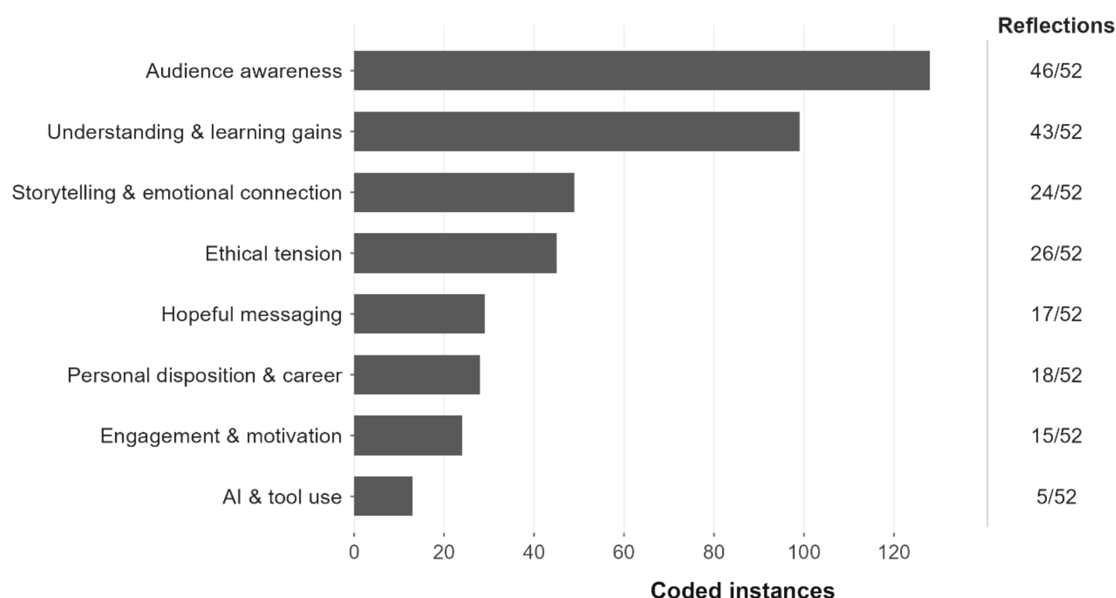

Figure 3. Coded instances and prevalence of each thematic code across student reflections (n = 52). Bars show the total number of coded passages per code across all reflections; the right-hand column gives the number of reflections in which each code appeared at least once.

Table 2. Thematic codes and representative quotations from student reflections.

Theme	Representative quotations
Audience awareness	• "The biggest challenge of this assignment was definitely trying to keep these scientific concepts while using simple language." • "Making climate change digestible for an elementary schooler who definitely doesn't understand complicated scientific jargon helped me to conceptualize it for a non-science based audience of any age."
Understanding & learning gains	• "I realized that if you cannot tell the story in simple terms, you may not understand it as well as you think." • "This helped me understand the science better because we had to reframe it in a way that made sense visually."

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Ethical tension & decision-making	• "Do we, as the people with the information, have the right to decide what other people need to know about climate science?" • "There is a balance of telling too much to not explaining enough. It is hard to decide what can be left out and what cannot."
Storytelling & emotional connection	• "People don't act on data — they act on stories, emotions, and connections." • "Pablo's fear, confusion, and bravery made the melting ice mean something. That emotional connection matters way more than just listing facts."
Personal disposition & career aspiration	• "Science has kind of been gatekept for a long time. Working on this book helped me see that science communication isn't just about having the facts but about how you share them." • "It made me want to approach all future science outreach with more empathy, more creativity, and more focus on making people care, not just understand."
Action-oriented & hopeful messaging	• "The main thing we wanted to avoid was scaring kids. We wanted to frame climate change as an important issue, but one that we were working towards solving." • "I realized that when the message feels too heavy, people tend to shut down or ignore it. I worked on keeping a more hopeful tone and focusing on what we can do instead of just all the problems."
Engagement & motivation	• "The children's book I wrote was also my favorite project I have ever completed at this university." • "I found more challenge — and entertainment — in workshopping my storytelling than I thought I would."
AI & tool use	• "It was hard to get a consistent style, so the images didn't match well with each other." • "It still feels wrong to use AI. Yes, it takes away jobs from artists, [and] books with AI lose a lot of the feeling and character when I see it."

3.2 Role of generative AI

Familiarity with generative AI tools entered at the lowest pre-project mean in the dataset (2.84, SD = 1.32) and changed
200 modestly (post M = 3.09, SD = 1.33; d = 0.19, p = .346; Fig. 1). Ethical concern about AI-generated visuals showed an inconsistent directional pattern across cohorts: a small decrease in 2025 (d = −0.24, p = .473) and a small increase in 2026 (d = 0.27), neither significant. Post-project, 93.6% of students agreed the project helped them understand the ethical challenges of simplifying scientific information (M = 4.38, SD = 0.61).

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205 AI tool use was the least common theme in coded reflections, appearing in only 10% of cases (5 of 52 reflections, 13 instances; Fig. 3). Representative quotations are presented in Table 2 alongside the other qualitative themes.

4. Discussion

4.1 Learning outcomes and ceiling effects

The two statistically significant pre-to-post changes were both in visual communication confidence, replicating across both 210 cohorts independently. For a population of science majors who typically receive little formal training in visual or multimodal communication, this finding is notable. Trumbo (1999) argued that visual literacy belongs at the center of science communication training, and Zhang and Jenkinson (2024) recently documented that visual science communication remains underdeveloped in undergraduate science curricula. While this study does not resolve this gap, we provide evidence that a well-designed assignment with a real audience and a concrete output can produce confidence gains in this area within a 215 single course.

The absence of significant gains on climate attitude and understanding items likely reflects a measurement ceiling rather than a lack of learning. Pre-project means on these items were already at 4.7 or higher on a five-point scale, leaving almost no room for improvement. Ceiling effects of this kind are a documented constraint in pre-post designs with motivated student populations (Cronbach & Furby, 1970; Nissen et al., 2018). We suspect that it is not that the assignment did nothing to these 220 dimensions but that the survey could not detect what it did. Reflective essays also show students found the assignment harder than expected and learned more than anticipated. High pre-project scores reflect perceptions before performance. Combined with the consistency between retrospective self-assessment and qualitative evidence of struggle and growth suggests the reported gains reflect genuine learning rather than measurement artifact.

4.2 Storytelling as a science communication intervention

225 Agreement that storytelling is effective for communicating complex scientific topics increased significantly across the combined sample ($d = 0.43$, $p = .035$), even though students entered the course already reasonably convinced of storytelling's value (pre $M = 4.26$). This pattern suggests that the assignment provided experiential grounding for an existing belief rather than introducing the idea. The literature has emphasized that narrative supports comprehension, recall, and engagement in ways that expository communication does not (Dahlstrom, 2014; Green & Brock, 2000; Negrete & Lartigue, 2010; Fischer 230 & Thies, 2026). Students who produced narratives for a real audience became more convinced of storytelling's value, even though most recognized its value before the assignment began.

The constraints of the children's book format compelled students to make decisions that abstract discussion of science communication cannot replicate: what a seven-year-old could reasonably be expected to understand, how to represent

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uncertainty without generating alarm, and which visual would carry a concept that the text could not. Peters (2024) reports comparable patterns in their work, where students developed communication literacy by producing books on topics ranging from the aurora borealis to biomagnification. The format also fits within the broader literature on authentic assessment, which holds that learning gains are largest when students produce work that resembles real-world tasks and carries real-world consequences (Wiggins, 1990; Gulikers et al., 2004; Villarroel et al., 2018), and project-based learning, where recent meta-analyses report consistently positive effects on conceptual understanding, motivation, and creativity in STEM contexts (Zhang & Ma, 2023; Kwon & Lee, 2025).

The children's book format pushes students past simplification toward translation. Simplification often involves removing jargon or shortening explanation, while translation requires students to determine what the audience needs to know, why it matters, and how the explanation should be rebuilt from that starting point (Dahlstrom, 2014). Most science writing assignments do not demand this. Coded reflections show students working out strategies to manage this challenge directly. The audience awareness theme appeared in 88% of reflections, the highest prevalence of any code. One student described the core problem clearly: "It was important that I met them where they are in terms of climate literacy — I made sure to use simple analogies so they could connect the information with something they have experienced, something they can grasp". Students described strategies such as anchoring abstract processes in a character's experience and grounding global phenomena in locally recognizable examples. These strategies suggest that students were not simply reducing the complexity of the science, but, rather, actively rebuilding explanations around audience needs.

4.3 Generative AI as a pedagogical variable

The AI-related findings do not point in a single direction. General familiarity with AI tools moved only modestly across the course ($d = 0.19$, $p = .346$), while confidence in combining text and images was one of the two largest effects in the study ($d = 0.68$). Whether and how much AI tool use contributed to that gain is not something this design can establish. The pedagogical value of generative tools likely depends on how they are integrated into the task, not on the tools themselves (Mollick & Mollick, 2023; Bearman et al., 2022). The modest movement in general AI familiarity may also reflect something specific to this population: students in a climate course are likely more attuned than most to the environmental costs of large-scale AI use, and that awareness may place a cap on how favorably they report their relationship with these tools regardless of how competently they use them.

The inconsistent pattern in ethical concern scores between cohorts in the surveys ($d = -0.24$ in 2025, $d = 0.27$ in 2026) resists a single explanation. The 2025 cohort may have entered with more abstract AI anxiety that direct engagement replaced with a more specific risk assessment. In 2026, ethical use of AI was more explicitly incorporated into course instruction, which may have influenced student opinions on the topic. Recent work on AI ethics in education has found that students' ethical reasoning tends to become more nuanced rather than uniformly more or less concerned with experience

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265 (Selwyn, 2022; Akgun & Greenhow, 2022). Only 10% of student reflections explicitly addressed AI tool use despite widespread engagement with these tools. We read this less as indifference and more as evidence that image generation became a relatively ordinary part of the creative process for most students rather than a focus of ethical concern. Future iterations with more direct reflection prompts about AI use could help clarify whether that ordinariness is something to build on or something to interrogate.

270 **4.4 Geoscience training and what this model offers**

Science majors at most universities finish their degrees with substantial content knowledge and limited training in communication, visual design, or public engagement (Brownell et al., 2013; Mercer-Mapstone & Kuchel, 2015). Calls for embedding science communication training within undergraduate science curricula rather than relegating it to optional electives have appeared in the geoscience education literature for over a decade (Brownell et al., 2013; Mercer-Mapstone and
275 Kuchel, 2015; Besley and Tanner, 2011). The assumption embedded in most science curricula is that these are separate competencies, developed elsewhere or not at all (Vickery et al., 2023). This project challenged that assumption from within a traditional climate science course rather than through a standalone communication requirement. Communication demands were intrinsic to the content course itself: students could not complete the assignment without understanding the science well enough to translate it accurately, and communicating it clearly enough that a child could follow the story. Integrated content-
280 plus-communication assignments have been advocated in the science communication literature for some time (Brownell et al., 2013; Besley & Tanner, 2011), but empirical evaluations of these designs in undergraduate climate education remain rare. Our results suggest that the integration produces measurable gains, particularly on the visual communication and storytelling skills that science curricula typically leave undeveloped.

4.5 Limitations

285 Several limitations constrain interpretation. The sample size, although doubled by combining cohorts, remains small for detecting effects below the medium range. Anonymous survey administration prevented matched pre-post comparisons at the individual level. Ceiling effects on climate attitude and understanding items reflect the self-selecting nature of an upper-level climate course. The qualitative coding combined human coding of a subset with automated coding of the full set of reflections; file-level binary agreement was moderate (Cohen's κ = 0.474). Retrospective self-assessment items are
290 vulnerable to social desirability and recall biases (Hill & Betz, 2005; Howard et al., 1979). The assignment was conducted at a single institution with a particular curricular structure, and generalizability to other settings cannot be established from the present design.

4.6 Implications for practice

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The replicated effect on visual communication confidence across both cohorts suggests that the assignment design is portable. Three features appear to drive that portability: the children's book format, which forces translation rather than simplification through its constraints of limited length, age-appropriate vocabulary, and mandatory visuals (Stocklmayer & Bryant, 2012); structured reflection, which creates documented opportunities for students to articulate decisions and limits in ways that support metacognitive engagement (Tanner, 2017); and a public-facing output that introduces accountability conditions absent from conventional assignments (Villarroel et al., 2018). Modifications that remove any of these features may reduce the gains the design produces. Across all three, the assignment requires students to produce a real science communication artifact for a real audience rather than describe one hypothetically, which is the condition the science communication and broader education literature consistently identify as producing durable skill development (Clarkson et al., 2018; Devonshire & Hathaway, 2014; Wiggins, 1990).

The model is adaptable across geoscience, environmental science, and broader STEM content areas (as in Peters, 2024), including water scarcity, biodiversity loss, food systems, energy transitions, natural hazards, public health, and emerging technologies. It may be especially useful for topics that involve uncertainty, contested implications, or emotional weight, because these topics require students to make explicit decisions about framing, tone, accuracy, and what a non-specialist audience needs.

Embedding communication training within a content course, rather than offloading it to a standalone science communication course, addresses a documented gap in undergraduate science curricula (e.g., Liverman & Jaramillo, 2011; Vickery et al., 2023). The assignment is scaffolded across the semester alongside regular course content rather than delivered as a standalone unit, but the iterative nature of the work, including drafting, peer feedback, revision, and public sharing, carries supervisory demands that warrant workload recognition proportionate to the labor.

5. Conclusion

This study evaluated a children's book assignment implemented across two cohorts of an upper-level climate and global change course. The assignment asked students to do something that most science courses do not: translate peer-reviewed climate research into a format accessible to young audiences. The constraints of the project, including a concrete format, a public-facing product, and the need to communicate with clarity and accuracy, became central to the learning process itself.

Students developed confidence in visual science communication and multimodal storytelling, skills that are often underemphasized in traditional science curricula yet increasingly important for public engagement with climate science. The children's book format required students to simplify without losing scientific meaning, reinforcing comprehension through the act of explanation. In this way, the assignment positioned communication not as an outcome separate from learning, but as part of the learning process itself.

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325 The project also demonstrated how creative assignments with public-facing outputs can extend beyond the classroom. The completed books continue to circulate in local classrooms and libraries, allowing the work to function not only as a course assignment, but also as a lasting community resource.

Code and data availability

The R code used for statistical analysis and figure generation is available at OSF:
330 https://osf.io/4fvtx/overview?view_only=abcb77ef92194fca829c67556fb5a8a3. Aggregated survey data underlying Figures 1, 2, and 3 are included in the same repository. The phrase-pattern matching code used in the automated qualitative coding procedure is provided in full in the Supplement (SI S3). Raw de-identified survey responses and the Taguette qualitative coding database are available from the corresponding author on reasonable request. Student reflection documents cannot be shared publicly due to the terms of IRB Protocol #20250305_34 but are available to reviewers during the review process
335 upon request to the corresponding author.

Supplement link

The link to the supplement will be included by Copernicus, if applicable.

Author contributions

SLF conceptualised the study, designed and taught the course assignment, collected the data, performed the formal analysis,
340 developed the automated coding software, and prepared the original manuscript draft. EF conducted the human qualitative coding of the 19-reflection subset used for validation and contributed to writing through review and editing. RG provided resources by facilitating distribution of student books to local schools and community partners, and contributed to writing through review and editing. All authors approved the final manuscript.

Competing interests

345 The authors declare that they have no competing interests.

Disclaimer

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Ethical statement

This study was conducted under Susquehanna University IRB protocol #20250305_34. The research was reviewed by the
350 Susquehanna University Institutional Review Board and determined to be exempt because it involved established educational practices in a commonly accepted educational setting and posed no more than minimal risk to participants under 45 CFR §46.104(d)(1). Students provided informed consent for the use of their de-identified survey responses and written reflections in research. Survey responses were collected anonymously, and student reflections were de-identified prior to analysis. The manuscript includes an explicitly marked ethics statement in the Data sources section and reports the IRB
355 determination, consent process, and de-identification procedures.

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Review statement

The review statement will be added by Copernicus Publications listing the handling editor as well as all contributing referees
365 according to their status anonymous or identified.

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