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Cultivating change through environmental dynamics: School-based sustainability education as a catalyst for youth agency

Terrius Bruce

tb058@uark.edu

University of Arkansas at Fayetteville

Kevin Fitzpatrick

University of Arkansas at Fayetteville

Richard Gragg

Florida Agricultural and Mechanical University

Article

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Abstract

This mixed-methods study explores how sustainability education, rooted in a broader environmental dynamics framework, can equip youth in under-resourced communities with the tools to understand and participate in local environmental systems. It examines how culturally grounded storytelling can support environmental literacy and awareness of local food systems among a sample of third-grade students in Arkansas. Anchored by two complementary interventions, a culturally grounded children's book and an ArcGIS StoryMap presentation and activities, the study employs a three-group design to assess changes in student knowledge and engagement through matched pre- and post-surveys. This research contributes to an emerging scholarship on environmental dynamics and positions culturally relevant children's literature and place-based experiential learning as viable tools for teaching complex relationships between food, land, and community. Quantitative analysis using the Wilcoxon signed-rank test revealed a statistically significant increase in agricultural knowledge across the full matched sample, rising from 8 percent to 64 percent following the interventions ($W = 8.5$, $p < .001$), while Group C showed no change, providing strong descriptive evidence that the interventions drove the observed gains. Qualitative analysis drawing on a narrative inquiry framework (Clandinin & Connelly, 2000; Daiute, 2013) revealed three emergent themes in student responses: community care and collective responsibility, food and health, and personal agency modeled on the book's protagonist. Findings suggest that school-based sustainability programs, when grounded in local context and culture, can produce measurable knowledge gains, deepen student engagement, and support the early development of environmental stewardship and land-based learning among historically underserved youth.

1. Introduction

Arkansas has long been recognised for its rich agricultural history (Whayne et al., 2019), yet the state now confronts growing challenges related to land access and food insecurity that disproportionately affect marginalized and under-resourced communities (Fitzpatrick & Willis, 2021; Neff et al., 2009). Arkansas currently has the highest rate of food insecurity in the United States, with the heaviest burden falling on small landholders and under-resourced communities with limited access to nutritious food and unequal land ownership (World Health Organization, 2022). Health inequities in Black communities remain tied to historical environmental exposure and structural marginalization (Whitted, 2020), and these challenges are rooted in historical land policies, environmental degradation, and shifts in agricultural infrastructure that continue to shape land and food access across the state (van Rossum & Manahan, 2021; Schuldt & Pearson, 2023). Arkansas also faces growing climate pressures that threaten agricultural sustainability and heighten ecological risks for vulnerable communities (Hale et al., 2024). Addressing these overlapping challenges requires localized strategies that integrate land stewardship, environmental literacy, and community resilience. This need is grounded in environmental dynamics, the changing relationships among land, ecosystems, and human communities over time, and in ecosystem services, the benefits ecological systems provide to people (Boyd & Banzhaf, 2007). Participatory governance and sustainability education have emerged as critical tools for building adaptive capacity in regions where land use and food systems are under stress, aligning with the United Nations Sustainable Development Goals on zero hunger, quality education, and climate action (Hoefsloot et al., 2022; Cash et al., 2006; United Nations, 2015).

Early childhood is a particularly important entry point for this work. Early childhood is a critical developmental period when values, attitudes, and behaviours take shape (Knudsen, 2004; Thompson & Nelson, 2001), making it an ideal stage to introduce sustainability concepts, land-based learning that connects children to food, farming, and local ecosystems, and responsible environmental practices. Through this process, children gain practical skills for understanding food systems and ecological processes while building confidence to participate in environmental action at home, at school, and in their communities (Chawla & Cushing, 2007). Within early childhood education, there is growing recognition of the need for sustainability learning that reflects diverse community experiences and local ecological contexts, as early exposure to environmental education shapes how children understand land, food, and climate throughout their lives (Iruka et al., 2017).

Storytelling and culturally grounded children's literature offer a particularly effective pathway for delivering this kind of learning. Narrative structures help young learners connect to food systems, land stewardship, and environmental processes by using culturally rooted characters and place-based imagery that make complex systems feel familiar and relevant (Daiute,

2013; O'Kane & Pamphilon, 2016; Bhagwanji & Born, 2018). Dialogical reading activities based on culturally relevant children's literature have been shown to serve as effective gateways to developing young children's local environmental agency (Kolmos et al., 2025; Bhagwanji & Born, 2018). By cultivating curiosity and environmental awareness through narrative, children's literature supports early learning pathways that encourage learners to explore how land, food, and community systems function together.

The primary objective of this research is to examine how children's literature and place-based experiential learning can support sustainability education and increase students' knowledge of and engagement with agriculture, food systems, and environmental stewardship. The study employs a three-group design comparing students who received both interventions (Story Map and book), Story Map only, and a control group, and assesses how storytelling and experiential learning together influence children's understanding of agriculture, food security, and environmental responsibility, offering an educational model designed to strengthen environmental awareness and land-based learning in Arkansas and similar regional contexts.

2. Literature Review / Background

The relationship between agriculture, education, and community land access in Arkansas is shaped by a long history of exclusion rooted in the plantation system that emerged from broader Atlantic slave economies (Brown, 2020). Throughout the 19th and 20th centuries, African American farmers faced systemic obstacles to land ownership, agricultural participation, and access to formal education, including discriminatory lending, labour exploitation, and exclusion from federal programmes (Hinson & Robinson, 2008; Bennett, 2022; Gilbert et al., 2002; Hinson, 2018; Cohen & Horton, 2012; Lindert & Williamson, 2016). In 1910, Black farmers owned nearly 14 percent of all U.S. farmland; by the 1970s, that figure had fallen below 2 percent due to forced displacement and exclusion from programmes such as the Homestead Act and the New Deal's Agricultural Adjustment Act (Edwards, 2021; Person & Douglas, 2022; Hinson, 2018). These shifts fractured intergenerational land stewardship and disrupted community-based food systems. Migrant labour systems further altered land-based economic participation in Arkansas (Castro, 2016), and continued structural volatility and denial of agricultural loans have compounded the challenges facing small and minority farmers (Key et al., 2019; Jones-Branch, 2021).

In Arkansas, these national patterns played out sharply in the Delta region, where racial segregation and economic exclusion shaped the agricultural landscape. Events such as the 1919 Elaine Massacre illustrate the violent suppression of organised efforts to secure fair land access and agricultural self-determination (White, 1919; Stockley et al., 2020; Stevens, 2019; Butts & James, 1961; Moneyhon, 1997; Brown, 2023). Beyond direct land loss, these events produced a generational disruption in agricultural knowledge. Agrarian traditions rooted in land stewardship, soil management, and sustainable food production were displaced by industrial, capital-intensive agricultural models (White, 2018; Higgs, 1982; Hurt, 2001). Educational systems contributed to this disconnection by failing to incorporate regional agricultural history and community-based environmental knowledge (Cohen & Horton, 2012; Span, 2015; Harris, 2003; Rosen, 2004; National FFA Organization, 2022).

These disconnections carry modern consequences. Communities in the Arkansas Delta face persistent food insecurity, soil degradation, and exposure to industrial pollutants (Bullard, 1996; Fitzpatrick & Willis, 2021). Without place-based education that centres learning within students' local environments, young people are less prepared to engage with local ecological systems and respond to shifting environmental conditions (Chollett, 2014; Garth & Reese, 2020). Sustainability education offers a key opportunity to intervene in this cycle, yet even when it is included in curricula it often lacks local relevance and fails to connect students to the environmental conditions shaping their everyday lives (Iruka et al., 2017; Chawla & Cushing, 2007; Ketschau, 2015). New frameworks such as the Black Farmer Commons have emerged to reestablish land-based knowledge in communities historically excluded from these opportunities (SARE, 2021; Bowden, 2021).

Culturally grounded education plays a critical role in shaping how students engage with environmental systems (Eitel et al., 2024; Johnson, 2020; Flueckiger, 2015). Practices such as school gardens, community-based learning, and foodscaping have been shown to increase student engagement, strengthen connections to place, and promote hands-on ecological literacy (Mejia et al., 2020; Henson & Munsey, 2014). Children's literature that centres culturally relevant characters and reflects the heritage of historically marginalised communities supports identity affirmation, deepens engagement, and strengthens

connections to place-based learning (Bhagwanji & Born, 2018; Brooks & McNair, 2009; McNair & Edwards, 2021). Narrative and digital storytelling tools such as ArcGIS StoryMaps support shared knowledge creation between educators, students, and community members, expanding access to environmental literacy and place-based learning (van Blerk et al., 2023; Garzón et al., 2022). Daiute (2013) argues that dynamic narrating connects individuals to social structures and allows them to craft their own place within their communities, while O'Kane and Pamphilon (2016) demonstrate that food stories reveal how individuals connect to land and community in ways that quantitative measures cannot capture alone. Narrative inquiry as a research methodology positions student-generated language as evidence of how individuals construct meaning from experience, making it particularly well-suited to studies examining how young learners make sense of sustainability concepts through story and place-based engagement (Clandinin & Connelly, 2000). The convergence of narrative as both an instructional tool and an analytical framework provides a coherent methodological foundation for mixed-methods sustainability education research, particularly in communities where quantitative measures alone cannot capture the depth of students' ecological understanding and agency (Creswell & Plano Clark, 2023). Children's literature that reflects diverse cultural experiences can further help young learners build connections to land and engage more deeply with sustainability themes (Bhagwanji & Born, 2018; Kamau, 1998).

The Young Garden King brings together children's literature and place-based sustainability education to address the very disconnections this literature documents. Developed as an act of dynamic narrating (Daiute, 2013), the book uses a culturally grounded protagonist to connect young readers in under-resourced communities to food systems, land stewardship, and community responsibility through narrative structures that make these concepts personally meaningful and actionable. By centring a child protagonist who gardens to feed and strengthen his community, the book positions young learners not as passive recipients of sustainability information but as potential agents of change within their own food systems, supporting both ecological literacy and cultural affirmation (Bhagwanji & Born, 2018; McNair & Edwards, 2021; O'Kane & Pamphilon, 2016).

Taken together, this body of research suggests that sustainability education is most effective when rooted in local history, cultural relevance, and environmental realities. Grounded in these contexts, this study investigates how *The Young Garden King* and an ArcGIS StoryMap intervention can serve as tools for sustainability education in a rural Arkansas community, with the following section describing the methodology used to assess their impact.

3. Methods

3.1 Research Design

This study employed a mixed-methods design integrating quantitative pre- and post-survey assessment with qualitative narrative inquiry. The quantitative component examined changes in student knowledge and awareness across five matched survey questions administered before and after two educational interventions: a Story Map combining a digital presentation and structured experiential activities, and *The Young Garden King*, a culturally grounded children's book. The qualitative component drew on open-ended student responses analysed through a narrative inquiry framework to illuminate how students made sense of sustainability concepts through storytelling and experiential engagement (Clandinin & Connelly, 2000).

3.2 Intervention Tools

Two primary educational tools were used. Group A received both tools across all three weeks of the intervention; Group B received the Story Map only; Group C received neither and served as the control.

StoryMap Intervention. The StoryMap combined a digital presentation titled *Our Green Adventure Begins! Exploring the World of Sustainable Living Together*, developed using the ArcGIS StoryMaps platform (Esri, 2024), with structured arts-based experiential activities. The presentation introduced students to core sustainability concepts including food systems, local agricultural environments, and environmental stewardship, situating these within students' own regional and community context. Digital story maps have been identified as effective tools for expanding environmental literacy and supporting shared knowledge creation in underserved communities (van Blerk et al., 2023; Manware et al., 2022). Following the presentation,

students created their own visual narratives connecting their communities to broader environmental and agricultural concepts, drawing on place-based education principles that centre learning within students' immediate ecological and social environments (Chawla & Cushing, 2007). Group B received this intervention without the book, enabling assessment of the Story Map's independent contribution to student knowledge gains.

The Young Garden King. The second tool was *The Young Garden King*, a children's book developed as a translational educational resource designed to operationalise sustainability and land-based learning concepts within early childhood settings. Grounded in Daiute's (2013) framework of dynamic narrating, in which storytelling connects individuals to social structures and allows them to position themselves within their communities, the book uses a culturally grounded protagonist named Imhotep to engage young readers with food systems, land stewardship, and community responsibility (Daiute, 2013; Bhagwanji & Born, 2018). Imhotep of the Third Dynasty served under Pharaoh Djoser as chief vizier, high priest, and chief builder, and is widely recognised as the most famous early physician in ancient Egyptian history (Metwaly et al., 2021). Aligning the book's protagonist with this historical figure provides young readers with a culturally grounded model of strength and purposeful action, consistent with scholarship demonstrating that culturally relevant characters support identity affirmation among readers from historically marginalised communities (McNair & Edwards, 2021; Brooks & McNair, 2009). The book's interconnected educational objectives address healthy eating and food deserts (Fitzpatrick & Willis, 2021), community collaboration and food security (Mejia et al., 2020), and environmental awareness through sustainable gardening and land stewardship (Ardoin et al., 2018). It also incorporates elements of African heritage and culture to enrich readers' appreciation for diverse agricultural traditions and the contributions of historically marginalised communities to food systems (Brooks & McNair, 2009). The book was read aloud and discussed across all three weeks of the intervention for Group A, reflecting research indicating that iterative narrative exposure deepens comprehension and strengthens conceptual retention (Bhagwanji & Born, 2018; Ardoin et al., 2018). Prior to its use in the study, the book was reviewed by educators, child psychologists, and parents to ensure age-appropriate standards aligned with the developmental needs of readers aged 5 to 11 (Iruka et al., 2017).

3.3 Participants

This study was conducted at a Title I public charter school in Jacksonville, Arkansas, a city in Pulaski County with a population of approximately 28,000 and a significant proportion of African American and economically disadvantaged residents. Despite the city's historical engagement with agriculture, structured sustainability education in its schools has remained limited. Participants were 28 third-grade students, a developmental stage when lasting perceptions about the natural world begin to form (Knudsen, 2004). A total of 27 students completed both the pre- and post-survey and were retained as matched pairs; one student completed the post-survey only and is included in descriptive summaries but excluded from paired analyses. Participation was voluntary, with written parental consent and verbal student assent obtained in accordance with IRB Protocol #2310498665R001, approved 15 December 2023. Data collection took place from 2 to 30 April 2024. Among participants, 61% identified as female, 75% were aged 9, and the majority identified as Black or African American (46%) or Hispanic or Native American (25%). The demographic composition of this sample underscores the critical need for culturally responsive environmental education in communities underrepresented in environmental policymaking and agricultural industries (Stapleton, 2020; Eitel et al., 2024).

3.4 Intervention Groups

Students were organised into three groups, corresponding to three consecutive third-grade classes. All classes completed the pre-survey at the start of week one. Over three consecutive weeks, Group A received both the Story Map intervention and *The Young Garden King* book reading; Group B received the Story Map only; and Group C received no intervention. All groups completed the post-survey at the close of week three. This sequential design administered consistent survey instruments across all groups while varying the intervention conditions. Given sub-group sample sizes of n = 7 to 10, within-group comparisons are reported as descriptive only; primary inferential analyses are conducted on the full matched sample of n = 27.

3.5 Survey Instruments

Survey instruments were developed and administered through Qualtrics. The pre-survey addressed prior knowledge of agriculture and sustainable agriculture, awareness of environmental challenges, attitudes toward environmental stewardship, and demographic information. The post-survey replicated five core knowledge questions to enable matched pre-post comparison and included book-specific items measuring enjoyment, perceived learning, food security, and community collaboration, plus an open-ended question asking students what they found most interesting or important. The five matched questions were: (1) Do you know what agriculture is? (2) What do you think sustainable agriculture means? (3) How can a community work together to ensure healthy food? (4) Do you know about Earth challenges in your community? and (5) Is it important to care for the Earth and land? Questions 1, 4, and 5 used Yes/No formats; Questions 2 and 3 were open-ended and scored dichotomously (0 = no substantive response, 1 = substantive response).

3.6 Analytical Approach

Data analysis proceeded in three phases.

Phase 1: Paired Pre-Post Statistical Analysis. The Wilcoxon signed-rank test was applied to Questions 1, 4, and 5 because the data were binary, paired, and non-normally distributed, making this non-parametric alternative to the paired t-test appropriate for small samples (Corder & Foreman, 2014). McNemar's test was planned for Questions 2 and 3, though as noted in the Results section, it was not applied due to the open-ended structure of the responses. Post-only book-related Yes/No questions were analysed using Fisher's Exact Test across groups, and ordinal scale items were compared using the Kruskal-Wallis test. All analyses were conducted in R.

Phase 2: Group-Level Descriptive Analysis. Pre- and post-survey proportions were calculated for Groups A, B, and C to illustrate directional patterns by intervention condition; these are reported descriptively due to insufficient sub-group sample sizes.

Phase 3: Narrative Inquiry. Open-ended responses were analysed using a narrative inquiry framework positioning student-generated language as evidence of how individuals construct meaning from experience and connect personal stories to broader social and community contexts (Clandinin & Connelly, 2000; Daiute, 2013). This approach is particularly well-suited to food systems research because stories about food reveal complex relationships between individuals, communities, and food environments (O'Kane & Pamphilon, 2016). Qualitative data were organised into emergent themes to contextualise and extend the quantitative findings, consistent with established mixed-methods approaches (Creswell & Plano Clark, 2023). The small sample size (n = 27) limits statistical power and generalisability; the non-parametric tests and narrative inquiry component address this limitation by generating evidence that does not depend on large-sample assumptions.

4. Results

4.1 Pre-Post Changes on Matched Questions

Although 28 students completed the pre-survey, one participant from Group B was absent during post-survey administration due to illness and could not complete the post-assessment, resulting in a matched sample of n = 27 pairs. Complete paired data were available for 25 of these 27 participants across Questions 1, 4, and 5; two additional participants were excluded from paired tests due to missing responses. For Questions 2 and 3, which produced open-ended written responses, McNemar's test was planned but could not be reliably applied because the response structure did not yield fixed binary pairs; results for these questions are therefore reported as descriptive proportions. Results for Questions 1, 4, and 5 are presented in Table 1 and visualised in Fig. 1; Q2 and Q3 proportions are visualised in Fig. 2.

[Figure 1 approximately here]

Table 1
Wilcoxon Signed-Rank Test Results for Binary Pre-Post Survey Questions (n = 25 complete pairs. Pre_Mean and Post_Mean represent the proportion of students answering Yes (Yes = 1, No = 0). Change = Post_Mean − Pre_Mean. W = Wilcoxon test statistic. ns = not significant. *** p < .001.

Question	Label	N	Pre_Mean	Post_Mean	Change	W_Statistic	P_Value	Sig
Q1	Do you know what agriculture is?	25	0.08	0.64	0.56	8.5	5.00E-04	p < .001 ***
Q4	Do you know about Earth challenges in your community?	25	0.8	0.88	0.08	2.5	0.4237	ns
Q5	Is it important to care for the Earth and land?	25	0.88	0.92	0.04	6	0.7656	ns

Question 1 (Do you know what agriculture is?) produced the study's strongest and most statistically significant finding. Prior to the intervention, only 8 percent of students (n = 2 of 25) indicated knowledge of agriculture. Following the intervention, this proportion increased to 64 percent (n = 16 of 25), a 56 percentage point gain confirmed as highly statistically significant by Wilcoxon signed-rank test (W = 8.5, p < .001). This provides strong evidence that the interventions were effective in increasing students' foundational awareness of agriculture among a population with little prior exposure, consistent with research demonstrating that brief targeted educational interventions can produce rapid knowledge gains in early childhood sustainability education (Ardoin et al., 2018).

Question 4 (Do you know about Earth challenges in your community?) showed a modest increase from 80 percent to 88 percent, a change that did not reach statistical significance (W = 2.5, p = .424), suggesting that awareness of local environmental challenges was already relatively high and was not substantially altered by the intervention. This is consistent with research indicating that community-level environmental awareness often develops through lived experience rather than formal instruction alone (Chawla & Cushing, 2007). Question 5 (Is it important to care for the Earth and land?) showed near-ceiling responses at both time points, increasing from 88 percent to 92 percent, a change that was not statistically significant (W = 6.0, p = .766). The consistently high agreement across both assessments suggests students entered the study with strong environmental values already in place, and that the interventions built knowledge and vocabulary on top of a pre-existing foundation of care, consistent with early childhood research indicating that young children often hold deeply felt ecological values before they can articulate ecological concepts (Knudsen, 2004).

For Questions 2 and 3, student answers were scored as demonstrating substantive understanding (1) or not (0) and reported as descriptive proportions (Fig. 2). Question 2 (What do you think sustainable agriculture means?) showed the largest descriptive shift of any question, rising from 33 percent (n = 9 of 27) to 74 percent (n = 20 of 27), a 41 percentage point increase indicating the interventions were particularly effective at building conceptual vocabulary around sustainable agriculture. Question 3 (How can a community work together to ensure healthy food?) showed a more modest shift from 74 percent (n = 20 of 27) to 82 percent (n = 22 of 27), suggesting students had some prior understanding of community food strategies that the intervention reinforced.

[Figure 2 approximately here]

4.2 Group-Level Descriptive Results (Groups A, B, and C)

Group-level comparisons for Questions 1, 4, and 5 are presented in Table 2 and visualised in Fig. 3. These are reported as descriptive only given sub-group sizes of n = 7 to 10. On Question 1, the three-way pattern is striking: Group A increased from 20 percent to 70 percent; Group B rose from 0 percent to 100 percent, meaning every student who could not identify agriculture before the intervention could do so afterward; and Group C remained at 0 percent at both time points. This divergence, substantial gains in both intervention groups and no change in the control, provides strong descriptive evidence that the interventions, rather than general classroom exposure or the passage of time, drove the observed knowledge gains.

Table 2

Group-Level Descriptive Statistics for Pre- and Post-Intervention Responses by Intervention Condition. Values represent the percentage of students within each group answering Yes to each question. Group A received both the Story Map and book interventions (n = 10). Group B received the Story Map only (n = 10). Group C served as the control and received no intervention (n = 7). Sub-group comparisons are descriptive only; sample sizes were insufficient for within-group inferential testing.

Group	Group_Label	N	Q1_Pre_Pct	Q1_Post_Pct	Q4_Pre_Pct	Q4_Post_Pct	Q5_Pre_Pct	Q5_Post_Pct
A	Group A: Both Interventions	10	20	70	90	100	80	90
B	Group B: Story Map Only	10	0	100	90	100	100	100
C	Group C: Control	7	0	0	42.9	50	85.7	83.3

[Figure 3 approximately here]

On Questions 4 and 5, Groups A and B entered the study at or near ceiling, with pre-intervention rates of 90 percent and above, leaving virtually no room for upward movement. The absence of post-intervention gains for these groups is therefore mathematically expected rather than substantively informative and should be interpreted accordingly. These patterns reinforce the interpretation that the interventions' primary contribution was knowledge-building rather than attitude formation, as environmental values were broadly shared across all groups from the outset.

4.3 Pre-Only Baseline Profile

Five background questions administered in the pre-survey only, covering knowledge of agriculture, its appeal, concerns about it, awareness of sustainable agriculture, and gardening experience, were not repeated in the post-survey and serve as baseline descriptors rather than pre-post comparisons (Fig. 4). Groups A, B, and C showed broadly comparable profiles, suggesting similar starting points. Notably, awareness of sustainable agriculture was low across all groups before the intervention, aligning with the substantial Q2 gains reported in Section 4.1. This baseline equivalency strengthens the interpretive value of the post-intervention comparisons, as groups did not differ substantially before the study began.

[Figure 4 approximately here]

4.4 Post-Only Book-Related Outcomes

Six Yes/No questions specific to the book intervention were included in the post-survey only, addressing students' responses to content assessable only after the reading (Fig. 5). Group A demonstrated consistently higher Yes response rates across all six questions. All 10 Group A students (100 percent) reported the book increased their interest in sustainable agriculture; 80 percent indicated the book mentioned food deserts; and 80 percent believed they could help their community like Imhotep, reflecting a strong sense of personal agency. In contrast, Groups B and C showed lower and more variable response rates, with up to seven of ten Group B students providing no response on some items, reflecting that not all students in those groups read the book or engaged with it fully. Cross-group comparisons in Fig. 5 should therefore be read as exploratory rather than definitive.

[Figure 5 approximately here]

Two 1-to-5 rating scales measuring book enjoyment (Q8_1) and self-reported learning (Q42_1) were compared across groups using the Kruskal-Wallis test. Results indicated no statistically significant difference across groups in either enjoyment ($H = 2.280$, $df = 2$, $p = .320$) or self-reported learning ($H = 0.612$, $df = 2$, $p = .736$). Among Group A students who provided complete responses, the majority rated the book at the highest enjoyment level (5 out of 5) and reported learning a lot from it. The non-significant Kruskal-Wallis results are partly attributable to the high proportion of missing data in Groups B and C on these

scale items, which reduced the statistical power of the comparison. Boxplot distributions for both scales by group are presented in Fig. 6.

[Figure 6 approximately here]

4.5 Narrative Inquiry: Student Voices on Sustainability

Of the 27 matched participants, 12 provided written responses to post-survey Question 14 ("What did you find interesting or important about food security?"). Ten came from Group A; the Group B response was non-substantive and the Group C response was illegible, leaving 10 usable responses drawn exclusively from students who received both interventions. All thematic findings in this section apply to Group A only and should not be generalised to Groups B or C. Word frequency analysis of these responses is presented in Fig. 7, with prominent terms including food, help, important, people, fresh, healthy, and community. Close attention to food-related stories offers unique insight into students' meaning-making around food systems in ways quantitative measures cannot capture (O'Kane & Pamphilon, 2016).

[Figure 7 approximately here]

Thematic analysis using a narrative inquiry framework (Clandinin & Connelly, 2000) revealed three emergent themes. The first, community care and collective responsibility, was reflected in responses such as "to help people," "that you should take care of your neighbourhood," and "so we can help everybody." These students connected food and gardening directly to the wellbeing of others, demonstrating an ethic of care that mirrors the book's central message and Imhotep's role as a community-oriented protagonist. The second theme, food and health, was evident in responses such as "it is important to have fresh food," "making food for the community," and "keeping the world healthy." These reflect foundational food security literacy and an understanding that food access is not guaranteed and that food production has direct consequences for human health. The third theme, personal agency modelled on Imhotep, emerged in responses such as "growing fruits is good because you're helping people that are sick" and "he made his own garden," suggesting the book's protagonist functioned as a meaningful role model whose choices students could imagine replicating.

Taken together, these findings are consistent with Daiute's (2013) framework of dynamic narrating, which holds that storytelling enables individuals to connect with social structures and craft their own place within their communities. O'Kane and Pamphilon (2016) further argue that food stories reveal how individuals connect to the earth and to those who grow food in ways difficult to capture quantitatively. The narrative structure of *The Young Garden King* appears to have functioned in precisely this way, providing students with not only factual content about food systems and sustainable agriculture but a narrative framework through which they could understand their own potential role in addressing food insecurity at the community level (Daiute, 2013; O'Kane & Pamphilon, 2016; Clandinin & Connelly, 2000).

5. Discussion

5.1 Overview of Findings

This study examined whether school-based sustainability education, delivered through a Story Map intervention, a culturally grounded children's book, or both, could increase third-grade students' knowledge of and engagement with agriculture, food systems, and environmental stewardship. The strongest and only statistically significant finding was for Question 1, which increased from 8 percent to 64 percent ($W = 8.5$, $p < .001$). These findings are discussed in relation to group-level patterns, the qualitative responses, and the broader literature on sustainability education.

5.2 Quantitative Findings: Pre-Post Change Across Groups

Statistically significant change was detected for Question 1 only. Knowledge of agriculture and conceptual understanding of sustainable agriculture showed the largest pre-to-post shifts, consistent with research suggesting that direct engagement with educational materials can rapidly build foundational environmental literacy among young learners (Chawla & Cushing, 2007). The absence of significant change on Questions 4 and 5 reflects pre-existing ceiling-level awareness and values rather than a

failure of the intervention, as Groups A and B entered those questions at or near 90 percent, leaving no meaningful room for upward movement.

The group-level pattern on Question 1 is particularly instructive. Group B rose from 0 to 100 percent; Group A increased from 20 to 70 percent; Group C remained at 0 percent throughout. This three-way divergence, substantial gains in both intervention groups and no movement in the control, provides strong descriptive support for the conclusion that the interventions, rather than general classroom exposure or the passage of time, drove the observed knowledge gains (Ardoin et al., 2018).

5.3 Post-Only Book Outcomes

Among Group A students, response rates were consistently high across all six post-only book questions. All 10 students reported the book increased their interest in sustainable agriculture, 80 percent indicated it mentioned food deserts, and 80 percent believed they could help their community like Imhotep. These findings support the argument that culturally grounded children's literature can function as an effective vehicle for sustainability education when the narrative directly reflects the community experiences and food system challenges of the student population (Daiute, 2013; O'Kane & Pamphilon, 2016). Cross-group comparison is limited by high missing data in Groups B and C, and Kruskal-Wallis comparisons of book enjoyment and self-reported learning were non-significant partly due to this missingness. These comparisons should be treated as exploratory.

5.4 Narrative Inquiry: Student Voices on Sustainability

The qualitative component, analysed through the narrative inquiry framework of Clandinin and Connelly (2000), demonstrates how students constructed meaning from their engagement with sustainability education. All ten usable narrative responses came from Group A; findings in this section describe the qualitative experience of students who received both interventions and should not be generalised to Groups B or C. This concentration of qualitative engagement in Group A is itself meaningful, suggesting that the combination of the Story Map and the book produced a depth of reflective engagement that neither element alone appeared to generate.

A central argument of this study is that *The Young Garden King* was created as an act of dynamic narrating in the sense described by Daiute (2013) as a deliberate effort to give young learners a narrative through which they could connect to social structures, make sense of the food and environmental challenges around them, and position themselves as potential actors within their own communities. As a visual reference for the narrative intervention discussed in this section, Fig. 8 shows the cover of The Young Garden King. The book was designed to engage young readers with sustainable agriculture, food systems, environmental stewardship, and community care through culturally grounded storytelling. The study then used narrative inquiry as its qualitative analytical framework, meaning the same narrative logic that shaped the book's creation also shaped how student responses were interpreted. This convergence of narrative as both intervention design and analytical method is not coincidental, it reflects a coherent methodological and theoretical stance in which story is understood as a primary vehicle for meaning-making in sustainability education (Clandinin & Connelly, 2000; Daiute, 2013; O'Kane & Pamphilon, 2016).

[Figure 8 approximately here]

Student responses confirmed this logic. Responses such as "growing fruits is good because you're helping people that are sick" and "that you should take care of your neighbourhood" reflect not merely factual recall but narrative reasoning in which students positioned themselves as potential actors within their own food systems. Because narrative inquiry does not require statistical power to generate meaningful findings, it is particularly well-suited to studies with limited participant pools, and these responses, modest in number but rich in meaning, provide interpretive depth that quantitative data alone cannot supply.

5.5 Implications for Practice

The findings carry practical implications for educators, school administrators, and curriculum developers working in under-resourced communities. Culturally grounded children's literature paired with experiential learning such as the Story Map represents an accessible, low-cost strategy for introducing sustainability concepts to young learners. When educational content reflects students' own communities, food systems, and cultural histories, engagement deepens and knowledge gains

are more likely to be retained (Chawla & Cushing, 2007; Eitel et al., 2024). The particularly strong performance of Group B, rising from 0 to 100 percent on Question 1, suggests that even a single arts-based experiential intervention can produce substantial foundational knowledge gains among students with no prior agricultural exposure. Introducing food and land security concepts in early childhood creates opportunities for students to think critically about food systems and recognise their own potential role in strengthening community food resilience (Ardoin et al., 2018). By embedding sustainability education in both curriculum and culture, future generations can be equipped with the tools to practise stewardship and contribute to long-term community resilience (Ketschau, 2015; Ardoin et al., 2018; Iruka et al., 2017). The book was designed for readers aged 5 to 11 and is suitable for classroom read-alouds, guided discussion activities, and community-based learning programmes.

5.6 Limitations and Future Directions

Several limitations must be acknowledged. The overall sample size (n = 27, with n = 25 complete pairs for statistical testing) limits statistical power and generalisability. Only one of five matched questions produced a statistically significant result, and the absence of formal effect size measures makes it difficult to fully assess the practical magnitude of the Q1 finding. Sub-group analyses were limited to descriptive statistics due to cell sizes of n = 7 to 10, and ceiling effects on Questions 4 and 5 in Groups A and B further limit the usefulness of those items as intervention measures. Future studies should report effect sizes, include baseline screening to identify questions with sufficient variability, and consider pre-registering instruments to avoid post-hoc analytical adjustments such as the deviation from planned McNemar's testing that was necessary here.

The high proportion of missing post-survey responses in Groups B and C, up to 70 percent on some book-related items, limits cross-group comparability and likely reflects uneven book delivery across groups. Future studies should implement fidelity checks to confirm intervention delivery before administering outcome assessments tied to specific interventions. The narrative inquiry component is limited by all usable responses coming from a single group; future studies should explore qualitative methods that generate richer responses across all groups, such as structured interviews or drawing-based activities, and longitudinal follow-up would help determine whether observed gains are retained over time.

Despite these limitations, this study makes a meaningful contribution to the literature on sustainability education in early childhood, demonstrating that culturally grounded, place-based tools can produce measurable and meaningful changes in students' environmental knowledge and engagement even in resource-limited settings. The control group pattern provides a level of interpretive confidence unusual for a study of this sample size.

6. Conclusion

The findings of this study reinforce the importance of integrating sustainability-focused learning into early education, particularly in communities with limited access to environmental and agricultural learning opportunities. When children engage with culturally grounded educational tools that reflect local land and food systems, such as *The Young Garden King*, they gain environmental knowledge and develop stronger connections to place, community, and land-based practices. Even brief educational interventions can produce measurable shifts in children's understanding of agriculture, food systems, and environmental responsibility, though deeper and longer-lasting sustainability thinking requires continued exposure, curricular integration, and reinforcement through school and community-based learning.

Storytelling and culturally grounded children's literature offer an effective pathway for this work precisely because narrative functions on two levels simultaneously in this study. *The Young Garden King* was created as an act of dynamic narrating, a deliberate effort to give young learners in an underserved community a story through which they could see themselves as capable of understanding and acting on the food and environmental challenges shaping their lives (Daiute, 2013). The study then used narrative inquiry as its analytical framework to examine what students did with that story. Daiute (2013) argues that dynamic narrating is not merely a pedagogical technique but a fundamental human activity through which people construct their place in the world. O'Kane and Pamphilon (2016) extend this argument to food systems specifically, demonstrating that food stories reveal how individuals connect to community, land, and the people who grow their food in ways that data alone cannot illuminate. The fact that students responded to the book's narrative with language about helping their neighbours,

growing food for the sick, and taking care of their communities confirms that the book functioned as Daiute's framework predicts, not simply transferring knowledge but giving students a story to inhabit and, in doing so, a place to stand (Daiute, 2013; O'Kane & Pamphilon, 2016; Clandinin & Connelly, 2000).

The most compelling evidence from this study is the contrast between students who received the interventions and those who did not. Among students who participated in the Story Map and book activities, knowledge of agriculture increased from near zero to a majority of the group. Among students in the control condition, no change occurred. This pattern, observed in a community where structured sustainability education has historically been limited, affirms that intentional, culturally responsive educational design can open pathways to environmental knowledge and agency that would otherwise remain closed. These young learners already cared deeply about the Earth. What the intervention gave them was the language, the concepts, and the story to act on that care.

Declarations

Competing Interests:

The authors declare no competing interests.

Ethical Approval:

This study was approved by the Institutional Review Board (IRB) at [Institution redacted for review]. Protocol #: 2310498665R001.

Competing Interests

The authors declare no competing interests.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the relevant institutional review body and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board of [redacted for double-anonymous review] (Protocol/Approval No. 2310498665) on 12/15/2023. The approval covered the recruitment of participants, administration of survey instruments, classroom-based implementation of the educational intervention, and the collection and analysis of anonymised student response data.

Informed consent

Written informed consent for participation and use of anonymised data was obtained from the parents or legal guardians of all student participants prior to data collection from April 2nd, 2024, through April 30th, 2024. Consent materials were distributed and collected through the participating school by authorised school personnel in coordination with the research process approved by the Institutional Review Board. Prior to participation, students were informed in age-appropriate language about the study activities, that participation was voluntary, that their responses would be kept confidential and anonymised, and that they could decline to participate. Verbal assent was obtained from participating students by the researcher in the classroom immediately before survey administration and instructional activities began.

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Author Contribution

T.B. conceived the study, designed the methodology, developed the educational intervention, collected and analysed the data, prepared figures 1 and 2, and wrote and revised the manuscript. K.F. reviewed and substantively revised the manuscript. R.G. reviewed and substantively revised the manuscript.

Data Availability

The datasets and supporting materials generated and analysed during the current study are provided as supplementary files submitted with the manuscript for editorial and peer-review purposes. These materials include the raw pre- and post-survey datasets, the processed dataset used for statistical analysis, survey instruments and questionnaire protocols, variable definitions and coding information, the R script used for statistical analysis, and documentation describing the analytical procedures used in the study. All materials have been anonymised to protect participant confidentiality.

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Figures

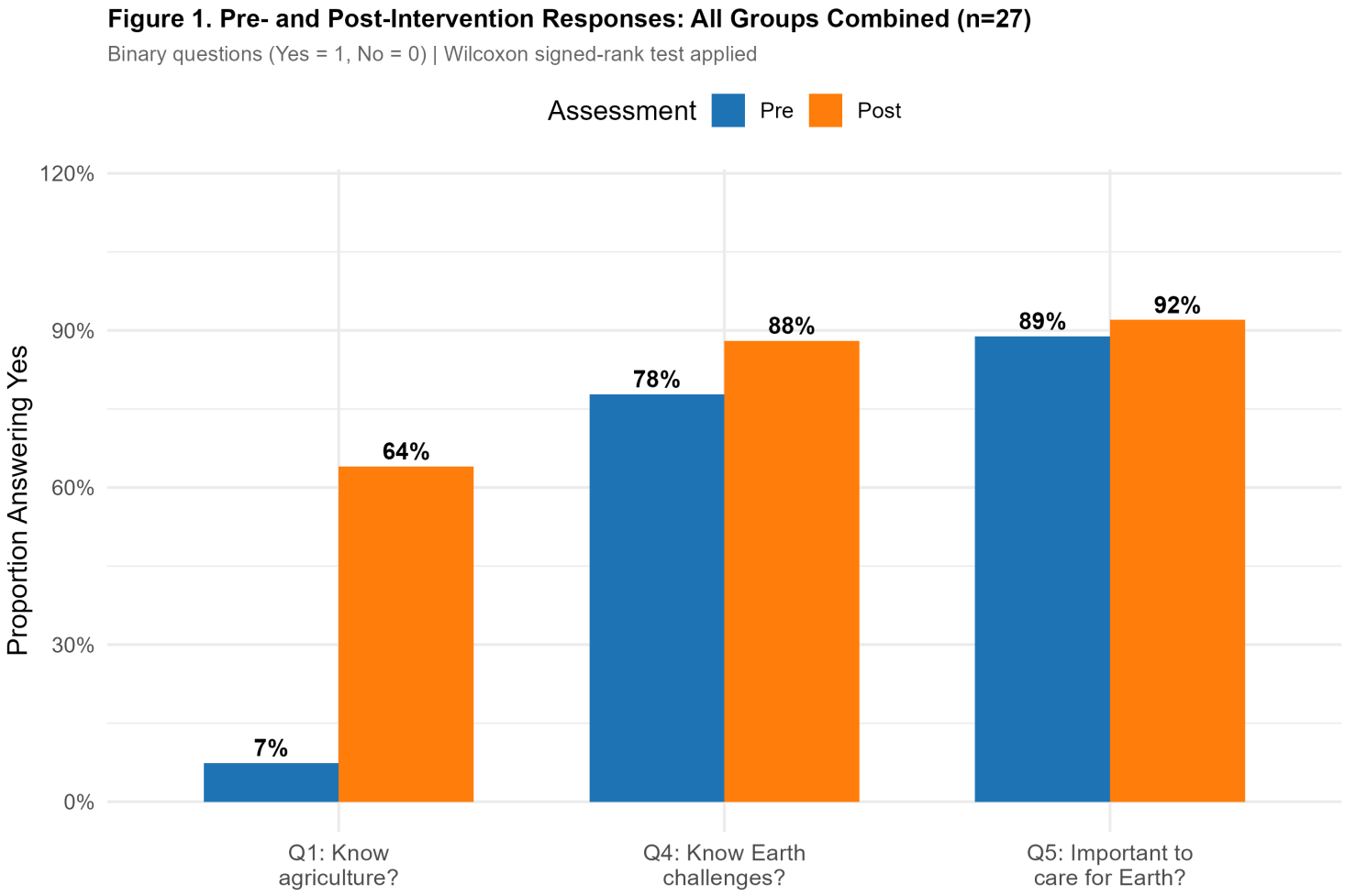


Figure 1

Pre- and post-intervention comparison of student responses to binary survey questions Q1, Q4, and Q5 (n=27). Proportion of students answering Yes to each question before and after educational interventions. Wilcoxon signed-rank test results: Q1, W = 8.5, p < .001; Q4, W = 2.5, p = .424, ns; Q5, W = 6.0, p = .766, ns.

Figure 2. Pre- and Post-Intervention Understanding: Q2 and Q3

Proportion of students giving a substantive response (vs. 'I have no idea' / 'I don't know')

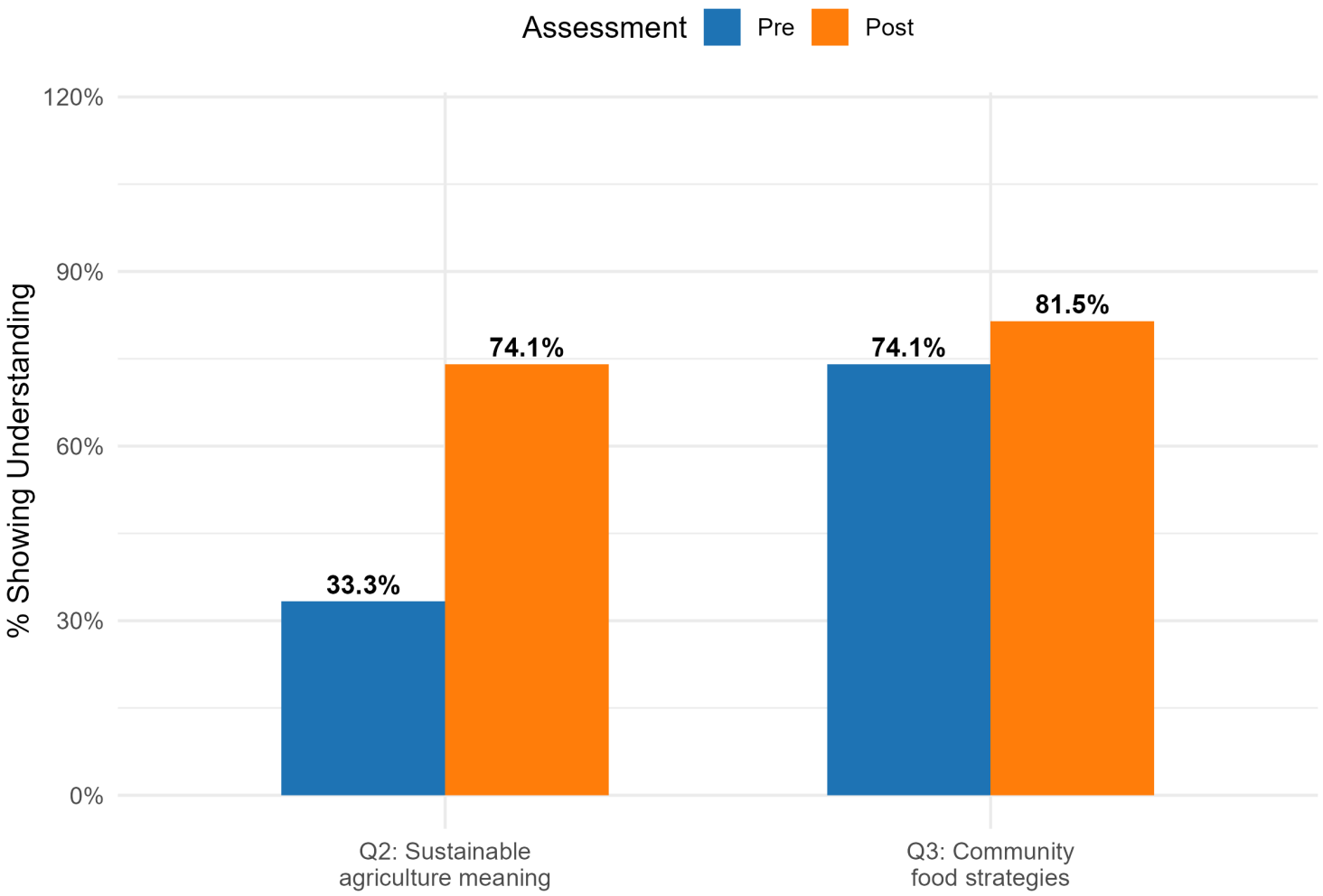


Figure 2

Pre- and post-intervention proportions of students demonstrating substantive understanding on open-ended questions Q2 and Q3. Responses scored dichotomously: 1 = substantive response, 0 = no understanding. Results are descriptive only. McNemar's test was not applied; see Results Section 4.1 for explanation.

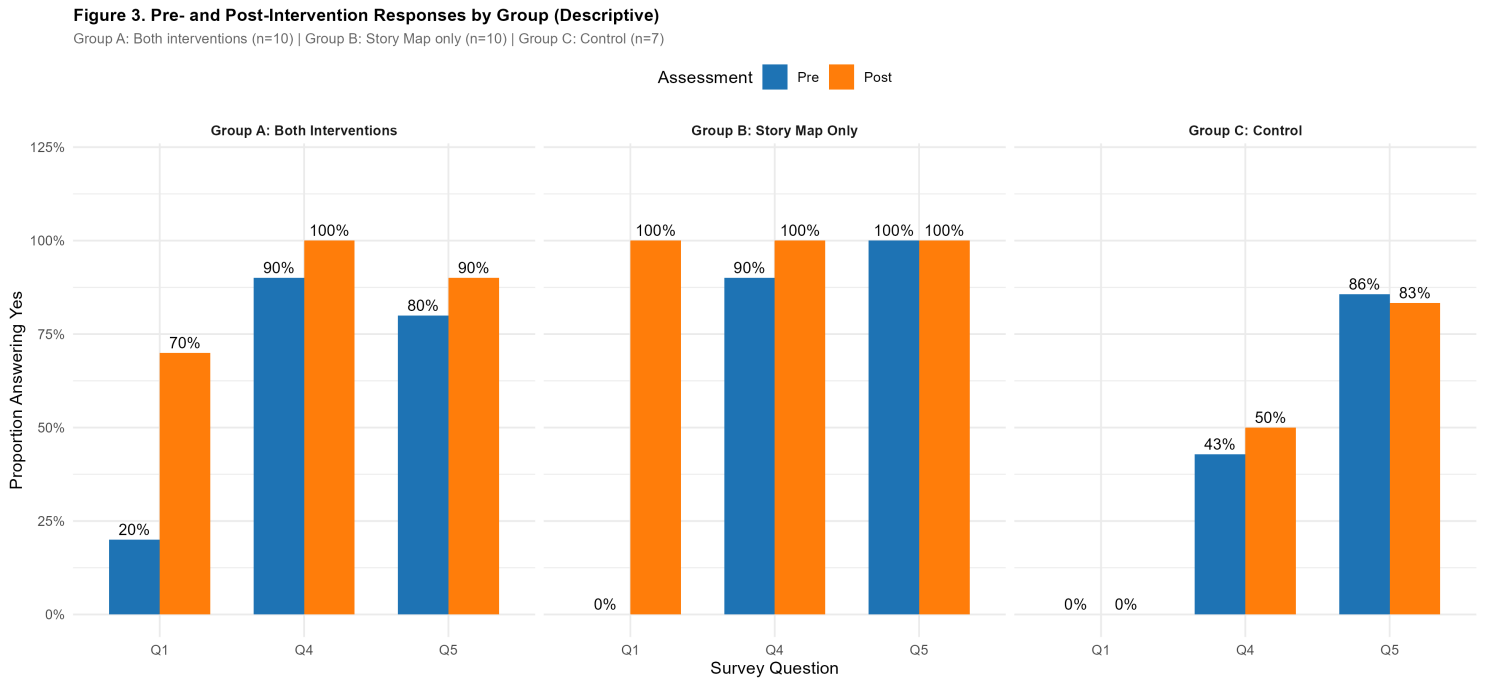


Figure 3

Pre- and post-intervention response proportions for Q1, Q4, and Q5 by intervention group. Faceted bar chart showing each group separately. Group A: both interventions (n=10); Group B: Story Map only (n=10); Group C: control (n=7). Reported as descriptive only due to sub-group sizes insufficient for inferential testing.

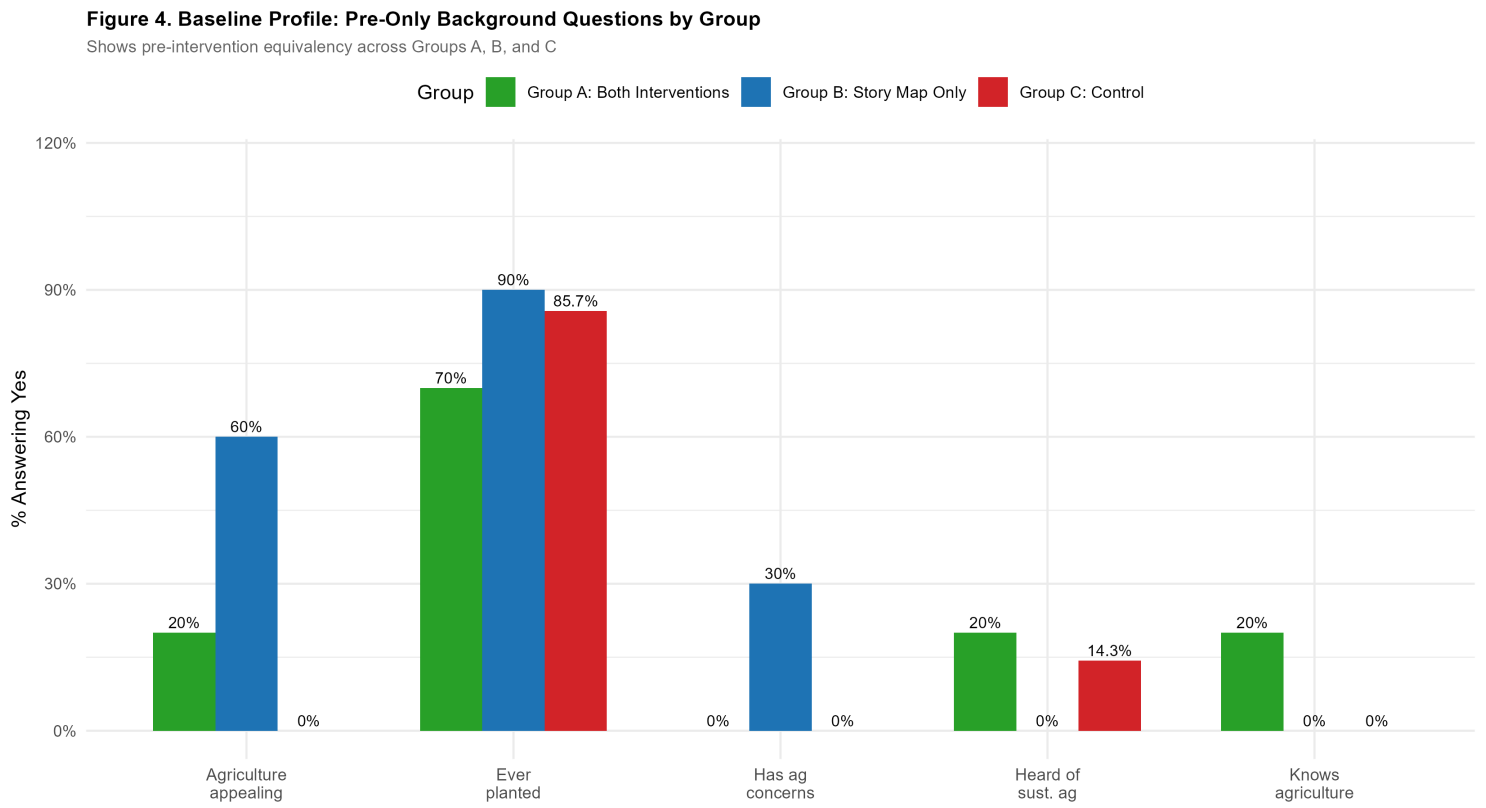


Figure 4

Baseline profile of pre-only background questions by group. Grouped bar chart showing five pre-survey-only questions (agriculture knowledge, agriculture appeal, agriculture concerns, prior awareness of sustainable agriculture, and gardening

experience) by Groups A, B, and C. Demonstrates pre-intervention equivalency across groups.

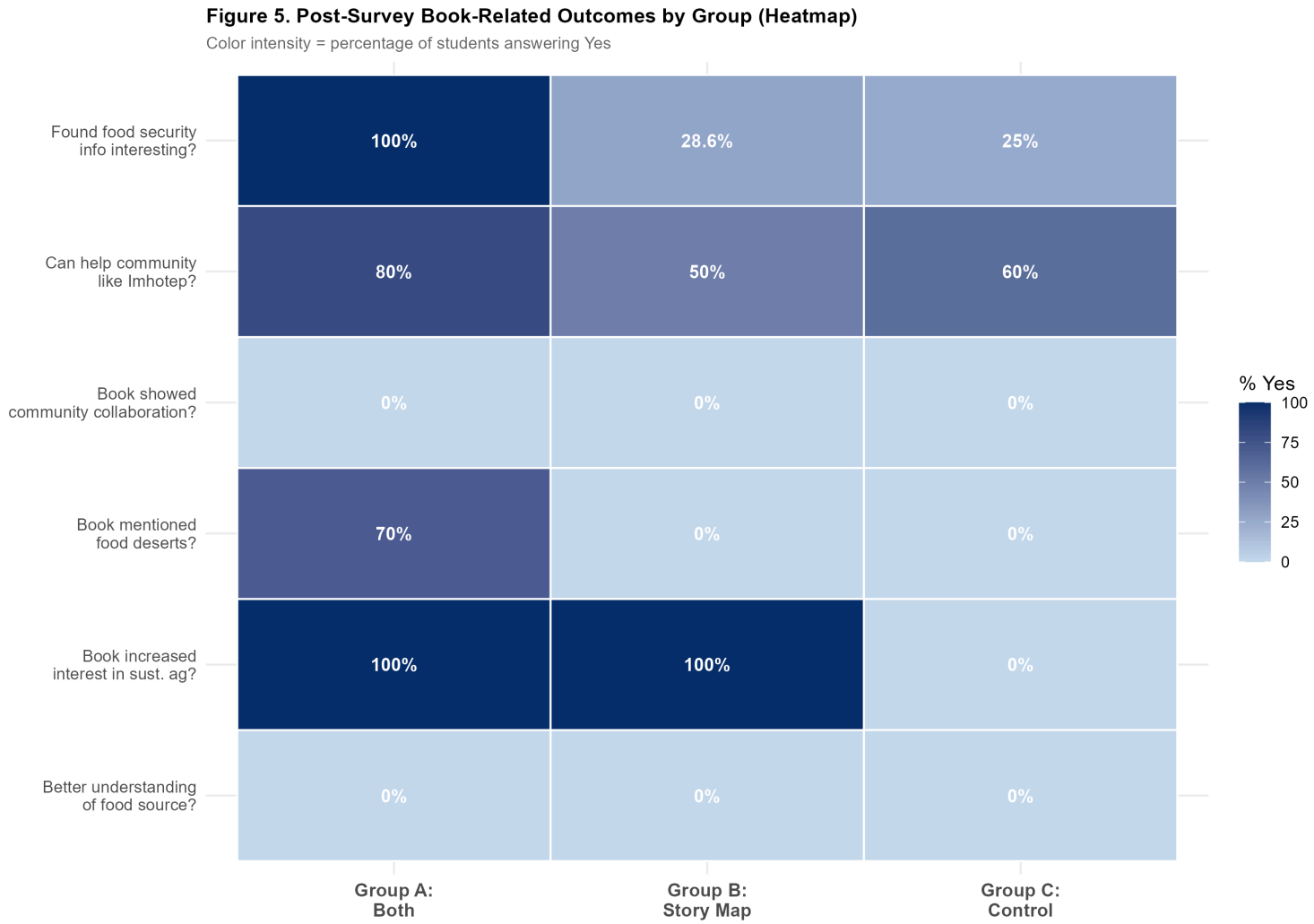


Figure 5

Heatmap of post-only book-related binary questions by group. Six Yes/No post-survey questions (Q10, Q12, Q13, Q15, Q19, Q20) by three groups, with cell colour indicating percentage answering Yes. Results are descriptive frequency distributions. Cross-group comparisons are exploratory due to high missing data rates in Groups B and C.

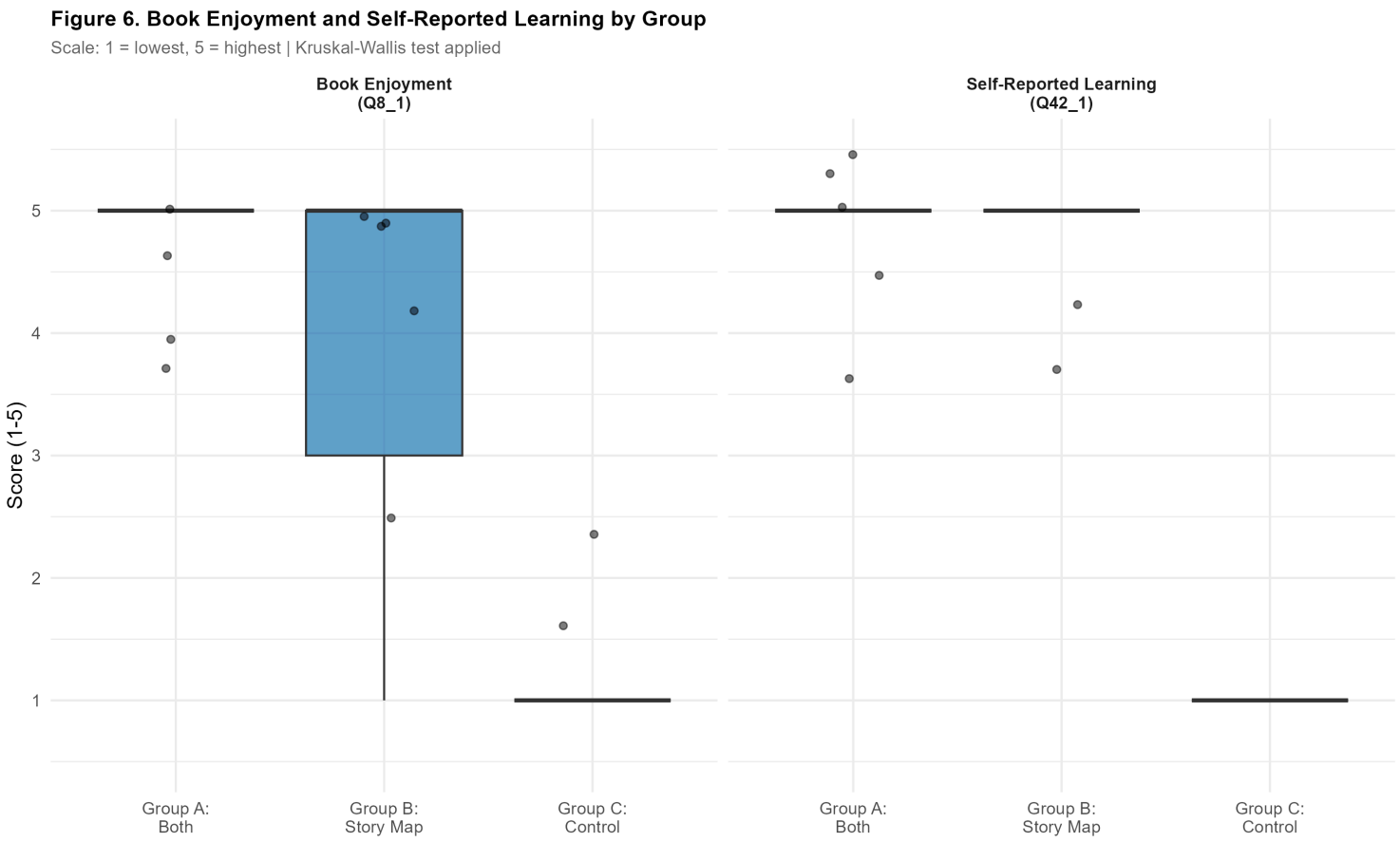


Figure 6

Boxplots of book enjoyment (Q8_1) and self-reported learning (Q42_1) ratings by group. Kruskal-Wallis test results displayed in caption. Scale: 1 = lowest, 5 = highest.

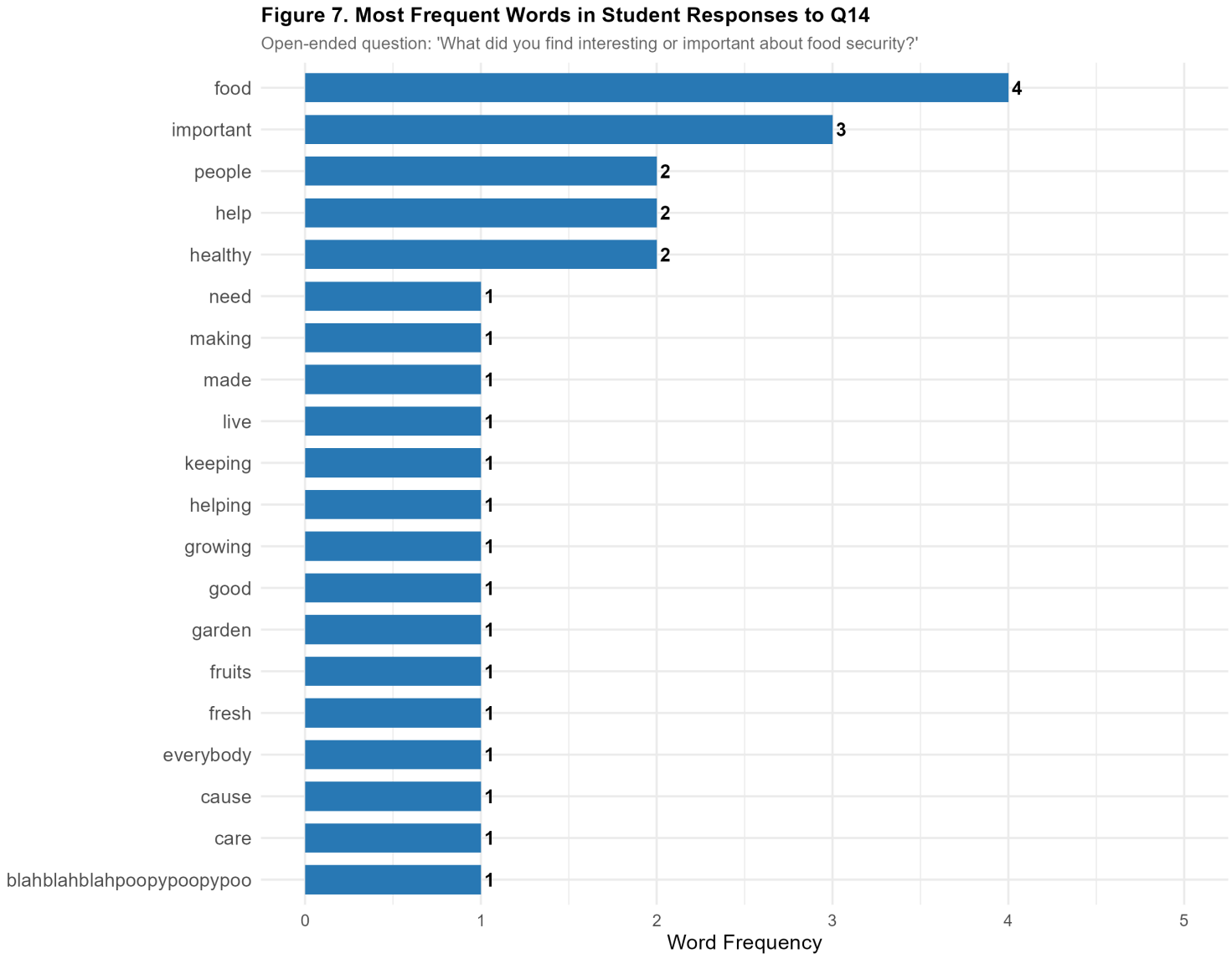


Figure 7

Word frequency bar chart of student open-ended responses to Q14 (“What did you find interesting or important about food security?”). Stop words removed. Visual anchor for the narrative inquiry analysis.

Image not available with this version

Figure 8

Cover of *The Young Garden King* children’s book used in the educational intervention. The book serves as a narrative-based learning tool designed to introduce young readers to themes of sustainable agriculture, food systems, environmental

stewardship, and community engagement.