Nature-based Constructionism

Using Digital Storytelling to Increase Computational Skills and Plant Awareness

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Abstract
Computing education often lacks real-world context, which can hinder young learners in connecting abstract concepts with nature experiences. The project "Digital Storytelling with Plants," hosted at the Botanical Garden at the University of Zurich, integrates computing education with nature-based learning for children aged 8 to 15. Participants (105 in total) combined art, programming, and video production in workshops centered on plant life. The project assessed shifts in motivation for media and technology usage and interest in botany. Rooted in constructionist pedagogy, the workshops emphasized nature-based, hands-on, and student-centered learning. Findings show that narrative and reflection foster interest in both plants and technology, with measurable gains in awareness, motivation, and confidence, highlighting the value of digital tools in environmental education.

Keywords and Phrases: Constructionism, Nature-based learning, Digital storytelling, Computational skills

1. Introduction
A growing body of research highlights the potential for storytelling to facilitate engagement and knowledge gain (Lynch and Mannion, 2021; Hills and Thomas, 2019). Digital storytelling encompasses a range of techniques, tools, and elements used to craft narratives in digital formats. It often blends traditional storytelling principles (text, images) with multimedia components (audio, video) to engage audiences in interactive ways. Studies have shown that learning in natural settings can improve perseverance, collaboration, and creativity (Sipos, 2008; Otto and Pensini, 2017; Burke, 2022). This project explores how narrative-driven, nature-based digital storytelling can develop a deeper understanding of ecological systems while advancing technical abilities (Jukes and Lynch, 2023, Van Kraalingen, 2021).

Constructionism, as pioneered by Seymour Papert (1980), builds on Piaget's constructivist theory, emphasizing the role of active learning through creating tangible artifacts. This pedagogical approach empowers students to explore concepts by

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designing, building, and reflecting on projects that are meaningful to them. Constructionist methods are particularly effective when combined with technology, enabling learners to create digital artifacts such as games, videos, or simulations. These tools not only enhance engagement but also encourage interdisciplinary connections between science, technology, engineering, arts, and mathematics (STEAM).

2. Workshops Description & Methods

Storytelling and video production were introduced through storyboards, group work and internet research guided by specific questions, focusing on plant-related information. Using iPhones, they filmed up to five short clips (each max. 30 seconds) and edited them in CapCut – an app many were already familiar. In *Plant Coding* (4h), participants used the Pocket Code app (Spieler et al., 2018) to create games, integrating concepts like photosynthesis and pollination into playful mechanics based on outdoor observations. In *Plant Art* (3d), they explored plant-insect interactions and produced stop-motion animations and zoetropes. All workshops ended with reflections, focusing on learning through creative process. A pre- and post-survey design was used to evaluate participants' engagement, technical skills, and plant awareness. Surveys incorporated validated instruments such as the Media and Technology Usage and Attitudes Scale (MTUAS; Rosen, 2013) and STEM Semantics Survey (Tyler-Wood, 2010).

3. Results

A total of 105 children aged 8 to 15 participated in the workshops (55 girls, 48 boys, 2 gender unknown). Girls showed a slightly higher mean age (11.04 years) compared to boys (10.27 years). Participants created a total of 50 short films, of which 20 were shared on social media platforms (on average 700 views per video). Videos were evaluated for creativity, narrative coherence, and technical quality, receiving an average rating of 5.2 out of 6. Projects ranged from animations about plant pollination to interactive games simulating plant growth. More than half of the participants reported already experiences with video production.

The study showed a significant increase in plant interest (Figure 1, left panel) and motivation for media and technology usage (right panel) across all workshops. The perception that "the apps and smartphones I used in the course were easy to use" increased significantly, with both boys and girls reporting improvements on both group and individual levels. Boys experienced a notable shift on an individual level (Δ mean ≈ 0.7, $p < 0.1$), while girls showed significant improvement on both a group and individual level (Δ mean ≈ 0.4, $p < 0.1$). Similarly, confidence in problem-solving skills improved, with participants agreeing more strongly with the statement "I can solve problems very well." This change was significant for girls on an individual level (Δ mean ≈ 0.3, $p < 0.1$). For *Plant Coding*, pre-survey data revealed a moderate correlation ($r = 0.48$) between prior digital literacy and post-workshop programming success.

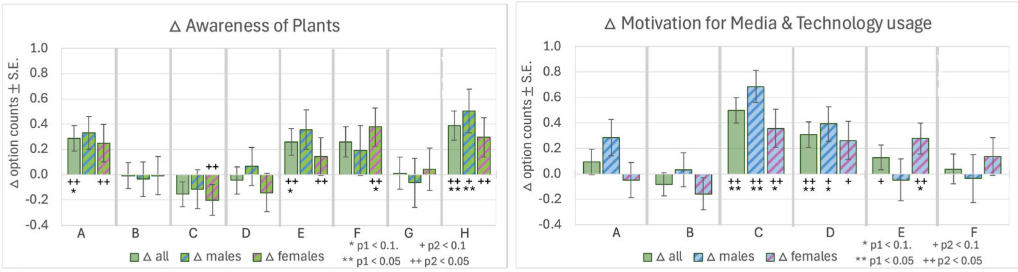

Figure 1: Change in awareness of plants (left panel) and motivation for media and technology usage (right panel). Shown are delta of means pre- and post-course (y-axis) of 5 Option (1-Not at all to 5 – highly). p-Values on group level (heteroskedastic, p1): * p1 < 0.1, **p1 < 0.05; on individual level (paired, p2): + p2 < 0.1, ++ p2 < 0.05. Left panel on x-axis = change in: A – plant interest, B – importance of plant knowledge, C – plants are boring, D – I would like to learn something about plants, E – willingness to work with plants, F,G – career aspirations in plant-related professions, H – engagement with plant filmmaking. Right panel on x-axis = change in how the technical devices (smartphones, tablets and apps) A – helped to learn new things about plants, B – helped to understand plants, C – were easy to use, D – were easy to use without help, E – problem-solving competence, F – technology's competence towards environmental problems.

Limitation

Participants noted various challenges during workshops, such as debugging programming errors and coordinating group tasks. Solutions often involved peer collaboration or instructor guidance, highlighting the importance of teamwork in problem-solving. Many participants expressed pride in their final projects, with one stating, "Creating a game about plants made me appreciate them more."

4. Impact

Digital storytelling bridges creativity, technology, and environmental education, offering learners a holistic approach to computational and ecological learning. The success of this initiative underscores the importance of integrating diverse learning approaches to prepare students for a complex, interconnected world. Educators are encouraged to adopt and adapt nature-based constructionist methods to inspire curiosity, creativity, and a deep connection to the environment. Future research should explore long-term impacts and broader applications in formal education settings.

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