



Autoethnographic Projection of Climate Change Education through Project-Based Learning: Perspectives from Early Career Scholars

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ABSTRACT

Purpose of the study: Project-based learning (PBL) is an effective pedagogical strategy for climate change education. This paper investigates the support early scholars receive and the challenges they face while conducting educational interventions using project-based learning (PBL) pedagogy for high school students' environment and climate change education

Methodology: A collaborative autoethnographic approach was used to analyze the narratives from the projects conducted by two early scholars regarding their experiences educating high school students on environmental and climate education in Pittsburgh and Indiana, in Western Pennsylvania, US. Convenience sampling was used in this study. This research's primary data collection method includes personal narratives, reflective journals, and field notes accumulated throughout the project. A thematic deductive qualitative analysis was conducted.

Findings: The findings demonstrate the effectiveness of PBL supported by institutional and community partnerships. The narratives reveal that universities and administrators have greater outreach capabilities than independent project leaders. Additionally, the study found that teachers' contributions were instrumental in enhancing student engagement. Collaboration between local universities, schools, and community organizations creates opportunities for project leaders that might otherwise be challenging to access.

Novelty/Originality of this Study: The study offers valuable strategies for project leaders to implement PBL successfully in diverse educational settings.

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1. INTRODUCTION

Climate change is a pressing global issue that demands attention from all sectors; it needs solutions beyond scientific and policy advancements [1]. Education plays a crucial role in fostering awareness of climate change. Students in K-12 across the world, including the United States, often lack sufficient exposure to environmental and climate change education (ECCE) [2].

According to the Aspen Institute's reference to the National Center for Education Statistics, at least 98000 or 29 percent of schools need to implement environmental and climate change education [3], [4]. However, ECCE is increasingly gaining importance, and teachers are implementing different pedagogical strategies [5]. Project-based learning (PBL) is one of the pedagogical strategies that has been employed by a significant number of scholars and practitioners for environmental and climate change education (ECCE) in various contexts and geographies, making substantial contributions despite challenges [6]. Much research shows that PBL is an effective strategy for K-12 students in ECCE [7]-[9]. However, the rise of climate change-related

issues and the lack of innovative teaching models require further research to highlight the effectiveness of PBL in the context of ECCE. A comparative curricula analysis conducted by [10], suggests that the vast body of research constituting ECCE is largely unacknowledged by school curricula globally. This demonstrates the growing importance of analyzing factors for successful PBL implementation in ECCE.

Potential institutional and community engagement are crucial factors for PBL in the context of ECCE at high schools. Community engagement is a two-way street involving citizens' needs and values in all policy, planning, and service delivery stages, with governments and other organizations actively including stakeholders [11], [12]. Community engagement enriches students' understanding by grounding concepts in real-world contexts. Community engagement fosters a sense of responsibility, encourages collaboration [12], and empowers learners to see the direct impact of their actions on the environment and their community [13], [14]. The research utilized a collaborative autoethnographic approach to capture experiences working with local schools and communities in two PBL projects within the ECCE context. The autoethnographic approach offers valuable insights into the practicalities of implementing PBL projects and highlights the importance of collaboration between researchers, schools, and communities [15]. Author 1 conducted the project in a high school in the US, while Author 2 led it in the US, Bangladesh, and India. Author 3 worked to facilitate the documentation and writing process. Both projects focused on building students' awareness about climate change, empowering them to develop solutions within the local communities.

Climate change education refers to the critical content and concepts central to climate crises, with climate science, social systems, and technology interventions to understand the unprecedented and significant human impact on the Earth System (Education at a Glance OECD, 2019), [16]. Scholars suggest that climate education in the United States is still a work in progress and that K-12 education has yet to be successful nationally in clearly communicating the scientific consensus around human-induced climate change [17], [18]. While science education has thus far been the most common way to teach and research about environment and climate change education (ECCE), much scholarship emphasizes that it should be a holistic cross-curricular project [19], [20].

Scholars and educators are taking significant steps to raise awareness of climate change among students. Amidst the lack of solid curriculum guidelines, many educators turn to project-based learning (PBL) to engage students. Project-based learning (PBL) is an instructional approach rooted in collaboration, student-led discussion, and real-world problem-solving [21]. In recent years, educational institutions have been trying to provide students with hard skills, for example, professional skills [22], [23], and soft skills, such as problem-solving and teamwork essential for ECCE.

Project-based learning (PBL) has emerged as a powerful educational approach that fosters deeper engagement and equips students with practical skills through hands-on and context-driven experiences. In their 2019 meta-analysis, Chen and Yang found that project-based learning has a favorable effect on students' academic performance compared to traditional instruction. Hence, PBL shows a knowledge transfer model that has the flexibility to positively impact students by training them about projects in a local context [24], [25]. Local communities and their schools remain key sites for actions tackling sustainability and climate change issues through government and community-initiated projects that can support the development of more effective community and school relationships [26]. Local communities are vital benefactors contributing to the impact, effectiveness, and innovation of PBL in diverse curriculums. Scholars found that the progressive development of PBL in K-12 education is impressive, even better than in higher education [27], making it a suitable approach for ECCE. The application of ECCE builds on recommendations to bring a human face to climate education via storytelling, narrative, and other strategies to increase engagement and hope rather than provoke adverse, detached emotional reactions that could be integrated into PBL. Our literature review identifies a lack of research in environment and climate change education among high school students across the US. In contrast, researchers suggest that PBL can significantly enhance environmental awareness among students [15], [22], [23]. This study is an effort to propose suggestions for implementing PBL projects regarding environment and climate change education.

Collaborative autoethnography refers to a collective approach where a group of individuals, collaboratively examines and reflects upon their shared experiences and cultural dynamics [29]. ECCE and its application in high school students through an auto-ethnographic narrative projection. Carolyn Ellis first introduced autoethnography in 1999 as a technique to unpack superficial beliefs and attitudes to come together for "new negotiated understandings of their positions by connecting the personal experience (auto) to a broader cultural understanding (ethno) through systematic analysis (graphy)" [29]. More recently, social scientists and collaborators have been applying auto-ethnographies to collate expertise among peers to understand the same target from multiple self-observations to arrive at a shared understanding. Social scientists and collaborators recognize individual experiences as an essential part of autoethnography. They believe that stories of experience always matter regarding negotiations, collaborations, and the presentation of personal values about broader culture. This paper uses collaborative autoethnography to bring the experiential ramifications of the PBL of high

school students in the contexts of climate change from cultural and educational perspectives to find possible solutions.

There is a growing recognition of the value of PBL, local knowledge, and community-driven narratives in fostering deeper climate awareness [30], [31]. Besides the collaborative autoethnographic narrative, which includes the importance of teaching climate change and using technology as an effective means, the significance of support from higher education institutions in the US is also reflected. The rapid development of transdisciplinary approaches to tackle problems around sustainability indicates that many practitioners realize the importance of knowledge co-production from the outset [32], [33]. The enunciations of two teaching approaches from two early career scholars integrating humanities and science learning in classrooms to generate climate change awareness through technology [34]. Through the two projects, both researchers share their intricate views by serving the project in various capacities and being part of it. Nuanced and more step-by-step autoethnographic testimonies of onsite implementation of technology and teaching of climate change to diverse students unfold discussions about the importance of participation, micro-level knowledge, and innovative strategies for community awareness. This collaborative autoethnographic study investigated the two research questions: 1) How do universities, local community, and school collaborations influence the success of educational projects?; 2) What challenges do project directors face in forming partnerships with schools and local communities, and how can these be mitigated?

2. RESEARCH METHOD

In this study, we employed a collaborative autoethnography qualitative research method. Collaborative autoethnography can be seen as a societal counterpart to autoethnography [35] Autoethnography is a process of self-care that converts personal experiences into critical theory that involves a reflective and analytical approach that is both a practical application, an embodiment, and a way of life. Collaborative autoethnography entails researchers collaborating to gather their narratives to identify similarities and discrepancies. Subsequently, they grapple with these narratives to uncover their significance within their sociocultural environments [36].

Both project directors documented their experiences as narratives demonstrating the partnerships, collaborations, challenges, and mitigations encountered. Data was collected between February 2021 to May 2024 for Author 1 and January 2022 to Sept 2023 for Author 2. Thus, in this study, we juxtapose the description and analysis of the life stories of Author 1 and Author 2. Both authors are international doctoral students at a Western Pennsylvania, US public research university. Author 1 is a thirty-two-year-old male researcher from India with six years of teaching experience and seven years of experimental and educational project development. Author 2 is a forty-two-year-old female researcher from Bangladesh with fifteen years of teaching experience and seven years of experience conducting educational projects. The analysis was conducted through deductive thematic analysis of qualitative data by selectively looking at the common themes of collaborations and partnerships that appeared in the data.

Table 1 gives an overview of the critical features of the projects 1) Twinocene: Using Digital Story Game Project for Climate Change Education and 2) Know Nature Local to Global. Table 1 briefly reflects the number of participants, location, duration, objectives of each project, and the relevant goal to provide an overview of the projects.

Table 1. Overview of the critical features of the projects

	Project Twinocene: Using Digital Story Game Project for Climate Change Education (Author 1)	Project Know Nature Local to Global (Author 2)
Participants	15/20 students: 10th, 11th, and 12th grade students, 3 teachers	50 students: grade 5 to grade 12 students, 5 Teachers
Location	Pittsburgh, Pennsylvania, US	Indiana, Pennsylvania, US
Duration	February 2021-May 2024	March-September 2023
Objectives	<ol style="list-style-type: none"> 1. Increase students' abilities to use language associated with climate change discussions. 2. Empower high school students to conceptualize changes they could make in their immediate environments to respond to climate change. 3. Increase students' familiarity and interest with 21st-century creative Game design and ability to narrate that in gamified settings 	<ol style="list-style-type: none"> 1. To enhance the capabilities of 15 high school teachers from three US, Bangladesh, and India schools in creating and executing environmental projects based on the framework outlined by Monroe et al. in 2007. 2. To equip 150 high school students (grades IX-XII) from three schools in the US, Bangladesh, and India with skills to design and implement locally relevant environmental projects aligned with objective (1), which have global significance, and to digitally present project reports with a critical awareness message. 3. Under the guidance of mentor teachers, participating students will produce standard digital awareness materials on local environmental issues. To ensure sustained impact, they will also maintain the project's designated webpage for two years after completion.

3. RESULTS AND DISCUSSION

3.1 Support from University

Author 1:

I am a part of a six-year-old initiative, The Digital Storygame Project (DSP), led by a professor at my university, Indiana University of Pennsylvania. DSP is a project-based teaching initiative fostering partnerships with multiple high school teachers from Eastern Pennsylvania for six years (2018-ongoing) to customize learning units to teach coding, writing, and decision-making in English Classrooms. DSP supports students in choosing and designing their own “choose your own adventure game” (CYOAG) and turning them into playable interactive story games through an open-source software called Twine. The DSP has traditionally been driven by English language arts (ELA) and Gifted Programs/ Arts Program (GP/AP) classroom-teacher collaboration.

DSP partnered with a high school in Pittsburgh, Western Pennsylvania, to foster an educational outreach to develop a collaborative project. While serving as the project manager of DSP, I was aided and supported exceptionally by the members of DSP to have diverse resources and advice to develop this collaboration. The DSP leader gave me the autonomy to design the project. Being an international student, it is important to understand the legalities and process for collaboration for which I received help from the DSP leader and the professors in the Department of English to facilitate the project. While serving in various capacities at DSP, I had the flexibility to engage with other teachers and professionals to foster a collaborative project that enhanced my skills in fostering partnerships. In pursuit of forming alliances with institutions, I had to contact teachers and professionals personally. He introduced me to professionals, community members, and stakeholders and helped me with specific directions to foster collaborations. All these supports helped me face and fix some challenges due to my international status.

Moreover, I was supported by my advisor, who is also DSP's leader, in designing materials and evaluating their application. I was explicitly supported by the technological integration of software-based writing and the training to apply that in diverse classrooms. I also got help from the Institutional Review Board (IRB). The project leader and my professor helped me write the IRB and distinctly supported me with the approval. Once approved, the DSP members went to school to decide the date, venue, and infrastructure to begin the three-

Author 2:

While conducting a high school environmental project in the US, India, and Bangladesh, I received invaluable support from my university, Indiana University of Pennsylvania, particularly from the Department of Education and Human Services professors. In this autoethnographic narrative, I will share only the US experience for this study. As an international doctoral program student, confirming two local schools for my project proved challenging because though I have lived in Indiana, Pennsylvania, for a few years, I am not originally from there. Initially, I attempted to contact schools independently, contacting teachers I knew from personal connections. However, I encountered two responses: some immediately declined due to time and scheduling constraints, while others did not respond. This made it difficult to proceed with planning and communication due to a lack of confirmation from the school.

After several rejections, I turned to professors from the College of Education and Human Services for assistance. One of them emailed her former student, a local public school teacher, inviting her to join my project. Within hours, she responded positively. Subsequent face-to-face meetings with that teacher helped kickstart the project planning process with the first school of the project. Additionally, my professors supported me regarding the institutional review board (IRB) process for conducting surveys and interviews with project participants. The department chair agreed to serve as my project advisor for the IRB and assisted me in preparing the necessary documents for approval. This support was crucial, as without IRB, I could not share my project experience with the academic community through scholarly writing.

Furthermore, I benefited from valuable suggestions from several professors for project implementation. Their local community expertise made their insights on participant selection and project planning invaluable. For instance, one of the professors recommended involving two teachers instead of one to ensure broader participation or focusing on students from a specific grade level to avoid the exclusion of any interested teacher. Another suggestion was to approach school principals instead of teachers for project permission, as projects initiated by principals tend to have smoother execution in the United States.

Apart from professorial support, the university provided resources for my project. The Department of Biology offered leftover resources from previous projects that fit into my project. Additionally, I utilized various technologies available to graduate students at my university to enhance the project further.

3.2 Discussion on University Support

Support from the universities was instrumental in both projects. Professors of the institution played critical roles in developing and implementing the projects in the classroom. The support of the professors was twofold: academic and administrative. Academically, the professors helped with project designing, instructional design, lesson planning, prototype designing, product testing, and implementation which enriched the project. Administratively, they offered liaising and legal support for project implementation, including access permissions, policies, background checks, and signing mandates. They helped move forward with collaborations with teachers, stakeholders, and partners. Besides the professors, the university administrators, such as the dean, officials from the research lab, navigators, and personnel from the human resources office, helped move the project forward. Support included getting permissions, fixing complex legal situations, and problem-solving. It can be interpreted that, without university support, conducting the project would have been exceedingly difficult due to limited resources, such as expert opinions, equipment, and technology. At the same time, administrative support from universities was crucial for project directors to establish communication, obtain permissions, and navigate administrative procedures with local schools and community organizations. Integrating international students as valuable contributors to developing, leading, and participating in collaborative projects requires comprehensive and diverse support from their university.

3.3 Support from Local Community

Author 1:

This project is one of the many successful collaborations I participated in, and I served in various positions—from meeting the partner teacher to outlining project modules. After the collaboration proposal was appreciated and approved by the high school coordinator, the leaders of the DSP, and the high school teacher/coordinator of the Sustainability Studies, I had a row of meetings to solidify the plan. Along with a row of Zoom meetings, we met near the high school to round up the plans for our roles, goals, and the specifics of installing the project.

A significant amount of support was provided by diverse community representatives and professionals who helped the DSP and me foster collaboration and install the modules at respective schools. While selecting a school is strenuous and consuming, executing project learning in specific classrooms and with students requires aid. The flexibility of schoolteachers, including the ELA coordinator, pushed forward our initiative and fostered collaboration to lay out the process. The teachers regularly contacted and updated the progress via email and guided us with the regulations by synergistically working with our members, including me. I received positive

and constructive feedback from the teachers about the plans and proposal, as both parties agreed to support and help me execute the project under DSP's project leader's supervision.

A crucial part of the community project for student-centered development through project-based teaching based on citizen humanities includes support from the administration. The school principal and other community leaders helped us with the clearances to engage with the students and legal processes for administrative approval of the project. As an international student, my permission to enter various school campuses and facilitate a project among school students was sanctioned by approving letters signed by school administrators. In addition to the support of academic personalities, non-academic people contributed to the project and helped us install it effectively.

Author 2:

Apart from seeking help from university professors, I reached out to several community leaders representing various sectors in Indiana County, Pennsylvania, US, to assist in selecting schools for the project. I noticed keen interest from several teachers, particularly intrigued by the opportunity to involve students from India and Bangladesh. However, logistical challenges in obtaining permission from school districts created obstacles. In this situation, reaching out to influential community leaders proved instrumental. For instance, one of the community leaders of the local church serving on the board of a private school helped arrange a conversation with a teacher from a local Christian school. It was crucial for that moment as many state-funded schools were overwhelmed with numerous STEM-related activities, making it challenging to accommodate the projects. However, with its smaller funding and staff, the Christian school was more open to projects supported by external grants. This approach succeeded when the Christian school embraced my project and agreed to involve their students. Due to the school's internal structure, some adjustments were made. Initially, the plan was to work with students from grades 9 to 12, but the Christian school included students from grades 5 to 12. This flexibility ensured maximum participation and aligned with the school's schedule so that the project aligned with the school's capabilities.

During the second phase of the project, the Christian school could not involve its students due to an early summer vacation, a local organization, the International Hospitality Center, provided essential support. Dedicated to assisting doctoral students at Indiana University of Pennsylvania, the center offered small tokens of appreciation for young students who independently participated in environmental projects. This initiative helped attract students from other independent schools. The International Hospitality Center which is a charitable organization supporting all international students at IUP, played a pivotal role by forming three student groups of students from grades 6 to 10, who conducted local environmental research and prepared reports. The center also fostered collaboration between students and project coordinators, enhancing the project's overall impact.

Some community leaders connected through my professional networks supported the project by providing facilitators, professional development resources, and toolkits. For example, CHESPAX, the environmental education program for Calvert County Public Schools in Maryland, led the teacher training sessions for the project. In addition to professional development resources, CHESPAX shared a toolbox of environmental science activities, which proved invaluable for preparing participating teachers and students.

3.4 Discussion on Community Support

Teachers' and school administrators' involvement was critical to the success of the projects as their active participation and support provided the foundation for effective implementation. School administrators supported the project directors by granting school access, arranging meetings with teachers, and setting up equipment for student projects. This administrative engagement led to better logistics, increased collaboration, and more innovation. In the same way, teachers highlighted their dedication and knowledge. They dedicated time to training and sharing sessions, gaining valuable project leadership insights and strategies for their schools. Beyond acting as the primary point of contact for students, teachers took ownership of the project, tailoring activities to meet the unique needs of their students and school contexts. For example, a teacher from a public school independently designed a local environmental activity, creating a schedule for students to observe birds in nearby forests, collect data, and write reports. Similarly, the teacher from the Christian school customized the project to meet her students' needs, executing it both on campus and at students' homes. The teachers' impressive enthusiasm and flexibility facilitated overcoming challenges, particularly limited resources. Their adaptability and problem-solving skills were key to the projects' success, highlighting educators' crucial role in creating impactful learning experiences.

Teachers, program coordinators, other partner educators, and community leaders were equally supportive of helping move the project to respective institutions and partner schools [37], [24]. Participating teachers were critical to both projects as they were immediate responders, emergency contact personnel, and front-line executors who interacted and implemented the activities with the students. The project directors gave teachers the autonomy to conduct the activities conveniently [38]. Teachers collaboratively helped by assisting the project members with training programs, services, and teaching students. School leaders provided

permissions and administrative support [39]. Community leaders offered help for collaboration by offering additional resources to the participants.

3.5 Discussion on Challenges Encountered

During the project implementation phase, some of the common challenges we faced were accessing local schools and communities due to our international status. Some other project limitations were getting permission for school visits or approval from the school districts. Being international students, it was not easy to teach in the classrooms with the teachers, for which specific regulations and permissions were required. We suggest that future project organizers consider these limitations of the international students before planning. We also suggest considering university resources, such as faculty members and administrators, to make successful liaisons with the local schools if the project implementation team is not local. Reaching out to schools will be easier if the teams proceed with university references. Additionally, we encourage them to reach out to various leaders in the community to get additional support for the participants.

4. CONCLUSION

The projects developed effective platforms to foster student engagement with the local environments and the communities to understand climate change. These two projects highlighted the critical role of local teachers, community leaders, and university resources. Both projects exemplify the relevance of implementing project-based teaching through specific curriculum and instructional design in diverse settings with specific goals. The goals specifically showed successful collaborative efforts like community intervention, institutional (university, schools, and other project-related spaces), non-institutional support, and productive implementation of resources that facilitated student progress. This paper discusses the support, attention, progress, and challenges of implementing and enhancing project-based learning (PBL) in climate change, sustainability, and environmental education. It highlights the necessity of getting support from the community for the successful implementation of PBL. Using a collaborative autoethnographic narrative to describe two projects, the paper emphasizes the importance of seeking support for project implementation from all stakeholders. It also illustrates the value of educating high school students about climate change issues through projects supported by the local communities.

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