

## GLOBE VSS Research Proposal Template

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**Project Title:**

STEAM Training: Environmental Transformation in Schools using GLOBE protocols

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## Research Question(s) and Hypothesis

### Research Questions

1. **Primary Question:** How does the implementation of a STEAM-based teacher training program (using the GLOBE protocol) impact on the integration of theory and practice in the teaching of Natural Sciences and environmental themes in middle schools in Pinheiro, MA?
2. **Secondary Question 1:** To what extent does the capacity-building of teachers in environmental data collection and analysis techniques (e.g., pH, dissolved oxygen, nitrate) enhance their pedagogical practice and confidence in conducting practical, inquiry-based activities?
3. **Secondary Question 2:** What is the effect of the GLOBE program implementation, through trained teachers, on student engagement and their understanding of local environmental issues, specifically related to water quality in the Pericumã River?

4. **Secondary Question 3:** How effective is the established network of continuous mentorship and support in ensuring the sustainable application of the GLOBE methodology in the school curriculum after the initial training period?

### Hypotheses

1. **H1:** The implementation of the GLOBE-focused STEAM training program will lead to a significant increase in the frequency and quality of practical, data-driven activities integrated into the Natural Sciences curriculum by participating teachers.
  2. **H2:** Teachers who complete technical training in environmental data collection and analysis will demonstrate greater self-efficacy and employ more active, problem-solving teaching methodologies compared to their pre-training practices.
  3. **H3:** Students taught by teachers who implemented the GLOBE program will show higher levels of engagement and achieve a more contextualized understanding of water quality parameters and their relationship to local sustainability challenges than students in a control group or prior to the intervention.
  4. **H4:** Schools where the post-workshop mentorship and support system is consistently maintained will show higher rates of continued and adapted use of GLOBE protocols one year after the initial training, compared to schools with less consistent follow-up.
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## Description of Study Site

This study will be conducted near the Pericumã River, in a municipality within the Baixada Maranhense Environmental Protection Area, in the Amazon region of Maranhão. Located in the Baixada Maranhense Microregion, the municipality covers an area of 1,513 km<sup>2</sup> within the state of Maranhão, which has 331,983 km<sup>2</sup>, and is 119 km from the capital, São Luís. According to IBGE (2021), it has an estimated population of 84,160 inhabitants and a population density of 51.67 inhabitants per km<sup>2</sup>.

The region's climate is predominantly hot, with temperatures ranging between 23 °C and 36 °C, due to its location in the equatorial zone, and is characterized by two periods: rainy and dry. The region has an extensive drainage network, including several river basins, such as the Mearim, Gurupi, Itapecuru, Grajaú, Turiaçu, Munim, Maracaçumé-Tromaí, Uru-Pericumã-Aurá, Parnaíba-Balsas and Tocantins rivers, being almost entirely located within the Parnaíba Sedimentary Basin, one of the most important hydrogeological provinces in the country (PINHEIRO, 2022).

The waters of the Pericumã River are used for supply, fishing and transportation by the riverside population (CATANHEDE, 2018), and are therefore of great social and environmental importance.

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## Data Collection Plan

### A. Data Types and Sources

Data Type	Specific Data to be Collected	Primary Source	Purpose / Linked Research Question
<b>1. Teacher Capacity &amp; Practice</b>			
a) Knowledge & Self-Efficacy	Pre- and post-workshop scores on diagnostic assessments about STEAM, GLOBE, and water quality science.	Participating Teachers (via Surveys/Tests)	RQ1, RQ2 / H1, H2
b) Pedagogical Application	Frequency and type of GLOBE/STEAM activities implemented in	Teacher Logs, Lesson Plan Portfolios	RQ1, RQ2 / H1

<b>Data Type</b>	<b>Specific Data to be Collected</b>	<b>Primary Source</b>	<b>Purpose / Linked Research Question</b>
	class; lesson plans developed.		
c) Perceptions & Feedback	Qualitative insights on training usefulness, challenges faced, and support received.	Post-workshop Feedback Forms, Semi-structured Interviews, Focus Groups	RQ1, RQ4 / H2, H4
<b>2. Student Engagement &amp; Learning</b>			
a) Engagement & Attitudes	Levels of interest, participation, and perceived relevance of science activities.	Student Surveys, Classroom Observation Protocols	RQ3 / H3
b) Knowledge Application	Understanding of water quality concepts and ability to interpret local data (Pericumã River).	Pre- and Post-activity Quizzes, Student Project Presentations	RQ3 / H3
<b>3. Environmental Data</b>			
a) Water Quality Parameters	Physical-chemical data (pH, dissolved oxygen, nitrate, conductivity, salinity, temperature).	Pericumã River (Cais da Boa Vista site) following GLOBE protocols.	Core Project Activity, Context for Learning

<b>Data Type</b>	<b>Specific Data to be Collected</b>	<b>Primary Source</b>	<b>Purpose / Linked Research Question</b>
b) Supplementary Data	Georeferenced location, photographic records, weather conditions at time of collection.	Field Collection Records	Data Contextualization

#### **4. Program Implementation**

a) Mentorship & Support	Records of mentorship sessions, frequency of support requests, topics addressed.	Mentor Logs, Meeting Minutes	RQ4 / H4
b) Process Documentation	Attendance records, workshop materials, field activity photos/videos.	Project Team Records	Process Evaluation

#### **B. Data Collection Schedule**

The schedule aligns with the project's methodological phases (01/10/2024 to 30/09/2025).

<b>Phase / Period</b>	<b>Activity</b>	<b>Data to be Collected</b>
<b>Phase 1: Baseline (Mar 2026)</b>	- Needs Identification - Workshop 1 Preparation	- Pre-workshop teacher diagnostic assessment. - Initial teacher interviews/surveys on current practices.

Phase / Period	Activity	Data to be Collected
		<ul style="list-style-type: none"> <li>- Initial environmental data from the Pericumã River (baseline).</li> </ul>
<b>Phase 2: Training (Mai 2026 - Jun 2026)</b>	<ul style="list-style-type: none"> <li>- Workshop 1 &amp; 2</li> <li>- Initial Mentorship</li> </ul>	<ul style="list-style-type: none"> <li>- Post-workshop 1 &amp; 2 feedback forms and knowledge assessments.</li> <li>- Lesson plans developed by teachers.</li> <li>- Field training performance (photos, data sheets).</li> <li>- Mentor session logs begin.</li> </ul>
<b>Phase 3: Implementation &amp; Monitoring (Jul - Sep 2026)</b>	<ul style="list-style-type: none"> <li>- Teachers apply GLOBE in classrooms.</li> <li>- Monthly support meetings.</li> </ul>	<ul style="list-style-type: none"> <li>- Teacher activity logs.</li> <li>- Student pre/post quizzes and engagement surveys.</li> <li>- Regular environmental data collection by classes (e.g., monthly).</li> <li>- Monthly meeting minutes and mentor logs.</li> <li>- Classroom observations (sample).</li> </ul>
<b>Phase 4: Evaluation &amp; Wrap-up (Oct - Dec 2026)</b>	<ul style="list-style-type: none"> <li>- Final data collection.</li> <li>- Impact analysis.</li> <li>- Reporting.</li> </ul>	<ul style="list-style-type: none"> <li>- Final teacher interviews/focus groups.</li> <li>- Final student surveys and knowledge assessments.</li> <li>- Compilation of all environmental datasets.</li> <li>- Final feedback collection from all participants.</li> </ul>

### **C. Equipment and Tools**

Purpose	Equipment/Tools	Specification/Notes
<b>Environmental Data Collection</b>	<ul style="list-style-type: none"> <li>- GLOBE Hydrology Measurement Kits (or equivalent)</li> <li>- Digital pH meter</li> <li>- Dissolved Oxygen test kit or meter</li> <li>- Nitrate test strips or kit</li> <li>- Electrical Conductivity/Salinity meter</li> <li>- Thermometer</li> <li>- Secchi disk (if assessing turbidity)</li> <li>- GPS device or smartphone with GPS</li> <li>- Water sampling bottles (sterile)</li> <li>- Data sheets (GLOBE protocol)</li> </ul>	<p>Calibration must be performed before each use as per GLOBE/manufacturer guidelines.</p>
<b>Survey &amp; Assessment</b>	<ul style="list-style-type: none"> <li>- Online survey platforms (e.g., Google Forms)</li> <li>- Pre/Post-test questionnaires (digital or paper)</li> <li>- Interview and focus group guides</li> <li>- Audio recorder (for interviews, with consent)</li> </ul>	<p>Tools must ensure participant anonymity for surveys.</p>
<b>Documentation &amp; Observation</b>	<ul style="list-style-type: none"> <li>- Digital cameras/smartphones</li> <li>- Classroom observation checklist/rubric</li> <li>- Logbooks for teachers and mentors</li> </ul>	

Purpose	Equipment/Tools	Specification/Notes
<b>Data Management &amp; Analysis</b>	<ul style="list-style-type: none"> <li>- GLOBE Data Entry Portal (<a href="http://www.globe.gov">www.globe.gov</a>)</li> <li>- Spreadsheet software (e.g., Excel, Google Sheets)</li> <li>- Statistical analysis software (e.g., SPSS, R) or basic online tools</li> <li>- Secure cloud storage (e.g., institutional drive)</li> </ul>	<p>Data must be backed up regularly. Student/teacher names will be replaced with ID codes for analysis.</p>

#### D. Who Will Collect the Data?

##### 1. Project Coordination Team (UFMA):

- **Primary Role:** Overall data management, instrument design (surveys, interview guides), and final analysis.
- **Specific Tasks:** Collect pre/post diagnostic tests; conduct in-depth interviews and focus groups with teachers; oversee the compilation and validation of all datasets; perform final impact analysis.

##### 2. Trained Teachers and Mentors:

- **Primary Role:** Implementation-level data collection and daily monitoring.
- **Specific Tasks:** Administer student engagement surveys and knowledge quizzes in their classrooms; maintain logs of GLOBE activities conducted; guide students in the collection of environmental data from the river using GLOBE protocols; participate in providing regular feedback.

##### 3. Students (Under Teacher Supervision):

- **Primary Role:** Primary agents for environmental data collection and providers of feedback on engagement.
- **Specific Tasks:** Collect water samples and perform measurements following trained protocols under teacher supervision; complete engagement and learning surveys; develop presentations based on their findings.

##### 4. Field Technicians / Specialists (Project Team):

- **Primary Role:** Ensure quality control for environmental data and conduct systematic observations.

- **Specific Tasks:** Conduct the initial and periodic calibration of field equipment; perform parallel water quality tests for data validation during school activities; carry out structured classroom observations using agreed-upon protocols.

**Data Flow:** Teachers/Students → (Raw Data) → Project Coordination Team → (Compiled, Coded, Analyzed Data) → Final Report.

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## Background and Supporting Information

### Scientific and Contextual Background:

Access to clean water is a fundamental human right and a critical determinant of public health, ecosystem stability, and socioeconomic development. In Brazil, despite abundant freshwater resources, many regions face significant challenges with water quality due to pollution from inadequate sanitation, agricultural runoff, and urban waste. The state of Maranhão, with its complex network of rivers and estuaries, is particularly vulnerable. The Pericumã River, located in the Baixada Maranhense Environmental Protection Area, is a vital water body for the municipality of Pinheiro, supporting local livelihoods, agriculture, and biodiversity. However, it is subject to increasing pressures from population growth, land use changes, and potential contamination, necessitating regular scientific assessment to monitor its health and inform conservation strategies.

### Why were this topic chosen?

This topic was chosen for three interconnected reasons:

1. **Educational Gap:** Pinheiro faces significant challenges in integrating theoretical knowledge with practical application in science education. This project addresses that gap by providing a hands-on, inquiry-based learning model.
2. **Methodological Opportunity:** The GLOBE program, a proven international protocol developed by NASA, offers a standardized, science-based framework for

environmental data collection. It transforms students and teachers into active citizen scientists.

3. **Local Environmental Relevance:** The quality of the Pericumã River's water directly impacts the community's health, economy, and environment. Focusing on this local issue makes learning immediately relevant and empowers participants to contribute to tangible solutions in their own region.

#### **Related Studies and Research:**

- **Local Research:** Studies in the Baixada Maranhense region, such as those by Catanhede (2018) on hydrochemical characteristics, have highlighted vulnerabilities in local water systems, though focused monitoring of the Pericumã near Pinheiro is limited.
- **The GLOBE Program:** Extensive research validates GLOBE's efficacy in STEM/STEAM education. Studies show it improves students' data literacy, scientific reasoning, and environmental attitudes (e.g., Penuel et al., *Journal of Science Education and Technology*).
- **STEAM and Environmental Education:** Theoretical support comes from foundational works like Freire's *Pedagogy of the Oppressed* (emphasizing contextual learning) and Genebaldo Freire Dias's *Environmental Education: Principles and Practices*. Research by the OECD (Schleicher, 2012) underscores the need for 21st-century teacher training focused on complex problem-solving, which this project embodies.
- **Policy Frameworks:** The project is explicitly aligned with Brazil's National Common Curricular Base (BNCC), which emphasizes investigative methodologies and socio-scientific issues, and with the UN's Sustainable Development Goals (SDGs) 4 (Quality Education) and 6 (Clean Water and Sanitation).

#### **Relevance to the Community and Region:**

This project is profoundly relevant to Pinheiro and the Maranhão region for several reasons:

1. **Capacity Building:** It directly builds local scientific and educational capacity by training teachers in advanced, participatory methodologies, leaving a lasting legacy of skills within the school system.
2. **Community-Informed Data:** It generates the first consistent, student-and-teacher-collected dataset on the Pericumã River's water quality, providing valuable baseline information that can inform community awareness and local public policy.
3. **Economic and Public Health Link:** The river supports fishing and agriculture. Understanding its quality links education to economic sustainability and public health, fostering a generation that is literate in environmental stewardship.
4. **Model for Regional Application:** By successfully integrating a global science program (GLOBE) with a pressing local issue, this project creates a replicable model for other municipalities in Maranhão and similar regions facing educational and environmental challenges.

In essence, this project is not merely an academic exercise; it is a targeted intervention using science and education as tools for local empowerment and sustainable development.

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## Expected Outcomes or Goals

### General Goal

To train teachers and mentors for the implementation of the GLOBE Program in high schools in Pinheiro, Maranhão, promoting the integration between teaching, research and outreach through the STEAM approach.

### Specific Goals

1. To provide knowledge about the STEAM methodology and the GLOBE Program;

2. To develop technical skills for the collection and analysis of environmental data;
  3. To establish a network of continuous support for teachers and mentors.
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