**Engineering Challenge: Sustainable Water Filtration for Rural Communities**

**Case Study Context:**

Access to clean water remains a major challenge in many rural communities around the world. The use of traditional water filtration methods can be expensive, inefficient, and unsustainable in areas with limited infrastructure. Your task is to design an affordable, efficient, and sustainable water filtration system that can be implemented in remote villages with minimal resources.

**Problem Identification:**

The core problem is providing a cost-effective, scalable solution for filtering water contaminated with harmful bacteria and pollutants. The system must be able to filter at least 99% of contaminants while being easy to construct, maintain, and operate in rural settings where resources are limited.

**Constraints:**

* The solution must be made with locally sourced or affordable materials.
* Energy consumption should be minimal or non-existent (e.g., using solar energy, manual pumps).
* The system must be sustainable for long-term use (low maintenance costs and durability).

**Instructions for Students:**

1. **Problem Identification**:
   1. Clearly define the specific challenges faced by rural communities regarding water contamination.
   2. Discuss the broader context, including the environmental and social implications of poor water quality.
2. **Information Gathering**:
   1. Research existing water filtration technologies and evaluate their effectiveness and cost.
   2. Identify technical data and environmental constraints that may affect the design (e.g., types of contaminants, water sources).
3. **Analysis**:
   1. Break down the problem into manageable parts (e.g., types of contaminants, materials available, environmental factors).
   2. Explore the underlying causes of contamination and evaluate how they affect the water quality.
4. **Idea Generation**:
   1. Use creative techniques such as brainstorming, mind mapping, and SCAMPER to generate multiple potential solutions for water filtration.
   2. Explore both conventional (e.g., sand filters, UV systems) and innovative solutions (e.g., using local natural materials like charcoal or bamboo).
5. **Evaluation and Selection**:
   1. Evaluate each proposed solution using criteria such as feasibility, cost, resource availability, and environmental impact.
   2. Select the most viable solution and provide justification for your choice.
6. **Implementation Plan**:
   1. Develop a step-by-step plan for building and implementing the water filtration system, including materials required, construction methods, and expected costs.
   2. Include testing phases, where you simulate real-world conditions to ensure the system's functionality.
7. **Evaluation of Success**:
   1. Propose a method for evaluating the long-term success of the filtration system.
   2. Discuss possible improvements based on future iterations or feedback from the community.

**Evaluation Rubric (Scale)**

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| **Criteria** | **Excellent (4)** | **Good (3)** | **Fair (2)** | **Poor (1)** | **Score** |
| **Problem Identification** (15%) | The problem is clearly and concisely defined, with detailed context and constraints. | The problem is well-defined, with most context and constraints explained. | The problem is defined but lacks detail and explanation of the context. | The problem is unclear or poorly defined, with little context provided. | /15 |
| **Information Gathering** (15%) | Relevant technical data and sources are thoroughly researched and cited. | Relevant data and sources are adequately researched and cited. | Limited research is evident, with few sources used. | Research is insufficient, with minimal or no use of relevant sources. | /15 |
| **Analysis** (20%) | The problem is systematically broken down, and root causes are clearly identified. | The problem is logically analyzed, and some causes are identified. | Analysis is superficial, and root causes are unclear. | Analysis is incomplete or lacks clarity; causes are not identified. | /20 |
| **Idea Generation** (20%) | A wide variety of creative and innovative ideas are generated using creative techniques. | Several creative solutions are generated, with adequate use of techniques. | Limited ideas are generated, with little creativity involved. | Inadequate idea generation; creative techniques are not used | /20 |
| **Evaluation and Selection** (15%) | Solutions are thoroughly evaluated, and the selected solution is well-justified. | Solutions are evaluated, and an appropriate solution is selected. | A solution is chosen, but the evaluation process is limited or incomplete. | Solutions are poorly evaluated, and the selection seems random. | /15 |
| **Implementation Plan** (10%) | The implementation plan is detailed, realistic, and includes step-by-step instructions. | The implementation plan is clear and realistic, with appropriate resource management. | The plan is incomplete, with unclear steps and inadequate resource management. | The plan is vague, unrealistic, or missing key details. | /10 |
| **Evaluation of Solution** (5%) | The success evaluation plan is clear, comprehensive, and includes improvement suggestions. | The evaluation plan is present and generally sufficient. | The evaluation plan is limited, with no improvement suggestions. | The evaluation plan is insufficient or missing. | /5 |